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Wissen

vidya
Progress Through Education

Presented by
Dept. of Electronics and Communication Engg

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Vision

"To be a centre of excellence in Electronics and Communication Engineering through value- based education and research".

Mission

M1: To provide students state-of-the-art academic ambiance for quality education.

M2: Facilitate inter-disciplinary learning, industry interactions, and research initiatives for long-term career development goals.

M3: To educate and mentor students on professional responsibilities, ethical values, and life- long learning.

PRINCIPAL 'S MESSAGE

It is a matter of great pride and satisfaction to know that the Department of Electronics & Communication is bringing out the magazine 'Wissen'. The Department has made tremendous progress in all areas including academic, non-academics, skill development of staff and students. I am confident that this issue of the Magazine will show case the accomplishments and talents of the students and will also serve as a reference document for the staff, students and for those who are interested in the technical education and/or technology based activities.

I congratulate the HoD and staff of ECE department who have put their best efforts to share the technical ideas and taken the initiative to release the third version of the technical magazine from the department, **WISSEN 3.0**. The student participation in bringing out this edition is really impressive.

I appreciate every student who shared the joy of participation in co-curricular and extracurricular activities, including the efforts to release this magazine, along with their commitment to curriculum. Such extra efforts will definitely add more feathers to their cap.

Happy Reading.
Regards
Principal

HOD 'S MESSAGE

Knowledge and contribution are two hybrid essences of professionalism. In the technological era, electronics and communication engineering is one of the most important and sustainable branches of industry. Electronics always silently distinguishes technical trades by constantly redefining its sphere of influence. It is indeed a happy moment for the students of the Electronics and Communication Engineering department who have successfully published the third edition of the technical journal “Wissen” Issue 03 for the academic year 2022-2023.

Over the years, the ECE has been publishing technical magazines that have provided an opportunity for budding engineering students to contribute their ideas. The articles contributed to the technical magazine by staff and students showed their intellectual insight and writing skills. The most important aspect of this journal is the tremendous effort of students and staff in publishing an article.

I appreciate the student, and staff for their contribution. Special compliment to technical magazine committee and their efforts in publishing this annual issue. Students, ‘keep working hard and surely you will successfully achieve your goal’.

I thank our management and director for their support and encouragement.

"All the best "

Dr. S. Swapna Kumar
Professor and Head
Department of ECE
Vidya Academy of Science & Technology, Thrissur

EDITOR 'S MESSAGE

Dear Readers,

We are delighted to announce the publication of WISSEN 3.0, the technical magazine of the ECE department's third issue. This magazine's goal is to provide teachers and ECE students with a venue for expressing their technical ideas.

We would like to thank the HoD of ECE Department and college authorities for offering full support in the design and publication of this magazine. We would like to extend our deepest thanks to everyone who contributed articles to make this endeavor a success.

Happy Reading!
Regards,

Remya K R
Hima Anna Thomas
Department of ECE
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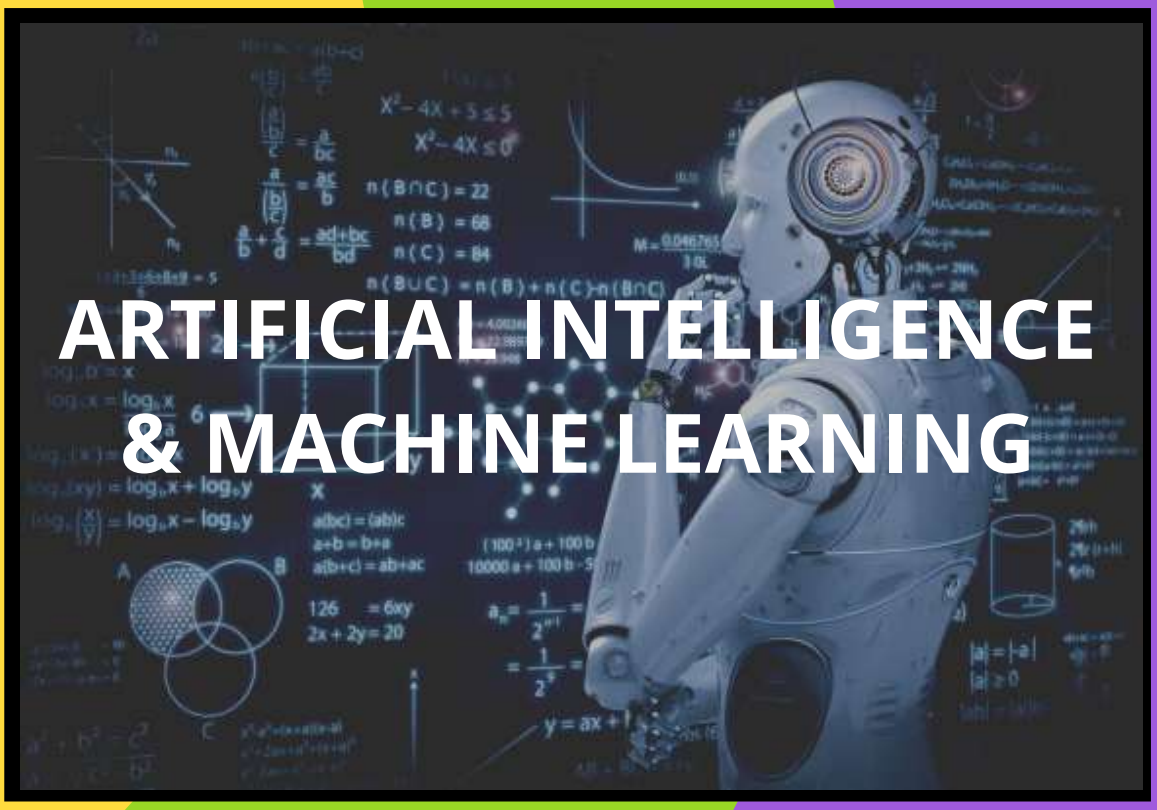
Table of Contents

Table of Contents



ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

EVOLUTION AND DEVELOPMENT OF ARTIFICIAL INTELLIGENCE

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Introduction

In contrast to the natural intelligence exhibited by humans and animals, artificial intelligence (AI) is intelligence demonstrated by machines. If computers could learn from their past errors and develop on their own, they would be deemed ”intelligent” and capable of resolving problems in the real world. When we talk about artificial intelligence, it's easy to envision a dystopian future in which machines have conquered humans. But in reality, AI is a way for people to collaborate with intelligent software to achieve more. AI makes use of a wide range of techniques, such as iterations of search and mathematical optimization, reasoning, and methods based on luck and economics. Computer science, mathematics, psychology, linguistics, philosophy, neuroscience, artificial psychology, and many other fields are all used in the subject of AI.

People are unable to interpret, assess, and make judgements using even a small percentage of the vast amount of data that exists in today's society. To make such complex decisions, higher cognitively capable entities than humans are required. We are working to develop AI, or machines that can do better than us, because of this. AI computers differ from us in that they are capable of repetitive learning. Repeated tasks have been discovered to be incredibly boring for people. Accuracy is another trait lacking in humans. Machines do tasks with an astonishingly high level of accuracy. Additionally, machines are able to assume risks in place of individuals. Nowadays, there are a lot of misunderstandings surrounding the terms machine learning, deep learning, and artificial intelligence (AI). The majority of people believe that these concepts are all interchangeable when they hear the term AI, and vice versa. While these concepts are related, they are not the same.

Here's is a basic definition of machine learning –
“Machine Learning is a technique of parsing data, learn from that data and then apply what they have learned to make an informed decision”
Deep learning is actually a subset of machine learning. It acts similarly and technically belongs to the machine learning group, but it has various characteristics. While machine learning models get better over time, they still need input, which is their main difference from deep learning. Instead of the programmer having to explicitly fix the problem when a machine learning model predicts incorrectly, deep learning models fix the problem on their own. A good deep learning example is a system for automatic driving. Deep learning and machine learning are both subsets of artificial intelligence (AI), which is fundamentally distinct from both. There isn't a single, universal definition of artificial intelligence, but the one provided here should help you understand what it is. AI refers to a computer program's capacity to behave similarly to the human brain.

AI is used in various fields like:

- Health Care
- Retail
- Manufacturing
- Ban

Artificial Intelligence is a branch of engineering, which basically aims for making the computers which can think intelligently, in the similar manner the intelligent humans think. Here are the top languages that are most commonly used for making the AI projects:

Fig. 1: Top languages that are most commonly used for making the AI projects (Courtesy : Google)

- **Python** : Due to its simplicity, Python is regarded as being at the top of the list of all AI development languages. Python's syntaxes are fairly straightforward and simple to learn. Consequently, it is simple to incorporate numerous AI algorithms into. Python requires less time to develop than other languages like Java, C++, or Ruby. Python supports procedural, functional, and object-oriented programming paradigms. Python offers a large number of libraries that facilitate our work. For instance, the Python module Numpy facilitates the resolution of several scientific computations. We also have Pybrain, which is a Python module for machine learning.
- **R** : One of the best environments and languages for analysing and modifying data for statistical purposes is R. We can quickly create publication-quality plots using R by adding mathematical notation and formulas as necessary. R is a general-purpose language, but it also offers a tonne of machine learning-related packages including RODBC, Gmodels, Class, and Tm. By using these packages, machine learning algorithms can be easily implemented to solve business-related challenges.
- **Lisp** : One of the first and best-suited languages for the advancement of AI is Lisp. John McCarthy, the creator of artificial intelligence, created it in 1958. It is capable of processing symbolic data in an efficient manner.
  Additionally, it is renowned for its superb prototyping ability and simple dynamic object creation with automatic trash collection. Because of its development cycle, it is possible to evaluate expressions interactively and recompile functions or files while the application is still running. Many of these capabilities have moved into numerous other languages throughout time due to advancements, which has a negative impact on Lisp's distinctiveness.
- **Prolog** : When discussing the advancement of the AI field, this language continues to coexist with Lisp. Its characteristics include effective pattern matching, data organisation based on trees, and automatic backtracking.

A programming framework that is surprisingly strong and adaptable is made possible by all these features. Both creating expert AI systems and working on medical initiatives use Prolog extensively. It's simple to picture a gloomy science fiction future where humans have been subjugated by robots when we talk about artificial intelligence. However, AI is actually a mechanism for people to work with intelligent software to accomplish more.We need to think of it as putting a more human face on technology: Technology that can learn from the vast amounts of data that are available in the modern world; Technology that can understand our kind of language and respond in kind; Technology that can see and interpret the world the way that we do. Let us look at some scenarios where Technology can play a huge part in our lives :

- Imagine if we could search our surroundings in the same way we search the web. Using existing cameras and advances in AI, we can now find things and people in the real world, in real time and take action to improve safety and well-being. When a dangerous spill occurs in a chemical plant, cameras recognize the incident, information about the spill is instantly shared with the people who need it the most enabling them to protect other employees from coming in contact with the hazard, and clean it up.
- This technology can also help keep people safer in hospitals. Patients recovering from heart surgery are limited to how much they should exert themselves. When someone exceeds the prescribed level of activity, a nurse is alerted, the location of the closest wheelchair is identified so that the nurse can quickly get the patient shifted and keep safe.
- This technology is also useful in an environment like a construction site where specialized tools needed by people are spread out, sometimes across multiple floors. Using cameras already in place, this technology can identify a specific tool as well as the closest authorized person who can deliver it saving everyone's time and keeping the workflow moving. With AI the digital and physical worlds have come together to make everyone more safe, secure, and productive.
- When using smartphone we interact with AI from the obvious features such as the built-in smart assistants (Alexa, Siri) to not so obvious ones such as the portrait mode (Google Pixel 2) in the camera. With Social Media becoming non-separable part of today's life, the feeds that we see in our timeline to the notifications that we receive from these apps everything is being curated by AI, impacting most of the decisions we make. The recommended videos section on Youtube or Netflix has become so good at knowing our tastes because AI is playing a big role in making decisions for us.
- Whenever we use Google/Apple Maps for navigating or calling an Uber or booking a flight ticket, we are using AI. AI is behind many of Google's products and is a big priority for the company. The banking and finance industry heavily relies on artificial intelligence for things like customer service, fraud protection, chatbots, investment.
- Spam filters in our email inbox and Smart email categorization that we experience with Gmail are AI-powered. E-commerce web application sites use AI neural networks to quickly return a wide list of the most relevant products as well as personalized recommendations on the home page, bottom of item pages and through email to increase their revenue tremendously.
- Brain.fm uses extensive research and trained professionals to produce music written and performed by AI. Receptiviti.ai allows us to analyze the psychology, personality and decision-making style of an individual by inputting a block of text, such as an email or blog post. Clarke.ai is an AI bot that dials into our conferences calls and does all the note taking work for us. Causal chess players regularly use AI-powered chess engines to analyze their games and practice tactics. AI-based Australian AgTech business firm The Yields in association with Microsoft takes microclimate sensing data and combines it with predictive modeling to help farmers improve their production and reduce their risks.

As illustrated above all of our lives are impacted by AI on a daily basis at every level. Artificial Intelligence became the most important part of our daily life. Our life is changed by AI because this technology is used in a wide area of day to day services.

Artificial Intelligence and Machine Learning Trends to Keep an Eye on in 2022

2021 has been a remarkable year for AI and ML and 2022 will not be any different. Here are some of the major AI and ML trends that will hold prominence in 2022.

- **AI and ML Augmented Hyperautomation** : As the term implies, hyperautomation is just another level of automation. Hyperautomation assists enterprises and organisations in finding processes to automate in addition to automating complex operations. And in order to do so, it employs technologies like RPA, ML, and AI (Robotic Process Automation).
  As 2022 draws nearer, an increasing number of businesses and industries will automate complex procedures for quicker and more precise results. Already, the current epidemic has brought attention to the need for greater automation in a number of industries. And as hyper-automation continues to advance, 2022 will be a crucial year to assess its accomplishments and predict what the technology's future holds.
- **AI and ML Injected Cybersecurity** : In 2022, the field of cybersecurity will become more important as machines become more complex. It's not unexpected that hackers come up with novel, riskier ways to target people and businesses as technology advances. Additionally, many of these attacks are launched via the internet. Along with data theft and privacy breaches, there is also the constant threat of complete organisations being destroyed by a cyberattack. Thankfully, increased cybersecurity powered by artificial intelligence and machine learning is here to strengthen cyber defence. Data protection in the virtual world will undergo a revolution thanks to AI-integrated online security measures because AI and ML depend on learning from their surroundings. It is not far when companies will use sophisticated AI algorithms to detect and analyze cyber threats, create their directories and devise measures to protect data against them.
- **IoT with AI and ML** : The Internet of Things, or IoT, is the collective term for the billions of internet-connected objects that are constantly sharing data online. IoT can include everything from a web-connected smart refrigerator to a highly advanced robot. In 2022, IoT is already anticipated to be a game-changing technology. IoT devices will become increasingly capable of analysing, transmitting, and exchanging sophisticated information as AI technology continues to progress, according to experts.
- **Metaverse and Its Incorporation of AI** : Metaverse, or the virtual world, is a long-standing concept that aims to replicate the real world on the internet. The term "Metaverse" traces its origins in the 1992 science fiction novel "Snow Crash" by Neal Stephenson. And though it came out of a sci-fi novel, the metaverse is close to becoming a reality today. Companies such as Meta (previously Facebook) and Microsoft have already defined their iterations of the metaverse and claimed it to be the future of the internet.
  2022 is a year when Artificial Intelligence and Machine Learning will see increased integration in many technologies. And the metaverse is no different. AI and ML will play a significant role in reproducing the details of the real-world much more accurately. Attributes like speech and vision will also see augmentations to incorporate them better in the virtual world.
- **Self Driving Vehicles and AI** :There is no denying that automation is the way of the future of driving. Additionally, businesses like Tesla, the largest manufacturer of electric vehicles in the world, are already providing us a taste of the future of automated driving. Self-driving vehicles were only available as prototypes and lab experiments a decade ago. But today, actual field tests have demonstrated that self-driving cars will soon become the norm. And in achieving this, AI and ML will play a significant role. Companies will use AI and ML to create more advanced and

consumer-centric algorithms for their self-driving vehicles. These algorithms will help vehicles detect anomalies and barriers faster, make driving on autopilot much safer, and decrease human dependence to a negligible amount.

- **NLP and AI/ML** : Natural Language Processing (NLP) is a subset of Artificial Intelligence that enables machines to understand and process human language. NLP analyses and translates human language, which is complex, vague, and less straightforward than machine language, and generates comprehensible output. With NLP, computers can perform tasks such as speech recognition, inter-language translation, keyword identification, and more. An example of NLP would be the voice assistants that ship with smartphones. Assistants like Alexa, Cortana, Google Assistant, Bixby, etc., use voice commands as inputs and generate outputs accordingly. And although the chores they do are not very complicated, they do tell us what the future of NLP holds. 2022 will be a year when NLP will see some noteworthy developments. And AI and ML will be crucial for these developments. Machines embedded with AI and ML will understand human language much more seamlessly. They will deliver spot-on results for anything we speak or write. Also, they will develop heightened abilities for interpreting and predicting words without any explicit programming.
- **AI and Ethics** : The potential for artificial intelligence is enormous in many different disciplines. It has infinite and limitless uses for simplifying our lives. However, concerns over the use of AI and ML for immoral purposes including terrorism, illegal pornography, and war have led many to evaluate its advantages. For instance, Deepfake, an AI-based technique that substitutes an artificial face for a real person's face in an image or video, has already generated a lot of controversy. It is being used by criminals to manufacture evidence, create sexually explicit content featuring their victims, and more. Thus, AI, like every other technology, is subject to a list of moral principles that should not be transgressed under any circumstances. And as the definitions of AI-related ethics grow and new ones originate, 2022 will see a more pronounced and rigorous following of moral principles concerning developments in AI and ML.

Conclusion

As demonstrated above, AI has a daily impact on every aspect of our life. We are now conducting study on how AI is used in the public, the military, and other fields. There will be further developments in AI after this; it is not over yet. Future society may consist entirely of robots. Artificial intelligence has taken centre stage in our daily lives. Because AI is employed in so many aspects of daily life, it has a significant impact on how we live.
The AI demonstrations and applications we'll see in the near future will heavily favour "cognitive prostheses"—systems that do well what humans do poorly or dislike. Both near-term and long-term systems will need to interact with humans smoothly, which will place special constraints on them. To create systems that we will trust and want to use, we must carefully consider and craft their implicit and explicit values.

Acknowledgement

I sincerely thank our professor and head of department of ECE, Dr. S. Swapna Kumar for the encouragement and guidance he showed during the process of preparation of the article.

ARTIFICIAL INTELLIGENCE CRIME: AN OVERVIEW OF MALICIOUS USE AND ABUSE OF AI

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Introduction

The capabilities of Artificial Intelligence (AI) evolve rapidly and affect almost all sectors of society. Four types of malicious abuse of AI (integrity attacks, unintended AI outcomes, algorithmic trading, and membership inference attacks). Four types of malicious use of AI (social engineering, misinformation/fake news, hacking, and autonomous weapon systems). Mapping these threats enables advanced reflection of governance strategies, policies, and activities that can be developed or improved to minimize risks and avoid harmful consequences. The EU AI Draft Act states that the term AI system "means software that is developed with one or more techniques and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with."

Malicious Abuse of AI : Vulnerabilities of AI Models

- **Integrity attacks** : Integrity attacks in integrity attacks, the data, and algorithms used to train an AI system are tempered that causing the AI system to behave differently. This adversarial attack is used basically in scenarios like avoiding malware detection, discrediting the product or company, bypassing network anomaly detection, etc.
- **Unintended outcomes of AI** :
  - Can create hidden errors
  - Lead to the loss of skill, critical thinking and understanding
  - Open new hazards
  - Can cause loss of control
- **Membership inference attack** : A membership inference attack aims to identify whether a data sample was used to train a machine-learning model or not. It can raise severe privacy risks as the membership can reveal an individual's sensitive information. For example, identifying an individual's participation in a hospital's health analytics training set reveals that this individual was once a patient in that hospital. Membership inference attacks have been shown to be effective on various machine learning models, such as classification models, generative models, and sequence-to-sequence models. Meanwhile, many methods are proposed to defend against such a privacy attack. Although membership inference attack is an emerging and rapidly growing research area, there is no comprehensive survey on this topic yet.
- **Algorithmic trading** : Algorithmic trading is a technique that has come into existence in the past few years only, it is used in the context of trading in financial markets like equity, derivatives, and

commodities. It refers to the technique using which the traders or investors make use of software programs to do automatic or programmed trading. The biggest disadvantage of algorithmic trading is that algorithm trading is not 100 percent accurate and it has the scope of failing in the sense that one glitch in the program can trigger many orders which in turn can lead to a dramatic rise or fall in the price stock which in turn can lead to the sudden downfall or flash crash in the stock market leading to panic and volatility. Since it requires the use of the program and technical expertise it can be done by only those people who have the required knowledge and expertise and hence it is not everybody's cup of tea which in turn does not provide a level playing field to all participants in the stock market

Malicious Use of AI : AI-Enabled and AI-Enhanced Attacks

- **Social engineering attacks** : The Social Engineering attack is one of the oldest and most traditional forms of attack in which cybercriminals take advantage of human psychology and deceive the targeted victims into providing the sensitive information required for infiltrating their devices and accounts. It can also be called "human hacking."Generally, cybercriminals take advantage of the security vulnerabilities of the system to infiltrate it and release malicious code. This may or may not require any human intervention. On the other hand, the Social Engineering attack needs human interaction to happen successfully
  - Phishing - Most types of phishing use some form of technical deception designed to make a link in an email (and the spoofed website it leads to) appear to belong to the spoofed organization. Misspelled URLs or the use of subdomains are common tricks used by phishers.
  - Big Nudging and Manipulation - Although the common uses of AI data manipulation are fairly innocent, there are notable risks and disadvantages. Industry leaders like Deloitte and Gartner warn that modern IT leaders must become more knowledgeable about fending off AI misuse. Unfortunately, AI data manipulation can also be wrongly used to fool algorithms and interfere with data that would otherwise be safe and reliable. Many times, this comes from extreme examples of user interference, such as when a group of users intentionally stoke an AI application with a bad or inappropriate date. If the AI application learns to use faulty data, it never performs as intended.
- **Misinformation and fake news** : An important method to create these models for discriminatory programs is referred to as the "adversarial" system. Adversarial machine learning is the process of creating malicious or misinforming content that can slip past detection programs.Grover and other AI systems improve their efficiency by generating articles and then using their own detection programs to evaluate the articles' believability. If the created content isn't as convincing, the generators keep reproducing text and learn what is real and what isn't. This ability to "generate" fake articles is what works as a double-edged sword.
- **Hacking** : A commonly used hacking definition is the act of compromising digital devices and networks through unauthorized access to an account or computer system. Hacking is not always a malicious act, but it is most commonly associated with illegal activity and data theft by cybercriminals. Hacking refers to the misuse of devices like computers, smartphones, tablets, and networks to cause damage to or corrupt systems, gather information on users, steal data and documents, or disrupt data-related activity. A traditional view of hackers is a lone rogue programmer who is highly skilled in coding and modifying computer software and hardware systems. But this narrow view does not cover the true technical nature of hacking. Hackers are increasingly growing in sophistication, using stealthy attack methods designed to go completely unnoticed by cybersecurity software and IT teams. They are also highly skilled in creating attack vectors that trick users into opening malicious attachments or links and freely giving up their sensitive personal data.

- Deep Fakes - Deepfakes are images or videos which have been altered to feature the face of someone else, like an advanced form of face-swapping. Although there are some deepfake videos that are very clearly doctored and inauthentic, most look and sound convincingly real. A most common use of this so far has been deepfake pornography in which the face of an actor in a pornographic video is replaced with that of a celebrity. Deepfake technology has also been used to contribute to fake news, hoaxes, revenge porn, and other types of deception.
- Malware - Malware is intrusive software that is designed to damage and destroy computers and computer systems. Malware is a contraction for "malicious software." Examples of common malware include viruses, worms, Trojan viruses, spyware, adware, and ransomware.

Autonomous Weapon System (AWS)

Although autonomous systems can achieve great flexibility to respond to the specific war situation and also can emerge unforeseen situations, such as :

- **Malfunctions and bugs** : As a system becomes more complex, the sheer number of mechanical parts and lines of code grows, increasing the number of elements that could malfunction or be coded improperly.
- **System failures** : System failures occur not from the breakdown of any given part but from unanticipated interactions between system elements. Verifying all possible combinations of the system's internal workings becomes increasingly difficult as the system's complexity increases.
- **Systems are not transparent to human operators** : While one of the benefits of automation in many cases is reducing the potential for human error, a negative side effect of greater complexity is that the system's functioning may be increasingly opaque to even trained users.Unanticipated
- **Interactions with the environment** : As the complexity of the system and/or its operating environment increases, the number of potential interactions increases dramatically. This can make testing the autonomous system's operation under every possible environmental condition effectively impossible.

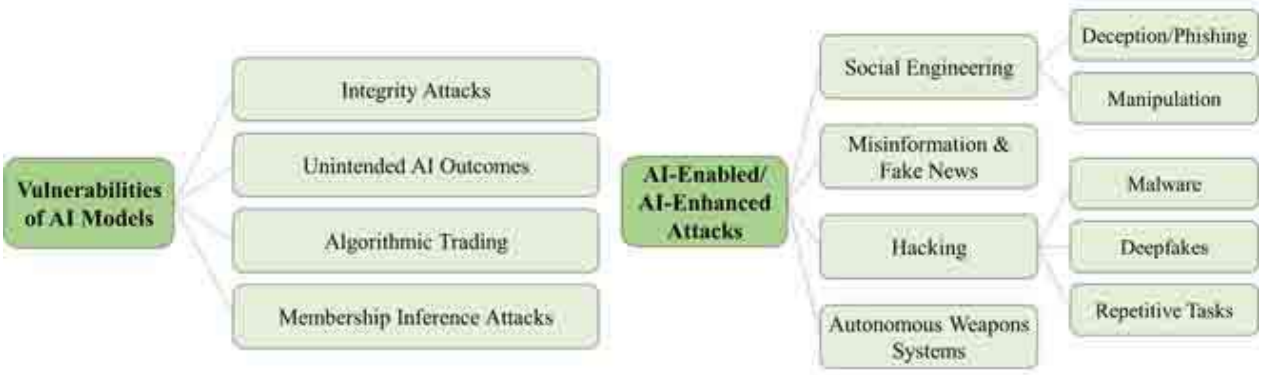

Fig. 1: Vulnerabilities and attacks on AI models (Courtesy : Google)

Conclusion

Starting with an introduction to Artificial Intelligence, the types of malicious use and abuse of artificial intelligence that we identified are discussed.

MACHINE LEARNING

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Introduction

Machine learning is considered a subset of artificial intelligence, mainly concerned with the development of algorithms that allow computers to learn on their own from data and past experiences. With the help of historical data samples, called training data, machine learning algorithms build a mathematical model that helps make predictions or decisions without being explicitly programmed. Machine learning gathers computations and statistics to create predictive models. Machine learning builds or uses algorithms that learn from historical data. The more information we provide, the better the performance will be.

Working of Machine Learning

A machine learning system learns from historical data, builds predictive models, and whenever it receives new data, predicts the output for it. The accuracy of the prediction output depends on the amount of data because the huge amount of data helps to build a better model to predict the output more accurately. A machine learning system learns from historical data, builds predictive models, and whenever it receives new data, predicts the output for it. The accuracy of the prediction output depends on the amount of data because the huge amount of data helps to build a better model to predict the output more accurately. Let's say we have a complex problem where we need to make a prediction, so instead of writing code for it we just need to feed data to general algorithms and with the help of algorithms. In this calculation, the machine will build logic according to the data and predict the output. Machine learning has changed the way we think about problems. The block diagram below demonstrates how the Machine Learning algorithm works:

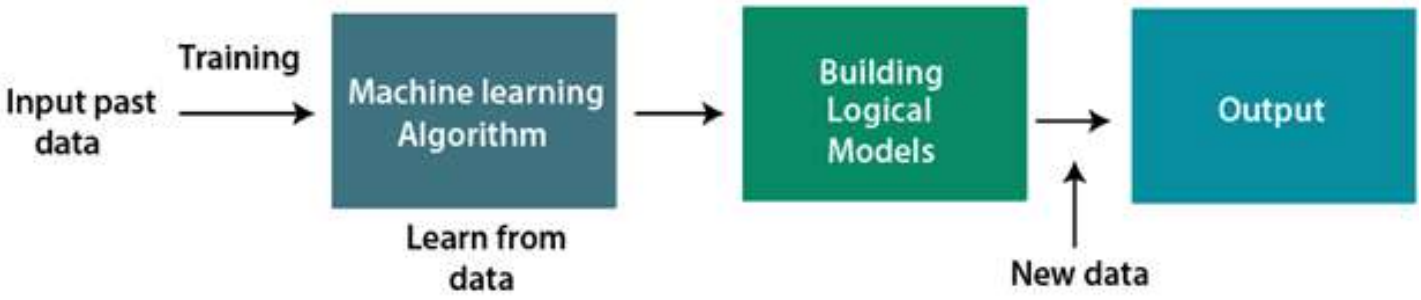


Fig. 1: Block diagram of ML algorithm (Courtesy : Javatpoint)

Features of Machine Learning

- **The ability to perform automated data visualization** : Large amounts of data are generated regularly by businesses and individuals. By visualizing remarkable relationships in data, businesses can not only make better decisions, but also build trust. Machine learning provides a number of tools that provide rich chunks of data that are applicable to both structured and unstructured data. With the help of machine-learning-friendly automated data visualization platforms, companies can gain a wealth of new insights aimed at increasing the productivity of their processes.
- **Automation at its best** : One of the greatest characteristics of machine learning is its ability to automate repetitive tasks and thus increase productivity. Many organizations are already using machine learning based paperwork and email automation. For example, in the financial sector, a large number of repetitive, data-heavy and predictable tasks must be performed. For this reason, the field uses different types of machine learning solutions to a large extent. This makes accounting jobs faster, deeper and more accurate. Some of the aspects that have been addressed by machine learning include processing financial queries with chat-bots, generating forecasts, managing expenses, simplifying invoices, and automating bank reconciliations.
- **Customer engagement like never before** : For any business, one of the most important ways to drive engagement, drive brand loyalty, and build lasting customer relationships is to spark meaningful conversations. with their target customers. Machine learning plays an important role in enabling businesses and brands to spark more valuable conversations about customer engagement. Technology analyses specific phrases, words, phrases, idioms, and content formats that are relevant to certain audience members. You can think of Pinterest successfully using machine learning to personalize recommendations to users. It uses technology to find content that will engage users, based on the audiences they've pinned.
- **The ability to take efficiency to the next level when merged with IoT** : Thanks to the great hype surrounding IoT, machine learning has become widespread. IoT is designated by many companies as an important strategic area. And many others have launched pilot projects to assess the potential of IoT in the business context. However, reaping financial gains from IoT is difficult. To be successful, IoT platforms and consulting companies need a clear understanding of what areas will change as IoT strategies are implemented. Many of these companies have failed to solve this problem. In this case, machine learning is probably the best technology that can be used to achieve a higher level of efficiency. By merging machine learning with IoT, companies can increase the efficiency of all their manufacturing processes.
- **The ability to change the mortgage market** : The reality is that promoting a positive credit rating often requires discipline, time, and a lot of financial planning for many consumers. When it comes to lenders, consumer credit score is one of the largest measures of creditworthiness involving a number of factors including payment history, total debt, length of credit history, and more. and better measure? Using machine learning, lenders can now get a more complete picture of consumers. They can now predict whether customers are spending more or less and understand their spending tipping points. In addition to mortgage credit, financial institutions use similar techniques for other types of consumer loans.
- **Accurate data analysis** : Traditionally, data analysis has always included trial and error, an approach that is not possible when we are dealing with large and heterogeneous data sets. Machine learning presents itself as the best solution to all these problems by offering effective alternatives for analysing huge volumes of data. By developing efficient and fast algorithms, as well as data-driven models for real-time data processing, machine learning can generate accurate analyses and results.
- **Business intelligence at its best** : The characteristics of machine learning, when combined with big data analytics work, can generate extremely high levels of business intelligence with the help of a number of different industries launching strategic initiatives. comb. From retail to financial services

to healthcare and more, machine learning has become one of the most effective technologies for driving business.

Classification of Machine Learning

There are three forms of machine learning:

1) Supervised learning
2) Unsupervised learning
3) Reinforcement learning

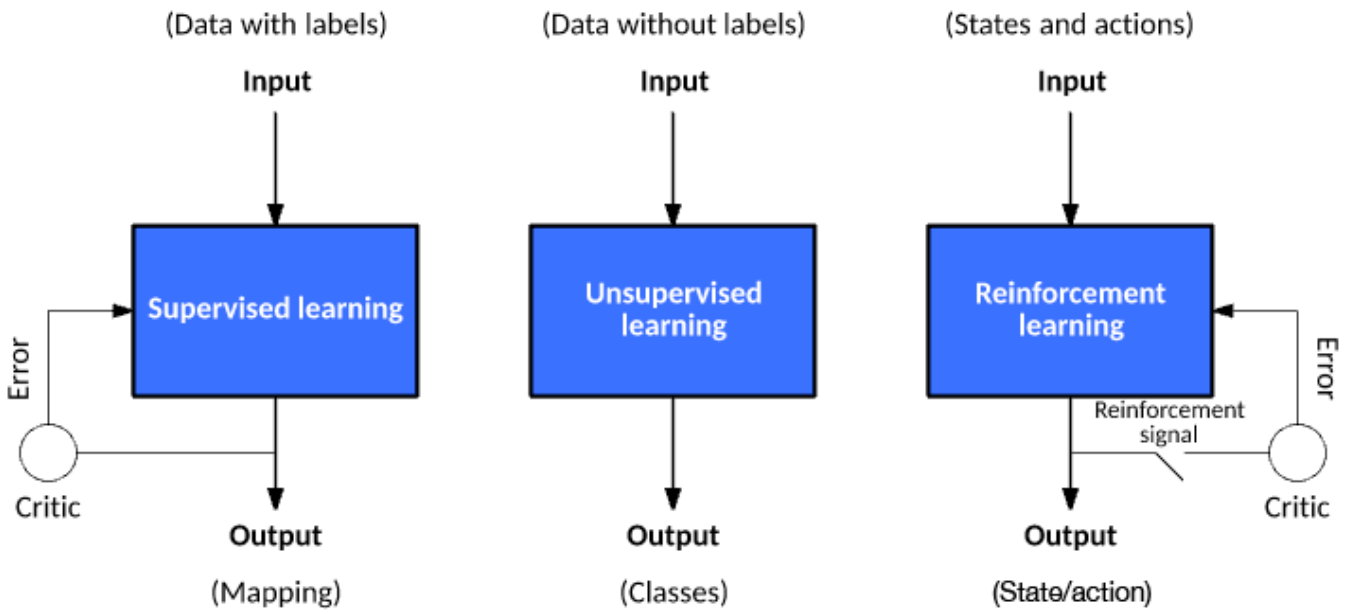


Fig. 2: Three forms of machine learning (Courtesy : researchgate.net)

- **Supervised learning** : Supervised learning is a type of machine learning method in which we feed labelled sample data to the machine learning system to train it and based on that it predicts the output. The system builds a model using labelled data to understand data sets and learn more about each piece of data. After the training and processing is done, we test the model by providing sample data to check if it predicts the correct output. The purpose of supervised learning is to map input data to output data. Supervised learning is based on supervision, and it is like when a student learns everything under the supervision of a teacher. An example of supervised learning is spam filtering. Supervised learning can be grouped in two categories of algorithms:
  - Classification
  - Regression
- **Unsupervised learning** : Unsupervised learning is a learning method in which the machine learns without any supervision. Training is fed to the machine with all data that has not been labelled, classified or classified, and the algorithm must act on this data without any supervision. The goal of unsupervised learning is to reconstruct the input data into new features or a group of objects with similar patterns. In unsupervised learning, we don't have predetermined outcomes. The machine tries to find useful information from the huge amount of data. It can be classified into two categories of algorithms:
  - Clustering

  - Association
- **Reinforcement learning** : Reinforcement learning is a feedback-based learning strategy in which a learning agent is rewarded for correct actions and penalized for incorrect actions. With these feedbacks, the agent automatically learns and improves its performance. An agent's purpose is to earn the most reward points possible, so it enhances its performance. In reinforcement learning, the agent interacts with and explores the environment. The robotic dog uses reinforcement learning to show how it instantly picks up the movements of the owner's arms.

Advantages of Machine Learning

- **Recognizes trends and patterns quickly** : TLarge amounts of data can be reviewed by machine learning, which can identify specific trends and patterns that humans might miss. For an e-commerce site like Amazon, for instance, knowing its users' browsing patterns and past purchases enables it to offer them the appropriate goods, discounts, and reminders. It makes advantage of the findings to show them relevant adverts.
- **No need for human intervention (automation)** : You no longer have to supervise your project at every stage thanks to ML. Giving computers the ability to learn enables them to make predictions and enhance algorithms on their own. Anti-virus programmes are a typical illustration of this; they learn to filter new dangers as they are identified. ML is proficient at identifying spam.
- **Ongoing Development** : ML algorithms keep become more accurate and effective as they gather experience. They can consequently make wiser selections. Take the example of creating a weather forecast model. Your algorithms become faster at making more accurate predictions as your data set expands.
- **Managing data with multiple dimensions and types** : In dynamic or uncertain contexts, machine learning algorithms are adept at managing data that is multidimensional and multivariate.
- **Broad Applicability** : You may use ML to your advantage as an e-tailer or a healthcare provider. Where it does apply, it has the potential to assist in providing clients with a far more personalised experience while also targeting the proper people.

Disadvantages of Machine Learning

- **Data gathering** : Machine learning demands large, comprehensive, unbiased, and high-quality data sets for training. They might occasionally have to wait while new data is generated.
- **Resources and Timing** : For machine learning (ML) to be effective, the algorithms must have enough time to mature and learn enough to achieve their goals with a high degree of accuracy and relevance. Additionally, it requires a lot of resources to run. This could result in you needing more processing power from your machine.
- **Results Interpretation** : The capacity to correctly comprehend the information produced by the algorithms presents another significant challenge. Additionally, you must carefully select the algorithms for your needs.
- **A high vulnerability to errors** : Although autonomous, machine learning is prone to mistakes. Consider training an algorithm with data sets that are too tiny to be inclusive. You obtain biased predictions from a biased training set in the end. This results in customers seeing irrelevant advertisements. Such flaws in ML can start a cascade of mistakes that may be undiscovered for a very long time. Furthermore, it takes a while for problems to be detected, and even longer for solutions to be found.

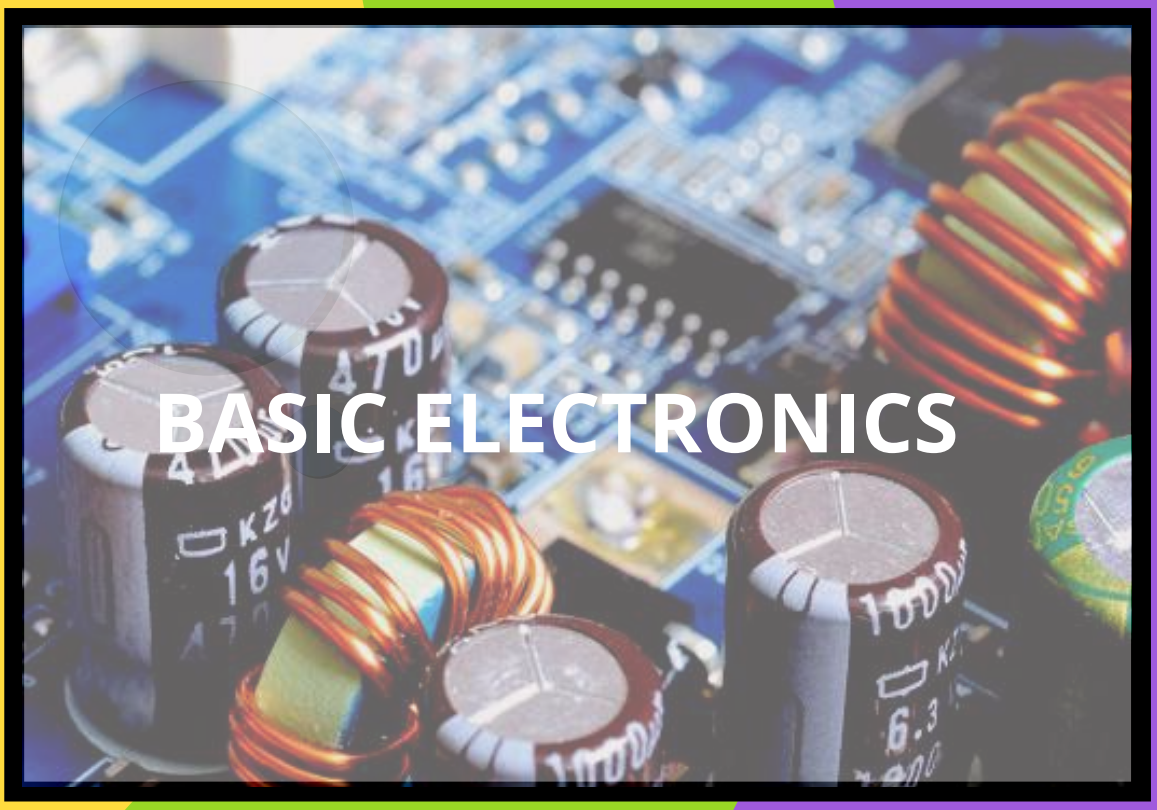
Applications of Machine Learning

- **Image Recognition** : One of the most popular uses of machine learning is image recognition. It is used to identify things like digital photos, people, places, and items. Automatic friend tagging recommendation is a common use of picture recognition and facial identification. Facebook offers us an automatic buddy tagging recommendation option. The face identification and recognition technique used in machine learning is what gives us an automatic tagging recommendation with names whenever we submit a photo of one of our Facebook friends. It is based on the ”Deep Facial” technology from Facebook, which handles face recognition and human identification in photos.
- **Speaking Recognition** : When using Google, we have the option to ”Search by voice,” which falls under speech recognition and is a well-known machine learning application. Speech recognition, often known as ”Speech to text” or ”Computer speech recognition,” is the process of turning spoken commands into text. Speech recognition applications currently use machine learning algorithms extensively. Speech recognition technology is used by Alexa, Google Assistant, Siri, Cortana, and Microsoft Cortana to carry out voice commands.
- **Product recommendations** : Various e-commerce and entertainment businesses, including Amazon, Netflix, etc., employ machine learning extensively to propose products to users. Because of machine learning, whenever we look for a product on Amazon, we begin to see advertisements for the same product while using the same browser to browse the internet. Google uses a variety of machine learning algorithms to assess user interests and makes product recommendations based on those interests. Similar to this, machine learning is also used to recommend TV shows, movies, and other entertainment options when we use Netflix.
- **Email spam and malware filtering** : Every time we get a new email, it is automatically classified as spam, important, or both. Machine learning is the technology that enables us to consistently receive essential emails marked with the important sign in our inbox and spam emails in our spam box. Here are a few spam filters that Gmail employs: Filters for content, headers, general blacklists, rules-based filters, and permissions. For email spam filtering and virus identification, some machine learning methods are utilised, including Multi-Layer Perceptron, Decision tree, and Nave Bayes classifier.
- **Traffic Forecast** : When planning a trip to a new location, Google Maps comes in handy because it anticipates traffic conditions and offers us the best route to take. It uses two methods to forecast traffic conditions, such as whether it will be clear, moving slowly, or jam-packed: The vehicle’s real-time location as determined by sensors and the Google Map app is combined with the average travel time over the previous days. Everyone who uses Google Map contributes to its improvement. In order to boost performance, it receives data from the user and delivers it back to its database.
- **Self-driving automobiles** : Self-driving cars are one of the most intriguing uses of machine learning. Self-driving cars heavily rely on machine learning. The most well-known automaker, Tesla, is developing a self-driving vehicle. In order to train the car models to recognise people and objects while driving, unsupervised learning was used.
- **Automatic Translation of Languages** : These days, it is not a problem at all if we travel to a new location and do not speak the native tongue. Machine learning also assists us in this situation by translating the text into one of our familiar languages. This function is offered by Google’s GNMT (Google Neural Machine Translation), which uses neural machine learning to automatically translate the text into our native tongue. A sequence to sequence learning method, used in conjunction with picture recognition and text translation from one language to another, is the technology underpinning automatic translation.
- **Medical Diagnosis** : Machine learning is applied in medical science to diagnose disorders. As a result, medical technology is developing quickly and is now able to create 3D models that can pinpoint the precise location of brain lesions. It makes it easier to discover brain tumours and other conditions related to the brain.

- **Trading on the stock market** : Machine learning is frequently utilised in trading on the stock market. Since there is always a chance that share prices may go up and down, machine learning's long short term memory neural network is utilised to predict stock market patterns.
- **Internet fraud detection** : By identifying fraudulent transactions, machine learning makes our online transactions safe and secure. Every time we conduct an online transaction, there may be a number of ways for a fraudulent transaction to occur, including the use of fictitious accounts and identification documents and the theft of money in the middle of a transaction. In order to identify this, Feed Forward Neural Network assists us by determining whether the transaction is legitimate or fraudulent. Each legitimate transaction has an output that is transformed into a set of hash values, which are then used as the next round's input. It identifies fraud and increases the security of our online transactions because there is a specific pattern for each legitimate transaction that changes for fraudulent ones.

Acknowledgement

I sincerely thank our professor and head of department of ECE, Dr. S. Swapna Kumar for the encouragement and guidance he showed during the process of preparation of the article


BASIC ELECTRONICS

NEXT GENERATION SPIN WAVE TECHNOLOGY

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Introduction

Our lives have undergone a significant transformation as a result of the electronic information technology revolution in just a few decades due to the rapid advancement of science and technology. The technical advances of this decade are beyond anything people could have imagined a century ago. Throughout the past 60 years, integrated circuits, which were first created in 1959, have advanced quickly.

Electronics itself has seen a remarkable advancement in nanotechnology, enabling the creation of smaller, quicker, and more effective devices. The study of electronic devices with nanoscale dimensions is the focus of the rapidly growing area of Nano electronics. In the field of Nano electronics, spin waves, commonly referred to as magnons, are a promising technology for next-generation computing. All of

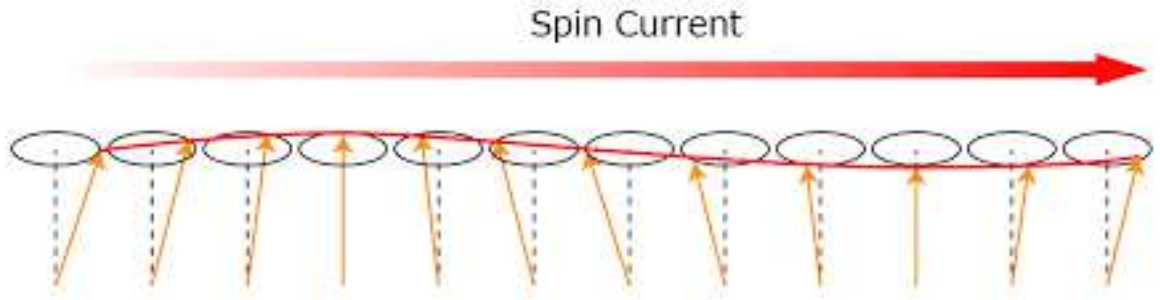

Fig. 1: Spin wave current (Courtesy : NTT Group)

the computers that house our data share a similar trait. A semiconductor chip that stores and processes information is known as CMOS technology. Up until now, more computer power has simply meant more chips, each one smaller. Engineers have little choice but to examine alternatives to CMOS, though, as we're slowly approaching a brick wall when it comes to scaling.

One such idea is spin waves , which are essentially the propagation of perturbations in the alignment of spins in magnetic materials. They behave like electromagnetic waves and have an inherent benefit. These magnetic excitations have already been successfully exploited by Albisetti in a platform for analogue computing, and they can be used for memory and computation applications as well.

The collective excitation of electron spins in a magnetic substance result in spin waves. They are an excellent choice for low power consumption computer applications because they can propagate over vast distances without suffering much from energy loss. This makes spin waves an intriguing possibility for Nano electronics in the future. Like electrical impulses in traditional computers, they can be used to transport and process information.

Quantum Spin-Wave Materials Interface Effects

With the continuous miniaturization of electronic devices and the increasing speed of their operation, solving a series of technical issues caused by high power consumption has reached an unprecedented level of difficulty. Fortunately, magnons (the quanta of spin waves), which are the collective precession of spins in quantum magnetic materials, making it possible to replace the role of electrons in modern information applications.

The subject of spin waves for next-generation computing is quickly developing, with fascinating innovations and patterns that are influencing the direction of computing. The following are some major developments in spin waves for next-generation computing:

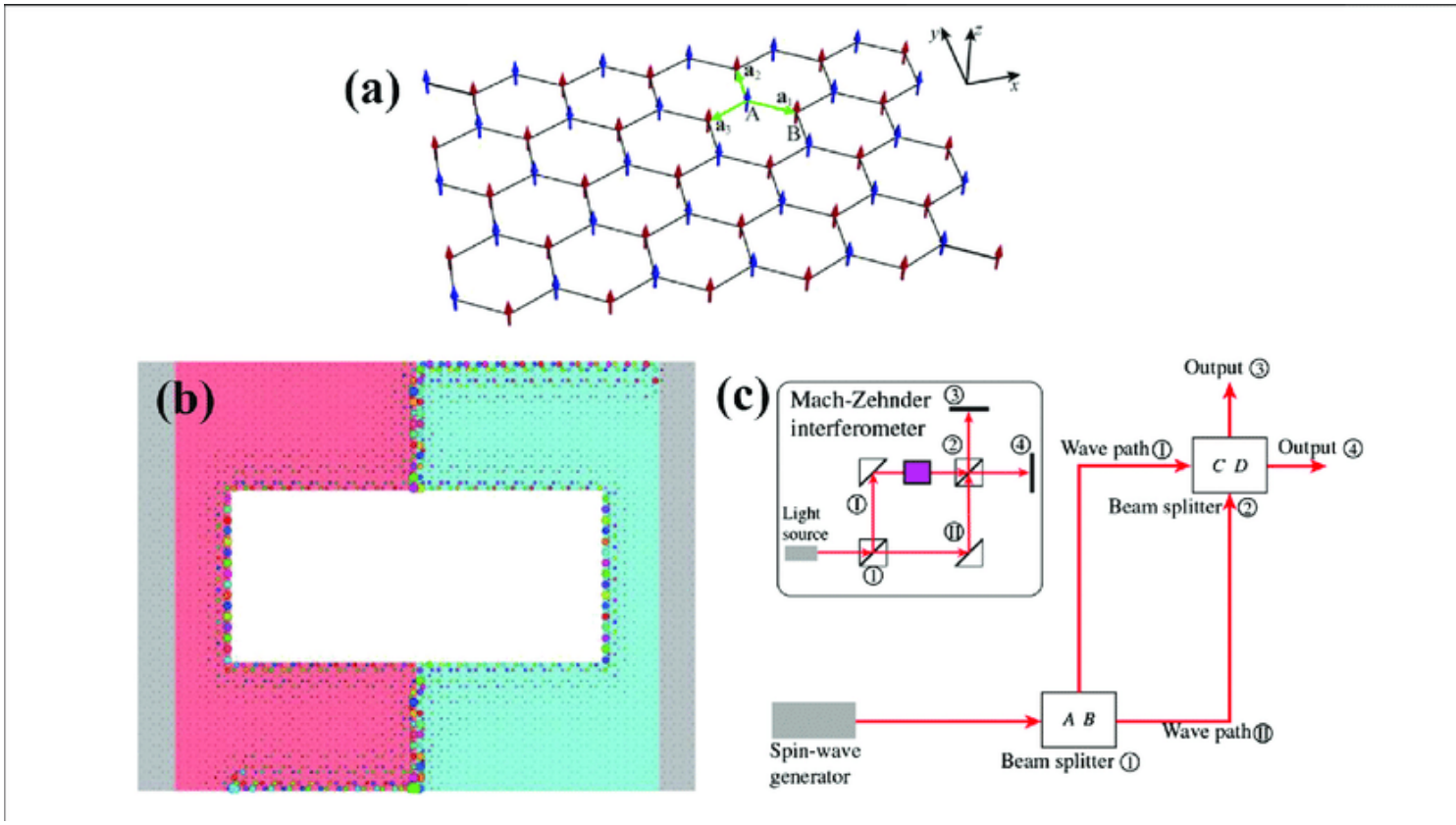

Fig. 2: Schematic diagram of perpendicularly magnetized ferromagnet with a honeycomb lattice for propagating TESWs (Courtesy : ResearchGate)

- **Integration with conventional electronics** : To produce hybrid systems that combine the best features of both worlds, spin wave-based devices are being combined with traditional electronics. New memory and logic devices based on spin waves can be created thanks to this integration and be used with traditional electronics without any issues.
- **Spin wave generation and detection improvements** : Much progress has been achieved in creating effective techniques for producing and detecting spin waves. In order to produce and detect spin waves, researchers are investigating novel materials and methodologies such as spin-orbit coupling, spin Hall effect, and magnetoelectric.

Development of New Spin-Wave Material Systems

Antiferromagnets are highly ordered magnetic materials having symmetrical magnetic moments that are periodic. Antiferromagnetic materials, in contrast to ferromagnetic materials, have two sets of opposite magnetic sublattices that are tightly connected and adjacent atoms' magnetic moments that are antiparallel (Kittel, 1951). Antiferromagnetic materials hence look macroscopically to be nonmagnetic below Neel temperature.

Spin waves and magnons have received a lot of interest recently from scientists. Antiferromagnetic materials (particularly NiO) have demonstrated distinct advantages in spin-wave manipulation at high frequency and high speed by utilising other technologies.

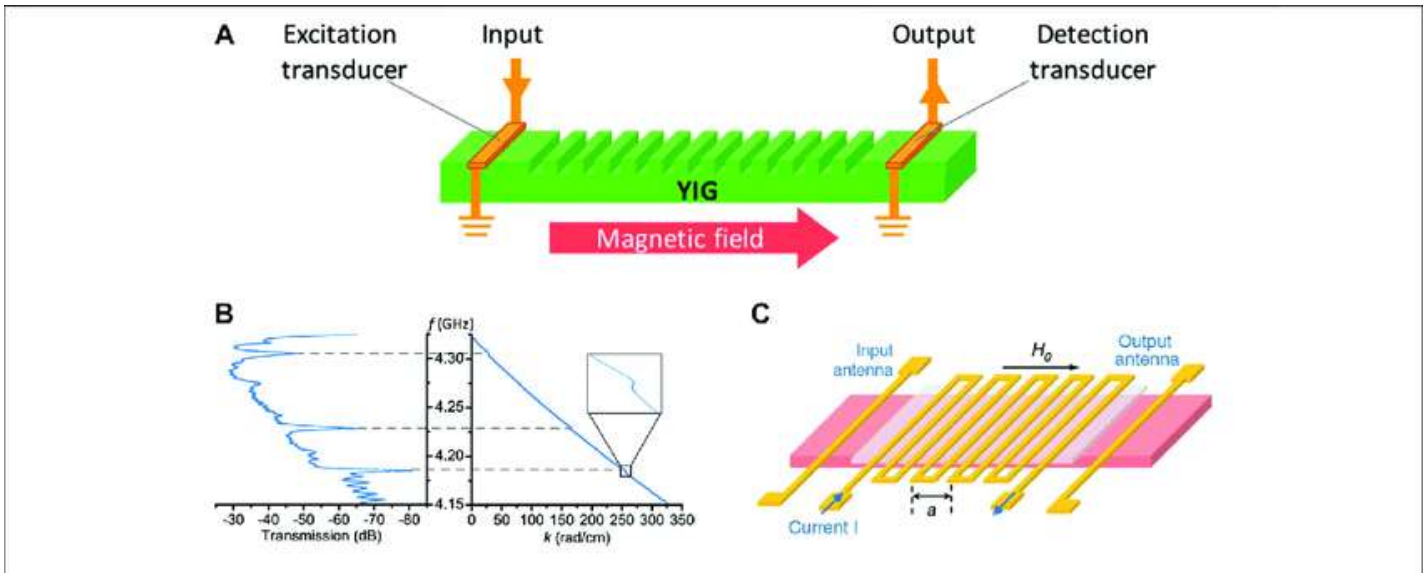

Fig. 3: A static magnonic crystal with a groove array (Courtesy : ResearchGate)

The THz spin-wave excitation of antiferromagnetic single-crystal NiO was achieved by Nishitani et al. (2010) under femtosecond laser irradiation, and it was demonstrated that Raman scattering is the most plausible cause for this occurrence. The domain wall can emit THz spin waves by raising the domain wall velocity to the spin-wave group velocity, according to the relativistic kinematics of antiferromagnets (Shiino et al., 2016). Moreover, it is demonstrated that optical excitation can transfer energy to the magnon mode.

Future Prospects

A promising area that provides many intriguing opportunities for the future of computing is spin waves for next-generation computing. With possible improvements in efficiency, storage capacity, dependability, novel computing paradigms, commercialisation, and applications in 5G and other communication networks, the prospects for spin waves in next-generation computing seem bright. A more effective and sustainable future may be possible with the continuous research and development of spin wave-based technologies, which have the potential to completely alter how we process and store information.

Here are some of the potential future prospects for spin waves in next-generation computing:

- **Increased efficiency and speed** : Spin wave-based devices have the potential to be more energy-efficient and faster than conventional electronics.
- **Higher storage capacity** : Spin wave-based memory devices have the potential to store more data in a smaller space compared to conventional memory devices.

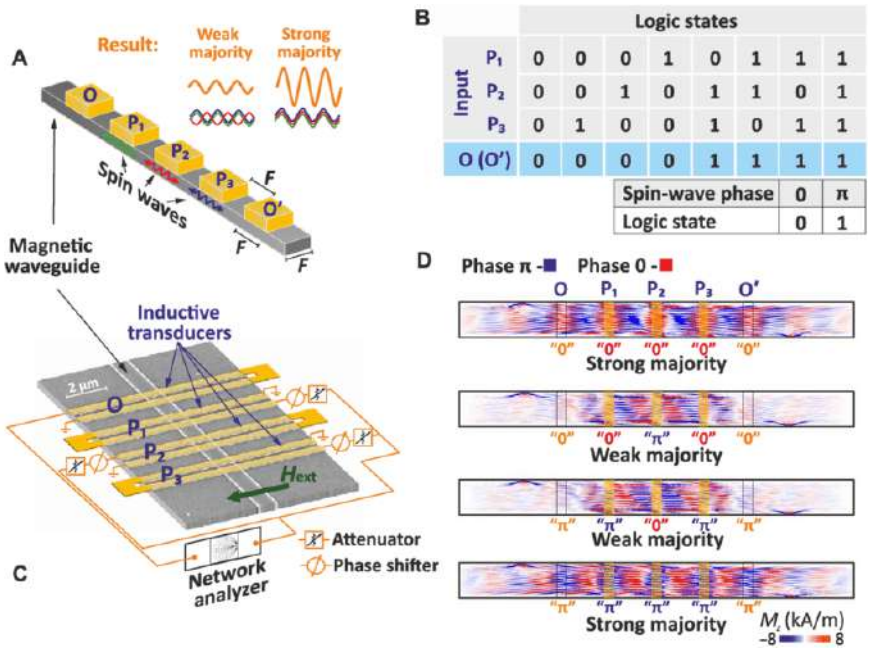

Fig. 4: Device structure and operation principle of the inline SWMG(Courtesy : ResearchGate)

- **Improved reliability** : Spin wave-based devices are less susceptible to electromagnetic interference and noise compared to conventional electronics.
- **Commercialization of spin wave-based device**: As research in spin wave-based devices advances, there is a growing interest in commercializing these technologies.
- **Spin waves in 5G and beyond** : Spin waves could play an important role in the development of 5G and beyond communication networks.

Applications

Figure shows the applications and link scenarios for

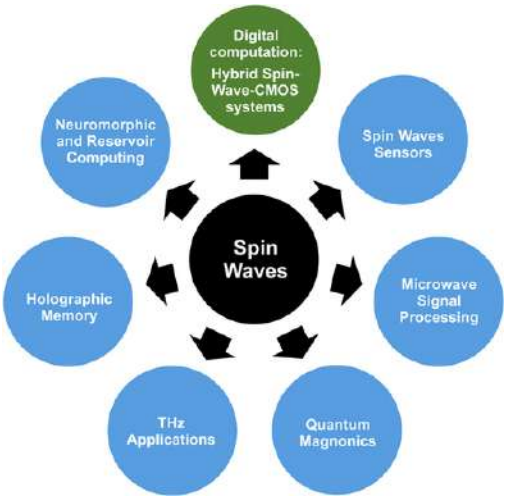

Fig. 5: Applications of spin wave (Courtesy : aip.scitation)

Conclusion

To sum up, spin waves for next-generation computing is a rapidly developing topic that presents a wide range of intriguing prospects for the development of computing in the future. Spin waves, which are the collective excitations of spins in magnetic materials, are appealing for application in next-generation computer systems because of their distinctive features. They have the potential for greater energy efficiency, more storage, and faster calculation rates and are less vulnerable to electromagnetic interference.

Acknowledgement

I would like to acknowledge the invaluable contribution of Google in providing access to a wealth of information and resources used in the research and writing of this article. The search engine has been an indispensable tool in facilitating my research, and I am grateful for its continued availability and ease of use.

TEXTILE BASED ELECTROCHROMIC DISPLAY

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Introduction

Chromic materials are materials which exhibit a reversible colour change in response to an external stimulus such as temperature (thermochromism) and light (photochromism). The source of the colour changes is the variation in absorption spectra of the materials across the UV–visible–near-infrared (NIR) region. Besides the above-mentioned stimuli, oxidation and reduction of certain substances upon application of an electrical bias can also lead to distinct photo-optical and colour changes. This phenomenon is known as "electrochromism". Electrochromic (EC) materials generally exhibit colour changes between two coloured states or between a coloured state and a bleached state. Materials that reveal coloured hues in their oxidised or reduced states are referred to as anodically colouring or cathodically colouring respectively. Several EC materials that exist in multiple redox states reveal the unique ability to switch between several coloured states. This is known as polyelectrochromism. EC materials are highly applicable in smart windows and optical display technology. Furthermore, as the region of optical changes can be extended beyond the UV–visible region into the NIR, the thermal infrared and even the microwave region, these EC materials are potentially useful in defence related applications.

History of Electrochromism

The first EC device was documented by Deb in 1969, where he demonstrated the controlled and reversible changing of colour with the use of tungsten trioxide (WO3). Since then, many classes of EC materials and corresponding devices have been reported, which include metal oxides, viologens and conjugated polymers. Due to their facile colour changes in the visible region, EC materials were highly sought after and employed for optical display applications. Early research in the US, Soviet Union, Japan and Europe on EC materials were motivated by their potential applications in information displays. There were intense research efforts during the first half of the 1970s at several large international companies such as IBM, Zenith Radio, the American Cyanamid Corporation and RCA in the US as well as Canon in Japan, Brown Boveri in Switzerland and Philips in the Netherlands. Through the years, electrochromism continues to receive wide attention in the area of fundamental research. In the mid-1980s, interest in EC materials was boosted again given the potential application in fenestration technology, which was deemed as a way to achieve better energy-efficiency in buildings. The newly conceived "smart" window technology could vary the transmittance of light and solar energy, leading to energy savings and indoor comfort. Moving on, breakthroughs in device engineering and manufacturing techniques allow for electrochromism to move beyond traditional applications such as smart windows and optical displays into emerging applications such as wearable electronics and defence-related technologies.

Mechanism of Electrochromism

The structure consist of electrode, Electrolyte, Electrochromic Polymer and Substrate. The substrate act as a base on which the coating is given. The Electrode is used to establish electrical contact. It emits or collects electron or control their movement. Electrolyte serve as catalyst to make it conductive by promoting the movement of ions from the cathode to anode on charge and in reverse on discharge. Electrochromism happens in Electrochromic materials like viologens, transition metal oxides, conducting polymer. So here they use Electrochromic polymer.

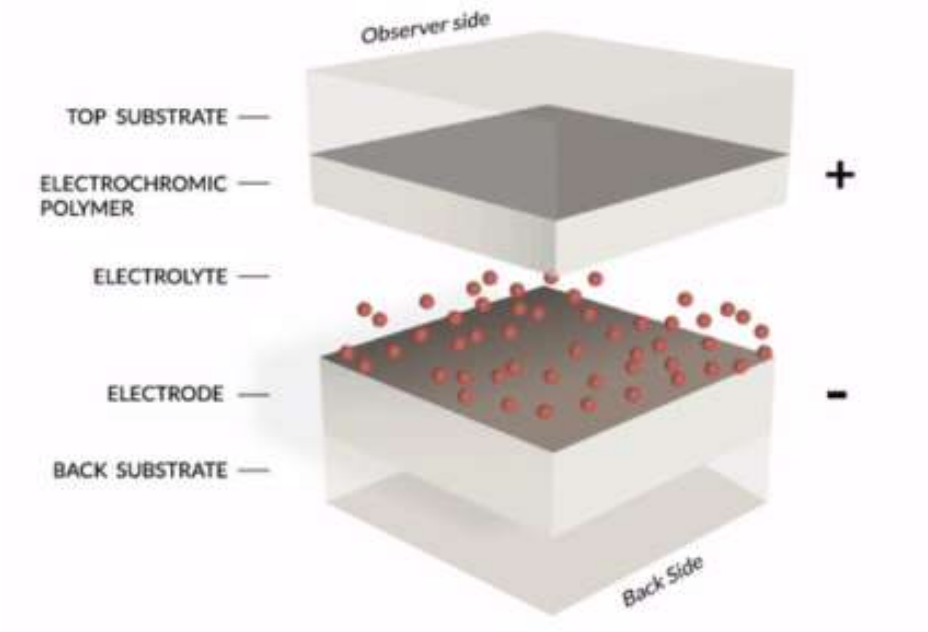

Fig. 1: Working of Electrochromism (Courtesy : IEEE Xplore)

A voltage is applied to the outer conductor. Say we use Li ions as electrolyte. Now Li ions move from the inner most electrode to the outermost one i.e the conducting Polymer. When a voltage is applied to the electrodes the ions migrate to the conducting polymer. When they into that layer they make it reflect light, effectively turning it opaque. They remain there all by themselves until the voltage is reversed.

Design and Development

Generally, the electrochromic device contains four basic ingredients as an electrochromic material, an electrolyte, conducting electrodes, and a substrate. Due to a lot of favorable properties of PEDOT:PSS as an electrochromic material, it is suitable for the incorporation as an electrochromic material. The H3PO4 gel electrolyte has inorganic HC ions, which is having higher mobility with maintaining its biocompatibility. Hence we use H3PO4 gel as an electrolyte. An aluminum sheet is used as a counter electrode. A textile fabric act as a substrate. For the preparation of the electrochromic solution, the PEDOT:PSS was mixed with demineralized water and stirred this mixture for approximately 10 minutes. In this mixture, 5% Dimethyl sulfoxide was dropwise added continuously stirred the mixture for 10 minutes more. The first step of the display production was to perform the coating of this solution onto the substrate. After a lot of iterations and comparison of different fabrics, the polyester-based flex printing fabric of 140 dtex has been selected for working as a substrate for our electrochromic displaying electrode.The coating has been done by manual dipping of a 2 cm x 2 cm polyester fabric, several times (3 to 4). For proper drying, this coated fabric was placed in an oven at 100 oC for 20 minutes. The dried PEDOT:PSS coated

fabric appearance was light grey. The gel electrolyte has been prepared by mixing 2 g of Poly (vinyl alcohol) in 1MH3PO4 in 40 ml of DI water, and this mixture was continuously stirred for 2 hours at 85 oC temperature. After 2 hours, the mixture became completely transparent and viscous. This signified that the transparent electrolyte gel was formed. This new generation of three-layer electrochromic devices contains an electrochromic displaying electrode (PEDOT:PSS coated polyester fabric), a semipermeable membrane (Tissue paper) representing the electrolyte container and a counter electrode (Aluminum sheet). The semipermeable membrane (tissue paper) was drenched in H3PO4 gel. The silver paste was deposited at the one end of PEDOT:PSS electrode. A 2.0 V DC power supply has been applied to this handmade device.

Applications

In the quest for automatization in the automobile interiors, this device can provide big support as it is a very flexible, robust, optimized structured, economical, biocompatible, very high cycle life, fast switching, and run at very low voltage (2.0 V). With the application of voltage, electrochromic displays offer a platform in which light's properties can be continuously and reversibly manipulated. These devices have been proposed for use in windows, energy-saving electronic price tags, flashy billboards, rear-view mirrors, augmented virtual reality and even artificial irises. As an inevitable display technology in the near future, non-emissive see-through displays will be ubiquitous and irreplaceable as a part of the Internet of Things, in which physical objects are interconnected through software.

Future Scope

The seven-segment display was also fabricated in a similar process as the two-segment display was formed, it means incorporating one device by one individual segment and controlled by a microcontroller circuit board. On a positive note, the operation of the seven-segment display was observed by this arrangement, but due to the number of wired connections complexity of these seven similar devices, the controlling and fixation was very difficult. As result, this seven-segment display was not very stable.

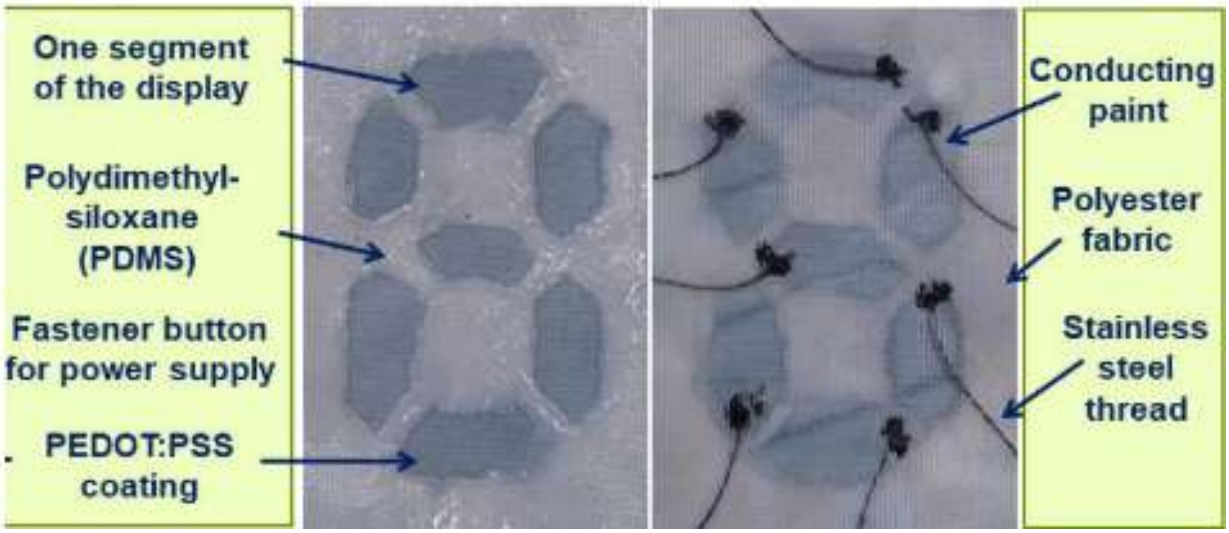

Fig. 2: Seven-Segment Display (Courtesy : IEEE Xplore)

Therefore, in the future, this seven segment display will come into existence by making a seven-segment display in a single fabric. With the incorporation of polydimethylsiloxane (PDMS), we can provide the shape of each segment. By using conducting paint and stainless-steel thread the supply to each separate segment will be provided. The current electrochromic device is tested at room conditions. In the future, this device will be tested and modify accordingly for extreme conditions of temperature, humidity, and sunlight. There is one more concern is the washability of PEDOT:PSS based electrochromic device. Yet, the coating of the silicon layer on the top of the electrochromic device is one the best solution to improve washability but, it needs more in-depth research to improve washability. This is also a future goal of this work.

Conclusion

The developed electrochromic device is having only a three-layer structure with the textile substrate. The materials which are used to fabricate the electrochromic device is supporting the biocompatible aspects. Different fabrics and dilution ratios of PEDOT:PSS solutions have been tested. The readymade 140 dtex polyester flex printing-based textile fabric directly coated by 2.0 times ratio diluted PEDOT:PSS solutions was performed the best for the two-segment electrochromic display. The simple structured display device is having a very high life cycle as it can run up to 2500 cycles without degradation. It is highly flexible and robust as it can function properly even after 1500 times of bending.

3-D PRINTED BONES

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Introduction

3D printing, that is, additive manufacturing, has solved many major problems in general manufacturing, such as three-dimensional tissue structure, microenvironment control difficulty, product production efficiency and repeatability, etc., improved the manufacturing speed and precision of personalized bone implants, and provided a lot of support for curing patients with bone injuries. The application of 3D printing technology in the medical field is gradually extensive, especially in orthopedics. The purpose of this review is to provide a report on the related achievements of bone implants based on 3D printing technology in recent years, including materials, molding methods, optimization of implant structure and performance, etc., in order to point out the existing shortcomings of 3D printing bone implants, promote the development of all aspects of bone implants, and make a prospect of 4D printing, hoping to provide some reference for the subsequent research of 3D printing bone implants.

The need for 3D printed bones

Human bones have the ability to self-repair and regenerate, but this ability is limited . When the bone damage exceeds its acceptable capacity, it will lose its self healing function and require artificial repair. The ideal treatment is to repair the damaged area by transplanting bones from other parts of the patient himself, thus possessing the same bone conduction ability. The application of this method is limited by the limitation of transplantable bones at the donor site of patients and the possible complications at the donor site after transplantation . The second reason is that the donor bone is from other people, so that enough donors can be obtained. However, there is often non-specific immunity to reject the external donor, which poses great difficulties for bone repair . Therefore, in order to overcome these limitations of traditional bone repair, researchers started to study the possibility of replacing human bones with grafts. 3D printing technology plays a huge role in the biomedical field due to its unique advantages. Researchers use cells and biomedical materials as discrete materials and make use of the characteristics of personalized customization of 3D printing to prepare different organs and tissue structures, which will solve the problem of insufficient organ donors to a large extent. In particular, for applications in bones and bone scaffolds, 3D printing offers a solution for the treatment of patients with complex bone defects. The intersection of 3D printing technology and the biomedical field will surely become a highlight of modern medicine. In the application process of 3D printing, in addition to the limitation of its own technology, the choice of printing materials also plays a vital role.

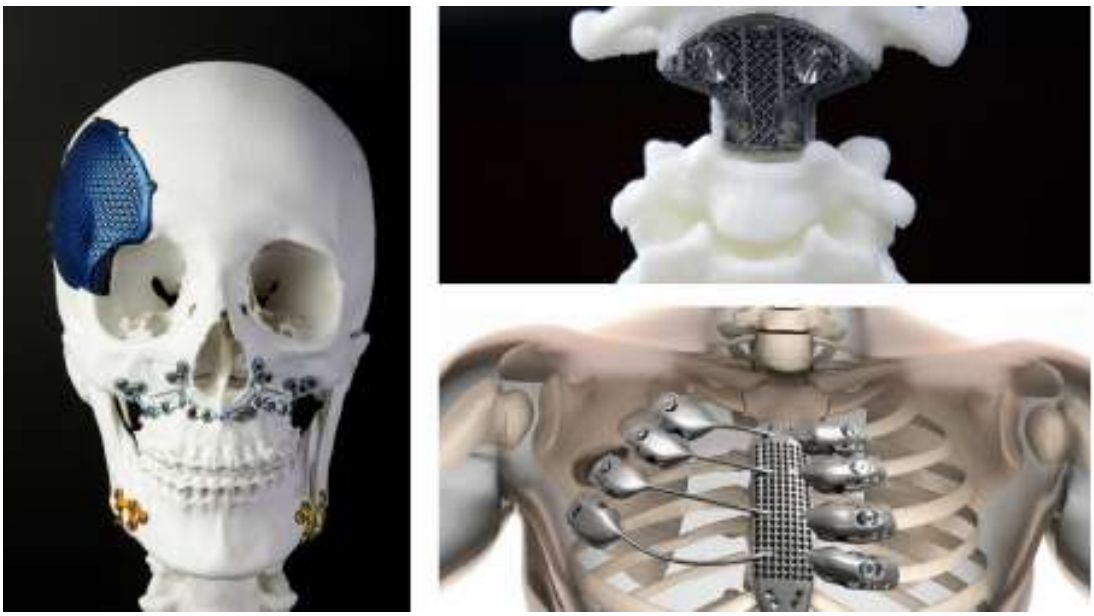

Fig. 1: 3D printed bones (Courtesy : Google)

Composition for BTE

Natural bone is a highly organized composite material, including about 60percent inorganic components. Its main components are hydroxyapatite crystals and about 30percent organic materials, mainly composed of type I collagen and a small amount of type V collagen, 5–10percent water and 3percent lipid. Natural human bones are structurally divided into periosteum, compact bone, cancellous bone and bone marrow. For BTE (bone tissue engineering), bioactivity covers two primary biological processes: osteo-conductivity and osteo-inductivity. At present, many materials have been used in BTE; their characteristics are shown in the table below.

TABLE I: Types of materials used in BTE and their advantages and disadvantages

Type of material	Advantages	Disadvantages
Metals	Biocompatibility, non-toxicity and corrosion resistance	Not biodegradable
BIOCERAMICS		
Bioactive glasses	Improve differentiation and osteogenesis	Low strength and brittleness
Hydroxyapatite	Bioactivity, biocompatibility, osteoconductivity, non-toxicity and non-inflammatory	Brittle, very slow degradation
Tricalcium phosphate	Supports in vivo osteogenic differentiation	Slow degradation, incompressible nature
NATURAL POLYMERS		
Collagen	Enzymatic biodegradability	Complexity of structure
Gelatin	Biocompatible, biodegradable	Poor mechanical properties
Chitosan	Support cell attachment, differentiation, and migration, non-toxicity, non-allergenicity, mucoadhesivity, biocompatibility, biodegradability and osteoconductivity	Poor mechanical strength
Hyaluronic acid	Biocompatibility, biodegradability, viscoelasticity, enzymatic biodegradability	Very rapid degradation and water solubility
Alginate	Biocompatibility, easy gelling, easy chemical modification	Non-degradable in mammals, sterilization causes degradation
Agarose	Wide range of gelling and melting temperatures, no need cross-linking agents, little inflammatory response in vivo	Poor cell attachment
SYNTHETIC POLYMERS		
Poly(α-hydroxy acids)	Degradation products can be excluded from the body	Degradation by bulk erosion, relatively poor mechanical properties, hydrophobicity of the polymer surface
Poly(ε-caprolactone)	Biodegradable, non-toxic, a low melting point	Hydrophobicity, slow degradation
Polyurethanes	Excellent mechanical properties, good biocompatibility	Toxicity of degradation products (from aromatic diisocyanate component)

Conclusion

Through summarizing the achievements of 3D printing technology in bone tissue engineering in recent years, we have found that it has great potential in this field. A qualified bone implant needs to meet the following tissue characteristics, cell structure pore size and porosity, mechanical properties, biocompatibility, osteoconductivity and osteo-induction, and angiogenesis potential, which is still a challenge for the current research. Only by studying the relationship between these tissue characteristics and the manufacturing method, can we have the opportunity to develop more appropriate biomaterials that more closely approximate the hierarchical structure of natural bone

THE ELECTRONICS OF CHARGER ADAPTERS

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Introduction

So, today when the world is rapidly undergoing a massive technological transformation, we have forgotten to think about the electronic device that influences our daily lives. After the current advancements in rechargeable battery technology, where the Lithium-ion cells are leading the race, they have made it into electric vehicles and even some advanced electronics after years of just being limited to handheld mobile phones, cameras, etc. These devices are recharged using “chargers” and specific cables, which double as a simple communication tool. In this article, we dive into the working of “charger adapters” and “USB cables”, which don’t get into the spotlight more often.

Charger Adapters

In India, electricity is transmitted using the standard 240V 50Hz.Recently, the connector pin of the LED lighting got damaged, it took me only a few minutes to cut away the pin and insert the wires directly into the socket, but the device still works like magic.

Fig. 1: A charger adapter (Courtesy : Wikipedia)

Now, this isn't the case with charger adapters. If we try out the same way, by inserting USB cables directly into the socket, the corresponding electronic device may get burned and will be permanently damaged. Electronic devices like mobile phones and laptops are designed to work with "Direct Current". As mentioned earlier, electrical components like LED lighting, water heaters, and washing machines, are designed to work with 240V "Alternating Current". That's why it isn't advisable to cross-connect the electronic devices without specific adapters.Adapters are designed to convert the incoming power supply into device-specific needs. For example, let us analyze a usual 5V DC charger adapter. It consists of a step down transformer, diodes, and capacitor, all of which together constitute a "bridge rectifier" circuit. The input of 240V is converted into 5V using the step down transformer. It's still Alternating Current. To convert it into DC, a bridge rectifier circuit is used.

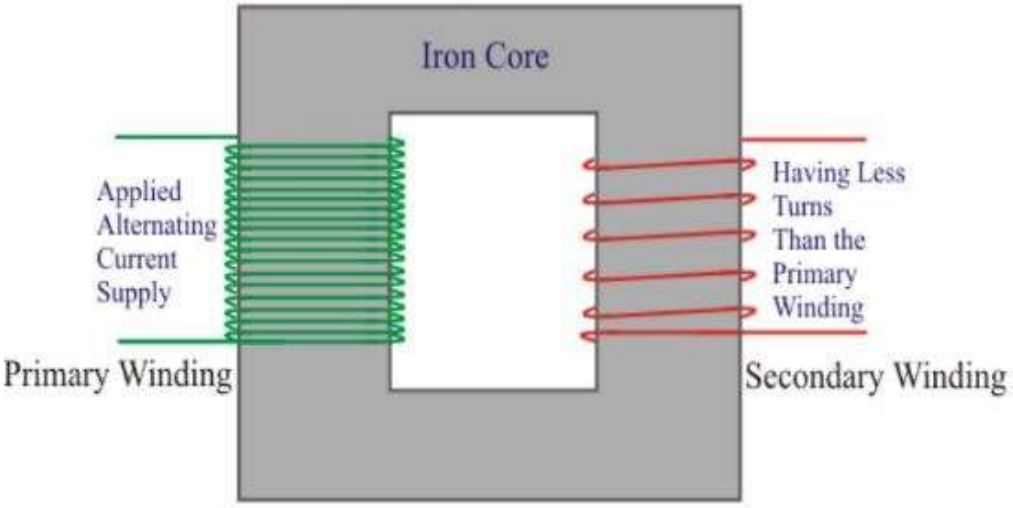

Fig. 2: Step Down Transformer (Courtesy : ResearchGate)

The fundamental characteristic of a diode is that current can flow only one way through it, which is defined as the forward direction. A diode bridge uses diodes as series components to allow current to pass in the forward direction during the positive part of the AC cycle and as shunt components to redirect current flowing in the reverse direction during the negative part of the AC cycle to the opposite rails.

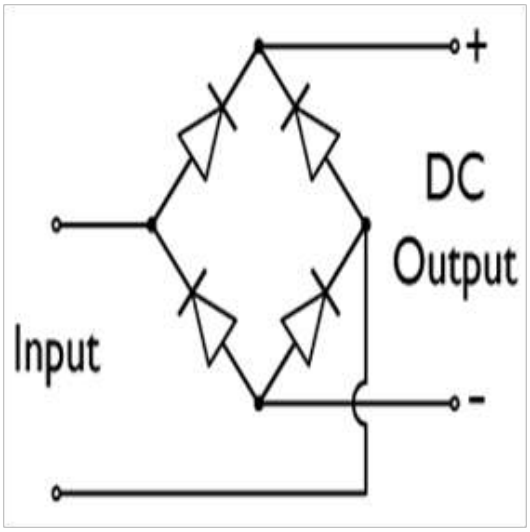

Fig. 3: A diode bridge (Courtesy : Wikipedia)

The obtained output current is now passed through a filter since the DC has a high ripple factor. For this, a capacitor is used. Capacitor charge till the waveform goes to its peak and discharge into Load circuit when waveform goes low. So when output is going low, the capacitor maintains the proper voltage supply into the Load circuit, hence creating the DC.

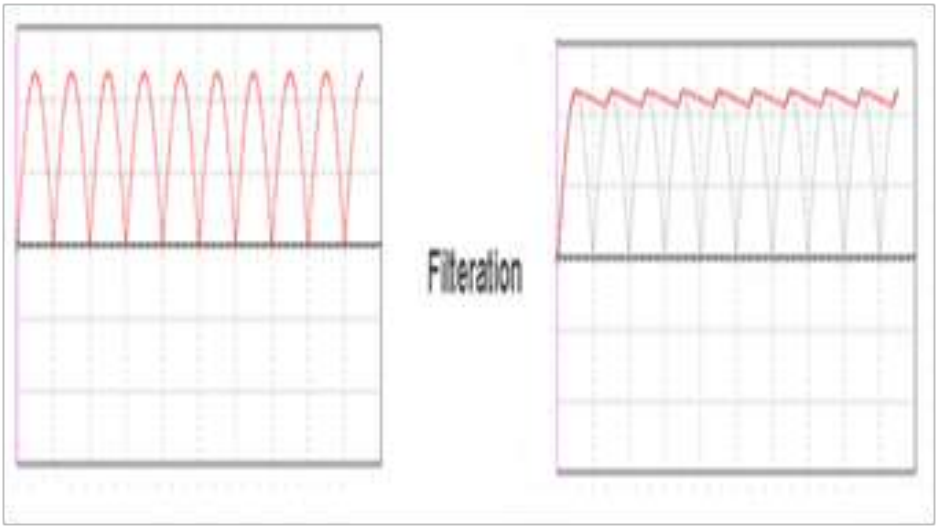

Fig. 4: Filteration

Thus, a charging adapter makes use of simple principles from electronics engineering. The amount of easiness this simple electronic device provides us in our daily life is invaluable.

Universal Serial Bus

Before the development of USB (Universal Serial Bus), it was often tricky to connect external devices. Users sometimes needed to open up their computers and add hardware to give them the communications port they needed.The Universal Serial Bus, which was released in 1996 by Intel, simplified things. USB ports now are standard on personal computers and are built into many other electronic devices such as smartphones, eBook readers, and game consoles. USB type-C is the latest update to the physical connector.

The type-c cable boasts a data transfer speed of up to 40 GBPS along with a power supply range of up to 100 watts. The functions of 24 pins are as follow ;

1. 4 VBUS pins for power supply.
2. 4 ground pins.
3. 2 SBU pins, they carry other alternate modes.
4. 8 Receiver and Transfer pins for data transfer.
5. 2 CC pins which function as OTG pins.
6. 4 D pins for data transfer with OTG.

The USB type-c debuted with the 3.0 version. Followed by 3.1 and 3.2. The latest update is the “Thunderbolt” version. It caps a data transfer rate of 40 GBPS along with the caliber of replacing an HDMI cable displaying an 8K video. The fact that the above-mentioned pins are placed in the same reverse orders, makes the orientation very symmetric.

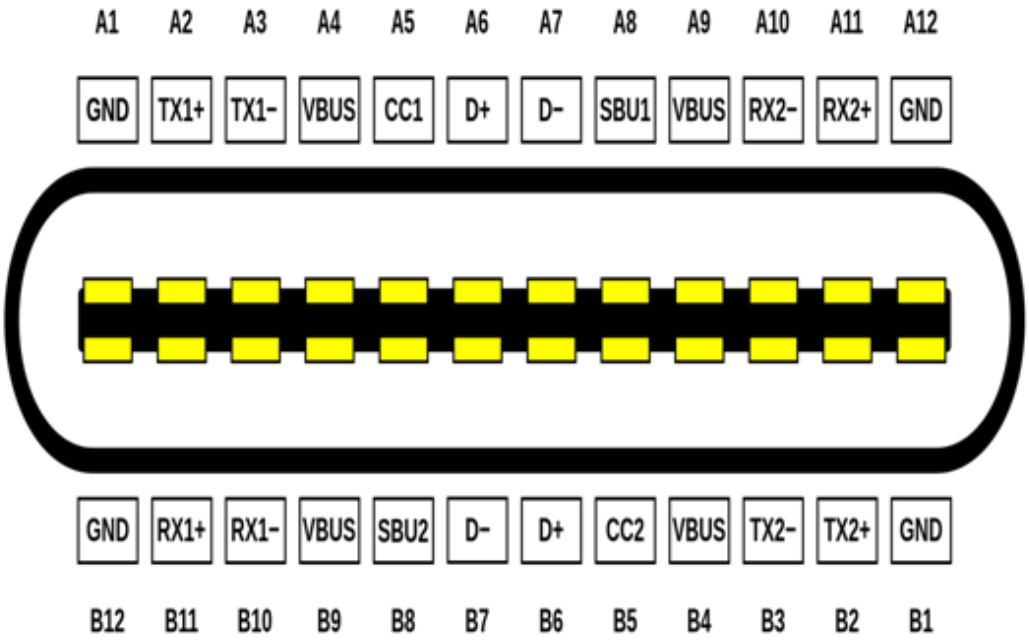

Fig. 5: Universal Serial Bus (Courtesy : Wikipedia)

Conclusion

That's how electronics engineers have an impact in our current technological era, where simple game-changing circuits play an important role in making our lives better.

QUANTUM DOT LED

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Introduction

Television display technologies have come a long way since the first commercial color CRT was produced in 1954 and it was not until the late 1990s that LCD technology began to surface and display technologies started evolving at an unprecedented rate. Gone are the days when the conventional cathode ray tubes (CRT) were the only thing for television displays, the technology for which dates back to the early 19th century. Later the more efficient Liquid Crystal Displays (LCDs) came to the picture and which was quick to rise to fame because of its passive nature that combined characteristics of low power and bright light viewing, factors that made portability a reality. LCD alone is not capable of emitting its own light. There should be a light source or backlight. A LED backlight used the three basic colors-blue, green, and red in order to come up with a white color light. Recently, one of the popular LED LCD colors is blue coated with a yellowish phosphor to achieve a white light color and QD LED TV is found as a more advanced version of this. The manufacturer no longer used the blue LED with yellowish, but instead they use QD particles for achieving white color. The QDLED absorbs the emitted blue light then transfer it to red and green to creating the desired white color. This process is also known for achieving an accurate LED colors.

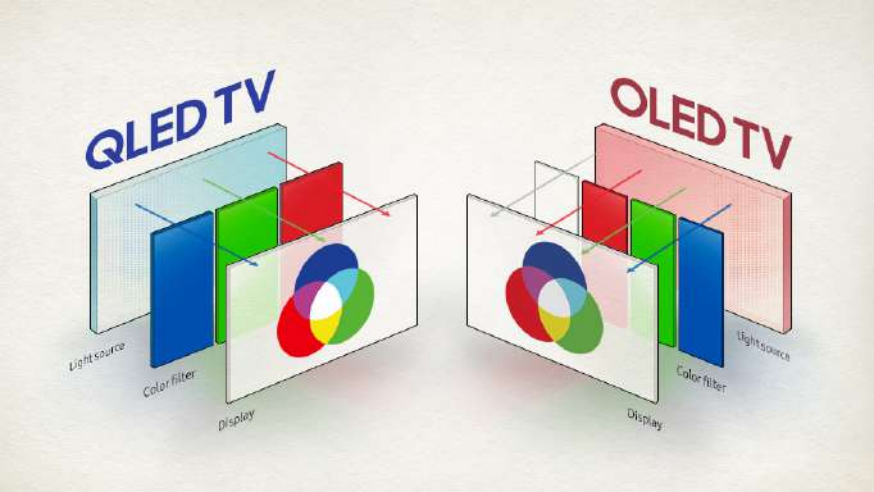

Fig. 1: QLED TV vs. OLED TV (Courtesy : Samsung Newsroom)

OLED is composed of organic molecules made of thin films that create light with the use of electricity. This type of lightning technology is capable of creating crisper and brighter displays on electronic devices than the traditional liquid crystal displays (LCD) and light emitting diodes (LED). Meanwhile, the Organic Light-emitting Diode (OLED) display is made of organic compound which releases light with the presence of an electric current. The pixel is capable of emitting light on its own. It only means that this type of LED display have no issues regarding backlight leaking.

Quantum Dot LED, or simply called a QLED, displays are the next generation of display technology based on quantum-dots light emitting diodes. The technology is quite similar to OLED display technology, but with a quantum dot layer instead of the OLED emitting layer. Quantum dots incorporate the best aspects of both organic light emitters and inorganic light emitters. They don't emit the colors directly; in fact they create picture very differently by adding an additional layer of quantum dots which in turn dictates an ideal color temperature when hit by light from behind, resulting in an immersive viewing experience that sets in a new revolution in television display technologies.

OLED

The acronym 'OLED' stands for Organic Light-Emitting Diode – a technology that uses LEDs in which the light is produced by organic molecules. These organic LEDs are used to create what are considered to be the world's best display panels. OLED displays are made by placing a series of organic thin films between two conductors. When an electrical current is applied, a bright light is emitted. A simple design which brings with it many advantages over other display technologies. OLED senable emissive displays - which means that each pixel is controlled individually and emits its own light (unlike LCDs in which the light comes from a backlighting unit). OLED displays feature great image quality - bright colors, fast motion and most importantly - very high contrast. Most notably, "real" blacks (that cannot be achieved in LCDs due to the backlighting). The simple OLED design also means that it is relatively easy to produce flexible and transparent displays.

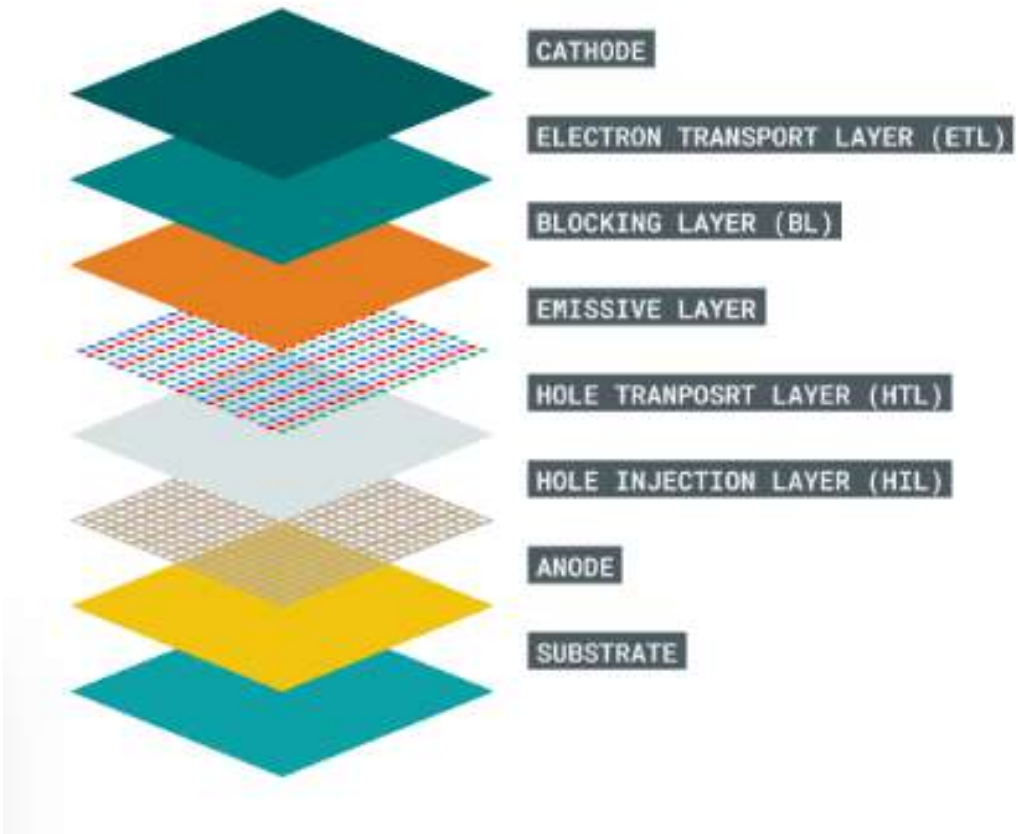

Fig. 2: OLED layer (Courtesy : Sensor Kit)

Operating principle of OLED

The conductive layer and emissive layers are made of special organic molecules that are helpful in conducting electricity. Anode and cathode are used for connecting OLEDs to the source of electricity. When power is applied to an OLED, the emissive layer becomes negatively charged and the conductive layer becomes positively charged. Due to electrostatic forces applied, the electrons move from the positive conductive layer to a negative emissive layer. This may lead to a change in electrical levels and creates radiation that varies in frequency range of visible light.

QLED

QLED stands for Quantum Dot Light Emitting Diode. A quantum dot display is a display device that uses quantum dots (QD), semiconductor nanocrystals which can produce pure monochromatic red, green, and blue light. The structure of a QLED is very similar to the OLED technology. But the difference is that the light emitting centers are cadmium selenide (CdSe) nanocrystals, or quantum dots. A layer of cadmium-selenium quantum dots is sandwiched between layers of electron transporting and hole transporting organic materials. An applied electric field causes electrons and holes to move into the quantum dot layer, where they are captured in the quantum dot and recombine, and emitting photons. The spectrum of photon emission is narrow, characterized by its full width at half the maximum value. There are two major fabrication techniques for QD-LED, called phase separation and contact printing.

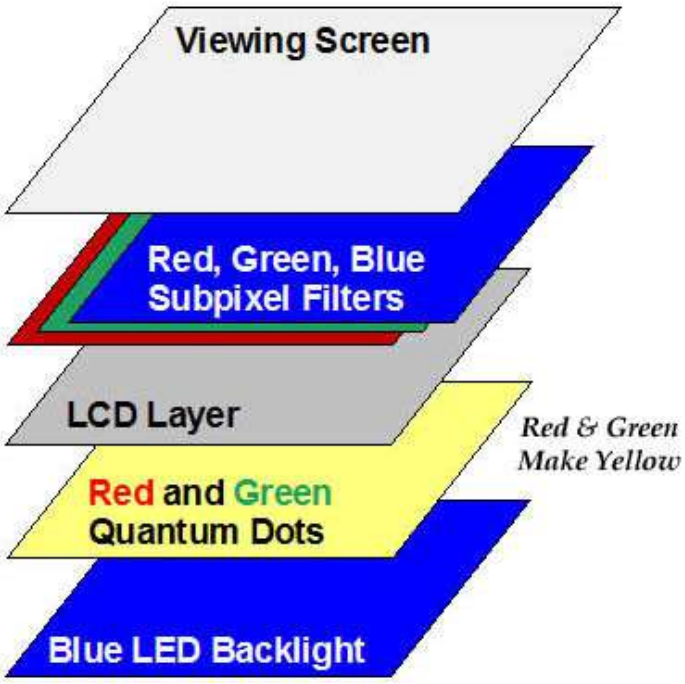

Fig. 3: QLED layer (Courtesy : PCMag)

QLEDs are a reliable, energy efficient, tunable color solution for display and lighting applications that reduce manufacturing costs, while employing ultra-thin, transparent or flexible materials Quantum Dot (QD) displays are quite different as the technology is based on small conducting nanocrystals, usually in the range of 2 to 10 nanometers in diameter. The color of light produced or filtered by a dot is based on its diameter and using a few of these could produce all your necessary colors. Like OLED, light and colors could be supplied on demand and QD LEDs can be very bright. However, current QD displays are

based on a blue LED backlight which is then filtered to a white light before passing through the familiar LCD color producing layer.

Difference between OLED and QLED

- **OLED** :
  - Low input lag. Gamer's rejoice, these QLED's have an excellent input lag time. The 2018 version has recorded lag-time of just 15.4ms. No excuse to lose a match on this TV.
  - 10 year no burn in guarantee. These QLED's are not susceptible to burn-in like other TV's. Great for not retaining that ESPN or CNN logo.
  - QLED's produce incredibly bright, vibrant and diverse colors.
  - Price - Generally you can find a QLED somewhat cheaper than an OLED
- **QLED** :
  - Light is emitted on a pixel-by-pixel basis, so complete black can be right next to bright white with neither impacting each other. This gives you deep blacks and amazing contrast.
  - No light bleeding because there's no back light. Each diode can operate individually without effect the others because they light up themselves.
  - OLED's tend to be lighter and slimmer than a typical LED panel.
  - Significantly wider viewing angles. Great for bigger spaces. Don't worry about sitting directly in front of these TV's.

Applications of QLED and OLED display technology

- In TVs
- Cellphone screens
- Computer screens
- Keyboards
- Lights
- Portable device displays

Conclusion

Though the structure of QLED is quite similar to OLED, you can easily tell the difference between the two by checking its light emitting centers which is made of cadmium selenide nanocrystals or simply called quantum dots. QLEDS are known for having less manufacturing costs and lower power consumption. QLED's manufacturers claim that QLED TVs are more power efficient than OLEDS with same color purity. When OLED hit the market, it was the absolute, most perfect TV technology ever. QLED, as an improvement over OLED, significantly improves the picture quality. QLED can produce an even wider range of colors than OLED, which says something about this new tech. QLED is also known to produce up to 40percent higher luminance efficiency than OLED technology. Further, many tests conclude that QLED is far more efficient in terms of power consumption than its predecessor, OLED. It's really tough to choose one from OLED and QLED, as both are the most popular and dominant display technologies out there. Each has its own set of advantages in terms of picture quality, contrast, and color correction. That being said, if you are looking for a high-definition television for a much brighter room or something that gives consistent dynamic quality from HDR, then QLEDs are the best choice


COMMUNICATION

RECENT TRENDS IN SPACE LASER COMMUNICATIONS FOR SMALL SATELLITES AND CONSTELLATIONS

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Introduction

Optical communication, also known as optical telecommunication, is communication at a distance using light to carry information. It can be performed visually or by using electronic devices. The earliest basic forms of optical communication date back several millennia, while the earliest electrical device created to do so was the photophone, invented in 1880. An optical communication system uses a transmitter, which encodes a message into an optical signal, a channel, which carries the signal to its destination, and a receiver, which reproduces the message from the received optical signal. When electronic equipment is not employed the 'receiver' is a person visually observing and interpreting a signal, which may be either simple (such as the presence of a beacon fire) or complex (such as lights using colour codes or flashed in a Morse code sequence).

Modern communication relies on optical networking systems using optical fiber, optical amplifiers, lasers, switches, routers, and other related technologies. Free-space optical communication uses lasers to transmit signals in space, while terrestrial forms are naturally limited by geography and weather. This article provides a basic introduction to different forms of optical communication.

Optical satellite communication is a wireless telecommunication network that operates on optical frequency as a medium to deliver data signals at a high bit rate. Optical satellite communication uses free space as a medium for communication. The optical satellite consists of a transmitter, receiver, and channel. Optical communication technologies in space have the potential for various applications such as Earth observation satellites, deep space explorations, and the International Space Station (ISS). Optical technologies are unencumbered by radio frequency (RF) limitations and may realize higher speeds, larger capacities, and smaller and lighter capabilities. Optical communications should revolutionize the space system architecture. The nano-satellite is defined as a small satellite with a mass of about 1– 20 kg. The higher frequency bands will be used more in future satellite missions to use wider bandwidths as the number of flying satellites will exceed several tens of thousands in the near future. The figure below shows an example of the down-link frequency bands for nano-satellites. The x-axis indicates various frequency ranges like GHz and MHz. The y-axis indicates the number of modules verified and planned in an orbit.

Trends in Space Laser Communications

Recently, the CubeSat micro-satellite which is a square-shaped miniature satellite of dimensions 10*10*10cm (roughly the size of a Rubik's cube) experiments have demonstrated in-orbit laser communications

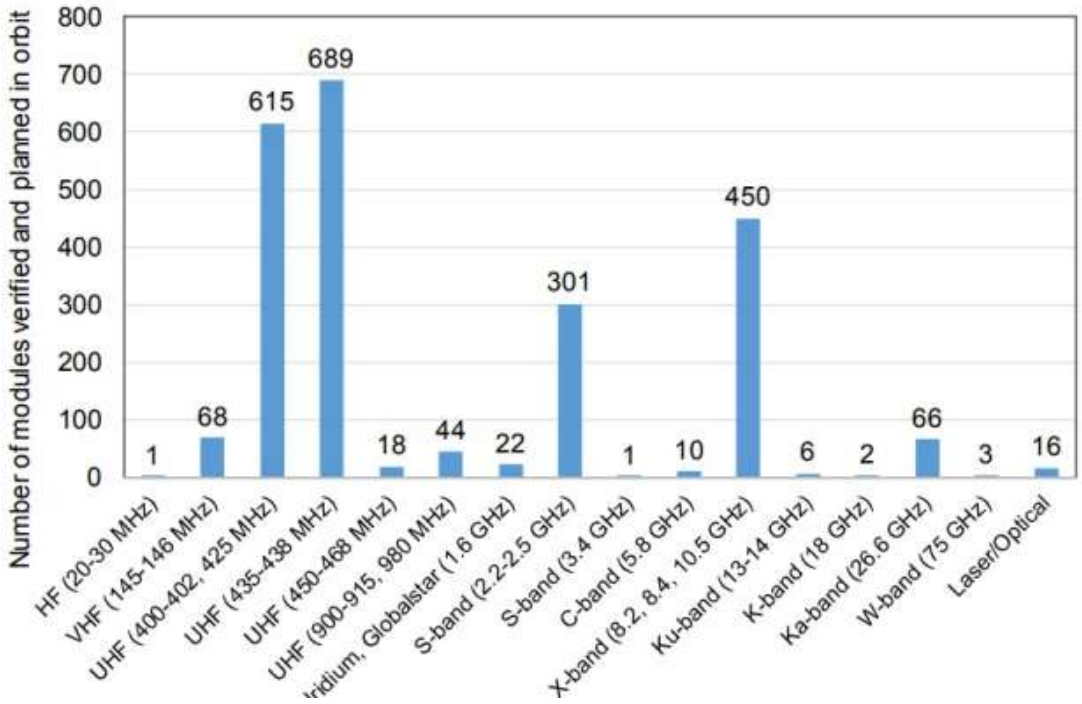

Fig. 1: Down-link frequency bands for nano-satellite (Courtesy : IEEE Xplore)

confirming the feasibility of space laser communications using Cube-sat class satellites. The figure shows the major applications of laser satellite communications, including short- duration optical communication missions, optical data relay satellite communications, deep space optical communications, advanced optical communication technologies, and satellite quantum communications. From 1994 to 2004 data rate of space laser communications programs in space has increased by a factor of 1000 times. Data Rate is defined as the amount of data transmitted during a specified time period over a network.

Further, the data rate has increased dramatically. And the overall number of in-orbit demonstrations have been doubled. In the future, WDM can further increase the data rate. WDM can be defined as wavelength Division Multiplexing is a fiber-optic transmission technique that enables the use of multiple light wavelengths (or colours) to send data over the same medium. Wavelength division multiplexing, WDM, has long been the technology of choice for transporting large amounts of data between sites.

Trends in Satellite Communication Technologies

The concept of free space optical communication has various future prospects and applications which are detailed below. Trends in mega constellation satellite communication technologies have a function of frequency. Figure 1 shows the recent trends in mega constellation services and applications with small satellites. Various applications of optical space communication as a function of frequency are plotted in the graph below. This comprises of

- Laser communication
- Imaging
- Internet of Things
- Broadband satellite communications.

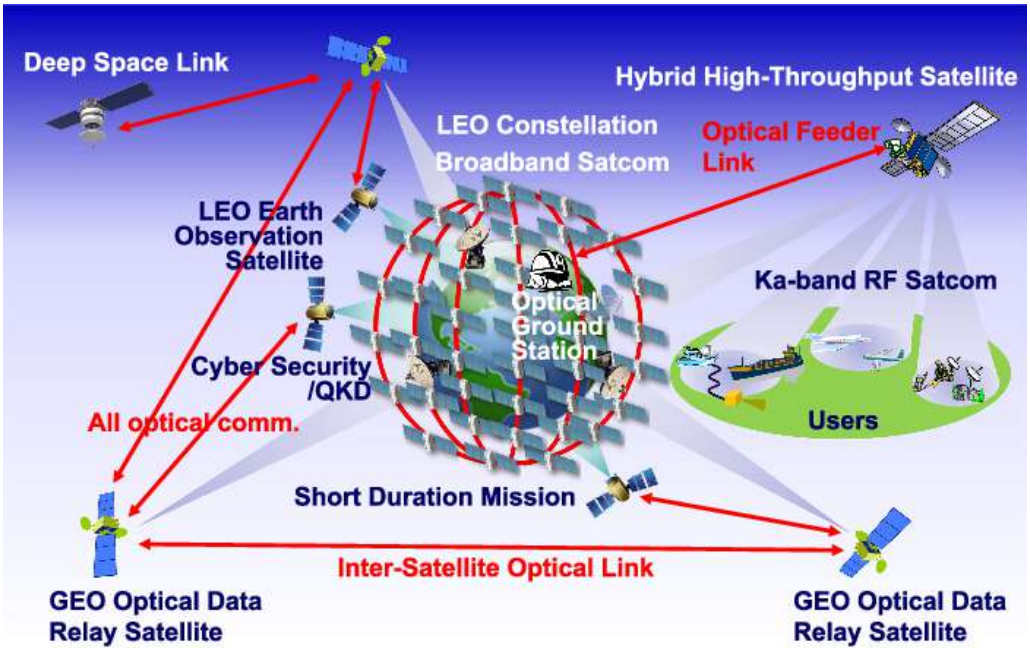

Fig. 2: Satellite Communication Technologies(Courtesy:Semantic Scholar)

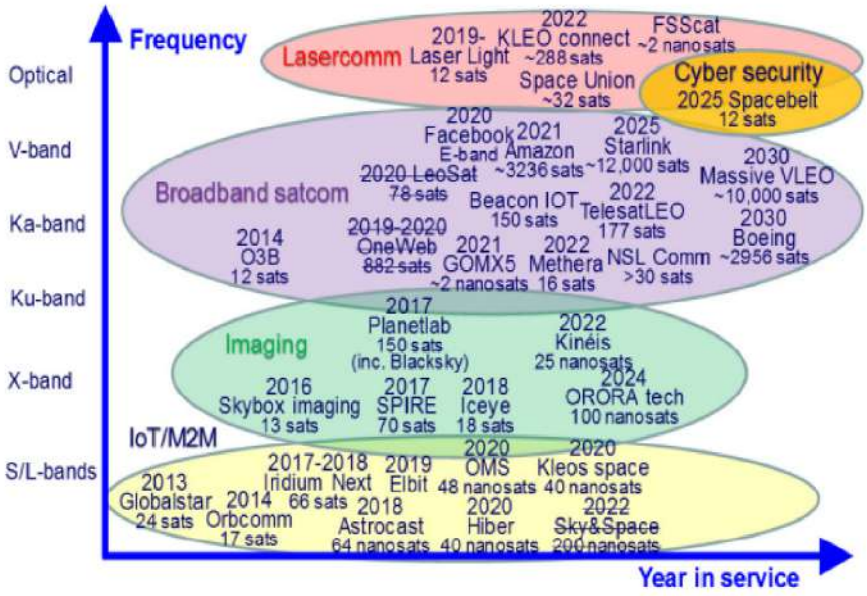

Fig. 3: Frequency map for mega-constellation satellite services and applications (Courtesy : IEEE Xplore)

Future Prospects

Laser communications in deep space will be tested on the Psyche mission to the main-belt asteroid 16 Psyche, planned to launch in 2022. The system is called Deep Space Optical Communications (DSOC) and is expected to increase spacecraft communications performance and efficiency by 10 to 100 times over

conventional means. The figure below summarizes the technological trends and the future services as a function of the frequency used for each service based on the figure (under trends in satellite communication technologies) mentioned earlier.

Space laser communication is categorized into five areas:

- Short-duration missions based on ground-to-satellite links
- GEO data relay
- Broadband Satcom using 10 thousand class satellites
- All-optical high-speed communications
- Cyber security guaranteed by QKD technologies.

Optical systems will be used in networks such as ultra-broadband due to the problems with frequency allocation. In addition to that, quantum cryptography and QKD based on laser technology can enhance space cyber security. Ideally, laser communications would also improve spacecraft, making them more energy-efficient, sustainable and smaller (and therefore more affordable). According to Suzanne Dodd, the director of the Interplanetary Network, lasers may be able to increase the data rate from Mars to about ten times what we receive from the radio. Dodd hopes that future space explorers will experiment with lasers on space missions.

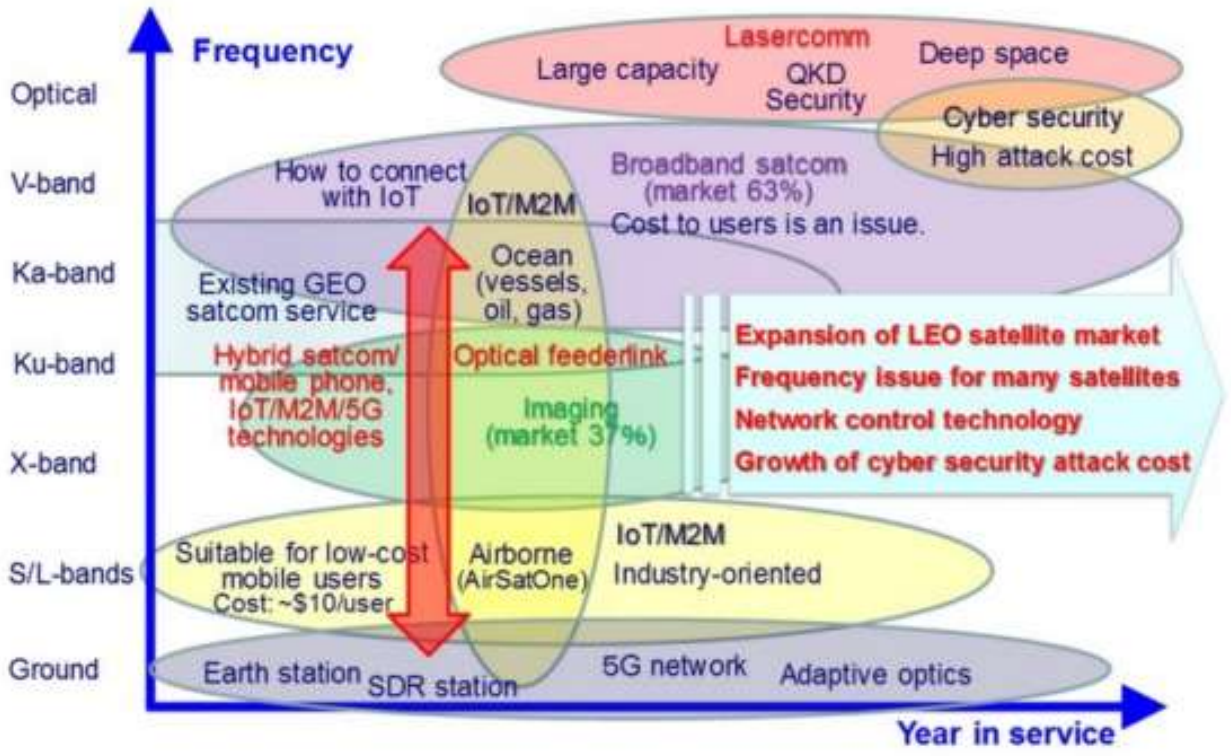

Fig. 4: Trends in mega-constellation satellite communication technologies as a function of frequency (Courtesy : IEEE Xplore)

Applications

Figure 5 shows the applications and link scenarios for space laser communications for mega-constellations.

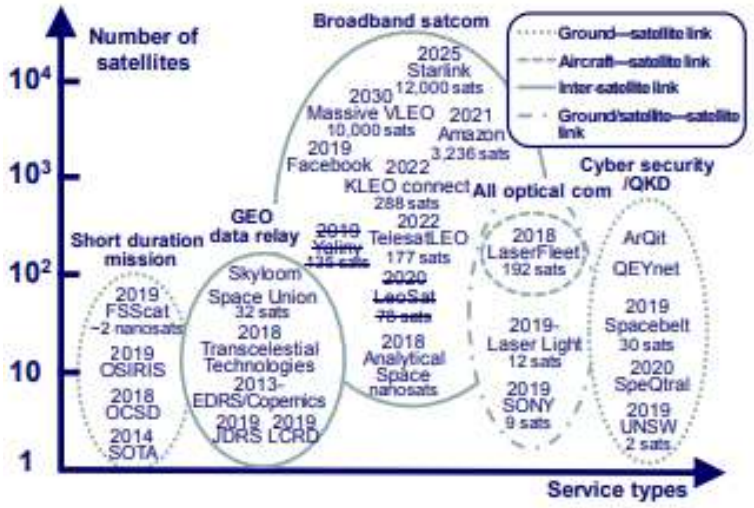

Fig. 5: Applications and link scenarios for space laser communications for mega-constellations (Courtesy : IEEE Xplore)

Conclusion

Starting with an introduction on Space Laser Communication, its trends, trends in satellite communication technologies, Future Prospects and applications that we identified are discussed.

MICROSTRIP ANTENNA

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Introduction

In general, an antenna is a part of transmitting or receiving system that can transmit or receive electromagnetic waves. There are different kinds of antenna that used in several applications. A number of them are: wire antenna, aperture antenna, printed antenna, array antenna, reflector antenna, and lens antenna. Amongst these antennas printed antenna is fabricated using photolithography technique. Most common model of the printed antenna is microstrip antenna. It is constructed using conventional microstrip fabrication technique. Microstrip antenna consist of a radiating patch on one side of a dielectric substrate and has a ground plane on the other side. The concept of microstrip antenna was first proposed in 1953 in the U.S.A. by Deschamps and in France by Gutton and Baissiont .However the practical antennas were developed by Munson and Howell in the 1970s.

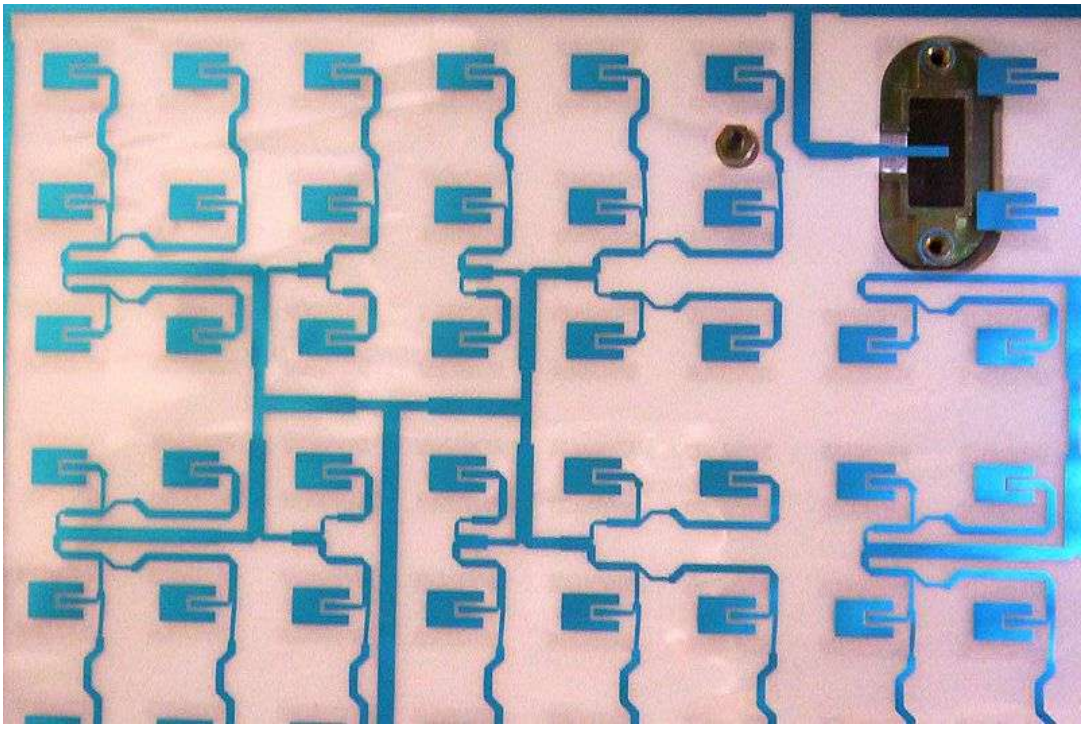

Fig. 1: A microstrip antenna (Courtesy : Wikipedia)

Microstrip antenna are low profiles antennas. A metal patch is mounted at a ground level with a dielectric material in-between constitutes a Microstrip and Patch Antenna. These are very low size antennas having low radiation. It is a kind of internal antenna. The patch antennas are popular for low profile applications at frequencies above 100MHz.
There are three types in microstrip antenna: Microstrip patch antenna, Microstrip slot/travelling antenna

and Printed dipole antenna. Among the above three types microstrip patch antenna can have any shape. Microstrip slot/travelling antenna is mostly rectangular or circular shape. Printed dipole antenna have triangular and rectangular shape. The most important thing in antenna design is to select the appropriate substrate material.

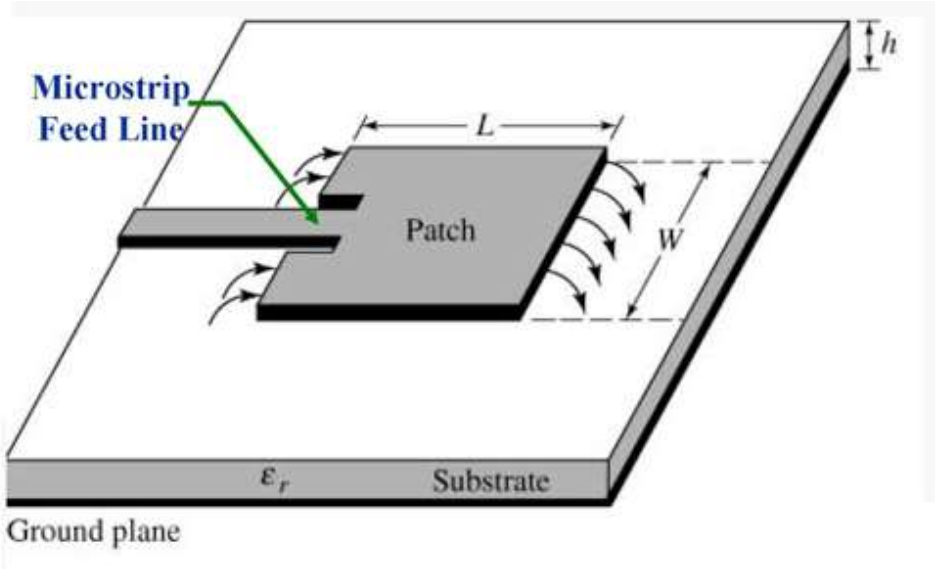

Fig. 2: Microstrip patch antenna dimensions (Courtesy : scientificresearch.in)

Basic Characteristics of Microstrip Antenna

A Microstrip Antenna in its simplest form consists of a radiating patch on one side of Dielectric substrate and a ground plane on the other side. Most common shapes are rectangular and circular. However, other Shapes such as the square, mendered, triangular, semicircular and annular ring Shapes are also used.
Radiation from microstrip antenna can occur from the fringing fields between the periphery of the patch and the ground plane. The length L of the rectangular patch for the fundamental TM10 mode excitation is slightly smaller than lambda/2, where lambda is the wavelength in the dielectric medium, which in terms of free- space wavelength lambda0 is given as lambda0/sqrrt (epsilon*e), where epsilon*e is the effective dielectric constant of a microstrip line of width W. The value of epsilon*e is slightly less than the dielectric constant of the substrate because the fringing fields from the patch to the ground plane are not confined in the dielectric body, but are also spread in the air. To enhance the fringing fields from the patch, which accounts for the radiation, the width W of the patch is increased. The fringing fields are also enhanced by decreasing the dielectric constant or by increasing the substrate thickness h.

Construction and Working of Micro strip Antennas

Micro strip antenna consists of a very thin metallic strip placed on a ground plane with a di-electric material in-between. The radiating element and feed lines are placed by the process of photo-etching on the di-electric material. Usually, the patch or micro-strip is chosen to be square, circular or rectangular in shape for the ease of analysis and fabrication.

The length of the metal patch is lambda/2. When the antenna is excited, the waves generated within the di-electric undergo reflections and the energies radiated from the edges of the metal patch, which is very low.

Radiation Pattern

The radiation pattern of microstrip or patch antenna is broad. It has low radiation power and narrow frequency bandwidth.

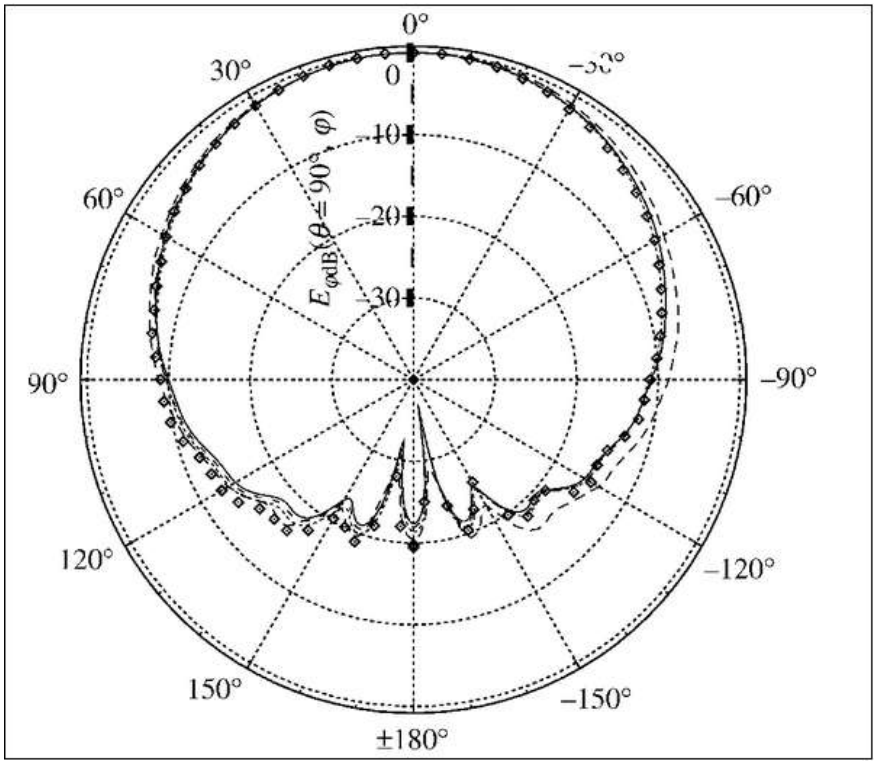

Fig. 3: Radiation pattern of a MSA (Courtesy : Tutorialspoint)

The radiation pattern of a microstrip or patch antenna is shown here. It has lesser directivity. To have a greater directivity, an array can be formed by using these patch antennas.

Applications of Microstrip Antenna

Feed lines and matching networks are fabricated simultaneously with the antenna structure making them suitable for numerous applications

- The telemetry and communication antenna on missiles need to be thin and are often microstrip antennas.
- Radar altimeters use small arrays of microstrip radiators.
- Other aircraft related applications include antennas for telephone and satellite communications.
- Microstrip arrays have been used for satellite imaging systems.
- Patch antennas have been used on communication links between ships or buoys and satellites.
- Smart weapon Systems use microstrip antennas.
- Pagers, the global system for mobile communication (GSM), and the global positioning system (GPS) are major users of microstrip antennas.

Advantages of Microstrip Antenna

- Light weight
- lnexpensive and robust
- Easy to fabricate (use etching and phototlithography)
- Easy to feed (coaxial cable, microstrip line, etc.)
- Easy to use in an array or incorporate with other microstrip circuit elements
- Dual frequency antennas can be made easily
- Compatible with MMIC (Microwave monolithic Integrated circuit design.)
- Low cost

Disadvantages of Microstrip Antenna

- Narrow bandwidth
- Low efficiency and low power gain
- Larger ohmic loss in the feed structure of array
- Polarization purity is difficult to achieve
- Excitation of surface waves
- High level of cross polarization and mutual coupling within an array environment at high frequencies

Conclusion

Compared with conventional antennas, microstrip patch antennas have more advantages and better prospects. They are lighter in weight, low volume, low cost, low profile, smaller in dimension and ease of fabrication and conformity. Moreover, the microstrip patch antennas can provide dual and circular polarizations, dual-frequency operation, frequency agility, broad band-width, feedline flexibility, beam scanning omnidirectional patterning.

Acknowledgement

I sincerely thank our professor and head of department of ECE, Dr. S. Swapna Kumar for the encouragement and guidance he showed during the process of preparation of the article.

PATH-LOSS OPTIMIZED INDOOR LASER-BASED VISIBLE LIGHT COMMUNICATION SYSTEM FOR VARIABLE LINK LENGTH GIGABIT-CLASS COMMUNICATION

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Introduction

In the last two decades, Radio Frequency (RF) communication suffers from interference and high latency issues. Along with this, RF communication requires a separate setup for the transmission and reception of RF waves The unprecedented growth of wireless communication systems along with their increasing demands on wireless data traffic is restraining the availability of the limited and expensive RF spectrum, which is driving the need for complementary wireless transmission techniques. This gave rise to visible light communication (VLC), an emerging technology in the field of wireless communication that concurrently provides communication alongside illumination and can be incorporated into existing lighting infrastructures as a complementary functionality.

VLC utilizes a light source as its transmitter where information is modulated into the intensity of the emitted light. The frequency of the modulating signal is kept high enough (typically above 300Hz) so that occupants assume the source to be normally lit. In simple words Visible light communication (VLC) is a wireless method that enables high-speed transmission of data with visible light. This data is transmitted by modulating the intensity of light given off by a light source. The signal is received by a photo-diode device that transforms the data into forms that are readable and readily consumed by end users.

Path loss in a variable link length indoor laser-based VLC system is being reduced using an optical ray-tracing-based method. Finding the best locations for the transmitter and receiver lenses where the collection efficiency is greatest results in the lowest possible path-loss. This study highlights the significance of optical system design, particularly the use of ray-tracing to improve light throughput and achieve effective communication and illumination at practically relevant connection lengths.

High latency and interference problems plague Radio Frequency (RF) communication. Also necessary for RF communication is a separate configuration for RF wave transmission and reception. Due to its high bandwidth and resistance to electromagnetic interference, Visible Light Communication (VLC), which overcomes the aforementioned restrictions, is a popular communication approach. Visible light communication (VLC) is a wireless method that enables high-speed transmission of data with visible light. This data is transmitted by modulating the intensity of light given off by a light source. The signal

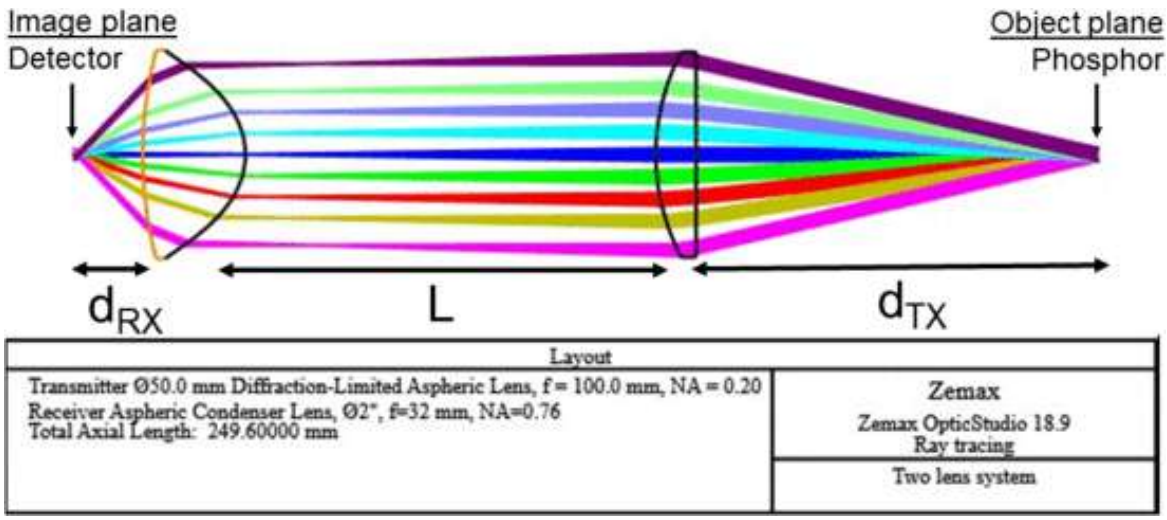


Fig. 1: Ray-tracing layout of the VLC link (Courtesy : IEEE Xplore)

is received by a photodiode device that transforms the data into forms that are readable and readily-consumed by end users.

Advantages of VLC

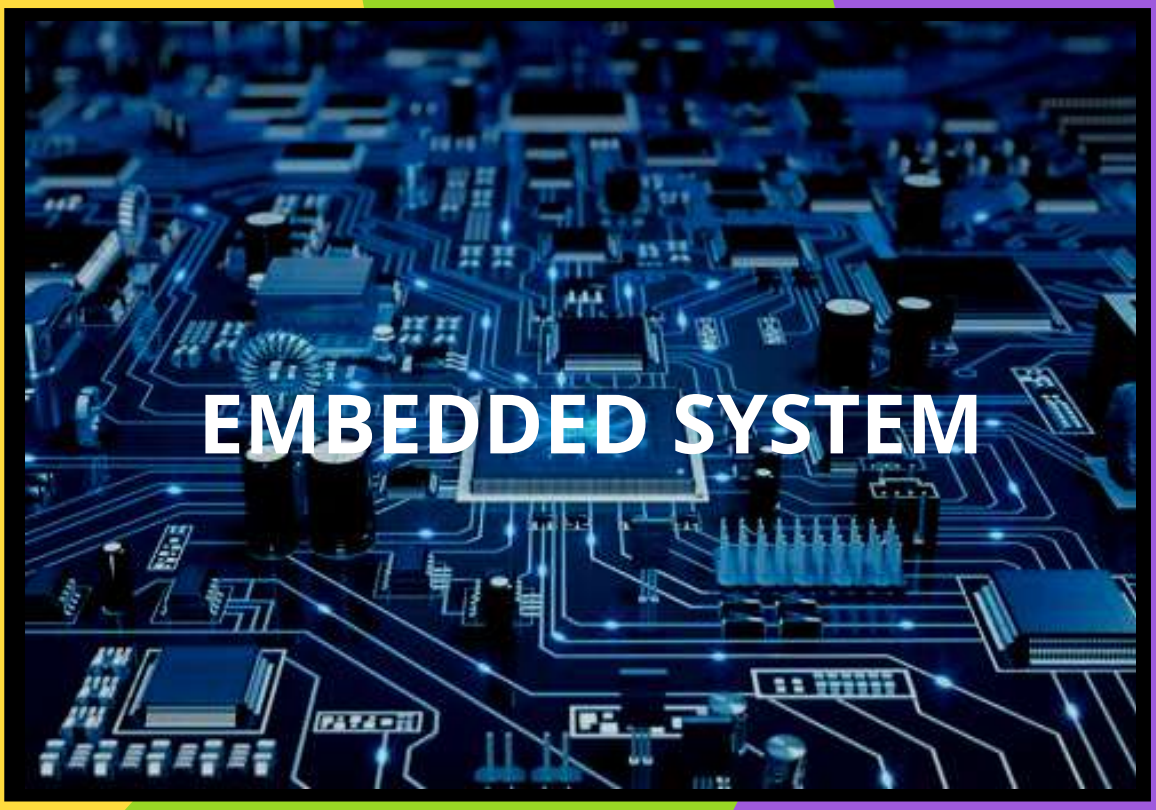
VLC can be used as a practical alternative for areas where RF signals are perceived as a hazard. Aside from using non-RF technology to deliver data, the light source used in these systems emit low energies, ensuring their safe use.

Applications of VLC

Being the fastest means of relaying messages, VLC has been put to use in a number of fields. However, wired VLC is used in more instances as wireless VLC is limited to open spaces and cannot pass through fields that have obstructions like walls. This limits wireless VLC to indoor applications and few outdoor functions provided that no barrier exists between the sender of the message and the recipient.

Conclusion

The optical link design presented here focuses on achieving best communication performance for variable link distances with minimal change to the optical system by finding optimal positions of transmitter and receiver lenses. The path-loss optimization is found to result in narrow beam spread, spot-light type illumination profile directed towards the receiver, to ensure efficient light collection for extended link distances. The illumination source is characterized to quantify the beam profile, color rendering and illuminance level as a function of link length.The work predistance for emphasizes the importance of optical ray tracing to maximize light throughput in the laser-based white light VLC link and achieve good communication at practically useful link lengths of few meters.


EMBEDDED SYSTEM

SoC

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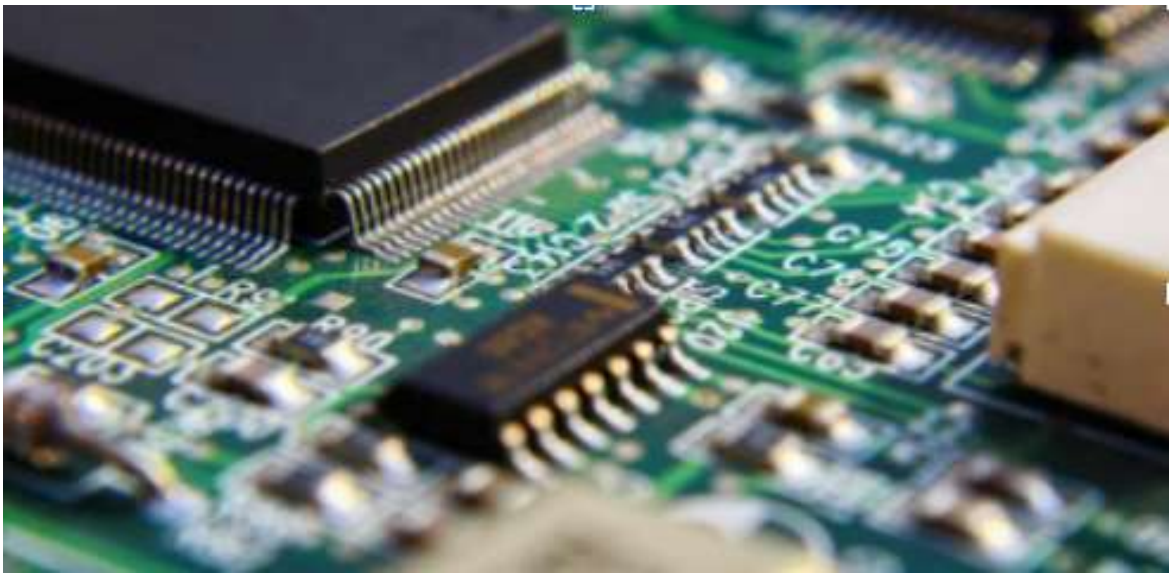

Fig. 1: (Courtesy : Wirecutter)

The “system on chip” in short SoC term is widely used in the electronics era. SoC is an integrated circuit that incorporates a majority of components present on a computer. With the development of 3G to 4G, 5G communication the demand for high end smartphones as well as many other engineering applications gave way to SoC. The concept of SoC differs from CPUs and microprocessors. Let’s understand its concept.

Introduction

In the early 20th century, the technological progression trends of electronics showed two different paths such as miniaturisation and integration. Miniaturisation concept is to reduce the circuit design size of the electronics. Thereby, the device becomes denser and it reduces the overall number of components. Miniaturisation makes electronic components such as capacitors, resistors, and transistors get smaller over time. Integration is a way of uniting the different smaller component parts together into a single system. In 1958 the Invention of the integrated circuit (IC) allowed for even further miniaturisation.

A SoC is an integrated circuit composed of many elements of a system, into a single chip. It is a microchip with related electronic circuits suitable for a given system, such as a computer, smartphone etc. assimilated on a single IC. An SoC includes a CPU, system memory, peripheral controllers, and more advanced peripherals such as graphics processing units (GPUs), radio modems (for Bluetooth or Wi-Fi), and more. SoC, takes a single platform and integrates an entire electronic or computer system onto it.

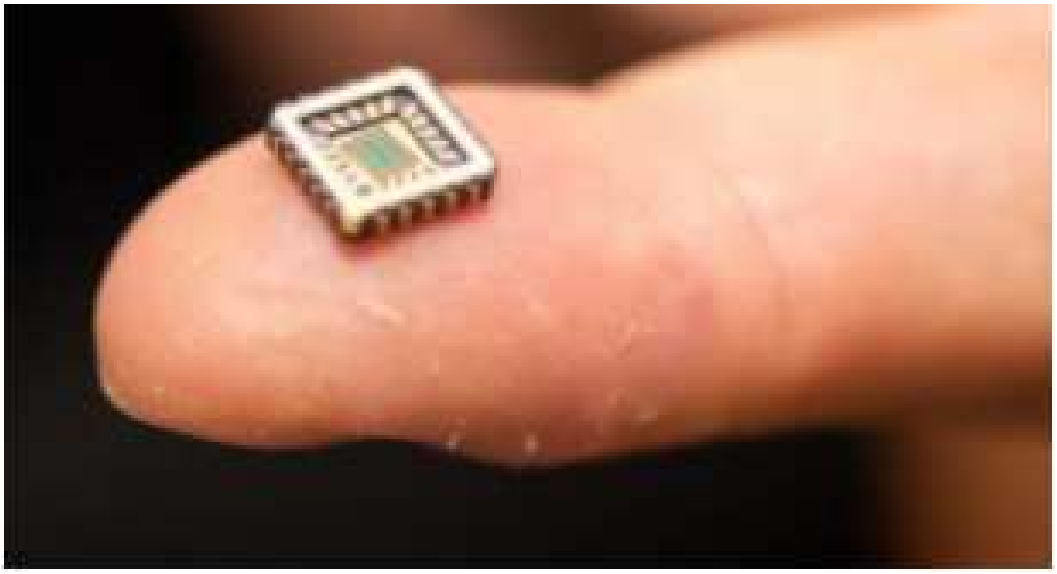

Fig. 2: (MIT Technology Review) (Courtesy : Creator: Nic Delves-Broughton, Copyright : © IDPS, University of Bath 2019)

Figure 2 shows SoC in the MIT Technology Review. A silicon chip that mimics the brain's neurons could cure paralysis. The body's nerve cells trigger the electrical signals to help patients cure the damaged nerves. As shown here the neurons are built into small silicon chips pass signals between nerve cells which is damaged by disease or injury. SoC is theoretically one billionth the power of a standard microprocessor, is used in medical implants to treat chronic diseases like heart failure or Alzheimer's.

Diversification

In the 20th century with the rise in the miniaturisation of electronics, the earliest digital computers were made of large discrete components such as relays or vacuum tubes. Later, they used discrete transistors, then groups of integrated circuits. In 1972, Intel combined the elements of a computer central processing unit (CPU) into a single IC. This has given rise to the first commercial, world's first single-chip microprocessor: Intel 4004. Microprocessors integrate elements of a CPU onto a single chip. With this development of the microprocessor, computers become smaller and consume less power.

In 1974, Texas Instruments released the first microcontroller, which is a type of microprocessor with RAM and I/O devices integrated with a CPU onto a single chip. Instead of needing separate ICs for a CPU, RAM, memory controller, serial controller, and more, all are integrated together into a single chip for small embedded applications such as pocket calculators and electronic toys. This enter another diversification of the Microcontroller and System on a Chip.

Microprocessors with separate controller chips, RAM, and graphics hardware resulted in flexible, personal computers. While microcontrollers are limited to general computing tasks. This made microprocessors with discrete supporting chips contributed to more applications.

Recently, the 3G-4G-5G drive toward smartphones and tablets has pushed integration even further than microprocessors or microcontrollers. The result in SoC packs many elements of a modern computer system (GPU, cell modem, AI accelerators, USB controller, network interface) along with the CPU and system

memory into a single package. It's one more step in the continued integration and miniaturisation of electronics that will likely continue long into the future.

Scope

Putting more elements of a computer system on a single piece of silicon lowers power requirements, reduces cost, increases performance, and reduces physical size. All of that helps dramatically when trying to create ever-more-powerful smartphones, tablets, and laptops that use less battery life.

For example, over the past 14 years, Apple has used SoCs in its iPhone and iPad lines. At first, they used ARM-based SoCs designed by other firms. In 2010, Apple debuted the A4 SoC, which was the first iPhone SoC designed by Apple. Since then, Apple has iterated on its A-series of chips with great success. SoCs help iPhones use less power staying compact and getting more capable all the time. Other smartphone manufacturers use SoCs as well.

The use of SoCs makes computers smaller, faster, cheaper, and less power-hungry. Until recently, SoCs rarely appeared in desktop computers. In 2020, Apple introduced the M1, its first SoC for desktop and notebook Macs as shown in figure 2. The M1 combines a CPU, GPU, memory, and more on one piece of silicon. In 2021, Apple improved on the M1 with the M1 Pro and M1 Max. All three of these chips give Macs impressive performance while sipping power relative to the traditional discrete microprocessor architecture found in most PCs.

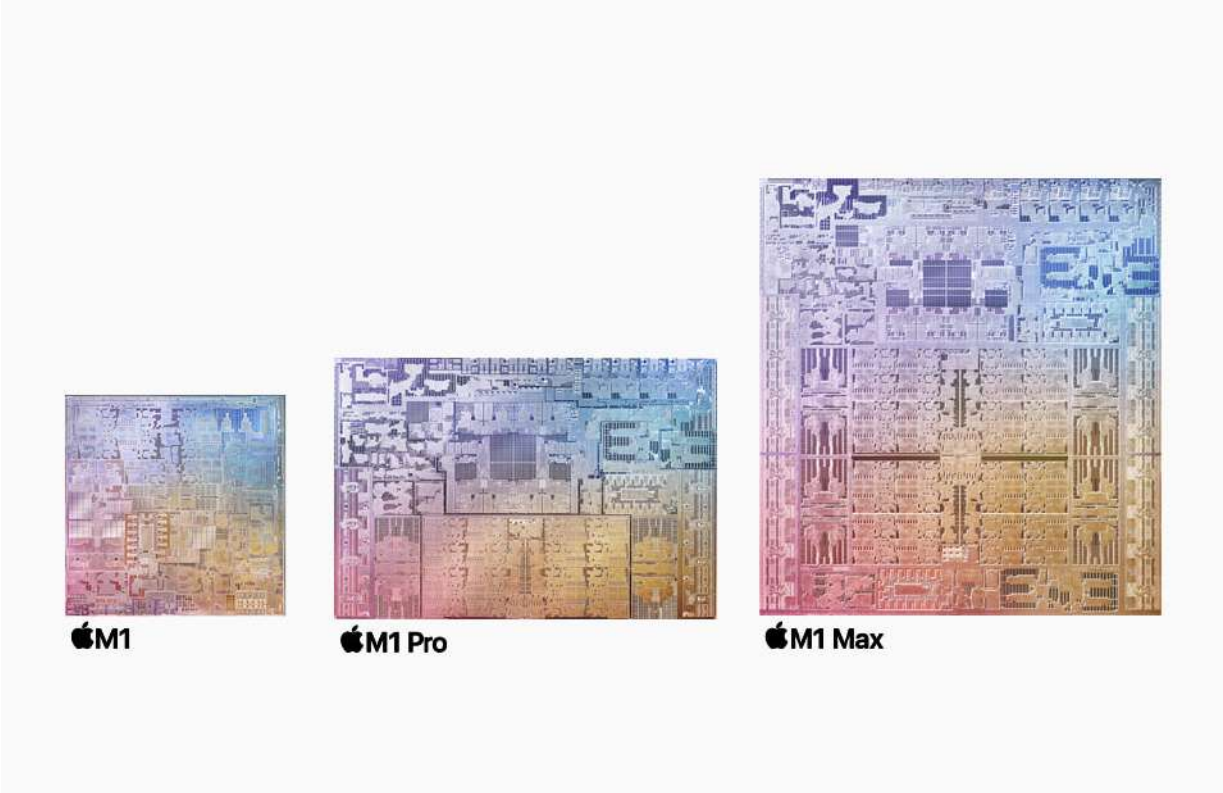

Fig. 3: Apple's new M1 Pro and Max chips (Courtesy: Apple M1, M1 Pro, and M1 Max)

The silicon inside the Apple M1, M1 Pro, and M1 Max SoCs shown here. The Raspberry Pi 4, a popular hobbyist computer, also uses a system on a chip (a Broadcom BCM2711) for its core functions,

which keeps the device cost low (about dollar 35) while providing plenty of power. The future is bright for SoCs, which continue the tradition of electronics integration and miniaturisation that began over a century ago. Exciting times ahead!

SoC Building Blocks

The SoC building block contains analog, digital, mixed signal and other radio frequency functions all lying on a single chip substrate. Figure 3 shows the block diagram of a low-power TI CC26xx processor that includes SoC layout as listed in the following:

- **Control Unit** : In SoCs, the major control units are microcontroller, a microprocessor, a digital signal processor, or an application specific instruction set processor etc. The SoC has multiple processor cores. It also needs a GPU or a Graphical Processing Unit in order to help visualise the interface.
- **Memory Blocks** : Secondly, the chip must have its memories which will allow it to perform computation. It may have RAM, ROM, EEPROM, or even a flash memory.
- **Timing Units** : Oscillators and PLLs are the timing units of the System on chip.
- Other peripherals of the SoC are counter timers, real-time timers, watchdog timer, and power on reset generators.
- Internal interface bus or a network connecting all the individual blocks includes I2C, and SPI buses.
- Analog interfaces, external interfaces, voltage regulators and power management units form the basic interfaces of the SoC.

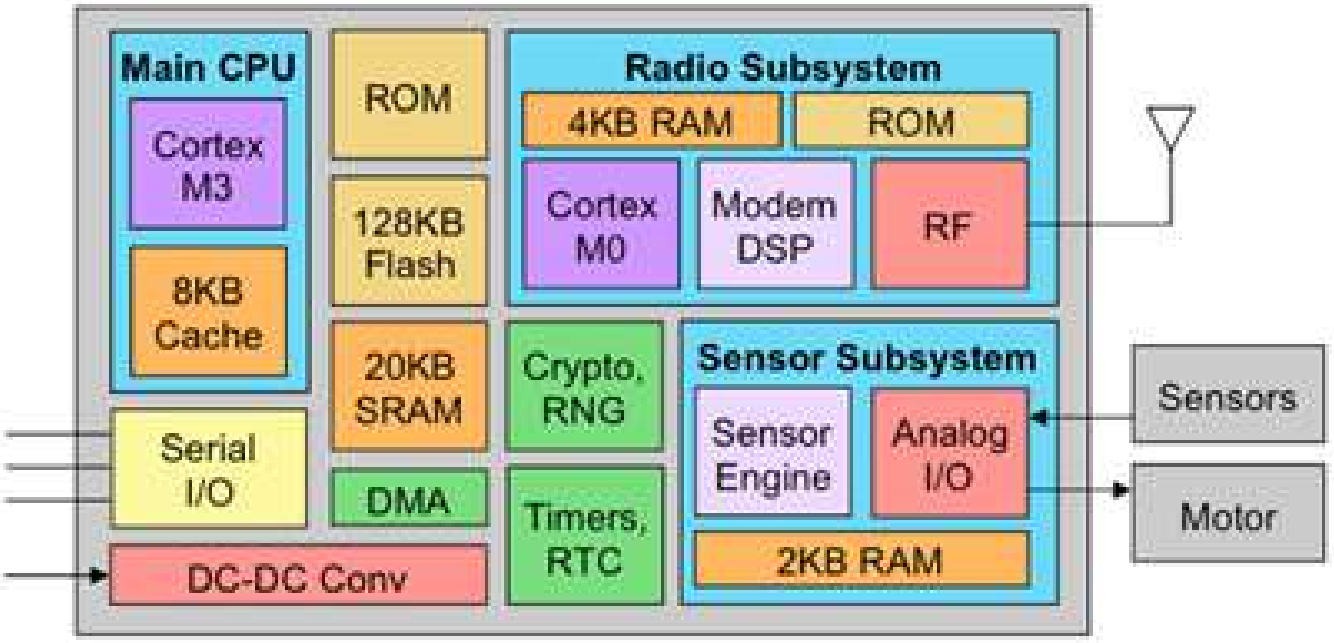

Fig. 4: Block diagram of a low-power TI CC26xx processor (Courtesy: The Linley Group, “Low-Power Design Using NoC Technology”; TI)

- The SoC must possess external interfaces which will help it comply with industry standard communication protocols such as USB, Ethernet, and HDMI. It can also incorporate wireless technology and involve protocols pertaining to WiFi and Bluetooth.
- Other stuff that a SoC may have includes voltage regulators, phase lock loop control systems and oscillators, clocks and timers, analog to digital and digital to analog converters, etc.

Ultimately, the elements incorporated in a SoC correspond to the function it is supposed to perform.

Disadvantages of Television

In general designing SoC silicon at 180nm is feasible for some small and medium sized enterprises (SME)s. However, shrinking the system tends to lower node design challenges like 28nm. SMEs which are developing IoT products choosing a higher node like 180nm over 28nm could be a good strategy. The different SoC design challenges are given below:

- **Architecture Strategy** : The type of processor used to design the SoC.
- **Design for Test Strategy** : SoC design help in checking the faults.
- **Validation Strategy** : SoC validation involves two major issues. First issue to verify the IP cores. While the second issue is to verify the integration of the system.
- **Synthesis Backend Strategy** : SoC tackles issues like IR drop, cross talk, 3D noise, antenna effects and EMI effects.
- **Integration Strategy** : Considered to be assembled to bring out a smooth strategy.
- **On chip Isolation** : Soc considered the impact of process technology, grounding effects, guard rings, shielding and on- chip decoupling.

Advantages of SoC

- Greater design.
- Small size.
- Low power.
- Low cost.
- High reliability.
- Small form factor.
- High integration levels.
- Fast operation.
- Minimise interference and interconnection delays.

Disadvantages of SoC

- Increased complexity.
- Fabrication cost.
- Time to market demands.
- More verification.

Applications of SoC

SoCs in the market are manufactured by Qualcomm Technologies, Intel Technology, Samsung Inc, Apple Inc. The most common application of SOCs are:

- Mobile applications, including smartphones, smartwatches, tablets.
- Signal speech processing, PC interfaces, data communication.
- Integration of communication modules like LTE and wireless networks onto the chip.
- 5G network compatibility.

The popular SoCs market manufactured by Qualcomm Technologies is for smartphones, smartwatches, and the upcoming 5G network compatibility. The SoC is having a wider scope in the near future.

APPLE SILICON M2 : THE NEW POWER PACKED REVOLUTIONARY NANO PROCESSOR

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Introduction

Fig. 1: Apple M2 Processor(Courtesy : Apple)

Apple launched the M2, beginning the next generation of Apple silicon designed specifically for the Mac. Built using second-generation 5-nanometer technology, M2 takes the industry-leading performance per watt of M1 even further with an 18 percent faster CPU, a 35 percent more powerful GPU, and a 40 percent faster Neural Engine.1 It also delivers 50 percent more memory bandwidth compared to M1, and up to 24GB of fast unified memory. M2 brings all of this — plus new custom technologies and greater efficiency — to the completely redesigned Macbook Air and updated the 13-inch MacBook Pro.

The Transition

Apple had already made a revolution using the M1 chip for it's transition from Intel chips to Apple's custom chip , making it much much faster at an accurate increase in performance of about 18 percent at peak clock rate. The integration of an 8 core neural engine provides a smooth lag free OS built for heavy development without putting any strain on the CPU. This makes sure to beat all other current gaming machines to dust in terms of the ecosystem Apple has built for the customers.

Fig. 2: Apple M2 Processor : Benchmark and Specs(Courtesy : NotebookCheck)

Why use Billion Transistors?

All these above features infer about the kind of a power packed machine Apple has launched , like for eg., the 20 Billion transistors, 18 percent faster CPU than the most powerful Windows machine ever existed, Retina Display and ProRes feature, 6K external display support, 4k Video rendering, etc.

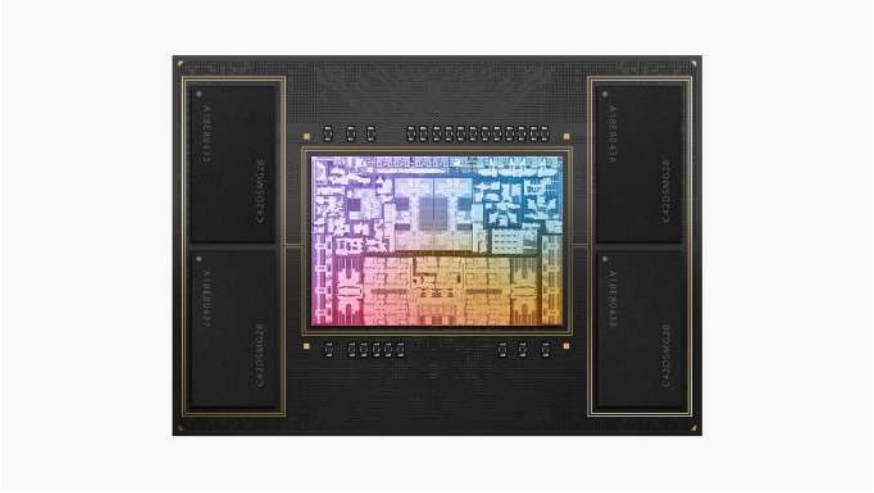

Fig. 3: Die shot of Apple M2 Processor(Courtesy : SemiAnalsis)

Now it's the waiting time for the actual transition into the M2 Pro Max Chip powered Macbooks, which is going to be a power packed beast . Sources predict the M2 Macbooks Air will start at dollar 1200 and M2 Pro Max Macbook Pro at dollar 3000.

Performance Supremacy

The M1 recorded competitive performance and efficiency in popular benchmarks (Geekbench 5, Cinebench R23).
The 2020 M1-equipped Mac Mini draws 7 watts when idle and 39 watts at maximum load, compared with 20 watts idle and 122 watts maximum load for the 2018 6-core Intel i7 Mac mini. The energy efficiency of the M1 increases battery life of M1-based MacBooks by 50 percent compared to previous Intel-based MacBooks.
At release, the MacBook Air (M1, 2020) and MacBook Pro (M1, 2020) were praised by critics for their CPU performance and battery life, particularly compared to previous MacBooks.

Conclusion

Recently, Apple in June 2022 introduced the M2 chip in the updated MacBook Air and 13-inch MacBook Pro. The M2 features the same 8-core CPU as the M1, but it offers more GPU cores, with nine and 10-core GPU options, up from the 7 and 8-core options in the original M1 chip.

ADVANCED DRIVER ASSISTANCE SYSTEM(ADAS)

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Introduction

According to a survey from the National Highway Traffic Safety Administration (NHTSA), human errors contribute to 94 percent of road accidents . With the goal of improving road safety and efficiency, enormous efforts have been made towards the development of electrical vehicles , intelligent transportation systems , and fully autonomous vehicles . However, a large number of challenges present in this process because of the complex nature of driving, as well as factors such as system capability, manufacturing costs, administration regulations, and community safety. It is expected that during the transition period to full automation, vehicles with different levels of automation and human driver engagement will be mixed together to form large-scale traffic environments. Therefore, to create a safe and efficient driving experience, visual guidance systems are suggested or necessary to alert potential risks and/or provide essential advice to drivers.

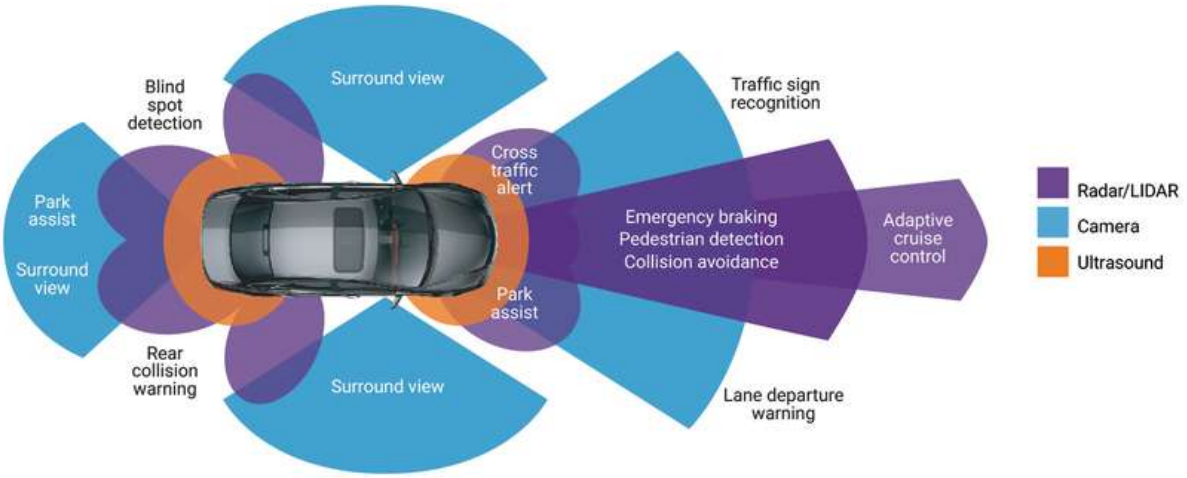

Fig. 1: ADAS : The circle of safety (Courtesy : Team-BHP)

Environment perception has been an essential component for both intelligent vehicles and Advanced Driver-Assistance Systems (ADAS). In addition, recent advancements in signal processing for smart vehicle technologies suggest that there is a growing need to better integrate drivers and vehicles in the research design of future vehicles , including conversational vehicle-driver interaction. International collaborations suggest that cooperation between groups could accelerate best practices , as well as advance driver modeling and system development for distraction detection . Common applications, such as object detection, semantic segmentation, drivable area detection, and object tracking, have been researched for decades in the field of computer vision with cameras as the most commonly used sensors. However, only real-time information of neighboring vehicles can be obtained based solely on cameras and state-of-the-art computer vision algorithms.

By leveraging Digital Twin technology, cloud servers could create and store digital representations of transportation objects (e.g., pedestrians, vehicles, drivers) in the physical world, then cloud-based modules/algorithms will process such data generated by these entities. Predicted information of target objects (e.g., target vehicle's lane change probability) from cloud servers could be used to augment the perceived information by ego-vehicle's cameras after finishing online processes, hence assist better decision making for the driver or ADAS.

Block Diagram

ADAS can be based upon various sensor systems such as radar, camera, lidar and ultrasound. Additionally, they can integrate and use external information sources such as global positioning systems, car data networks and vehicle-to-vehicle or vehicle-to-infrastructure communication systems to efficiently and accurately achieve desired goals. While different sensor modalities have varying performance based on different environmental conditions and applications, camera sensors are emerging as a key differentiator by car manufacturers. Camera based ADAS use various computer vision (CV) technologies to perform real-time driving situation analysis and provide warning to the driver. The advantages of camera based ADAS include reliability and robustness under difficult real life scenarios, and ability to support multiple varied applications such as traffic sign recognition (TSR), traffic light detection, lane and also we can use for an obstacle detection.

To enable different safety aspects of ADAS, camera based systems are deployed in front and back viewing and surround viewing . The front camera systems are used for applications such as AEB and FCW. The rear view and surround view systems are used for park assist and cross traffic alert applications. Front camera systems can use mono or stereo camera setup. Stereo camera is useful to obtain 3D information by generating disparity. However, stereo camera systems are more expensive compared to mono camera systems. Structure from Motion (SFM) technology, which enables obtaining depth from a single camera that is moving, is being widely researched for its applicability in ADAS. Surround view systems use multiple cameras (4 to 6) placed around the car. The feed from multiple cameras are re-mapped and stitched to provide a 360◦ view to the driver. Also, analytics are performed on these images to alert the driver. Recently, Camera Mirror Systems (CMS) are increasingly replacing mirrors in mid/high end cars. In CMS systems the side and rear view mirrors are replaced by cameras and the camera feed is displayed to the driver via display panels (typically OLED display panels). Cameras with wide angle field of view avoids blind spots for the driver. Sophisticated features like wide dynamic range (WDR) and noise filter allow the system to be used in variety of lighting condition including low light, high glare scenarios. Due to the low surface area of the camera lens vs a conventional mirror, a CMS system is less susceptible to the effects of dust, rain. CMS have added advantage of reduced wind drag and thus aiding fuel efficiency. Also, the CMS opens the possibility of running vision analytics on them . In order to fully utilize the capability of camera based systems for multiple applications, it is therefore an absolute necessity to have a high

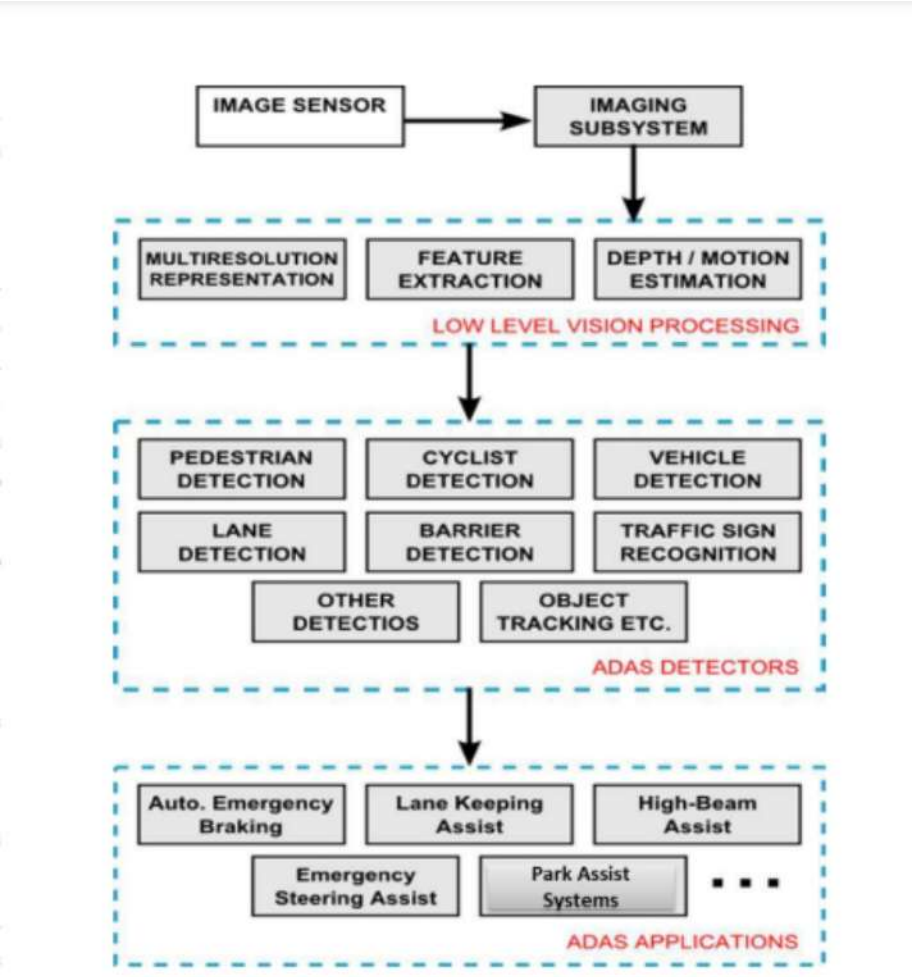

Fig. 2: Blockdiagram of ADAS (Courtesy : thecvs.com)

performance, low power and low cost embedded processor, which is capable of analyzing the data from multiple cameras in real time. In order to solve this problem, Texas Instruments has developed a family of System-on-Chip (SOC) solutions that integrate heterogeneous compute architectures like General Purpose Processor (GPP), Digital Signal Processor (DSP), Single Instruction Multiple Data (SIMD) processor and Hardware Accelerators (HWA) to satisfy the compute requirements while meeting the area and power specifications

- **TDA3x Introduction** - The TDA3x SoC has a heterogeneous and scalable architecture that includes a dual core of ARM Cortex-M4, dual core of C66x DSP and single core of Embedded Vision Engine (EVE) for vector processing. It integrates hardware for camera capture, Image signal processor (ISP) and Display sub-system resulting in better video quality at lower power. It also contains large on-chip RAM, rich set of input/output peripherals for connectivity, and safety mechanism for automotive market and offers lower system cost. There are three types of programmable cores in the TDA3x SoC.
- **Digital Signal Processor (DSP)** - TDA3x contains a dual core of C66x DSP. The C66x DSP is a floating point VLIW architecture with 8 functional units (2 multipliers and 6 arithmetic units) that operate in parallel as shown in Figure 3. It comprises of 64 general purpose 32-bit registers shared by all eight functional units. There are four arithmetic units .L1/.L2, .S1/.S2, two multiplier units for .M1/.M2 and two data load and store units .D1/.D2. Each C66x DSP core has configurable 32KB of L1 data cache, 32KB of L1 instruction cache and 288KB of unified L2 data/instruction memory.

- **General Purpose Processor (GPP)** - The dual core or ARM Cortex-M4 CPU running at 212.8 MHz serves as the general purpose processor in the TDA3x . The M4 cores deliver efficient control and processing camera stream.
- **Embedded Vision Engine (EVE)** - TDA3x contains a single core of Embedded Vision Engine (EVE). EVE is a fully programmable accelerator specifically to enable the processing, latency and reliability needs found in computer vision applications. The EVE includes one 32-bit Application-Specific RISC Processor (ARP32) and one 512-bit Vector Coprocessor (VCOP) with built-in mechanisms and unique vision-specialized instructions for concurrent, low overhead processing. The VCOP is a dual 8-way SIMD engine with built-in loop control and address generation. It has certain special properties such as transpose store, de-interleave load, interleaving store and so on. The VCOP also has specialized pipelines for accelerating table look-up and histograms.

Applications

- Adaptive Cruise Control
- Glare-Free High Beam and Pixel Light
- Adaptive Light Control
- Automatic Parking
- Autonomous Valet Parking
- Navigation System

Advantages

Advantages of ADAS include: Automated adaptation and enhancement of safety systems to improve driving among the population. ADAS are intended to avoid collisions by using technologies to alert drivers to potential hazards or take over control of the vehicle to avoid such dangerous adaptive features.

Conclusion

ADAS applications require high-performance, low power and low area solutions. ADAS are one of the fastest-growing segments in automotive electronics. ADAS will be completely accepted and widely introduced in near future. Introduction of some sub-systems are technically possible now but public introduction on a large scale is waiting for safety provisions.

As the automotive industry seeks to find better ways to help ensure the safety of drivers, pedestrians, property, and vehicles, ADAS offers the technology and ability to reduce driver error and, as such, accidents. They also provide consumers with the benefits of convenience and safety.

A REMOTE CONTROL SYSTEM FOR EMERGENCY VENTILATORS DURING SARS-CoV-2

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Introduction

When COVID 19 began to spread all over the world in a fast pace, it caused a lot of troubles. Among which the people mostly affected by it was those living in low socio-economic status regions. The advanced medical technologies and treatments were not within their proximity. They had to rely on what is available to them. Following this the global communities sprang into action mass producing emergency makeshift ventilator designs. This created another major problem. There arose this huge gap between the quantity of new mechanical ventilators and the number of skilled physicians to operate them.

New trainees were not able to complete training at the rapid pace of ventilator production. So basically even if there was functional ventilators available they were rendered unusable next to the untreatable patients. As a solution this article covers over a universal remote control system for makeshift ventilators that uses low cost hardware add on modules to connect to different ventilators featuring a 3 tier control architecture to interface with telemedicine software allowing caregivers to quickly and easily monitor and control these ventilators remotely and efficiently. The ventilator design varies between 2 extremes:

- Most advanced systems that contain digital systems to control and monitor ventilator parameters.
- NHS RMVS001 specification based Ventilators for emergency therapeutic systems.

The most fundamental structure of a ventilator consists of a bag valve mask (BVM) that is automatically squeezed by a motorized contraption at regular intervals depending on patient's various parameters. The makeshift ventilators are often built from salvage materials and feature only basic electronic control of respiratory rate. Ventilated patients must be carefully monitored by a physician to avoid treatment injuries such as barotrauma. Given limited number of caregivers, taking care of such large number of ventilated patients is almost impossible. This can be solved by the use of a remote monitor to control various ventilators handled by a trained personal. This will limit physical access to a percentage and make the whole process achievable. Remote care subsequently improves access to care in medically underserved and low socio-economic status based communities and reduces the need for PPE and such expensive equipment.

Objective

The main objective of this concept is to develop a universal remote control simple enough to be built from salvaged parts yet sophisticated enough to be universally compatible with a wide range of ventilators. Since a hierarchy based approach is employed here, it will be able to work with even the cheapest model to the most advanced ones without further trouble. Hardware add-on designs that facilitate remote access

to the major class of ventilators via a 3.5 mm audio jack is made possible. Since this whole idea revolves around low economy regions, smartphones providing average features will be most common there and they will feature an audio jack most definitively in contrary to high end models that provide Bluetooth only connections. Smartphone remote control software that automatically negotiates the most sophisticated tier of control with ventilators is provided. The remote control technology is most required most acutely in low SES regions since these areas have the fewest doctors per capita and benefit the most from the tele-health aspect.

Architecture

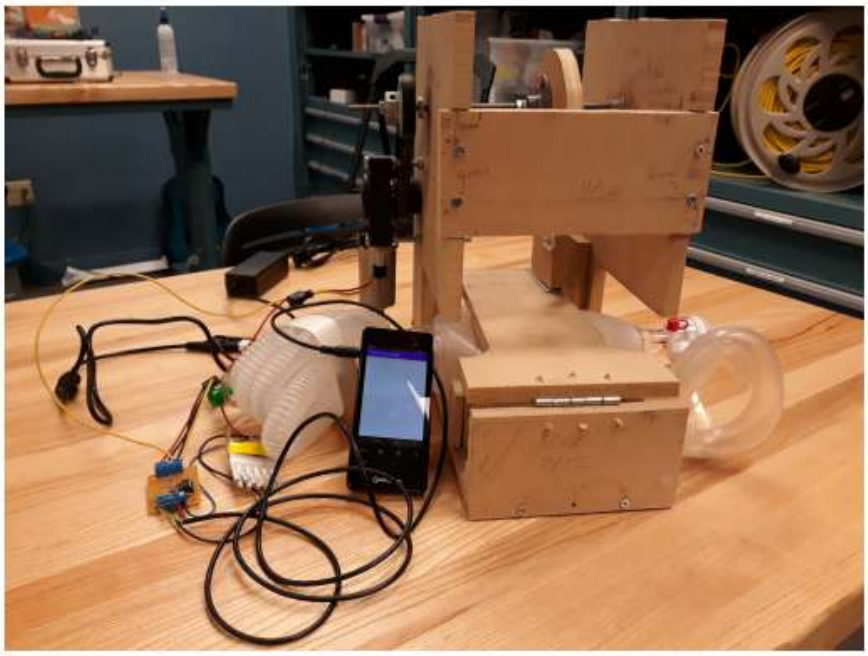


Fig. 1: Example of Universal Control for a simple Tier 1 makeshift ventilator (Courtesy : IEEE Xplore)

The architecture used can enable the use of a smartphone as a remote interface to different ventilators with varying specifications. This makes possible for a physician to easily connect to the ventilator, monitor and control the patient's respiration parameters. It allows different ventilators to connect to a tele-medicine service which allows the physician to monitor and handle multiple patients at once. The novelty in this approach is the graduating sophistication of ventilator control protocols by using orthogonal encoding mechanisms. This architecture also features a plug and play smartphone control of devices no matter the complexity whether it is a simple motor grade pump or ICU grade ventilator device.

The framework uses a simplex connection in TIER 1 in which a mobile device connects to a ventilator using pulse width modulation to control the speed of a ventilation actuator. TIER 1 features only control over the basic ventilator parameter only being the respiration rate since they are typically built from salvage and do not use microcontrollers rendering them unable to take data from patient's side and inability to process information. TIER 2 controls are specifically for those ventilator designs with RMVS001 specification and provides complex control of ventilator parameters with capacity to read patient data. To meet this standard, an orthogonal encoding using frequency shift keying modulation is employed to support a message passing interface between the mobile device and a central microcontroller unit. The mobile device will provide a half-duplex connection to a central MCU which supports a far wider variety of interface connections to the ventilator such as GPIO, I2C and SPI. This provides the system capable

of read and write of ventilator control registers to control additional parameters such as Tidal volume, Positive end- expiratory pressure, Peak Pressure, Plateau Pressure etc... The TIER 3 model uses the same architecture as found in TIER 2 but allows a ventilator to negotiate additional custom control capability to extend the RMVS001 specifications. This higher level architecture is still open to further research and modifications. With necessary tweaks in this models it can provide similar functionality to an ICU grade ventilator system.

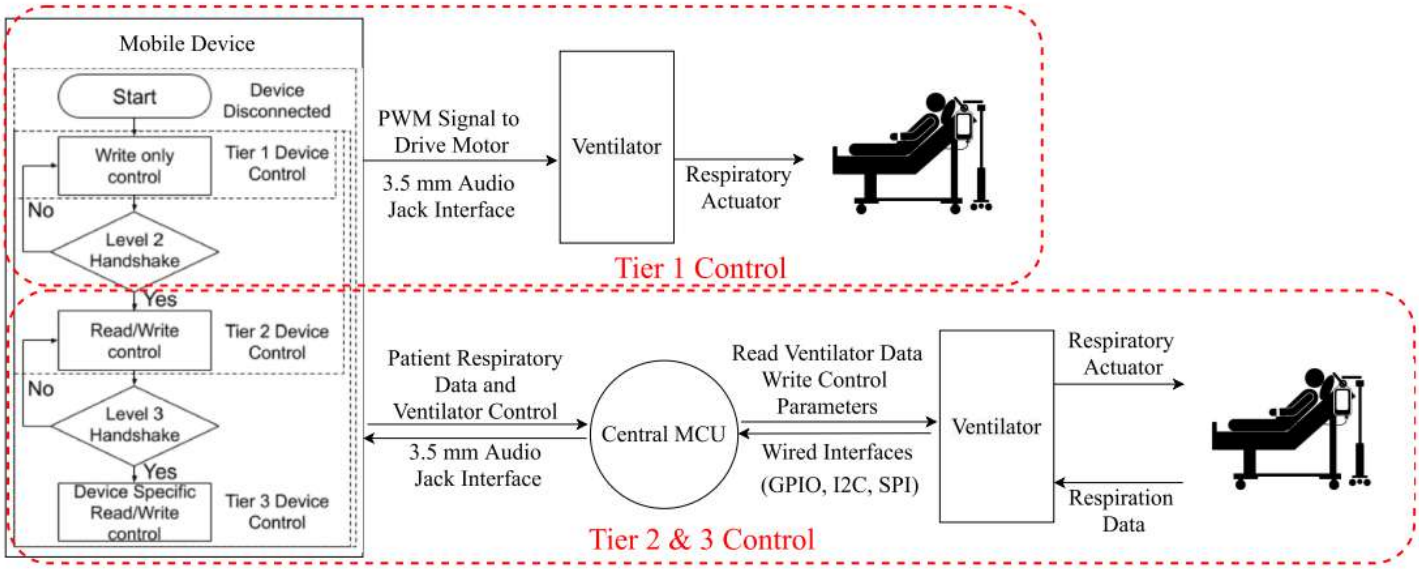
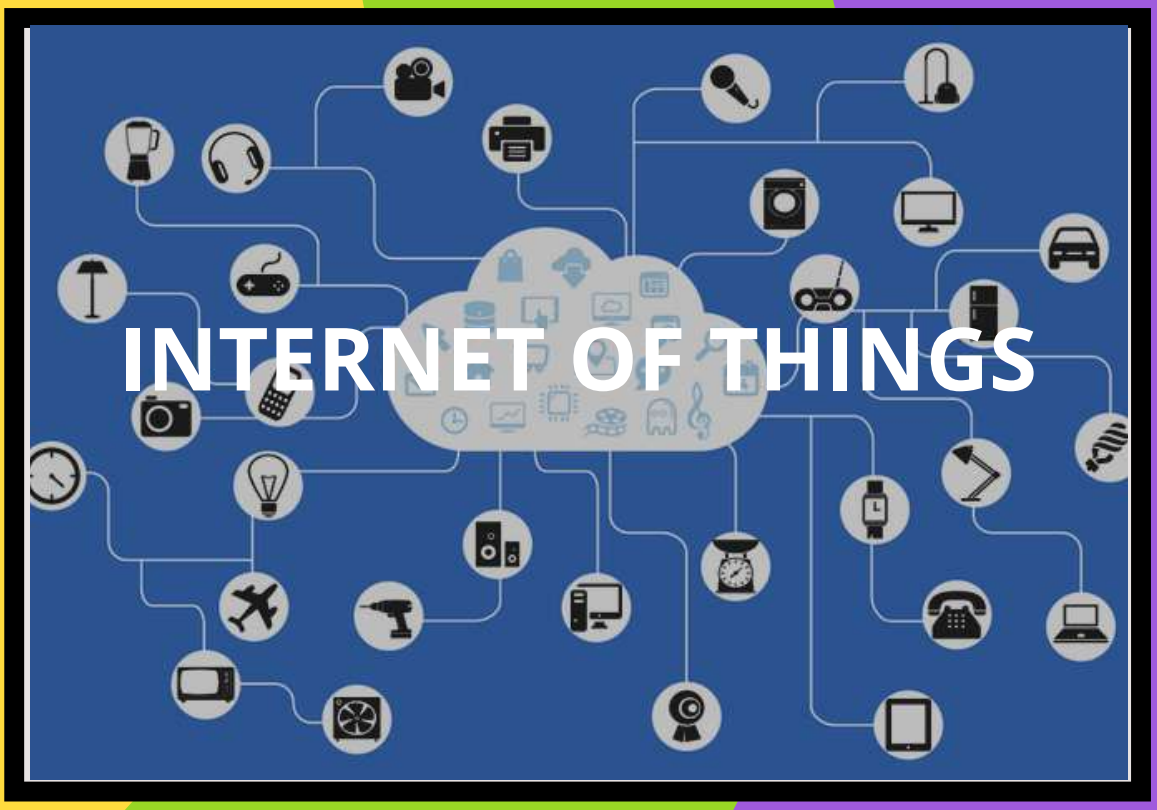


Fig. 2: Three-tier ventilator control architecture (Courtesy : IEEE Xplore)

Conclusion

The COVID-19 pandemic caused a large surge in the demand for ventilators. This was responded to via the design of makeshift ventilators. However, this only gave rise to another problem. That is how to control these ventilators given a limited amount of physicians. The problem was addressed by the development of a three-tier universal ventilator remote control architecture. The architecture involves integrating remote control into two makeshift ventilators at different ends of design complexity found in the literature. By integrating telehealth with our architecture, our remote control scales the number of patients a single physician can treat


INTERNET OF THINGS

IoT BASED SMART ENERGY MANAGEMENT SYSTEM

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Introduction

Rising power consumption with temperature is a challenging situation for the power sector to manage demand at consumer side since devices like air conditioning consume massive power. Smart solutions for this include designing Smart Grids, energy management systems (EMS). Smart control of consumer devices using the internet of things (IoT) with the inclusion of IoT in EMS has given birth to smart EMS (SEMS), IoT enabled devices that can be controlled smartly from anywhere in the world and providing efficient energy management.

Data provided by the SMs is used by power supply companies to revolutionize power distribution and consumption through various techniques such as, non-intrusive load monitoring and demand-side management (DSM).

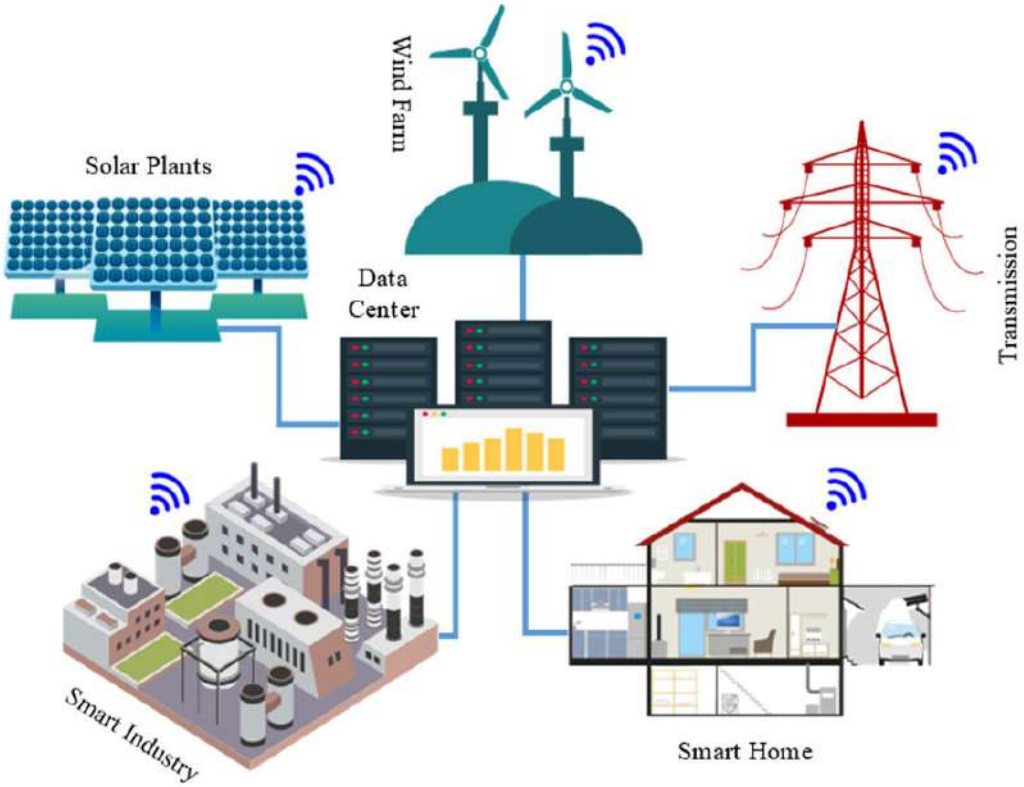

Fig. 1: Smart Grid(Courtesy : researchgate.net)

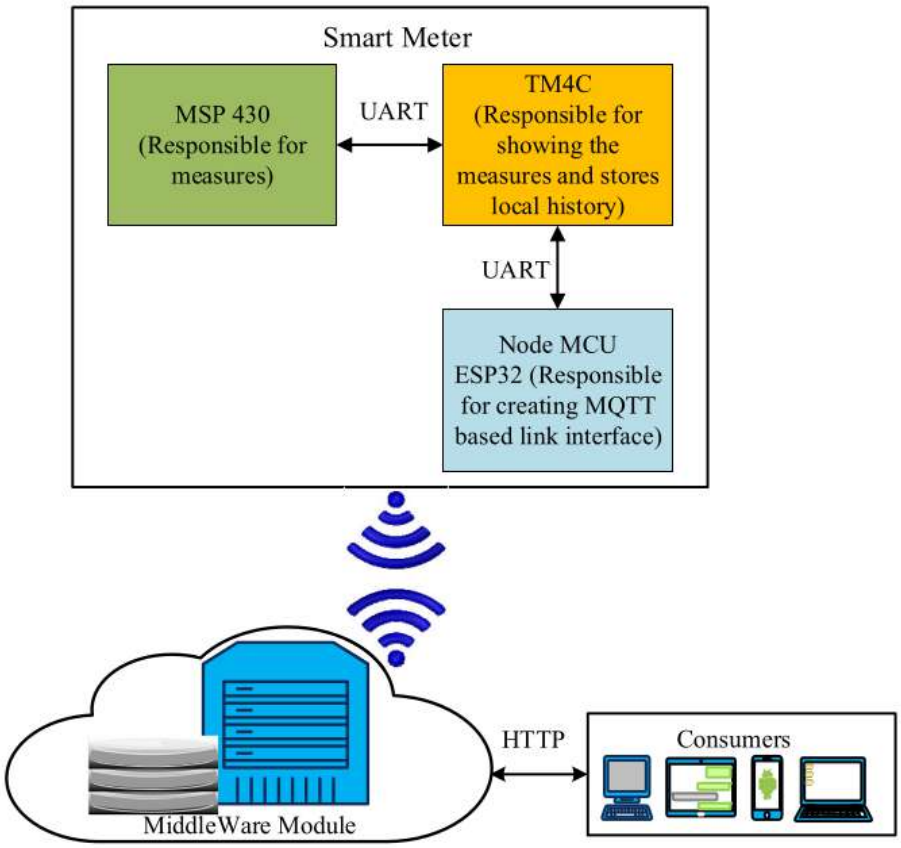

Fig. 2: Schematic of a Smart Grid(Courtesy : semanticscholar.org)

Transmitter end

MSP430 MCU reads the parameters of the grid, gathers data such as current and voltage and transmits the data via UART to other MCU TM4C. TM4C collects and stores the data and updates it roughly once in every 30 seconds and saves in EEPROM memory with an interrupt. a function in TM4C sets up a link with each collected grid parameter obtained through MSP430 to a valid JSON format. enabling the transmission of data to the third MCU using UART. further empowering the SM to facilitate MQTT protocol for IoT middleware module (every 30 seconds).

Receiver end

IoT middleware links basic systems like various IoT based devices to mediator applications facilitating connectivity and inquiries to users. API is used to link the IoT middle to the consumers to support bidirectional communication and real time data collection. The analytical engine server tool further enables SEMS to evaluate efficiency of the electricity provided to the facilities, characteristics of usage and analysis at different times.

The IoT middleware uses MQTT (Message Queuing Telemetry Transport) a messaging protocol for restricted low-bandwidth networks and extremely high-latency IoT devices.

The communication between MCU(UART) and the ENTRACK software can be further used for energy analysis. Data of users can be analyzed and further developed as a means to control energy consumption by analyzing power allocation, utilization, and consumption at both, single device, and network level. U's are attained using universal asynchronous receiver-transmit

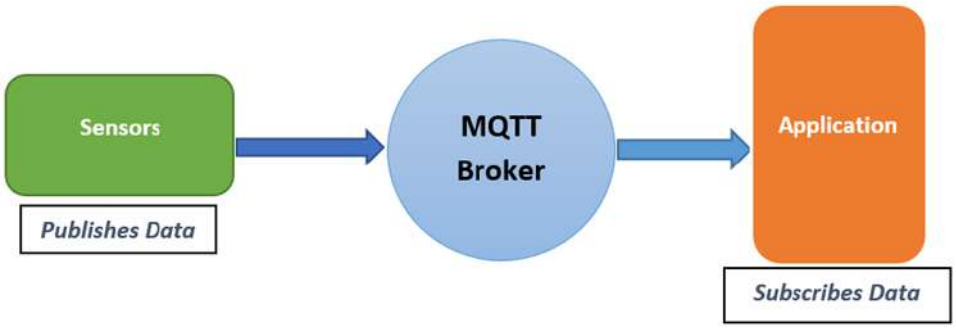

Fig. 3: MQTT(Courtesy : circuitdigest.com)

Common applications

- Data provided by the SMs is used by power supply companies to revolutionize power distribution and consumption
- Can find solutions for shortage of energy distribution throughout a building, identifying problem areas.
- Theft Monitoring and transparency in usage.
- Monitor the area having more demand for power.
- Low cost design for implementing smart grids.

Advantages of SEMS

- **Reduce energy consumption**-It comes with smart metering, real-time power usage monitoring, and data-driven predictions that eliminate energy waste in buildings.
- **Minimize carbon emission in buildings**- decrease the carbon footprint up to a great extent. At the same time, it optimizes resource utilization, measures environmental impact, and builds future-oriented strategies.
- **Predict energy consumption patterns**-The advanced IoT technology and machine learning algorithms help in predicting energy consumption in the future. It allows energy companies to prepare a data-driven strategy for energy production and improve their demand-based pricing models. Ensuring energy savings becomes possible with IoT data and machine intelligence.
- **Cut down operational expense of facilities**-The operational expense depends on automation, an optimized workforce, and effective asset maintenance. IoT-based energy management solution reduces 90% of time and effort spent on energy analysis, reporting, and calculation.

Disadvantages of SEMS

- Ensuring the security of metering data
- Transitioning to new technology and processes
- Verifying that the new meter is accurate

Conclusion

Starting with an introduction on smart energy management systems, its working, implementation, advantages and disadvantages that we identified are discussed.

IoT SECURITY

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Introduction

IoT security is the technology segment targeted on safeguarding connected devices and networks within the IoT. As in keeping with latest estimates, the wide variety of internet of things (IoT) devices will surpass 50 billion by the coming years. Unsurprisingly, this increase of IoT devices has drawn the attention of attackers who searching for to take advantage of this new technology for their own benefit. It's important to ensuring the safety of networks with IoT devices related to them. IoT safety, consists of a huge variety of techniques, techniques, protocols and actions that goal to mitigate the increasing IoT vulnerabilities of present day businesses.

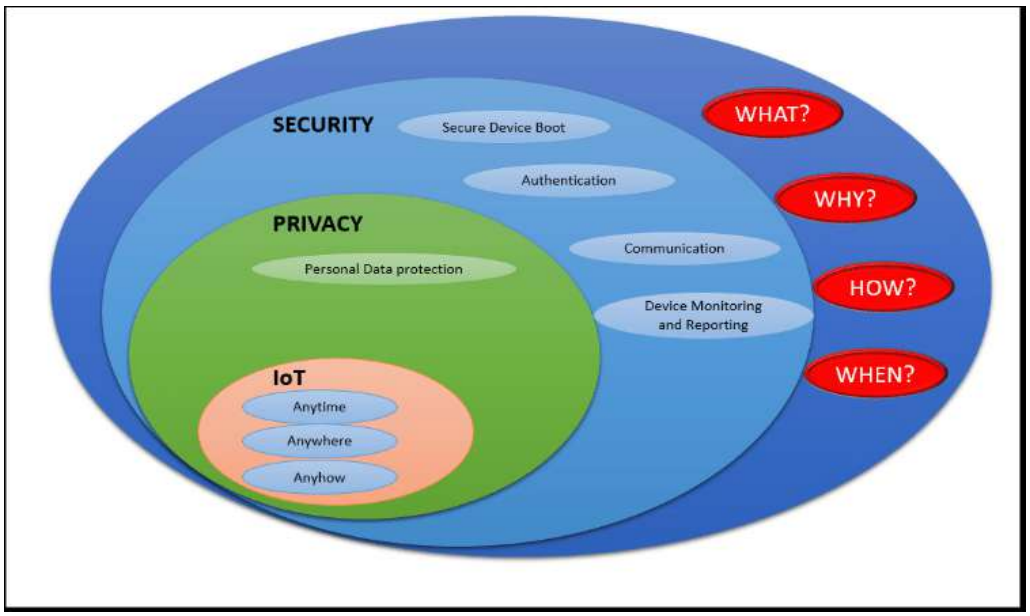

Fig. 1: IoT security model (Courtesy: ResearchGate)

Internet of things security remains a veritable minefield, and problems with IoT cyberattacks and malware can most effective continue to grow together with the range of devices. So why is it so tough to comfy IoT devices, and what are we able to do about it?

When thinking about conventional Internet programs, common dangers revolve around monetary losses, leakage of private non-public records and harm of popularity of the agency. But, as IoT starts to penetrate to virtually all sectors of the society, along with retail, transportation, domestic automation or even healthcare, any protection breach may show catastrophic to the actual person and its physical world. Such concerns may also decrease the person's confidence in the direction of the IoT technology as an entire and impede its adoption.

Common IoT use cases

- **Home Automation** - Display and control domestic attributes like temperature, lights, entertainment systems, home equipments, and alarm systems. Common smart devices for home automation encompass assistant speakers, thermostats, fridges, plugs, and bulbs.
- **Healthcare** - Medical IoT (MIoT) Affords plenty of possibilities for healthcare specialists to monitor patients, in addition to for patients to monitor themselves. Smart devices for MIoT include wirelessly connected fitness bands, blood pressure and heart charge monitoring cuffs, and glucometers.
- **Smart cities** - Use informations accrued by means of smart devices to improve infrastructure, public utilities, and offerings. Such gadgets can be connected sensors, lights, meters, waste bins, and air quality monitoring structures.
- **Wearables** - Primarily used for healthcare and sports. Such devices include health trackers, electrocardiogram video display units, blood stress video display units, and smart watches.

Fig. 2: Common IoT use cases (Courtesy : Apriorit.com)

- **Connected cars** - Automobiles equipped with access to the internet that can share that access and data with devices inside and outside the automobile. This technology allows people to remotely access the vehicle functionality using a mobile app, enhance safety, and pay tolls automatically.
- **Smart warehouses** - Use automated and interconnected technologies to help agencies increase productivity and performance. Common components of a smart warehouse encompass robots, drones, radio frequency identification (RFID) scanners, artificial intelligence-driven programs, and complex warehouse management software.

Why protection/security comes last in IoT devices?

Fast innovation mixed with the promise of brief earnings in an immature and competitive marketplace is clearly no longer true for security. Smart devices focus on innovative capability and ease of use, and including safety may restrict center features or degrade the user revel in. That is in particular proper for consumer-oriented products that need to run instantly out of the box with out overly technical setup procedures. IoT devices create a bridge between a secure network and insecure devices. Whilst compromised, they can cause leaked information or unauthorized access. This is due to the very nature of the devices. Often, they're too low-powered to support necessary encryption, and they usually grant access to shared networks.

A way to secure IoT devices on your corporation

As the market and generation mature, necessities and satisfactory practices must emerge to manual IoT tool manufacturers in growing and delivering greater secure products. In the interim, stopgap IoT security solutions are available, inclusive of security services that isolate devices from public internet with the resource of performing as a proxy to clear out any malicious web site traffic. For devices that offer an internet client interface and/or communicate through rest APIs, you may use an internet vulnerability scanner to test for problems.
Other than that, the best advice is to research the device, supplier, and software application in detail earlier than committing to a product and to deal with any IoT device as insecure via default. In the end, practice some common-sense security functions to make certain no longer whatever slips under the radar: preserve an inventory of all devices, deploy the modern day firmware earlier than deployment, limit administrative get proper of entry to, and isolate devices from manufacturing systems as lots as feasible.
The devices connected to IoT may be secured by means of enforcing active security features of their software. Offering security features together with password protection for gaining access to the software is one of the methods to guard devices from threats and capacity attacks. Passwords may be in the form of virtual codes, static or dynamic, exclusive to the consumer. Every other technique to offer IoT security is to restrict using internet on the linked devices. Blockading a application at the back of a firewall or proscribing usage to most effective positive capabilities of the software program, saving critical data from leaking. All of the devices linked to the community ought to be up to date to the trendy software program. Constant tracking for capability threats should be placed into practice and immediate resolution need to be sought for bugs and safety loopholes discovered in the course of an inspection.

Types of IoT Security

- **Network security** - Users want to guard their devices towards unauthorized access and potential exploitation. IoT network security implements a zero-trust security strategy to reduce the corporate attack surface.
- **Embedded** - Nano marketers offer on-tool safety for IoT devices. Runtime protection monitors the current state of the device and takes action based totally on anomalies to discover and remediate zero-day attacks.
- **Firmware Assessment** - Firmware security starts with assessing the firmware of a protected IoT device. This unearths potential vulnerabilities within an IoT device's firmware.

Conclusion

On the aspect of an exponential increase in connected devices, each thing in IoT communicates packets of information that require reliable connectivity, storage, and protection. With IoT, an organization is challenged with handling, tracking, and securing immense volumes of data and connections from dispersed devices. As consumers come to be greater aware concerning their privacy and safety of the IoT devices, protection need to improve. For the safety of these devices, IoT will in all likelihood use hardware firewalls to make certain security from hacks, viruses and phishing scams.

IoT ENABLED DISASTER MONITORING SYSTEM USING UGV AND UAV

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Introduction

IoT can't stop disasters from happening, but it can help identify life-threatening hazards, alert authorities at an early stage, and assist in rescuing those affected, saving lives, resources, and money. Through the use of IoT technologies emergency management and response can be enhanced, and as a result have far better outcomes.

Australian bush fires, Indian monsoons, earthquakes in Japan, Northeasters along the US east coast – most natural disasters are inevitable, but the worrying news is that they are on the rise. According to a United Nations (UN) report from October 2020, extreme weather events have dominated the disaster landscape in the 21st century, and it can be linked to a rise in climate-related disasters, including extreme weather events.

To put this in perspective, between 2000 and 2019, there were 7 348 major recorded disaster events, which claimed 1.23 million lives and affected an additional 4.2 billion, resulting in nearly dollar 3 trillion in global economic losses. What makes these figures stand out is that they show a sharp increase over the previous twenty years, which saw just over 4 000 disasters which led to roughly dollar 1.6 billion in economic losses and claimed 1.19 million lives.

Floods and storms have seen the most prevalent increase, with floods more than doubling, but there have also been major increases when it comes to drought, wildfires, and extreme temperature events, along with a rise in geo-physical events, such as earthquakes and tsunamis, which have killed more people than any other natural hazard. Add man-made disasters, such as hazardous material spills, infrastructure failures, and explosions, to that pile and it's obvious that emergency preparedness has to not just improve but become more efficient.

Disaster response systems have always been a concerning factor for Disaster relief and prevention agencies all over the world. A heap of heavy blows in nature can cause the cycle of balance to trip off. Which is why many agencies are investing more into disaster prevention systems. A new such concept is the UGV and UAV integrated monitoring system. It uses a clustered UGV and UAV System to monitor data and take necessary measures to tackle a disaster.

Deep Analysis

An unmanned ground vehicle (UGV) is a vehicle that operates while in contact with the ground and without an onboard human presence. UGVs can be used for many applications where it may be inconvenient, dangerous, or impossible to have a human operator present. Generally, the vehicle will have a set of sensors to observe the environment, and will either autonomously make decisions about its behavior or pass the information to a human operator at a different location who will control the vehicle through teleoperation.

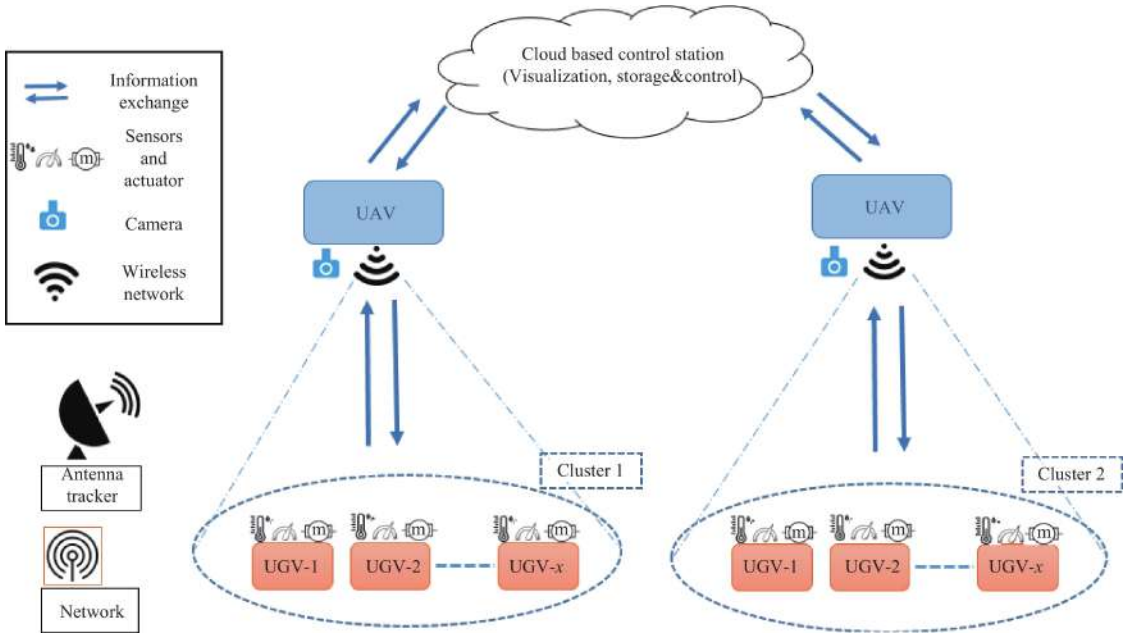

Fig. 1: System architecture of IoT enabled autonomous system (Courtesy : IEEE Xplore)

Cluster Analysis

Most of the aforementioned studies are theoretical concepts, while a practical low-cost implementation of a platform that combines these functionalities of UAVs along with UGVs through an efficient M2M communication protocol, is lacking in the literature. To address these gaps, we propose a heterogeneous framework in which UGVs, UAVs and human operators at the remote control station work collaboratively to accomplish a mission. In this platform, UGVs collect environmental information through their onboard sensors.

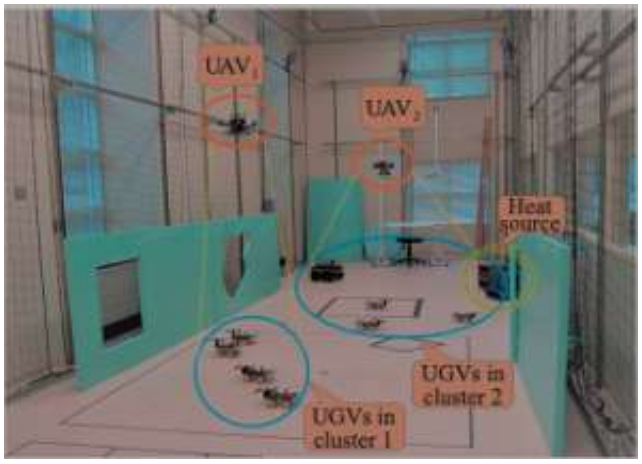

Fig. 2: Demonstration of collaborative search and rescue operation using UGVs and UAVs.(Courtesy : IEEE Xplore)

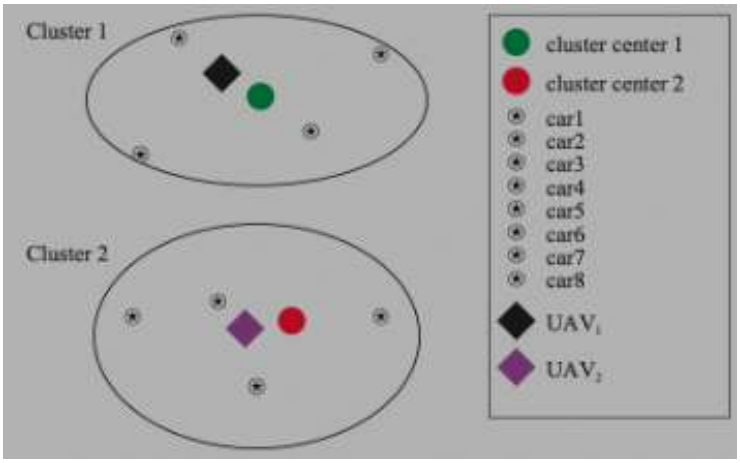

Fig. 3: The clustering algorithm running in real-time and sending signal to the UAVs to hover at the centre of group of UGVs.(Courtesy : IEEE Xplore)

UAVs monitor UGVs and the search environment from above, while relaying the UGVs' collected information to the remote control station. An Antenna tracker is designed and developed which connects to the UAVs to extend the infrastructure coverage to UGVs and enable UGVs to explore farther locations. Finally, the performance of the proposed framework is verified through AADL to ensure that the design meets predefined system requirements.

Conclusion

Currently this field is under research and a market model is expected to be released around 2025.
The Internet of Things technology becomes actually a part of one human life. In fact, it can connect the world and allow humans to connect with each other. In some applications, this technology could be life-saving. As an example, it allows us to save lives of many by disaster management where there is a loss of human life and disruption to a large-scale environment due to natural and man-made disasters. As the IoT permits interconnections of different devices, the IoT-enabled disaster management system, for early-warning systems, is used by implementing information analytics and computational tools. We relate various open research issues for IoT disaster management programs in this survey. In disaster management, IoT devices are playing a very important and unique role and mitigate the effect of disaster. This survey paper presents IoT-based disaster management of different disasters and compares between some existing solutions for disasters presenting the role of IoT in disaster management. It shows implementation of some examples of IoT applications, such as, the early-warning system for fire detection and earthquake. It describes the whole application, IoT architecture, and focuses on the study of different disasters.


METAVERSE

METAVERSE

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Introduction

The metaverse is a concept of a persistent, online, 3D universe that combines multiple different virtual spaces. You can think of it as a future iteration of the internet. The metaverse will allow users to work, meet, game, and socialize together in these 3D spaces. The metaverse is a concept of an online, 3D, virtual space connecting users in all aspects of their lives. It would connect multiple platforms, similar to the internet containing different websites accessible through a single browser.

Metaverse Approaches

Natural interaction is an essential condition for increasing immersion in the Metaverse. It can reproduce the faces of friends and celebrities to enable realistic interactions and to instill the illusion of users with familiar and famous places. Temporary dissociation, concentration, and heightened enjoyment are important factors in the interaction, and emotions of control, curiosity, and intrinsic motivation are used. The target of interaction is mainly human, and hands are an important feature.

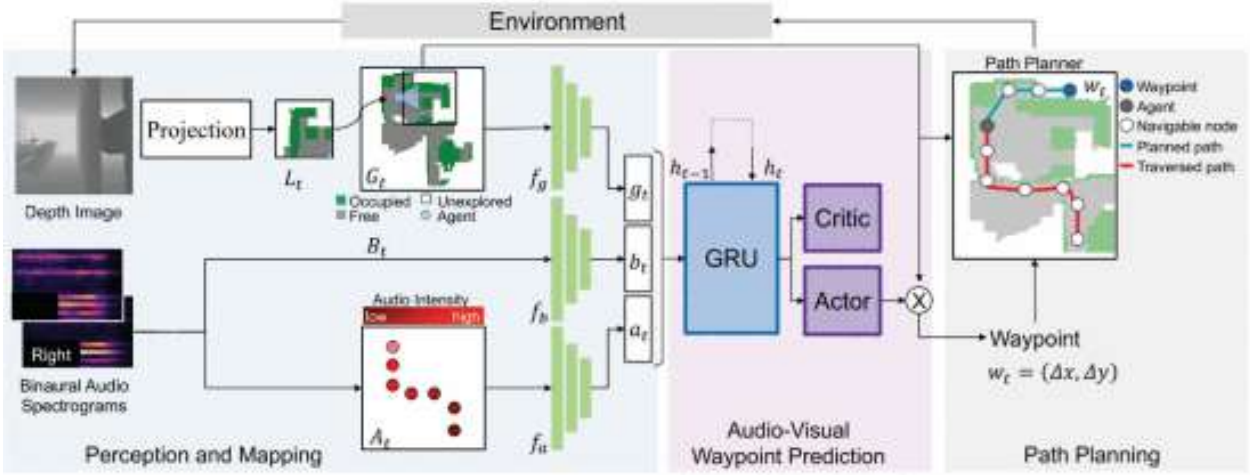

Fig. 1: Approaches of Metaverse (Courtesy : Google)

Metaverse Examples

- **SecondLive** : SecondLive is a 3D virtual environment where users control avatars for socializing, learning, and business. The project also has an NFT marketplace for swapping collectibles.

- **Axie Infinity** : Axie Infinity is a play-to-earn game that's provided players in developing countries an opportunity to earn consistent income. By purchasing or being gifted three creatures known as Axies, a player can start farming the Smooth Love Potion (SLP) token.
- **Decentraland** : Decentraland is an online, digital world that combines social elements with cryptocurrencies, NFTs, and virtual real estate. On top of this, players also take an active role in the governance of the platform. Like other blockchain games, NFTs are used to represent cosmetic collectibles.

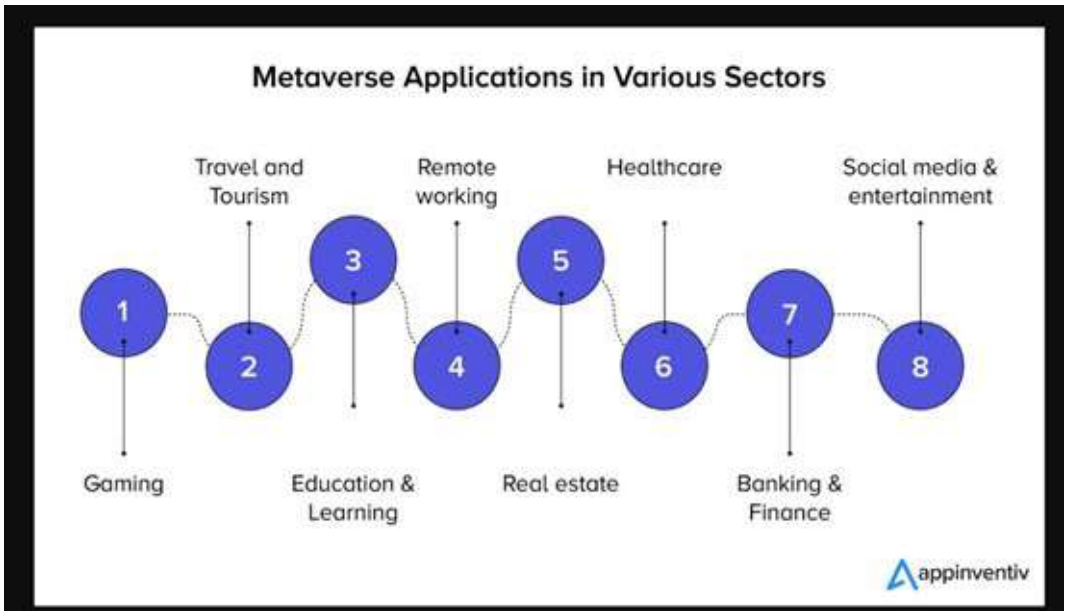

Fig. 2: Applications of Metaverse (Courtesy : Google)

Metaverse Applications

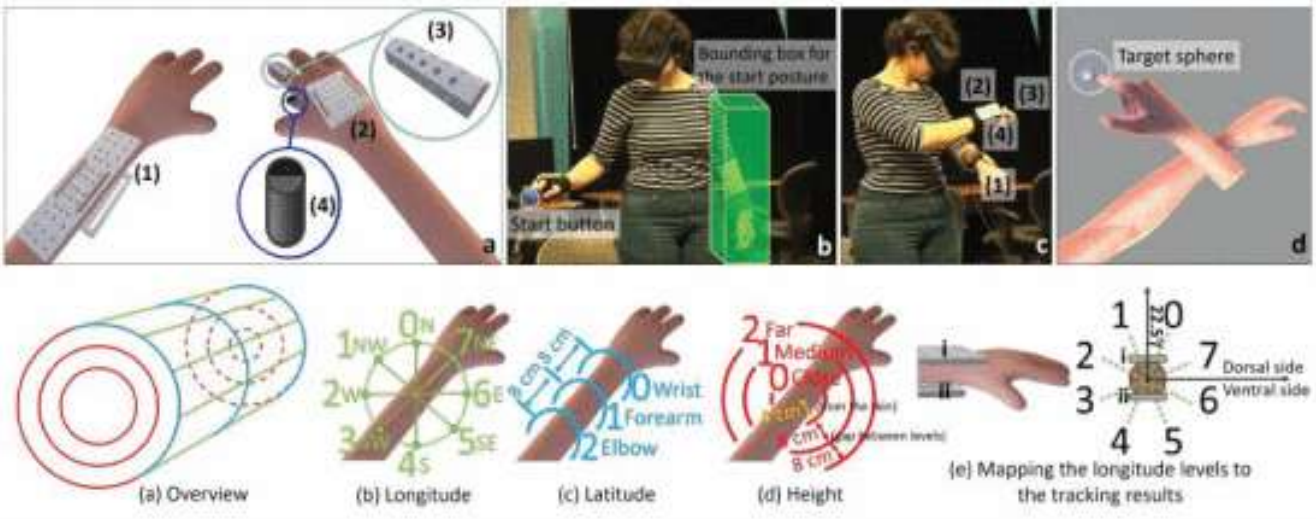

Fig. 3: Healthcare Applications of Metaverse (Courtesy : Google)

- **Gaming** : Gaming industry is said to be one of the core and primary investors of Metaverse technology. This technology allows players to interact with other participants within a single interoperable environment.
- **Education and Learning** : The education and learning potential of the Metaverse is as promising as its other applications. VR combined with effects of Metaverse has brought the learning experience to a qualitative new level.
- **Healthcare** : Metaverse use cases in healthcare and have opened new channels for delivering treatments at low costs with improved outcomes.Telemedicine and Telehealth is a concept fueled by the Metaverse post pandemic where patients and doctors can interact in virtual 3D clinics.
- **Banking and Finance** : Metaverse use cases in banking are underrated yet flourishing and taking new heights. The banking metaverse gives a 360-degree overview of physical banks from any location.
- **Social Media and Entertainment** : Metaverse for social media is a long running concept that has radically transformed online entertainment for audiences. Users have now started communicating using digital avatars and virtual clones. On another instance, Facebook has already changed its name Meta which is an obvious sign of heavy business opportunities in the digital media space.

Future of metaverse

Facebook is one of the loudest voices for the creation of a unified metaverse. This is particularly interesting for a crypto-powered metaverse due to Facebook's Diem stablecoin project. Mark Zuckerberg has explicitly mentioned his plans to use a metaverse project to support remote work and improve financial opportunities for people in developing countries. Facebook's ownership of social media, communication, and crypto platforms give it a good start combining all these worlds into one. Other large tech companies are also targeting the creation of a metaverse, including Microsoft, Apple, and Google.

Disadvantages of the Metaverse

- Privacy Issues. The metaverse is the next version of the internet, and we use technology like augmented and virtual reality to immerse ourselves in the digital world.
- Protecting Our Kids.
- Health Concerns.
- Access Inequality.
- Metaverse Laws.
- Desensitization.
- Identity Hacking.

Conclusion

Starting with an introduction on metaverse, its types, overall idea, advantages, disadvantages and applications that we identified are discussed.

AUGMENTED REALITY

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Introduction

Augmented reality is forging ahead from a mere science fiction concept to a science-based reality. The very concept of augmented reality was first presented by Frank.L.Baum in his novel “The Master Key” penned in 1901. “Character Marker”, a set of electronic spectacles that overlays data onto people.
Contemporarily, augmented reality is a view of the actual physical world in which components are aggrandized by computer-generated input.

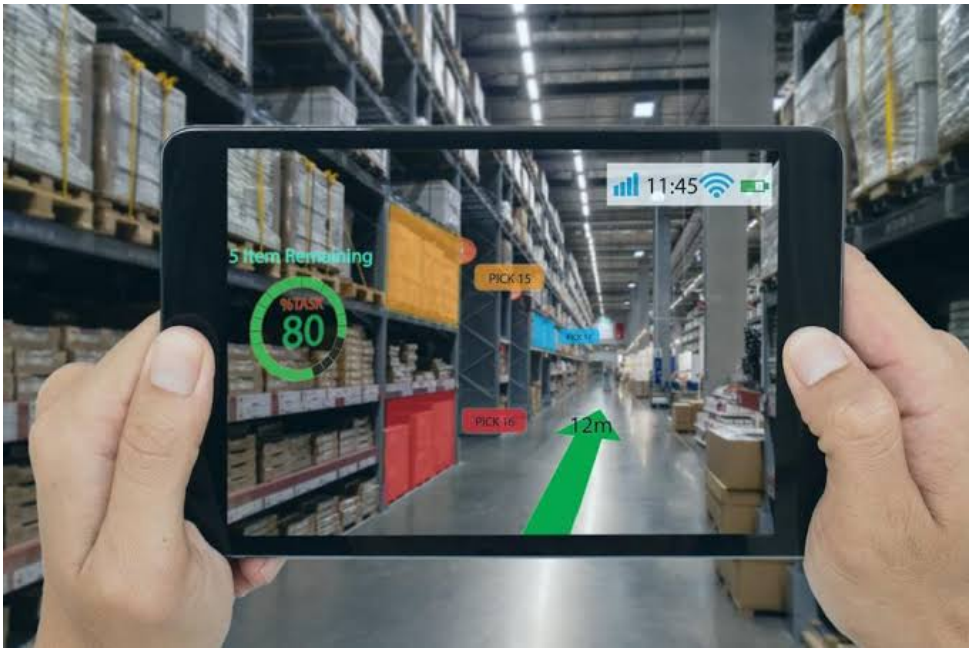

Fig. 1: Augmented reality for business (Courtesy : TechRepublic)

It is composed of visual, auditory, olfactory and somatosensory modalities. We can view 3D images as well as create an entire world that exist parallel to our world.
AR technology is employed across industries such as marketing ,healthcare ,education, product development, manufacturing and many more. It has tremendously helped to bridge the gap between digital and physical world.

Essential components of AR

With the advancement of AR there are components which are essential for its smooth functioning;

- **Sensors** : AR relies on sensors to understand the environment around it.
- **Algorithms** : Responsible for mapping the physical world and determining where the digital content must be placed.
- **Output devices:** : Most common o/p device is head mounted display (HMD) and conveys the information regarding the virtual world created

Differences between AR and VR

AR employs a real time setting and can be accessed with a smartphone also the users can control their presence in the real world. On the other hand, VR is wholly virtual and requires a headset device also the users are controlled by the system. Fig. 2 shows some differences between AR and VR.

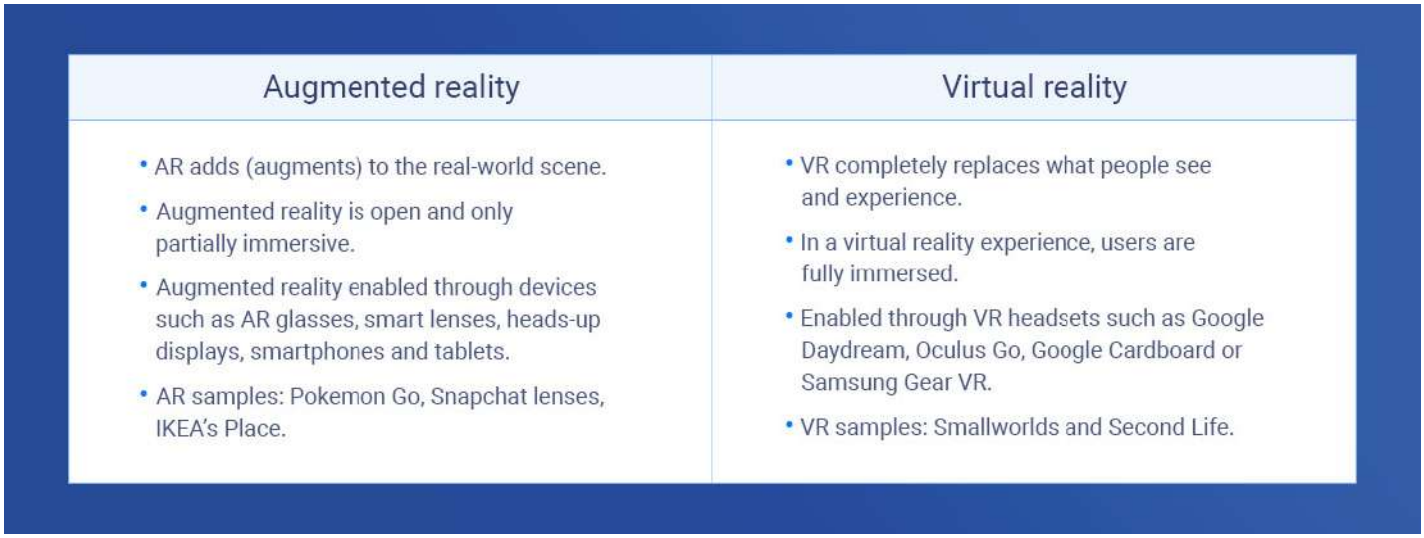

Fig. 2: Differences between AR and VR (Courtesy : SCAND)

Applications of Augmented Reality

- **Education** : Text , graphics and audio may be superimposed into real-time environment. An example of AR that can replace corporeal classroom is Google Glass.
- **Healthcare** : Surgeons could use AR to provide real time guidance during complex procedures and to create virtual model of patient's organs for better understanding.
- **Retail** : With the help of AR technology buyer can 'try before they make the purchase'. For example ,IKEA Place app allows you to see what your room looks with 3D models of the furniture. Meanwhile companies like Target are using AR to modify instore navigation.
- **Gaming** : The global sensation 'Pokemon GO' let the people experience real world with AR.

Fig. 3: Pokemon GO (Courtesy : The Conversation)

Concerns regarding AR

- **Reality Modifications** : One of the major concerns of AR. The global sensation “Pokemon GO” caused an inordinate rise in the vehicular crashes , property damage, injuries and fatalities. According to a survey, people showed an inclination towards wanting to modify their surroundings by eliminating all the disturbing elements, billboard ads and so on. This will substantially affect the brand reputation and also the wearers would become unaware of the surrounding dangers and put their lives in jeopardy.

- **Privacy Concerns** : These are on a rise these days as AR depends heavily on the capacity of the device to record and analyze the surrounding in real time. Due to this, there are potential legal concerns over privacy. Especially in areas were copyrighted media is exhibited.

Conclusion

Starting with an introduction on augmented reality, its types, overall idea of its applications and concerns associated that we identified are discussed.


NETWORK AND SECURITY

EDGE COMPUTING ASSISTED D2D NETWORKS

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Introduction

Device to device communication abbreviated as d2d communication is an advanced data transmission technology, which was developed in the motive of improving the communication network efficiency. In the LTE direct technology, the d2d enabled devices can communicate directly with each other, obeying a set of standard secure routing protocol. Device to device communication is a promising solution for the existing problems in network such as, spectrum utilization in the next generation cellular network. D2D communication provides a lot of advantages to the network such as high data transfer rate, reduced delay by maintaining the required QoS constraints.

Introduction of D2D communication was made after LTE release 12 in the 4th generation communication network. D2D maintains its power level based on the cellular uplink power control in order to avoid the issues that may arise due to interference with the cellular base station. The D2D communication can provide better reuse of the radio spectrum as it shrinks the radio transmission to the direct device to device communication scenario. It also helps to reduce the transmission power and makes the network much more energy efficient. D2D communication has got many advantages including congestion control, reduced delay, QoS guarantees, enhanced cell coverage etc. but still there exists some challenges that need to be cured in efficiently deploying this technology.

Edge computing is an upcoming technology that has got burning importance now a days. Edge computing allows the users to access cloud services within the range of the network. The main aim of edge computing is to reduce the latency by minimizing the spectrum between computing device and the storage location. The cloud computing platforms are brought closer to the user equipment with the advent of edge computing technique. The basic components of edge computing network are:-

- Edge devices : includes all types of device in the network.
- Edge cloud : deployed in the base station.
- Public cloud.

Edge computing has an important role in collaborative computing. Collaborative computing is being used in scenarios from simple sensor networks to the highly complex automatic robotic functionalities.

By combining the features of mobile edge computing technique with the device to device communication technique, the performance of the resulting network shows a tremendous improvement. This will help to overcome the limitations of both the technologies. Traffic offloading or computational offloading is the main advantage of the integrated network. The devices which are draining out of energy and resource gets a chance to recover their efficiency by sharing the burden of computational tasks with the willing co-nodes present in the communication network. Compared to the cloud computing, the edge computing technology can provide fast response to the device to device communication enabled devices and which further reduces the execution delay.

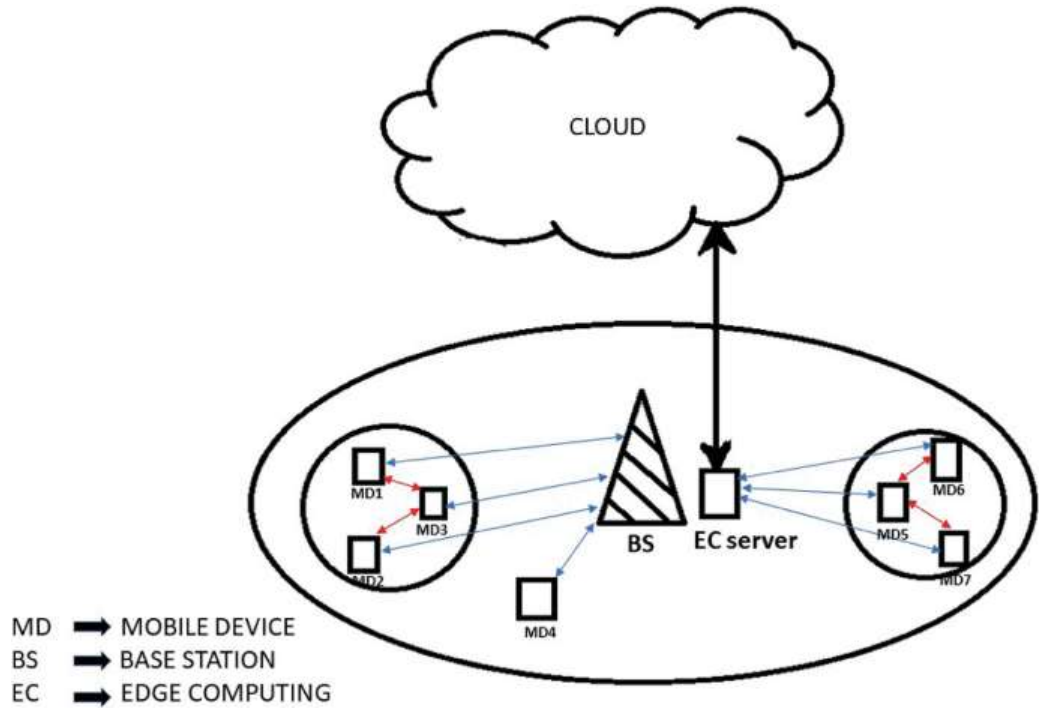

Fig. 1: System architecture of D2D enabled edge computing network. (Courtesy : Google)

Challenges in existing techniques

Due to the low complex nature of the d2d devices, they have got widely accepted. The applications they are being used are also increasing day by day. But it has got some challenges in aspects such as device discovery, mode selection, resource management, mobility related issues, security, privacy, economic constraints etc. some of the challenges are discussed here:-

- **Device discovery** - In d2d communication, the member nodes communicate directly. They don't have a central coordinator to coordinate the communications. The device nodes themselves will have to discover the nearby node to communicate. In the distributed device discovery method the devises themselves have the permission to discover other d2d users without including the base station. The time and energy required for the device discovery should be efficiently managed.
- **Interference Management** - Interference issues from the cellular users is a major challenge in d2d communication. Since the d2d users and the cellular users will have to share the same resource in inband communication scenarios. The chances of getting interfered is very high in such situations. So efficient interference methods have to be employed.
- **Security and privacy** - Security and privacy threats are being identified in every communication network, especially in the wireless networks. Some of the important security threats that the d2d networks have to face are authenticity of users, confidentiality of data and user related information, integrity, non-repudiation, secure routing and transmission, dependability etc.
- **Power control** - Power control has to be maintained at the edge user during the uplink communication and at the base station during the downlink communication. Various factors such as path loss, interference, number of units, delay etc highly effects the energy of the devices. It is very important to maintain power consumption at the optimal value in-order to save the energy resource.
- **Mode selection** - In the d2d cellular network, the devices can communicate directly, this further improves the network throughput and reduces the delay in communication. There are mainly four modes of communication in the d2d communication, namely pure cellular mode, partial cellular mode, dedicated mode, underlay mode.

Edge based performance enhancement in D2D networks

Improvement of computational capacity

- **Proper task scheduling** - Zhigan Xie et. al. proposed a peer-to-peer supported task scheduling network to reduce the In MEC mode, based upon sorting algorithm and some optimization technologies a novel iterative algorithm is presented. This algorithm helps to find an optimal solution to the nonlinear programming optimization problem. In P2P mode, the original problem is converted to a one-to-one assignment problem, which is further resolved using Hungarian method of task scheduling. The third mode of operation is the hybrid mode, in which the solutions are found by incorporating linearization technology.
- **Integration of access point nodes** - Han Hu et.al. have proposed a performance analysis method for the edge computing assisted device to device communication networks. This method makes use of two computing nodes namely device to device node and the access point nodes. The end users are enabled to find a nearby access point or device to device node to offload their abundant computational tasks. They have also proposed a prioritized channel access policy to reduce the unwanted interferences among the mobile nodes present in the device-to-device communication network. Prioritized channel access policy divides the available channel for both uplink and downlink into two sets, in which one is reserved for the cellular users and the other set is shared between both the device-to-device links and the cellular links.
- **Edge based approach** - Abdelhamied A Ateya et. al. have presented an efficient method to overcome the major issues in 5G cellular system such as traffic, security issues and capacity issues by combining device to device communication and edge computing technology. By developing these two technologies the system can improve its overall capacity as well as reduce its traffic related issues. The proposed system divides the entire structure in four parts namely cloutlet tire, micro cloud tire, mini cloud tire and the main cloud tire. Cloutlet tire consists of the gateway devices and the master device. Gateway device can be considered as a powerful user equipment with wide range of capabilities, where as the master device processes the data provided the gateway devices in order to generate the desired result. The second part is the micro cloud tire, which consists of the mini cloud units and the micro clouds. The third and fourth sections are the mini cloud tire and the main cloud tire which are the higher levels of the previous two units.
- **Enhanced traffic offloading** - Liu Yang et. al. have proposed a novel technique in data traffic offloading scenario. In the other existing techniques, the device to device nodes can offload their traffic burden only with the nodes which are closer to them obeying various distance constraints. Whereas in the proposed system, they have implemented an incentive system which promotes the nearby nodes to exhibit their willingness to offload the traffic in desire of the incentive. These nodes also share the data and information about the offloading task to their adjacent mobile nodes too. This helps in increasing the reachability of the offloading requirements and reduces the delay in the offloading tremendously. It helps to find the nodes with lower computing cost in carrying out the required task.

Conclusion

This paper discusses various techniques employed in order to enhance the performance of edge computing assisted D2D networks. The challenges faced by both device to device communication and the edge computing techniques are discussed. By evaluating the various techniques employed in integrating device to device communication and edge computing shows that the performance has improved tremendously in aspects such as traffic offloading, reduction of delay, energy optimization etc.


RENEWABLE ENERGY

BLADELESS WIND POWER GENERATION

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Introduction

One of the legitimate sources of energy is the wind energy over the past few decades, which has a more alternate turbine designs which provides a large amount of power. Even though a record of 6730 billion global investments has been in the industry in 2014, it may be the limit of turbine growths.
The bladeless wind power generation uses a new approach in capturing the wind energy through vorticity., an aerodynamic effect that has plagues structural engineers and architects for ages. Naturally design of such device is completely different from the traditional one. Instead of the usual tower, nacelle, and blades, the device has fixed mast, a power generator, and a hollow, lightweight and semi-rigid fibreglass cylinder on top.
The bladeless turbined generate electricity 40 percent lesser in coset compared with the conventional sources with more efficiency.one of the alternate solution to the challenging approach in traditional way of wind turbines might be this latest entry of a radically different type of wind turbine: a bladeless cylinder that oscillates or vibrates.

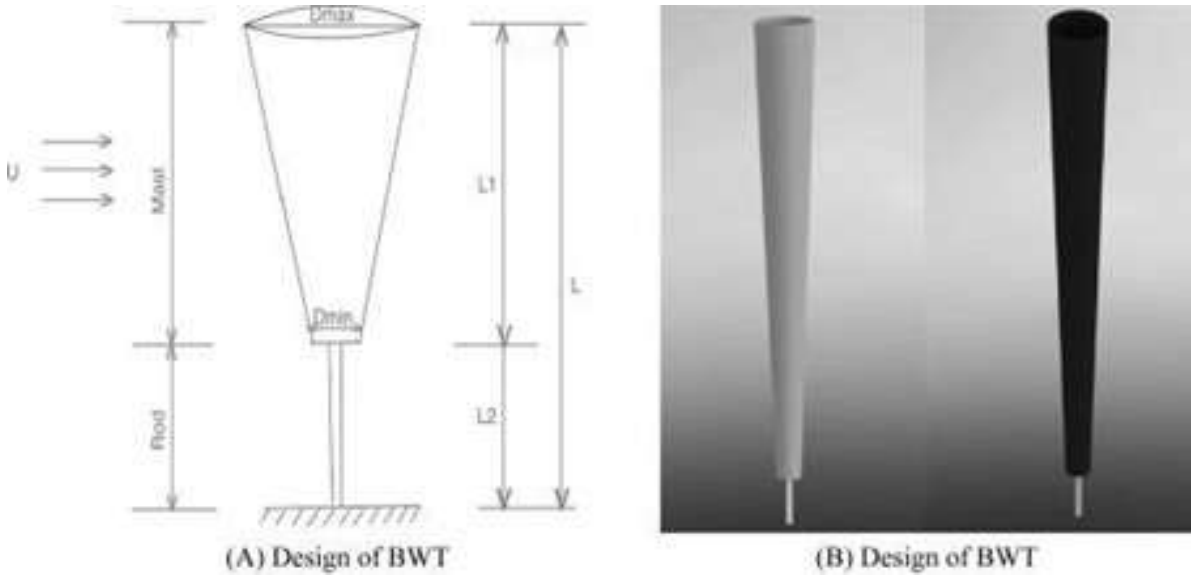


Fig. 1: Design of bladeless turbine (Courtesy : ijsdr)

Fig. 2: Bladeless wind turbine (Courtesy : Urja Daily)

Structure

It consists of a conical cylinder fixed vertically with an elastic rod. When the cylinder oscillated in the wind it generates electricity through a system of coils and magnets. The outer conical structure is rather rigid and can vibrate, remaining anchored to the bottom rod. The top of the cylinder is unconstrained and has the maximum amplitude of the oscillation. The structure is built using resins reinforced with carbon and/or glass fibre, materials used in conventional wind turbine blades.
The inner cylindrical rod, which will penetrate the mast for 10 percent - 20 percent of its length (depending on the size of the mast), is anchored to it at its top and secured to the ground at its bottom part. It is built to provide highest resistance to the fatigue and allow its elasticity to absorb the vibrations generated by the cylinder.

- **Centre Base** : Base is made up of the rigid iron angular structure. The base provides equidistant point for the position of the mast. It can tolerate the mechanical stress acting on it. This provides the strong foundation to the mast and spring.
- **Mast** : The mast is a conical shaped, rigid structure which Rotates when subjected to wind. The Mast is lighter in structure in order to increase the Rotational Motion also decrease the mechanical stress on the suspension spring as well as the base.
- **Thread** : The thread is used for the conversion of the linear motion of the mast to the rotational motion of the generator. Thread used is of nylon material which as a property of the non-elasticity. This thread is connected to the chain of the sprockets. These threads are connected to the chain using the guide ways to provide proper path to the thread.
- **Belt** : The leather belt is used to drive the generator. The belt is connected to the pulley of the generator and the flywheel.
- **Chain drive** : Chain drive helps in increasing the speed. The sprockets are connected to the cycle hub and tightened and supported using a metallic frame. The compound chain drive is used to reduce the space required. It uses total five chains from input to the output shaft.
- **Generator** : The alternator is driven by the power wheel via the belt drive. The generator is design by using a ceiling fan stator which consists of 16 set of windings. It is made to generate to electricity

by replacing the metal rotor with a wooden rotor which comprises of Neodymium magnets.

- **Load** : When the generated voltage is less than 12V, the power must be dumped. Therefore, a dummy load is connected. The load consists of LED bulb.

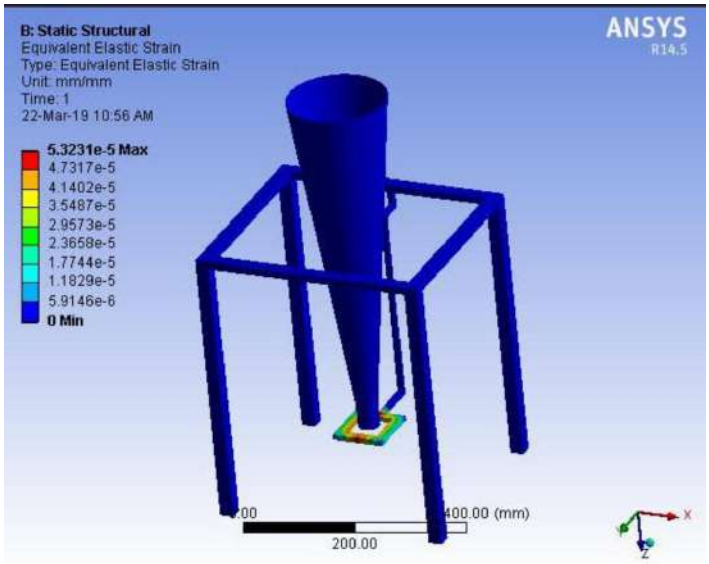


Fig. 3: Equivalent Elastic Stress of BWT (Courtesy : IRJET)

Advantages

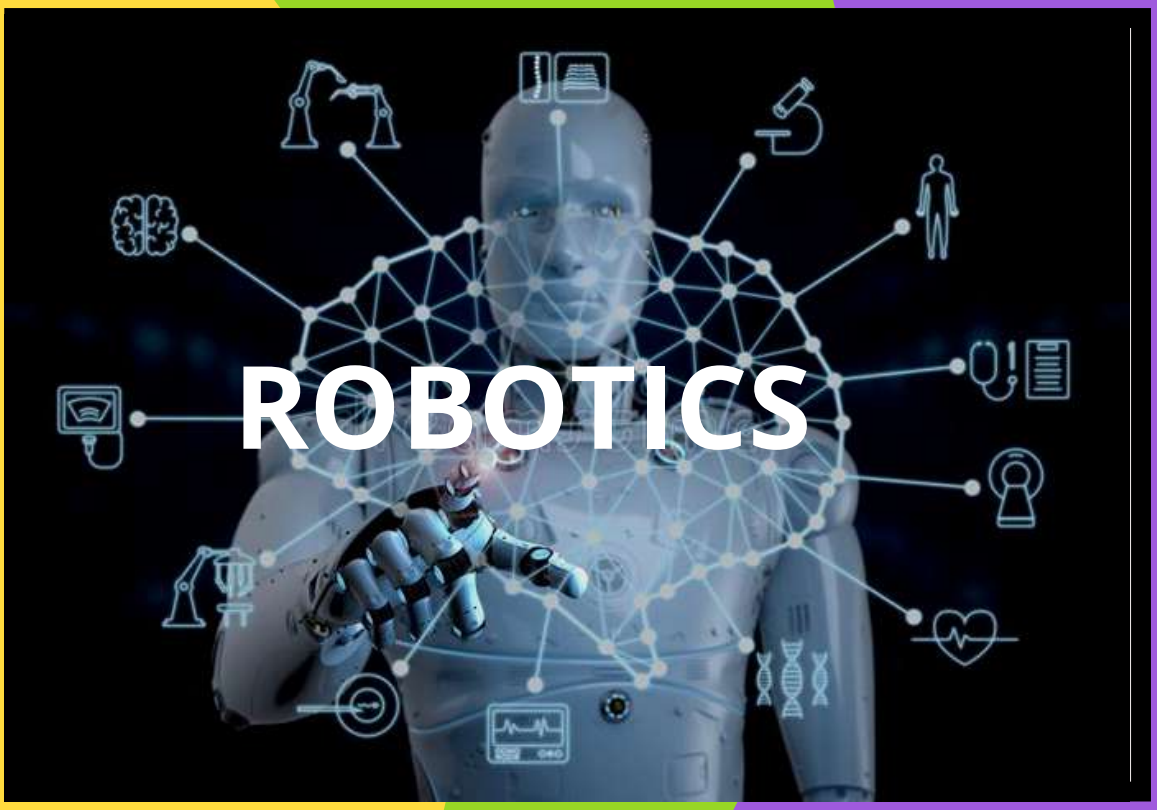
- No gears and bearings, reduces manufacturing and maintenance drastically.
- No lubricants needed, noise less, more environmentally friendly.
- Cost of energy production is 40percent less than conventional turbines.
- Birds can fly around them without being sucked in.
- We can put many vortex blades turbine unit in an area when compares to conventional wind turbines.

Disadvantages

- The efficiency of energy absorbs from the wind is competitively less than that of the conventional wind turbine.
- The requirement of control systems for controlling the oscillation to meet the natural frequency of the mast and the control of the frequency at higher velocity winds. The height of the mast can be increased based on the output required

Conclusion

Starting with an introduction, its types, overall idea, advantages, disadvantages and applications that we identified are discussed.


ROBOTICS

ROBOT FOR THE SAMPLING

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Introduction

The outbreak of COVID-19 pandemic leads to profound challenges in people's daily lives in different fields lastingly and globally.At the forefront of combating COVID-19, oropharyngeal viral nucleic acid (VNA) detection is critical to identify potential patients for their timely diagnosis, effective quarantine and dedicated treatment However, due to the highly contagious nature of COVID-19, the manual face-to-face VNA sampling is a high-risk task to the medical doctors/nurses involved medical staffs' COVID-19 infection and even death continue to be reported across the globe.To minimize the infection risk robotic sampling is a promising solution to this challenge.Robotic technology has been consistently implemented to replace humans during the execution of various dangerous task

Fig. 1: Sampling (Courtesy : Dmitri Maruta)

A swab robot with sampling force control within 10-60 gm has been developed for clinical application with preliminary efficacy validation.A low-cost robot to assist swab sampling has been reported with efficient and convenient deployability.A remote human-robot has been developed for swab sampling.To mount specialized sampling tools on commercially available robot arms have also been reported to facilitate robotic sampling Although pioneering efforts have been made to apply robotic technology in OP/NP swab sampling, there are two major concerns about existing OP/NP swab robots. First, the safety concern towards the testee is evident when a bulky and rigid robot is manipulated inside the narrow oral cavity with delicate soft tissue. Second, the dexterity of the terminal end-effector is highly limited with most robots only employ- ing a one-directional swab insertion and retraction. Compared to human operators, existing robots are significantly inferior in terms of safety, user comfort, manipulation dexterity, and potential sampling completeness.To tackle the above challenges, soft robotics technology developed in recent years

provides an avenue for safe and effective swab sampling enabled by its inherent compliance and simplified system complexity

Practicality of safety

Accuracy is a major concern for a robot.when dealing with human it increases the significance.The robot performs as a human behavs The TSS hand is designed in a human hand similar configuration and connected at the terminal of the RCM platform.The cover of the finger contact area is made of deformable material and has a cylindrical slot to fit the shape of the swab holder.It is intended to achieve multi- directional bending as dexterous as a human wrist in a confined space. Besides, the stiffness of the wrist is better to be adjustable to ensure both sampling safety and forceful interaction.

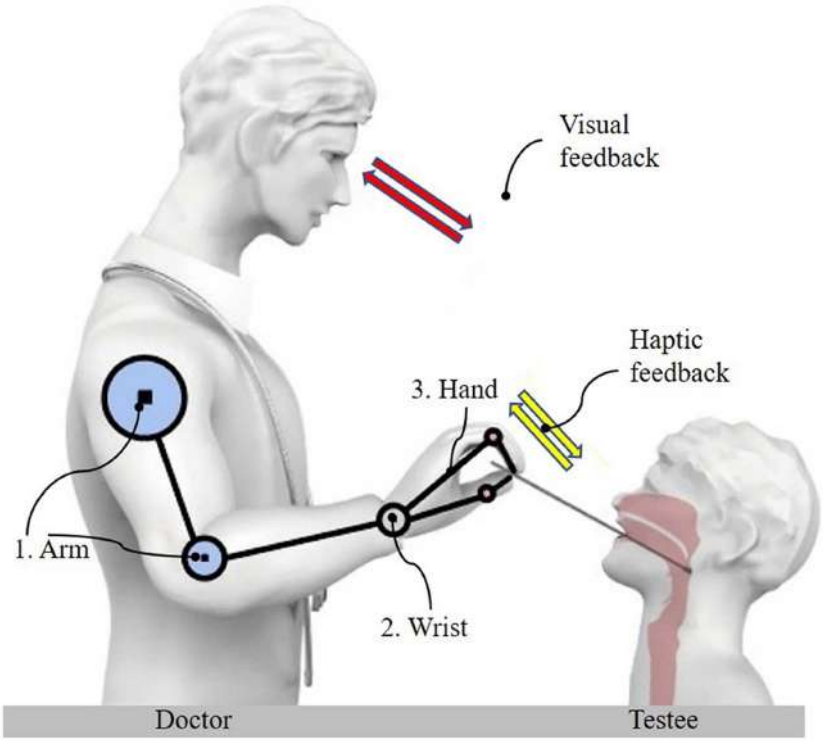

Fig. 2: Healthcare staffs manual oropharyngeal swab sampling illustration (Courtesy : IEEE Xplore)

It is intended to achieve multi-directional bending as dexterous as a human wrist in a confined space. Besides, the stiffness of the wrist is better to be adjustable to ensure both sampling safety and forceful interactionThe stiffness of soft wrist can be pre-adjusted. The stiffness of soft wrist determines the interaction force indirectly and influences the kinetic stability of the TSS hand. Therefore, the variable stiffness capability is helpful to provide suitable interaction force and desired kinetic stability.The variable stiffness characteristic provides the safety

Adaptation

Even the technology new to the medical field the operator can be easily adaptable.Tele- operated oropharyngeal swab (TOOS) sampling system is composed of a 3-DOF medical platform and a Tstone soft (TSS) hand and Doctor operates in room with doctor and teleoperation systems based on terminal camera feedback.

Integrated a camera to provide the visual feedback and a haptic device to provide the hand's haptic feedback.which is 5mb camara works with an led.For brightness compensation of the testee's throat.Besides, a Geomagic touch haptic device is used to provide the haptic feedback and also as the master device to tele-operate

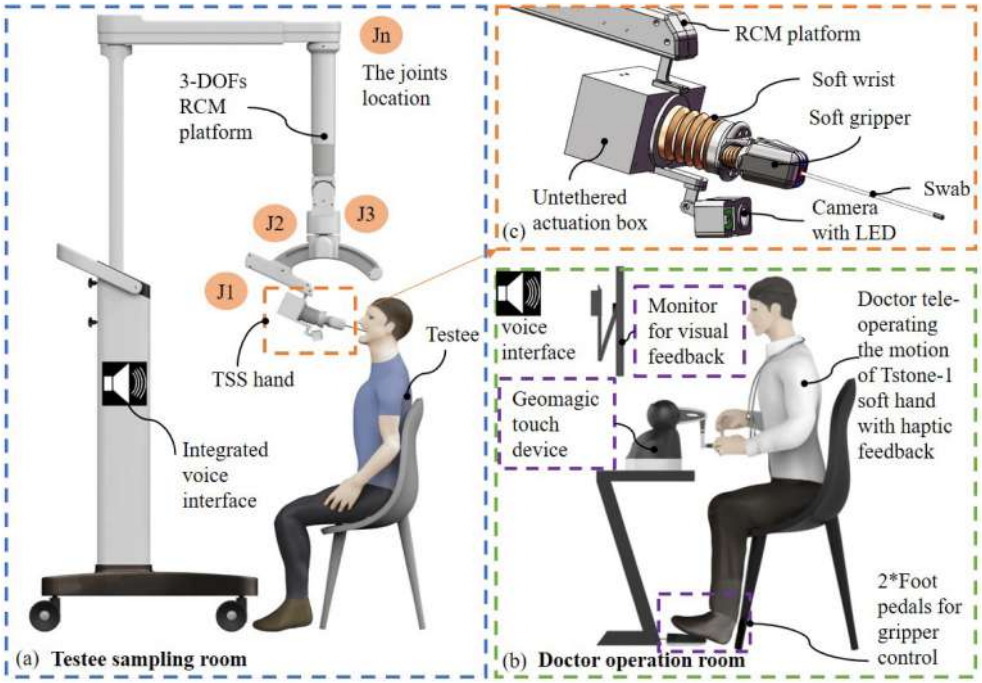

Fig. 3: Tele-operated oropharyngeal swab (TOOS) sampling system (Courtesy : IEEE Xplore)

Highlights of robot

- A TOOS robot is presented for safe and effective OP swab sampling using existing disposable swab teleoperated by medical staff.
- A novel TSS hand is proposed, which is one of the most dexterous robotic hands dedicated to OP swab sampling using disposable swabs. TSS hand achieves human hand comparable swab manipulation dexterity. The wrist stiffness can be pre-adjusted based on the task requirement and weight of terminal components.
- A teleoperation controller with a novel hybrid motion/force virtual fixture (H-VF) is designed with the consideration of real-time motion teleoperation based on visual feedback and haptic constraint. Sampling safety and comfort can be ensured by the dedicated H-VF constraints

Dependability

The high sampling success rate was ensured by the vision feedback-based teleoperation with a dexterous TSS hand.Motion accuracy and robustness of the system's dexterity in wrist motion and grasping robustness in swab picking without obvious difference from its original state. TSS hand is still effective and provides similar performance to its original state, which validates the durability of the prototype TSS hand.

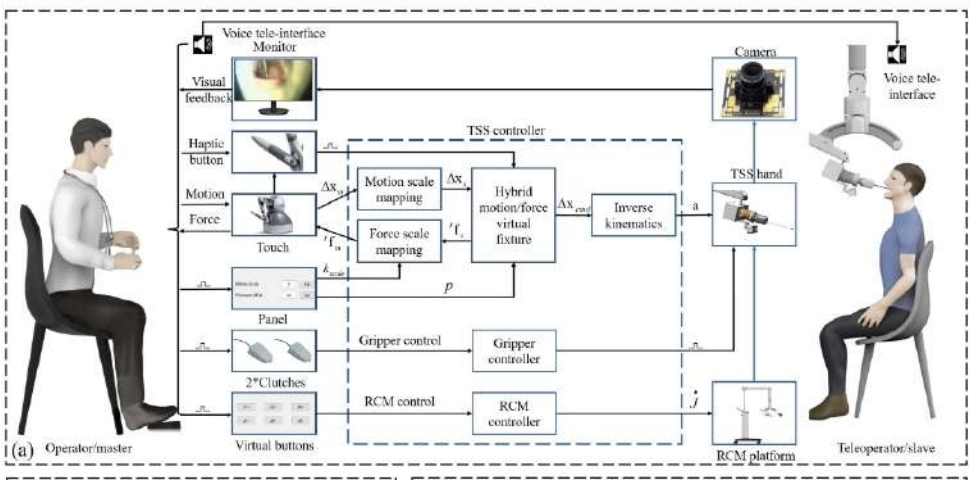

Fig. 4: Overview of the applied teleoperation framework (Courtesy : IEEE Xplore)

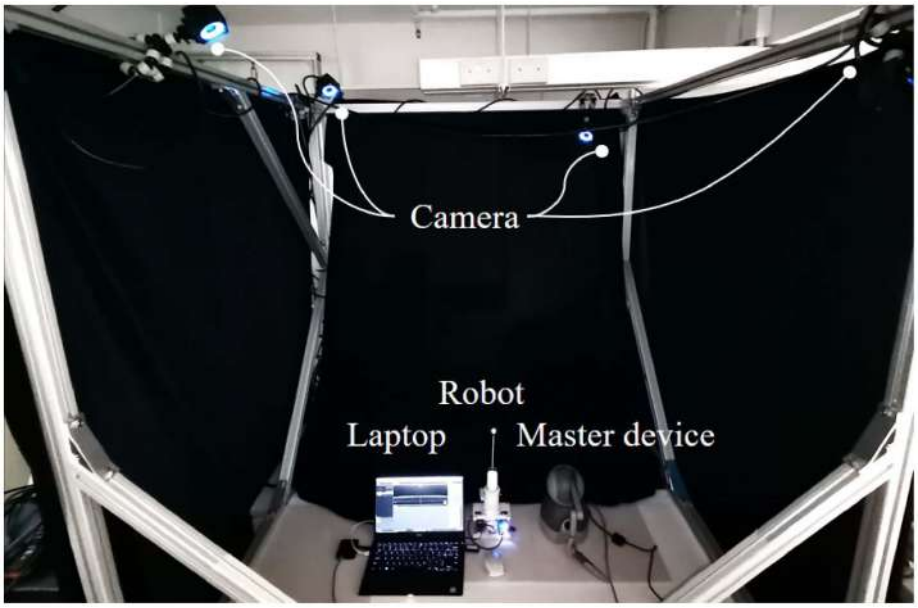

Fig. 5: The optical tracking system setup for teleoperation accuracy test (Courtesy : IEEE Xplore)

The whole sampling process was performed without report from the human user of any uncomfortable contact generated by the robot.The swab can be tele- operated at will by the operators. The VF constraint was also acceptable for all three operators to restrict their over large motion.The overall sampling time is around 30 Seconds for our OP sampling robot. The human sampling time is around5 to 10 seconds. Voice communication time is around 10 seconds for testee to fit the position and prepare for sampling.The consumed time are quite similar between manual and robot operation.

Next generation

Seeking ethics approval to perform in-vivo test using our OP sampling system, further refining the TSS hand, integrating sensors to detect contact of the specimen, detect the oral configuration in real-time,refining the hybrid virtual fixture controller, and transferring the TSS hand to two collaborative arms

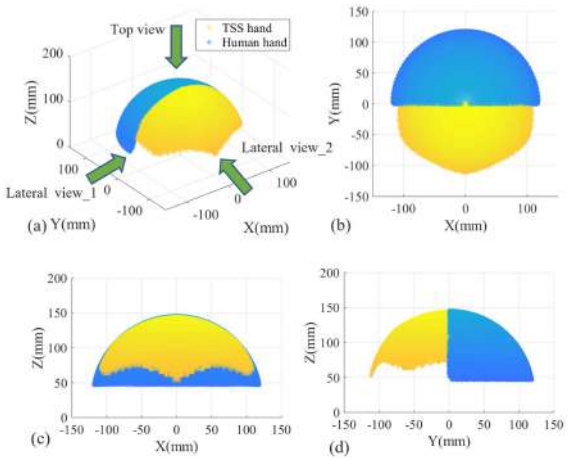

Fig. 6: TSS hand and human hand workspace comparison. (a) 3D view. (b) Top view. (c) Lateral view-1. (d) Lateral view-2. (Courtesy : IEEE Xplore)

for dual-arm manipulation. In terms of disinfection, disposable shielding cover

Conclusion

Soft robotic technology is a viable solution for safe and effective robotic OP swab sam- pling. Based on human sampling observation, we concluded three physical interaction components (arm, wrist, and hand) and two sensing components (visual hand haptic feedback) were mainly involved in the manual OP sampling.

A MULTI-MODAL OPERATIONS QUADRUPED ROBOT FOR PACKAGE DELIVERY APPLICATIONS

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Introduction

Fig. 1: Robot crossing a cross walk with a package (Courtesy : IEEE Xplore)

Modern quadruped robots are more capable than ever before at performing robust, dynamic locomotion over a variety of terrains, but are still mostly used as mobile inspection platforms. In recent years, the legged robotics community has seen a large number of successful platforms capable of impressive dynamic locomotion. In particular, there have been a large number of quadrupedal platforms due to their favourable stability properties: ANYmal C from ANYbotics employs IP67 rated hardware and custom SEA's in order to provide robust inspection and mobility in even the most extreme environments. Cheetah 3 from MIT demonstrates an impressive full 3D gallop at 3 m/s, popularizing the use of proprioceptive actuators for legged robotics. Lastly, Spot from Boston Dynamics is capable of extremely robust walking in various terrains both indoors and out, and also can equip a single robotic arm to open doors and pick up small objects. With their ability to have robust mobility across different terrains, quadrupeds like these are starting to be deployed in surveillance and inspection applications that require such performance. However, for applications that involve tasks such as picking up a package or using tools, a legged robot needs to have versatile limbs it can use for manipulation. Bipeds (e.g. humanoids) are not statically stable

during locomotion and require active balancing which makes their control much more difficult. Compared to bipeds, quadrupeds and hexapods are typically more stable and robust mobility platforms, but require additional features in order to be effective at manipulation.

This robot is a quadrupedal robotic platform that features proprioceptive actuation with all of the actuators collocated at the hip. However, this robot utilizes a non-traditional kinematic leg configuration by swapping lateral ab/adduction (typically achieved with a hip-roll DoF) with medial rotation (with a hip-yaw DoF) (Fig. 2). This modification sacrifices some of the dynamical benefits of the traditional configuration in order to provide a much greater range of motion. Combining the robot's large workspace with simple end-effectors allows the robot to have different operating modes to handle a multitude of tasks, providing this robot with capabilities beyond those of current quadrupeds.

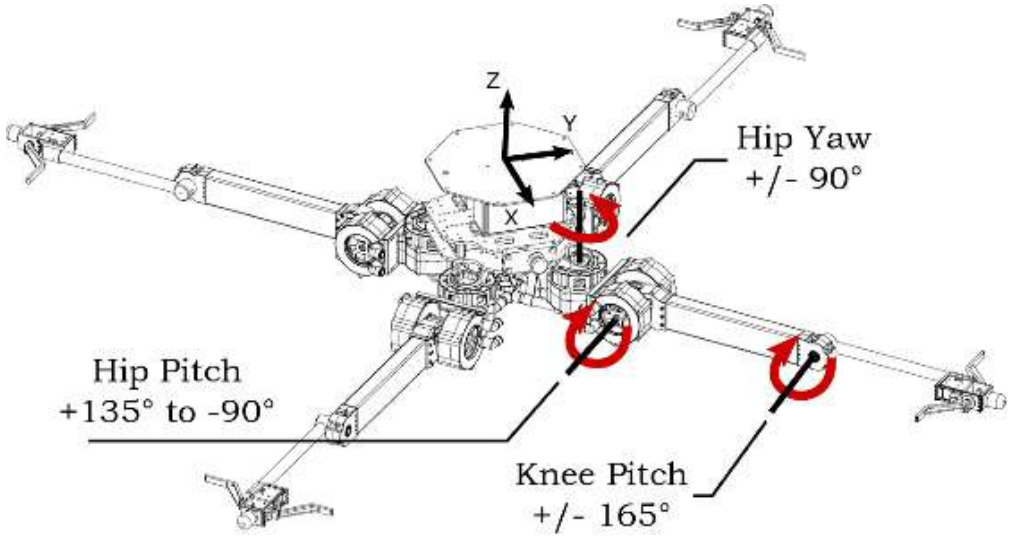

Fig. 2: Robot's unique kinematic configuration providing a large continuous workspace (Courtesy : IEEE Xplore)

Concept of operation

This robot was designed to test the feasibility of having legged robots perform package delivery tasks in urban settings, such as picking up packages from the back of a vehicle and placing objects on elevated surfaces such as tables or desks. This robot's unique kinematics allow it to reconfigure into several different operational modes. The robot's nominal configuration is a wide sprawl symmetric stance that allows the robot to easily and stably move in any direction (Fig. 3a). This mode is used to transition between modes and to accurately position the robot for manipulation tasks. The robot can switch into a more traditional quadrupedal mode, increasing the frontto-back and decreasing the left-to-right distance of the legs (Fig. 3c). In this mode the platform is capable of a stable 1.5 m/s trot over real world terrain. For more stability, the robot can go into a broader stance and use jumping/pronking for locomotion (Fig. 3e). For improved efficiency on flat terrain, the robot can enter a wheeled mode by lowering itself onto passive caster wheels (Fig. 3d). Once the robot is resting on the four wheels the robot uses its limbs to push itself, providing an efficient mode of transportation on flat smooth terrain. The four previously mentioned modes of transportation provide this robot with the ability to safely and efficiently traverse many different types of terrain, but it is this robot's ability to perform simple manipulation tasks that really differentiates it from other quadrupedal robotic platforms.

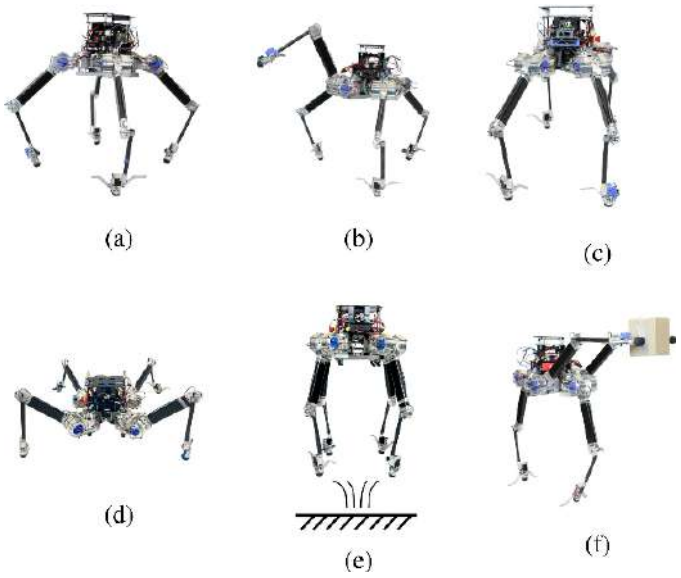

Fig. 3: a) Symmetric stable mode, b) Tripod single manipulation mode, c) Dynamic mode, d) Caster/wheeled mode, e) Jumping/pronking mode, f) Biped dual manipulation mode (Courtesy : IEEE Xplore)

By lifting one limb off of the ground, this robot can enter tripod mode, giving the robot a stable base for single manipulator tasks such as pushing a button (Fig. 3b). This mode offers enough support and strength for the manipulating limb to punch through a wooden board. Finally, the robot is capable of going into a bipedal mode by using its custom end-effectors to provide a large enough support polygon for the robot to balance on two limbs, freeing up the other two for dual limb manipulation (Fig. 3f). This robot's dual arm manipulation is capable of picking up and transporting boxes of various size and weight. This mode also has the potential to be used for bipedal walking.

Design

This robot is composed of four identical limbs that are attached to a central body in a radially symmetric distribution with a total mass of 17.9 kg. The body of this robot (Fig. 4) is comprised of an upper body which houses the electronics, and lower body frame which acts as the chassis. All parts on the robot's body were designed to be lightweight while also ensuring that the structure does not interfere with the limbs' large kinematic workspace. The upper body structure without sensors and electronics weighs 0.63 kg and the lower body frame weighs 0.62 kg, resulting in a total weight of 1.25 kg, which is less than 7% of the total weight of this robot. This robot's limbs have 3 DoF: hip yaw, hip pitch, and knee pitch (Fig. 2). These joints are actuated by proprioceptive BEAR modules mounted at the hip to reduce limb inertia and mass. The knee and hip actuators use a parallel configuration, with the knee joint being driven by a 1:1 belt transmission which runs through the carbon fiber leg structure and provides the joint with a range of motion that is nearly 360○, as shown in Fig. 5. The parallel configuration of the hip and knee actuator resulted in an antagonistic coupling of the two actuators. The parallel configuration was chosen over a serial configuration to simplify the design, decrease the mass of the limb, and decrease the inertia of the limb. The limb lengths and range of motion were the result of a kinematic study that was driven by the requirement that this robot is able to reach into a vehicle and pick up and drop off a package. The resultant kinematic design was then used in a preliminary locomotion simulation to ensure that the BEAR actuators were capable of the required torque.

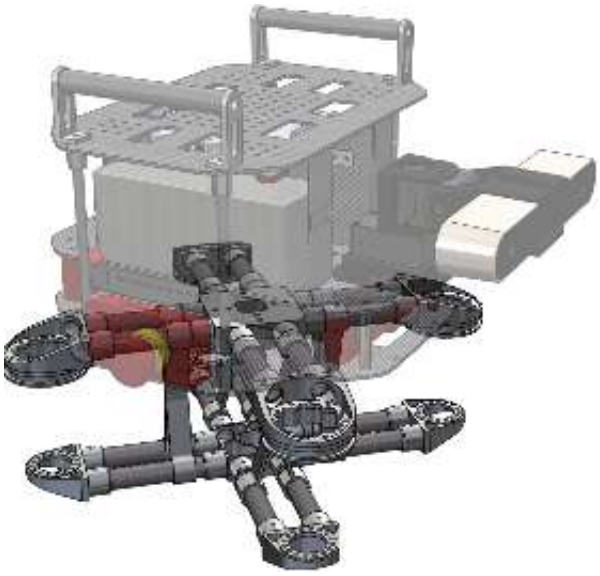

Fig. 4: The transparent part is the upper body structure that houses the electronics and the solid part is the robot chassis (Courtesy : IEEE Xplore)

TABLE I
BEAR SPECIFICATIONS

Parameter	Value	Unit
Reduction Ratio	10	
Torque Constant	0.88	Nm/A
Peak Torque	32	Nm
Max Velocity	27	Rad/s
Voltage	30	V

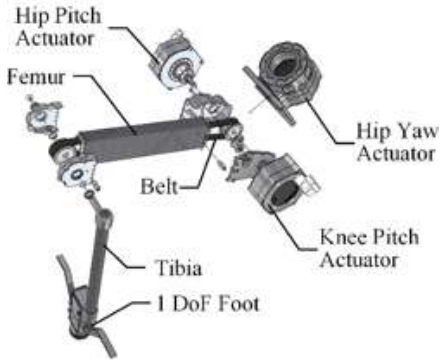

Fig. 5: Robot's leg exploded view (Courtesy : IEEE Xplore)

Software or tools environment

- This robot's codebase is mostly written in Python, but utilizes external C/C++ libraries such as Eigen and Boost when applicable.
- This robot runs an architecture tailored for simplicity and modularity to invite multiple developers to easily contribute to modular components that can be easily assembled.
- It has many concurrently running processes which include a motor communication thread, user input thread, finite state machine (FSM) thread, and a state estimation thread. All communication between threads is done using a custom shared memory library for the sharing of structured data.

Applications

- Picking up a package from the back of a vehicle.
- Using tools.
- Placing objects on elevated surfaces such as tables or desks.
- Helping a rescue team.

Future scope

- In the last three decades, the mobile robot has received much attention because of exploring in the complex environment, space, rescue operation, accomplishing a task without human effort, etc.
- Inspection
- Construction (surveying)
- Delivery
- Security and monitoring
- Law enforcement and anti-terrorism efforts

Conclusion

This platform utilizes a unique kinematic design giving it the ability to operate in different modes for both transportation and manipulation. This configuration change coupled with high torque proprioceptive actuators preserves the benefits of quadrupedal robots, stability and reliability, while also providing capabilities that go beyond that of traditional quadrupeds. This is only the first step in moving towards a world with fully automated robotic package delivery. To move closer to the ultimate goal the next steps include improving the maximum run time of the robot, improving the autonomous capabilities of the robot, and adding a package storage system.

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