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2022

# Wissen

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

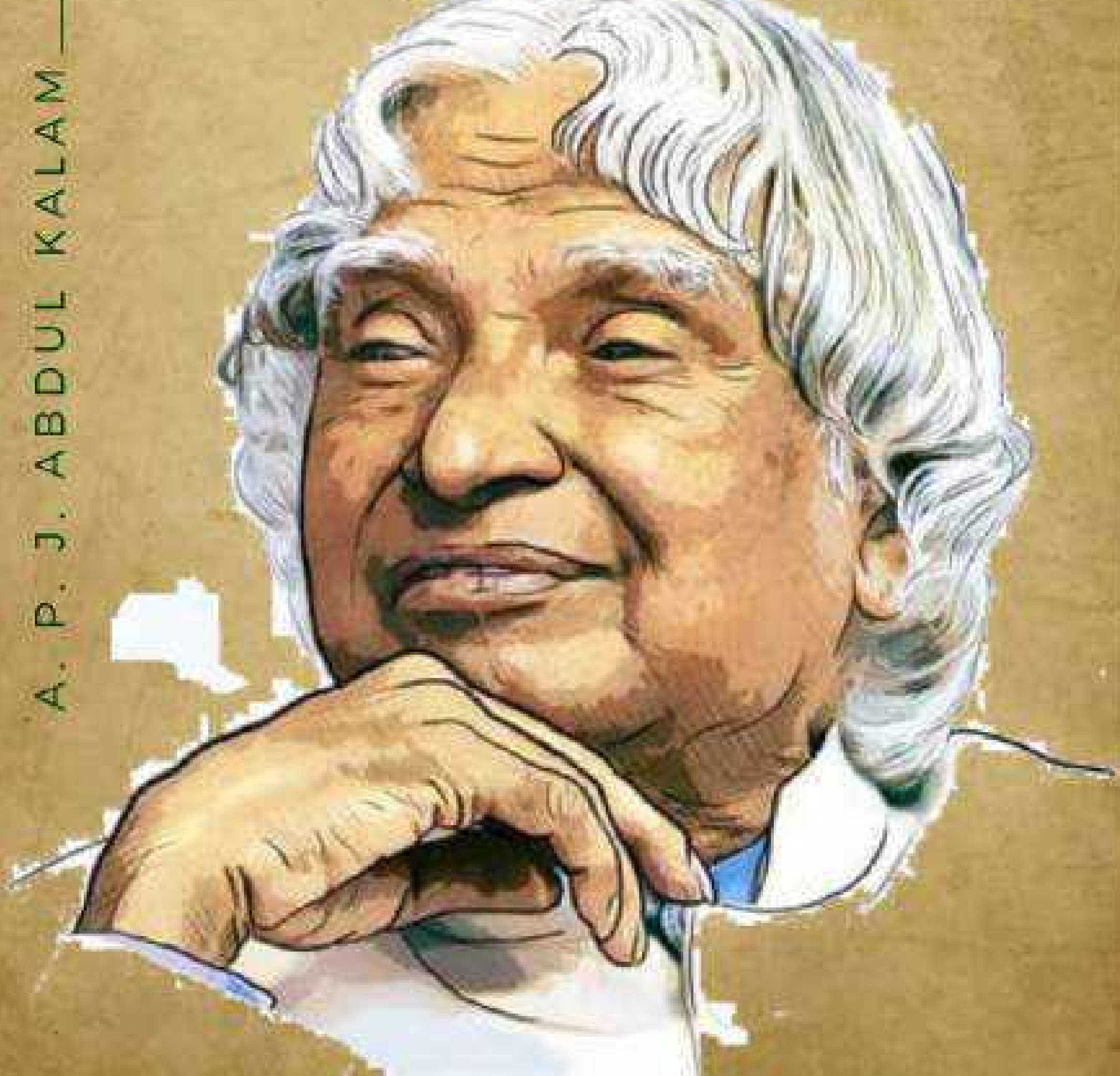
**M1:** To provide students state-of-the-art academic ambiance for quality education.

**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.

" Excellence
is a **continuous** process
and **not an accident** "

A. P. J. ABDUL KALAM



# PRINCIPAL 'S MESSAGE

It is a matter of great pride and satisfaction for Vidya Academy of Science And Technology to bring out the magazine **'Wissen'** from the Department of ECE. The College has made tremendous progress in all areas including academic, non-academics, skill development of staff and students. This magazine will be great milestone in getting NBA for ECE department. I am confident that this issue of Department Magazine will send a positive signal to the staff, students and the person who are interested in the Technical education and Technology based activities.

I congratulate HOD and staff of ECE department who put their efforts to share their technical ideas and taking initiative to release the second version of the technical magazine from the department, WISSEN 2.0.

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. Stay Safe.**
**Regards,**
**Principal**

# HOD 'S MESSAGE

It gives me immense pleasure to lead the department of Electronics and Communication Engineering towards the goal of our institution. The prime motive of our department is to provide innovative and qualitative education for the students to achieve academic excellence as well as to develop their professionalism to serve the nation. Our excellent infrastructure of devoted teaching faculty, good interaction among students, parents and staff, along with a placement cell always gives way for a global competitive edge.

The department played an instrumental role in releasing the second volume of "WISSEN" technical magazine for the period 2021-22. Such steps indeed reflect the manifold learning skills of our student's technological knowledge and their ethical values. My thanks to esteemed members of the editorial team, faculty and students for their support in putting their best, in bringing out this issue of the technical magazine on time.

We believe that the department will emerge as an asset to this institution. Let me thank our Management and Principal for their necessary support and encouragement.

**Dr. S. Swapna Kumar**
**Professor and Head of Dept**
**Electronics & Communication Engineering**
**Vidya Academy of Science & Technology**

# EDITOR 'S MESSAGE

Dear readers,

We are delighted to introduce the second publication of the Technical magazine of ECE department, **WISSEN**. The objective of this magazine is to give an opportunity to teachers and students of ECE to transform their technical thoughts into words.

We would like to thank HoD-ECE and college authorities for offering full support in design and publication of this magazine . We extend our special thanks to all those who have contributed articles to make this effort a success.

**Happy Reading!**
**Regards,**

**Simi Simon**
**Fetsy K Francis**

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# POWER ELECTRONICS

# ENERGY HARVESTING TECHNOLOGY

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## Introduction

Energy harvesting is considered one of the most versatile and significant topics in the current generation. This is widely being discussed actively in the research field. The energy harvesting market is considered to be large and growing rapidly. According to analysts at IDTechEx, the energy harvesting market is projected as 468 million in 2021 and it is expected to exceed USD 701 million by 2026, at a compound annual growth rate (CAGR) of 8.4 %.

Energy harvesting is simply defined as the conversion of ambient energy into electrical energy. It is simply the collection and storage of energy for on-demand and off-grid use. Energy harvesting is also known as power harvesting or energy scavenging to tap energy from external sources to preserve and reuse as per demand. The on-demand condition rise when harvested energy is generally required to match the demand with the supply. And off-grid energy is an independent energy harvesting source when normal energy is not available or is costly.

## Current Technologies and Applications

Energy is all around us in different forms such as thermal, chemical, mechanical, electrical etc. Energy harvesting devices capture ambient energy, convert it into electricity, and finally deliver to load. The most common energy sources are solar, wind, heat, vibration, and RF. The energy harvesting technologies convert ambient energy into the desired form using a transducer. In figure 1 shows the connection process between the three components of an energy-harvesting system, namely, the interfacing mechanism, the transducer, and the collection and conditioning circuit.

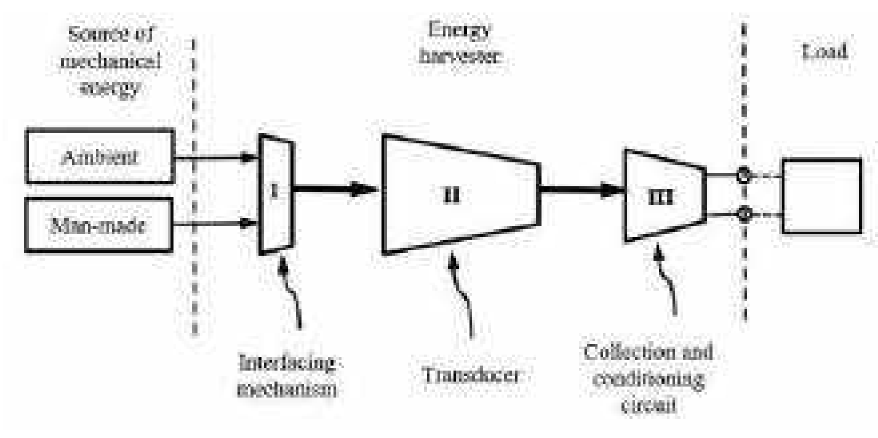


Fig. 1: Process of harvesting energy (Courtesy SPIE)

The process of energy harvesting is based on the source, amount of energy, and type of energy being converted into electrical energy. The energy harvesting system requires a source of energy such as heat, light, or vibration, and the three key components.

- **Transducer/harvester**: The energy harvester collects and converts the energy from the source into electrical energy. Typical transducers include photovoltaic for light, thermoelectric for heat, inductive for magnetic, RF for radio frequency, and piezoelectric for vibrations/kinetic energy.
- **Energy storage**: It is an energy storage device such as a battery or supercapacitor.
- **Power management**: There is a need to condition the electrical energy into a suitable form for the application. Typical conditioners include regulators and complex control circuits that can manage the power, based on power needs and the usage power.

Energy harvesting is primarily used in low-power electrical utilities, such as sensors, consumer electronics, watches, and home appliances. The rooftop solar panels generate a small amount of energy, to power low-power devices, such as consumer electronics, smartphones, laptops implantable biosensors, wireless sensor nodes, and military equipment.

Energy harvesting is a self-generating powering device where there are no conventional power sources. The energy harvesting system is the alternate source of power sources that eliminates the need for replacing batteries frequently. With proper design, energy harvesting devices can even replace batteries altogether in some applications. The well-known energy harvesting is solar panels and wind generators, is the alternative energy sources for the power grid. Figure 2 shows the basic components of energy harvesting system. But small embedded devices rely on energy scavenging systems can capture mill watts of energy from light, vibration, thermal, or biological sources.

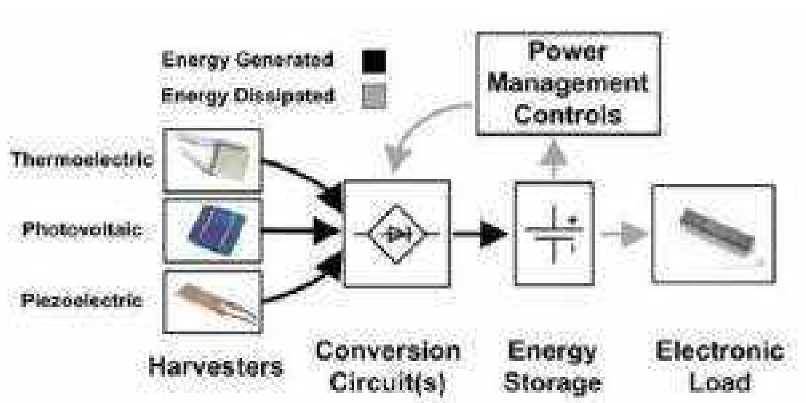


Fig. 2: Basic components of an energy harvesting system, (courtesy of harvesting-energy.com)

Energy harvesting is a promising technology with objectives are:

a. Develop of batteryless devices and sensors
b. Optimise usage of power
c. Maximise the energy reutilising capability of systems
d. Increase the life of electronic devices

The performance of energy-harvesting devices depend on the performance and specific properties of materials.

### Energy Harvesting Sources

Energy harvesting taps various sources of ambient energy such as light energy, thermal energy, RF energy, kinetic energy, chemical energy, biological energy, among others, the wind, solar, thermal, and vibrational energy. Sound, cosmic radiation, atmospheric pressure variation and nuclear radiation are universally present have no allied energy. The most widely used energy harvesting devices are solar, thermal, RF, and piezoelectric sources of energy.

- **Solar energy or Photovoltaic (PV)** cells convert light energy into electricity. Photovoltaic cells have the highest power density and highest power output of energy harvesting devices. For example, Samsung applied clothing technology with a built-in energy harvesting device that gains power from solar light, solar heat, and body heat.
- **Thermoelectric energy** harvesting converts heat into electricity. It has a Seebeck effect on arrays of thermocouples that generate power from hundreds of W to mW in response to a temperature differential across their bimetal junctions. Also, the reverse condition of the Peltier effect by impressing voltage on a thermocouple junction heats one junction while cool the other.
- **RF energy** harvesting capture ambient RF radiation, converting energy from the electromagnetic (EM) field into the electrical. RF energy rectifies it, boost it, and apply to power ultra-low-power embedded devices. The power emitted by the source and the distance from the source (from 10s cm up to 10 m), typical power levels harvest range from 10W to mWs. Figure 3 shows the Powercast P2110 RF Power harvester receiver converts low-frequency RF signals to 5.25V, providing up to 50mA output current.

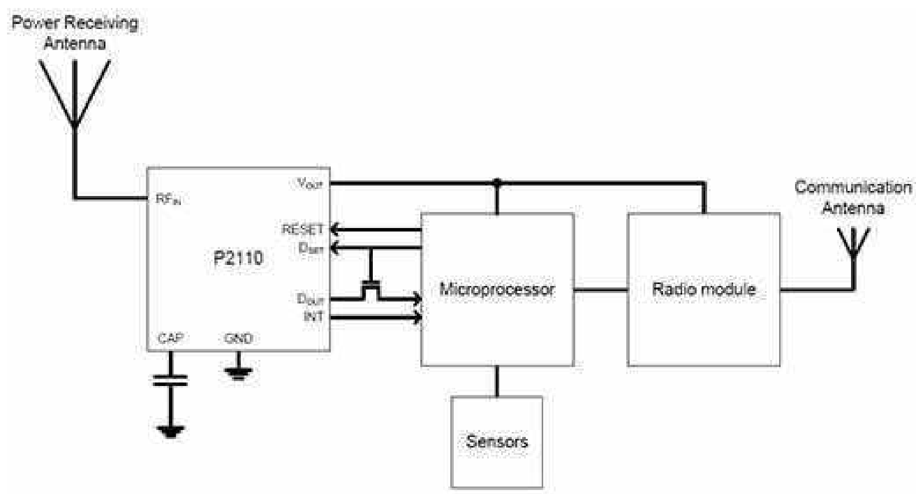


Fig. 3: Powercast P2110 in a batteryless wireless sensor (Courtesy of Powercast)

- **Piezoelectric energy** transducers convert pressure or stress into electricity. The vibration from bridges, motors, airfoils, or vehicles etc., commonly power piezoelectric energy harvesters to turn on power applications.
- **Vibration energy** harvesting has seen rise in interest during the past years growing awareness for alternative energy sources. It is a low power device. Figure 3 shows the Piezoelectric energy harvester. The circuit is a portable electronics, sensor-controlled and condition monitoring system. With vibration the cantilever set in motion generates an AC output voltage that is rectified, regulated, and stored in a supercapacitor or battery.

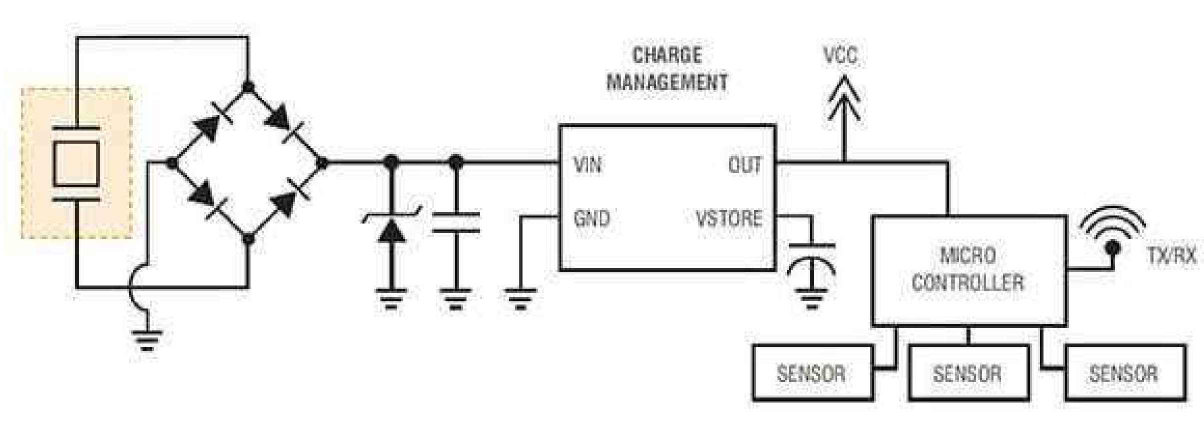


Fig. 4: Piezoelectric energy harvester (Courtesy of Mid Volture)

The energy source is determined by the operational environment, available energy density, and the required energy level to power the intended device. Figure 5 shows some of the popular energy sources and the corresponding energy density.

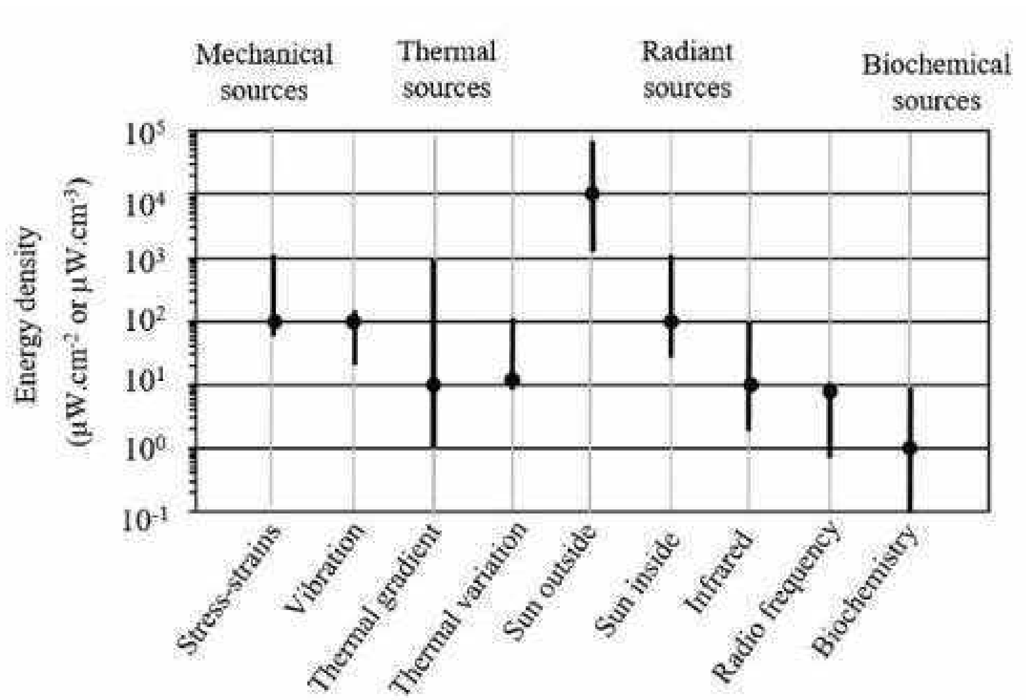


Fig. 5: Ambient Energy densities vs. ambient energy sources, (Courtesy Energy Harvesting)

It is noted that solar luminance has the highest available power density, it cannot be replaced, and its availability is not always guaranteed.

### Energy Harvesting Technologies

Energy harvesting is the conversion of ambient energy in the environment into electrical energy for powering electronic devices or circuits.

By Technology Energy harvesting are:-

- Light Energy
- Kinetic Energy
- Thermal Energy
- Radio Frequency Energy

The energy harvesting system mainly consists of transducers, power management integrated circuits and storage systems. Harvesting electrical power from non-traditional power sources remains a challenge while using thermoelectric generators, piezoelectric transducers, and solar cells. Each of these requires a form of power conversion circuit to efficiently collect, manage, and convert the energy sources into usable electrical energy for microcontrollers, sensors, wireless devices, and other low-power circuits. In the energy harvesting the energy management system components ought to have:

- High energy *efficiency* in capturing, accumulating, and storing small energy packets. The energy consumed by the energy harvesting circuit is much smaller than the energy captured from the source.
- High energy *retention* with minimal leakage or losses in energy storage.
- As per application energy *conditioning* ensure the output meets power requirements.
- It has the *tolerance* of a wide range of voltages, currents, and other irregular input conditions.

There are several energies referred in Table 1 (Courtesy Energy Harvesting) that summarize the state of the art of harvesting technologies. It classifying them by their characteristic parameters, operation mode, power density, system efficiency, technology development status and generated signal type.

**Table 1.** Current energy harvesters' technologies' characteristics summarized.

| Harvester | Physical/Chemical Operation Mode | Power Density | Efficiency (%) | Mature/Emerging |
|---|---|---|---|---|
| Photovoltaic | Photovoltaic effect | Outdoors: 15 mW/cm$^2$<br>Indoors: 10–100 μW/cm$^2$ | Until 40 | Mature |
| Piezoelectric | Piezoelectric effect | 330 μW/cm$^3$ shoes insert | Until 30 | Mature |
| Electromagnetic | Faraday's law | Human: 4 μW/cm$^3$ @ kHz<br>Industrial: 306 μW/cm$^3$ @ kHz | Until 67 | Mature |
| Electrostatic | Vibration-dependent capacitors | 50 μW/cm$^3$ to 100 μW/cm$^3$ | 9.5–23.6 | Emerging |
| Pyroelectric | Olsen cycle | 3.5 μW/cm$^3$ at the temperature rate of 85 °C/s @ 0.11 Hz | 1–3.5 | Emerging |
| Thermoelectric | Seebeck effect | Human: 100 μW/cm$^3$<br>Industrial: 100 mW/cm$^3$ | 10–15 | Mature |
| Magnetic | Ampere, Maxwell, and Faraday laws | 1.8 mW/cm$^3$ with 400 A at 4 cm from conductor | 0.1325 | Emerging |
| RF | Ubiquitous radio transmitters | GSM: 0.1 μW/cm$^2$<br>WiFi: 0.01 μW/cm$^2$ | 50–70 | Mature |
| Wind and Water | Faraday's law | 1.16 mW/cm$^3$ at the speed of 5 m/s<br>4.91 μW/cm$^3$ at the speed of 3 l/s | 0.61–17.6<br>1.7–29.5 | Emerging in small scale |
| Acoustic | Helmotz effect | 1.436 mW/cm$^3$ at 123 dB | 0.012 | Emerging |

By Components Energy harvesting are:-

- Transducer/Harvester
- Photovoltaic
- Thermoelectric
- Inductive
- Radio Frequency
- Piezoelectric
- Battery/Super Capacitor

- Power Management
- Others

### Energy Harvesting Benefits

There is abundant energy in the environment that can be converted into electrical energy to power a variety of electronic circuits. Energy harvesting is having a significant benefit by providing power to electronic devices where frequent replacement of battery can be eliminated and running wires to end applications. It opens up new applications in remote locations, underwater, and other hazardous locations where batteries and conventional power are not realistic. Energy harvesting is also largely maintenance-free and is environmentally friendly.

### Energy Harvesting Challenges

There is a different challenge associated with energy harvesting as follow:

1) A proper trade-off in the design process of energy harvesting devices is needed.
2) The devices are to be designed to operate in an energy harvesting environment.
3) The selection of energy harvesting sources shall be available as per the application.
4) RF power for energy harvesting shall be deployed with care to avoid associated health risks.

### Energy Harvesting Market Trends

As per the energy harvesting systems market report of 2021-2031; the forecasts show as follow:

- by Technology (Light Energy Harvesting, Vibration Energy Harvesting, Electromagnetic/Radio Frequency (RF) Energy Harvesting, Thermal Energy Harvesting, Wind Energy Harvesting, Other),
- by System (Autonomous Energy Harvesting Systems, Autonomous Hybrid Energy Harvesting Systems, Semi-Autonomous Energy Harvesting Systems, Battery-Supplemented Energy Harvesting Systems, Other),
- by Components (Wind Turbine, Solar Panels, Thermoelectric Generator, Antenna, Power Management ICs, Secondary Batteries),
- by Application (Industrial Application, Consumer Electronics, Building & Home Automation, Transportation, Security, Other)

### Energy Harvesting Applications

The energy harvesting is to supply the low-power circuit and transmit the infrared or wireless radio signal. Circuits that receives harvested energy consume the lowest standby current, operate at the low-voltage range. By Application energy harvesting are:

- Industries and IoT
- Remote corrosion monitoring systems.
- Implantable devices and remote patient monitoring.
- Structural monitoring
- Consumer electronics
- Building and Home Automation
- Automobile industries

- Transportation
- Smart Wearable Without Battery Backup
- Energy Harvesting Driven Pacemakers
- Equipment monitoring.
- Smart Home
- Calculators and Watches
- Other Small Instruments
- Others

### Energy Harvesting Future

With the advancement of technology and its maturity, new applications are enabled to shift by energy harvesters. Some of the energy harvesting future applications areas are as follow:

- Smart cities: wireless sensors will become ubiquitous
- Falling costs: mass-market consumer applications
- Biological systems: ultra-low power medical implants
- System integration: designing complete systems
- Low power electronics: microelectronics companies
- Low power wireless communications: communications protocols

### Conclusions

The success of any technological solution is based on performance, availability, efficient management and reutilisation of energy available to increase the potential life of the entire system. Harvesting energy from non-conventional sources in the environment has received more interest over the past few years. Even though energy harvested is small and in the order of mill watts, it can provide enough power for wireless sensors, embedded systems, and other low-power applications. This made the designers look for alternative energy sources for low-power applications. The energy harvesting systems are the future technology that will play a key role in building sustainable systems. The most promising advantage associated with energy harvesting is battery-free, the wireless sensor with cloud connectivity enables enhanced monitoring of environmental conditions in different applications such as data centres, industrial predictive maintenance, construction and power, cold chain, digital farming and smart healthcare.

# FUTURE OF ELECTRIC MOBILITY

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Electric vehicles have started dominating the Indian roads. Still many of us believe EVs are best suited for grandpa to go buy milk, we still associate it with small size, plastic toy looks, limited range, slow speed, etc. Gone are the days  today in 2021, EVs are ready to take over  ready to replace the traditional IC engine vehicles. The likes of Tesla, Wolksvogan, have changed the face of electric mobility. Today, EVs are packed with high density lithium-ion battery pack, real time traffic monitoring, climate control, hyper charging networks, etc. Well, in this article we will look onto some developing technologies, which could further revolutionalize the electric mobility.

Fig. 1: Electric mobility system,(courtesy of solarmobility.com)

### Solid State Batteries

Range anxiety, the disappointing factor about EVs. Even though some models have attained 500km+ range in a single charge, it is still something which bothers EV owners, unlike traditional fuel engines, which can be replenished in a few seconds. Lithium-ion batteries have their energy density limits, they are constructed with liquid electrolyte and traces of other hazardous materials, which are unstable at high temperatures  susceptible to environment damage

Industry veterans  scientists are working on to solve this issue through Solid state batteries. They are expected to replace the heavy liquid electrolyte in lithium-ion batteries. They are more compact  denser, which expands energy  helps to attain faster charging speeds. Solid state batteries can be manufactured using graphite  sodium while replacing lithium, thereby reducing the concerns of environmentalists.

Solid state batteries are currently in developmental phase  expected to come into markets by 2030. Manufacturers like Quantumscape are heavily invested in this technology.

### Artificial Intelligence


Fig. 2: Quantumscape,(courtesy of quantumscape.com)

EVs are basically vehicles built around a perfect software. The success of EVs mainly attribute to its intelligent software system. This software perform everything from onboard diagnostics, optimization, managing the battery life, monitoring the traffic, etc, something which IC engine vehicles always lacked.

These cutting edge processors  a robust machine learning platform is the reason behind the Teslas successful Autopilot feature. The makers have promised that by 2030, they would deploy completely self driving EVs. Ambitious !!!

We develop  deploy autonomy at scale. We believe that an approach based on advanced AI for vision planning, supported by efficient use of inference hardware is only way to achieve a general solution to full self driving cars  stated by tesla on its official website

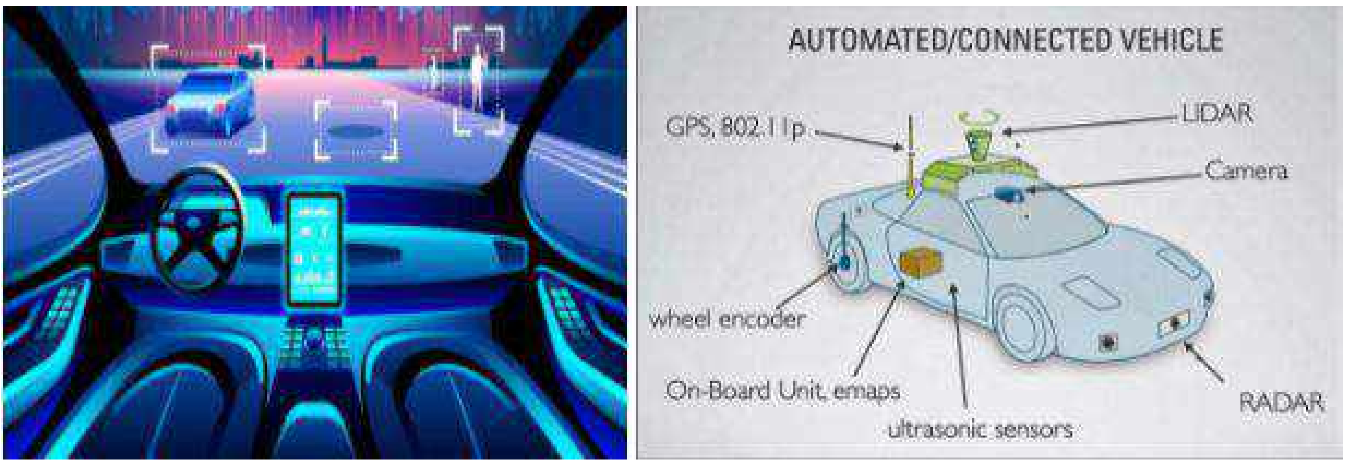



Fig. 3: Artifical Intelligence(courtesy of quantumscape.com)

### 5G

The 5G millimeter wave infrastructure is already being rolled out around the globe at rapid phase. It is touted that more than 50 billion IOT devices will be connected with 5G by 2030. When the electric mobility is equipped with 5G connectivity, it will help them with real time communication at much lower latency, streaming the data back to cloud. Its said to optimize the performance  fuel efficiency. With 5G, the EVs can be synchronized with each other, thus avoiding the risk of accident  human error.

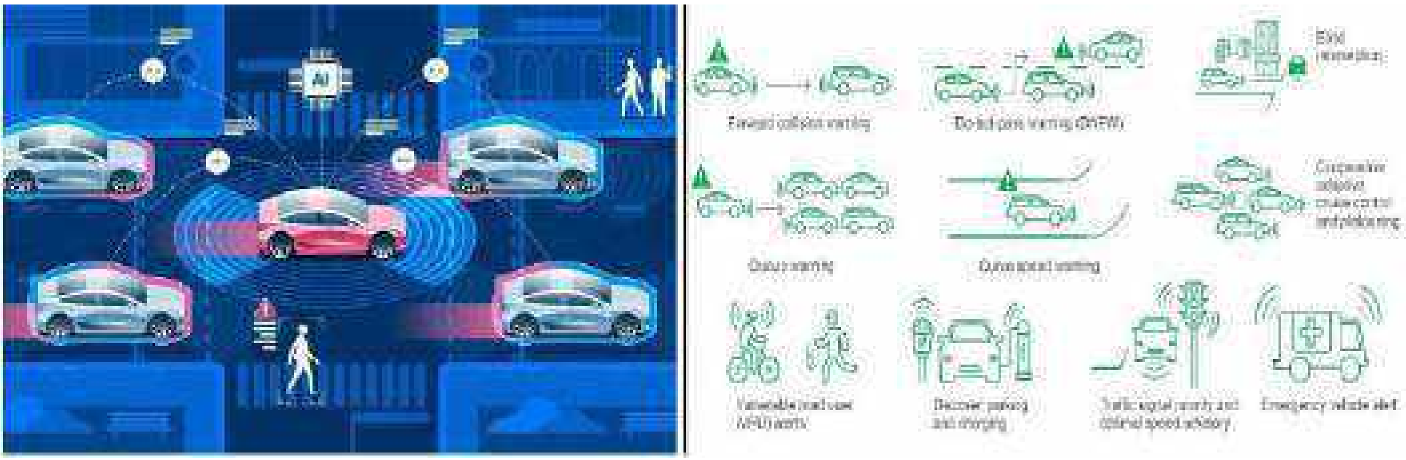


Fig. 4: Use of 5G in automobiles(courtesy of 5G systems)

### Advantages

- **Quality of life**-It improves peoples quality of life by not emitting toxic gases. Furthermore, as electric vehicles do not have combustion engines, they avoid the emission of tonnes of greenhouse gases, which in turn helps in the fight against the effects of climate change .
- **Sustainable mobility**- obtains more and more support around the world through public policies related to the electrification of urban public transport, changes in tax policies, creation of regulatory frameworks to regulate it and even its integration in projected urban infrastructures
- **Eco-friendly and sustainable transport.**-Electric mobility has come to stay and will mark the future of transport. A more efficient, eco-friendly and sustainable transport.

### Disadvantages

- **Range Might be a Problem**-Unlike gas-powered vehicles which usually come with good mileage, EVs have comparatively shorter ranges. They are best suited for driving in the city and are not appropriate for longer drives. Shorter ranges can become a serious problem out on the highways or on a country road. Moreover, the range of the battery would also drop in chilly weather conditions.
- **Could be Expensive**-Investment in RD and technological breakthroughs have made it possible for many companies to offer their electric vehicle at affordable prices. But for the huge part, EVs are still relatively expensive and would garner a hefty initial investment by the buyer. Again cutting the cost of production can come a long way in finding a solution to this.
- **Government Policy**-Lack of clarity in government policy can act as an impediment to the growth of this industry. Goods and Services Tax for EVs are high. The government should take better initiatives

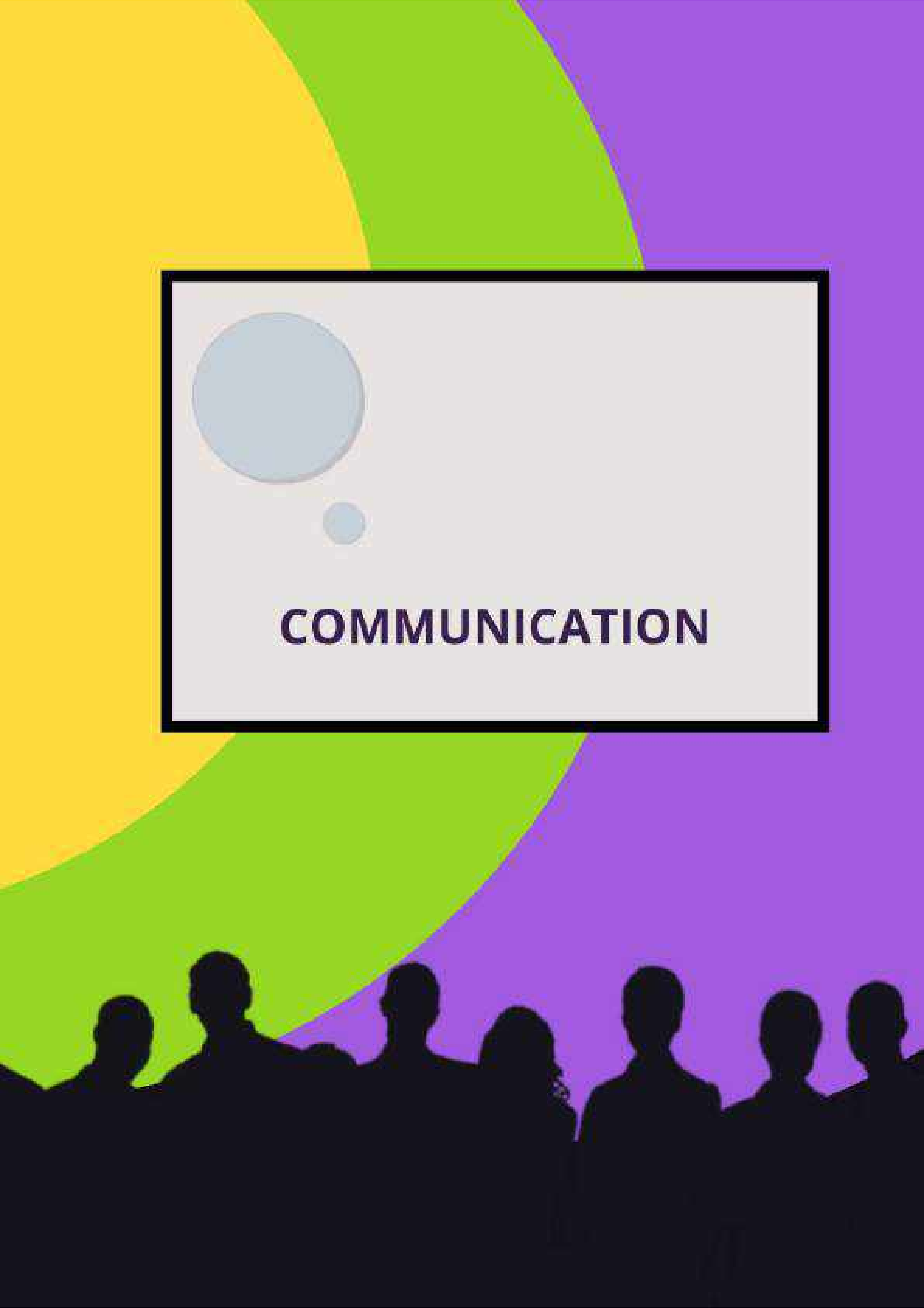
to further the production and use of EVs.

## Conclusion

It must be noted that this technology is constantly evolving, making electric mobility increasingly efficient and creating new uses for it: lorries, aircraft and electric boats that are in an experimental phase would mark the beginning of the electrification of all mobility.

## 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.


COMMUNICATION

# SPACE ELEVATOR

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A space elevator is a concept for planet-to-space transportation. Here the mass is lifted out of Earths gravity without using rockets. The problem in using rocket is that the engines jettison mass in one direction to generate thrust for a spacecraft this requires huge volumes of propellant which is accelerated along with the spacecraft but finally discarded. This increases the cost. Therefore a cable stretching from Earth to geostationary orbit provides a way to climb into space. The climbing process can be powered by solar energy and therefore does not require onboard fuel. The force of gravity at the lower end and outward centripetal acceleration at the other end would keep the cable stretched and stationary in a single position on Earth. Thus making it possible to fix a payload to the cable and lift it to orbital height. At this height the mass will attain a velocity to remain in the orbit or we can use an additional in-space propulsion system to send it to deep space destinations.

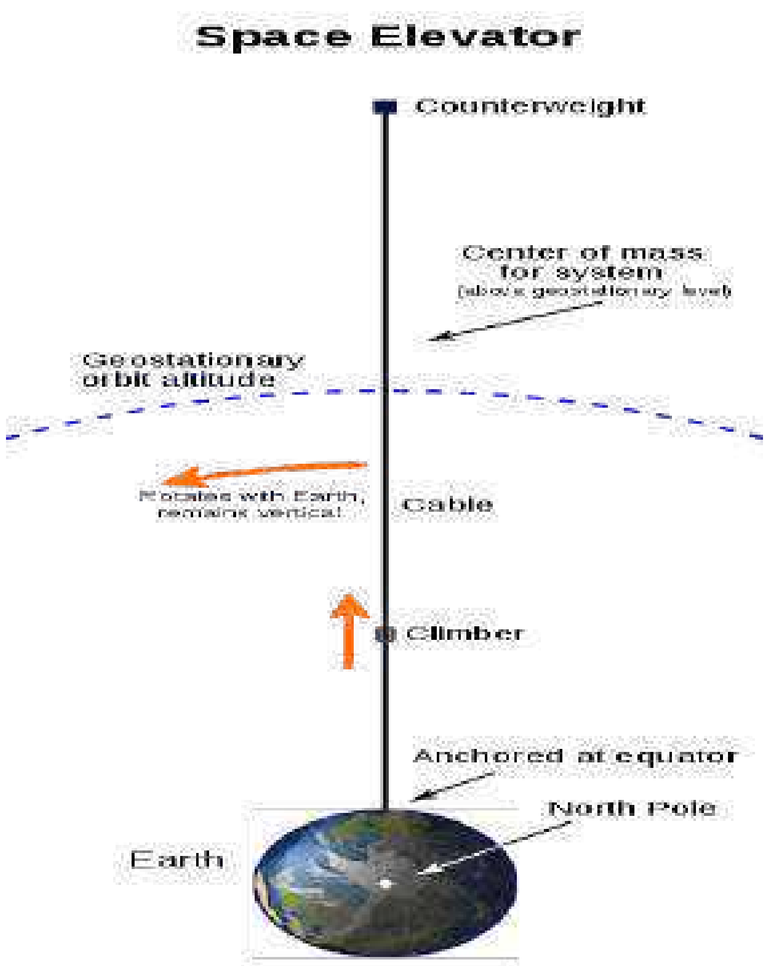


Fig. 1: Space Elevator, (courtesy of britannica)

Carbon nanotubes are a possible material if they can ever be made long enough. The main component would be a cable (tether) tied to the surface and extending into space. The design would allow weights to travel along the cable from Earth to orbit, without the use of large rockets. The space elevator comprise of a cord with one end attached to the surface and the other end in geostationary orbit. The force of gravity is stronger near Earth surface and the outward centrifugal force is stronger at the upper end geostationary orbit, will help to hold the cable. In 1895 Konstantin Tsiolkovsky first published the concept of a tower reaching geosynchronous orbit.

**Components**

1) **Base station:**
   They are typically mobile stations or other mobile platforms. Mobile base stations have the advantage over stationary concepts proposed earlier since they can move to avoid storms, and space debris. Oceanic anchor points are normally in international waters thus reduces the cost of negotiating territory use. Stationary land based platforms would be simpler and less costly. They can be at high altitude, such as mountain tops or could be a tower with a space elevator which comprises both a compression tower near the surface, and a tether structure at higher altitudes. Combining a compression structure with a tension structure would reduce loads from the atmosphere at the Earth end of the tether, reduce the distance of cable extending into Earth's gravity, and thus reduces the critical strength-to-density requirements for the cable material.

2) **Cable:**
   A space elevator cable should carry its own weight as well as the weight of climbers. The required cable strength varies along the length because at various points it has to carry the weight of the cable below and counterweight above. Maximum tension on the cable will be at geosynchronous altitude so the cable should have to be thickest there and narrow as it approaches Earth. The cable must be of a material with a high tensile strength or density ratio. Therefore a material with very high strength and lightness is needed like carbon nanotubes and graphene ribbons.

3) **Climbers:**
   A space elevator cannot use moving cables due to the need for the cable to be wider at the center than at the tips. Climbers would need to be paced at adequate timings so as to reduce cable stress and oscillations and to maximize throughput. Lighter climbers could be sent up with several going up at the same time this increases throughput but lower the mass of each individual payload. The horizontal speed due to orbital rotation increases with altitude. When the payload has reached GEO, the horizontal speed is exactly the speed of a circular orbit at that level. A space elevator will also gain horizontal speed (angular momentum). The angular momentum is taken from the Earth's rotation. The climber move upwards initially slower than each successive part of cable it is moving on to. This is the Coriolis force: the climber as it climbs drags (westward) on the cable and decreases the Earth's rotation speed. For descending payloads, the cable is tilted eastward increasing Earth's rotation speed. Due to centrifugal force the cable constantly try to return to the energetically favorable vertical orientation. When an object has been lifted, the counterweight would swing back toward the vertical. The design of space elevator should be such that the center of mass is always well-enough above the level of geostationary orbit to hold up the whole system.

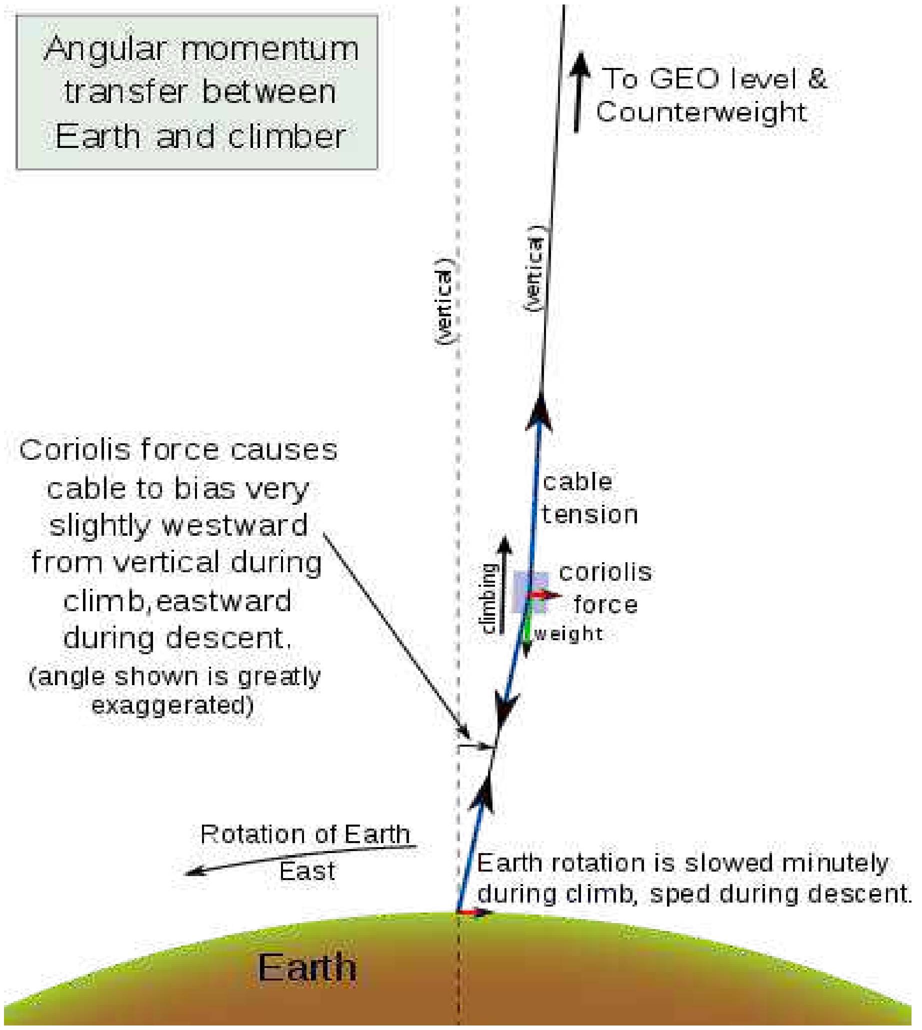


Fig. 2: Angular momentum transfer between Earth and climber (courtesy of britannica)

4) **Powering climbers:**
Power and energy are significant issues for climbers; the climbers should gain a large amount of potential energy as fast as possible to clear the cable for the next payload. Proposed methods for the energy to the climber:
   - Transfer the energy through wireless energy transfer while it is climbing.
   - Transfer the energy through some material structure while it is climbing.
   - Storing the energy in the climber before it starts; this method requires a high energy such as nuclear energy.
   - Solar power.

5) **Counterweight:**
Proposed solutions to act as a counterweight:
   - A heavy, captured asteroid.
   - A space dock, space station or spaceport can be positioned past geostationary orbit.
   - An upward extension of the cable same as an equivalent counterweight.

### Applications

- Launching into deep space.
- Extraterrestrial elevators.

### Advantages

- Opening of Opportunities.
- Lower energy and cost of operating the space elevator.
- Reduce the costs of telecommunication.

### Disadvantages

- Place for the construction of elevator on Earth.
- Cost overruns.

### Conclusion

A space elevator concept is used to transport mass from Earth to outer space without the use of rocket by using a cable. This reduces the requirement of huge propellant for acceleration. Thus reducing the fuel cost and can carry payload to orbit.

### 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.

# HYPERLOOP

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A Hyperloop is a different mode of ground transportation that is used for faster and mass transportation of both humans and load. It is depicted as a fixed cylinder or arrangement of cylinders with low pneumatic force through which a unit might travel significantly liberated from air opposition or grinding. The Hyperloop might move individuals or items at aircraft or hypersonic speeds while being energy effective contrasted and existing rapid rail frameworks. This, whenever implemented, may decrease time-wasting with the existing mode of transportation like train and plane travel over distances of under thousand five hundred kilometers.

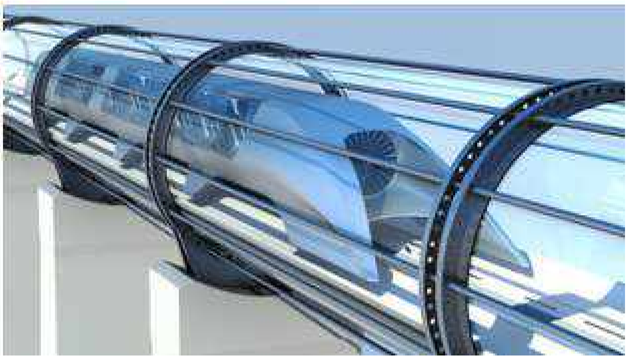

Fig. 1: Hyperloop, (courtesy of virginhyperloop)

The Hyperloop idea has been explicitly ”open-sourced” by Musk and SpaceX, and many startups and industries have been urged to make the thoughts and further foster them. With that in mind, a couple of organizations have been framed, and a few interdisciplinary understudies drove groups are attempting to propel the innovation. It has three significant parts: a tube, pod, and terminal. The cylinder tube is a huge fixed, low-pressure framework that can be built above or subterranean. A mentor runs inside this controlled environment and can be defined as a pod. The pod utilizes attractive or streamlined levitation (utilizing air-bearing skis) alongside the electromagnetic or streamlined drive to skim along a fixed guideway. The terminals deal with the point for arrival and departure.

## Components

The hyperloop concept can be explained through its major components like

1) Capsule (Pod) - The capsule(pod) in the hyperloop is an encased segment in a diminished pressure tube. They are upheld using air orientation that work utilizing compacted air repository and streamlined lift. The capsule would get its underlying speed from an outside straight electric engine, which would speed up it to ’high subsonic speed’ and afterward give it a lift every seventy miles or thereabouts; in the middle, the case would drift along in close to vacuum. Each capsule could carry twenty eight travellers or more some baggage; another form of the units could convey load and vehicles.

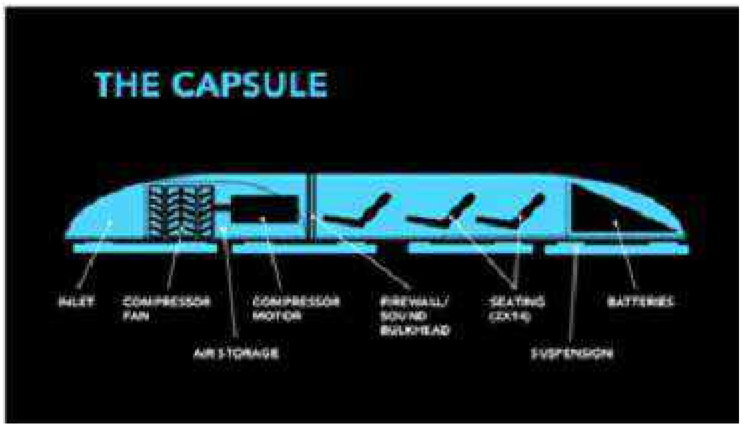


Fig. 2: Capsule, (courtesy of virginhyperloop)

2) Tube  The tube is made of steel and adjacent tubes of some constant length are welded together to make a path for the capsule. Pylons are a type of pillar that is placed on every hundred feet to support the tube. The pressure of the air inside the Hyperloop tube is about one-sixth the pressure of the atmosphere on Mars. The top of the tube is covered with solar cells which provide energy to the system.


Fig. 3: Tube with pylon,(courtesy of hyperlooptt.com)

3) Terminal  Terminal is an architecture in which the capsule pauses more clearly it is a point for arrival and departure. This space provides for people to connect with major cities.

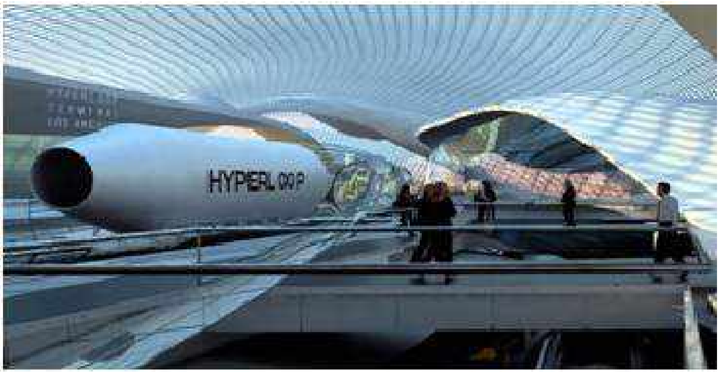


Fig. 4: Terminal,(courtesy of hyperlooptt.com)

4) Propulsion- Propulsion is another significant segment in the hyperloop. The linear induction motor assists the case with impelling forward. LIM is a specific reason framework that we use to accomplish rectilinear movement as opposed to rotational movement as on account of traditional engines. Thoughtfully, a linear motor is a rotatory engine where its rotor and windings have been removed open and laid level.

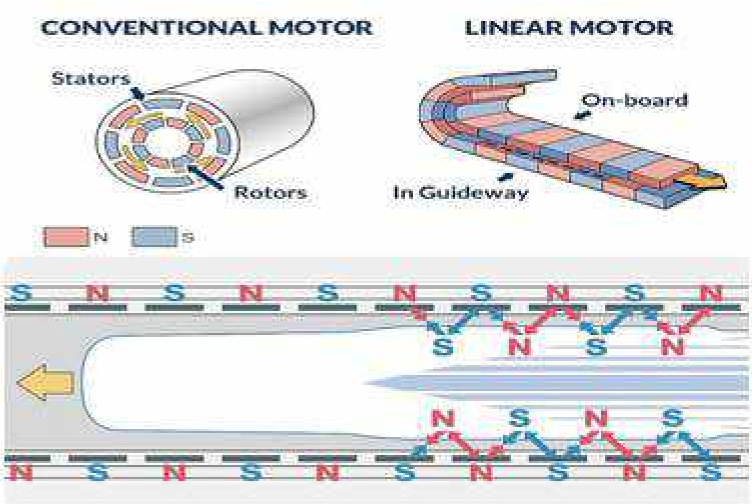


Fig. 5: Hyperloop Propulsion, (courtesy of hyperlooptt.com)

**Working**

The hyperloop is only a Maglev train encased in a tube in which there is negligible pressure and subsequently basically no air opposition. The fundamental working principle of the hyperloop is magnetic levitation.

**Magnetic levitation/Maglev:**

Magnetic levitation, or maglev, is the method by which an object floats or stands only with the help of a magnetic field without any external support.


Fig. 6: Magnetic Levitation (courtesy of maglevjp)

Magnetic levitation's most popular use is in maglev trains. Right now, just in activity in a small bunch of nations, including China and Japan, Maglev trains are the quickest on the planet, with a record speed of 375 mph (603 km/h). There maglev technology are of two types electromagnetic suspension (EMS) and electrodynamic suspension (EDS). EMS uses electronically controlled electromagnets in the train to attract it to a magnetic steel track, while EDS uses superconducting electromagnets on both the train and the rail to produce a mutually repellent force that makes the carriages levitate.

A variation of EDS innovation as utilized in the Inductrack framework utilizes a variety of long-lasting magnets on the underside of the train, rather than fueled electromagnets or cooled superconducting magnets. This is otherwise called passive magnetic levitation innovation. With this strategy, magnets are put on the underside of the capsules in an array. This centers the magnetic power of the magnets on one side of the array while predominantly offsetting the field on the opposite side. These attractive fields cause the pods to float as they disregard electromagnetic loops inserted in the track. Push from straight engines moves the cases forward. Hyperloop One is additionally utilizing a passive magnetic levitation framework where pod side permanent magnets repulse a passive track, with the input energy coming from the speed of the pod.

**Advantages**

- The hyperloop technology provides the ever fastest mode of transportation.
- Low power consumption.
- Highly efficient.
- Cheaper mode of transportation.
- Can withstand any weather conditions.
- Promotes economic growth.
- Reduces the risk of human errors.
- Earthquake resistant.

**Disadvantages**

- Higher cost of construction and development.
- Chances of failure causes risks to life.
- High speed may cause difficulties to passengers.
- Steel track changes shape and expands with outside temperature.

**Application**

- Human transportation.
- Delivering goods over countries can be done within hours.

**Conclusion**

The innovation of Hyperloop is in its simple stage. Albeit the innovation is triple-crown, it very well may be worked upon for development later on. An inside and out style for the stations, along with stacking and dumping of travelers, further developed security choices, and impetus of the case, includes a gigantic degree towards creating Hyperloop. One of the preeminent difficulties for Hyperloop is its flexibility to geology sharp turns and change in heights. The current container configuration allows exclusively twenty-eight travelers to drive at a time.

**Acknowledgement**

We 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.

# 5G NETWORK IN INDIA

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## INTRODUCTION

In telecommunications, 5G is the fifth generation technology standard for broadband cellular networks, which cellular phone companies began deploying worldwide in 2019, and is the planned successor to the 4G networks which provide connectivity to most current cellphones. 5G networks are predicted to have more than 1.7 billion subscribers worldwide by 2025, according to the GSM Association. Like its predecessors, 5G networks are cellular networks, in which the service area is divided into small geographical areas called cells. All 5G wireless devices in a cell are connected to the Internet and telephone network by radio waves through a local antenna in the cell.

The main advantage of the new networks is that they will have greater bandwidth, giving higher download speeds, eventually up to 10 gigabits per second (Gbit/s). In addition to 5G being faster than existing networks, 5G can connect more different devices, and even if people are in crowded areas, the servers will be more unified, improving the quality of Internet services. Due to the increased bandwidth, it is expected the networks will increasingly be used as general internet service providers (ISPs) for laptops and desktop computers, competing with existing ISPs such as cable internet, and also will make possible new applications in internet-of-things (IoT) and machine-to-machine areas. 4G cellphones are not able to use the new networks, which require 5G-enabled wireless devices.

Mobile wireless communication networks have experienced a remarkable change in the last few decades. Since the launch of the first generation of mobile network to the currently used 4G network (fourth generation mobile network) mobile networks have seen a major transformation. The mobile wireless generation (G) refers to a change in the nature of the system, speed, technology, frequency, data capacity, latency etc.

Television has played an integral role in replacing radio, which was the most popular mass medium in the 1950s, at the time when some people find it difficult to imagine being without it. Both shaping and reflecting cultural values, television has at times been criticized for its alleged negative effect on young people and children and at other times lauded for its ability to create a common wisdom for all its viewers. In the modern world, as satellite broadcasting and Internet technology change the way people watch television, the medium continues to evolve, solidifying its position as one of the most important inventions of the 20th century.

The first generation (1G) mobile wireless communication network was capable of transmitting only normal voice calls. The second generation (2G) was a digital technology which also supported text messaging. The third generation (3G) mobile network came up with higher data transmission rate, increased capacity and it provided multimedia support. The fourth generation (4G) integrated 3G technology with fixed internet so that it could support wireless mobile internet. This was an evolution in the mobile technology, 4G network increased bandwidth and reduced the cost of resources.The basic difference between these generations is that each generation have some standards, different capacities, new techniques


Fig. 1: 5G ,(courtesy of 5G systems)

and features which differentiate it from the previous one.

However, with the changing connectivity needs, rising mobile data traffic and a new category of connected-ecosystem products, a yet newer generation of mobile network is required that can provide even higher data speeds at low latency and enhanced throughput to handle more simultaneous connections without causing disruptions. And, this is exactly what 5G telephony is all about.

As the name suggests, 5G is the fifth-generation cellular network technology. It is designed to improve network connections by addressing the legacy issues of speed, latency and utility, which the earlier generations and the current generation of mobile networks could not address. 5G is promised to deliver data speed at a rate 100 times faster than 4G networks. Importantly, it is designed to transmit data almost instantly with a network latency of less than 10ms. It will also have an enhanced throughput to handle more simultaneous connections at a time than current-generation networks.

Globally, 5G network deployment is rapidly moving from trials to early commercialisation. In India, network operators like Airtel, Vodafone Idea, Reliance Jio, etc, have already partnered with vendors like Ericsson, Huawei and Samsung for planned trials sometime by the end of this year, before the services forecast commercial rollout in 2020. According to the GSM Association, a trade body that represents the interests of mobile network operators worldwide, the following developments have taken place in India on the 5G front:

- **Bharti Airtel and Huawei** Bharti Airtel and Huawei have successfully conducted Indias first 5G network trial under a test setup at Airtels network experience centre in Manesar, Gurgaon, achieving a user throughput of more than 3 Gbps. Bharti Airtel has signed a memorandum of understanding (MoU) with Nokia and Ericsson to support the company in its preparations for 5G rollout.

- **Vodafone Idea** Vodafone Idea has also proposed 5G trials with multiple vendors, including Huawei and Ericsson.

- **Samsung** Samsung will conduct 5G field trials in New Delhi in 2019, and is working closely with the DoT. The company is also likely to be one of Reliance Jio's partners for its 5G field trials.

- **BSNL -** BSNL has signed an MoU with Ciena to conduct field trials with the goal of a commercial launch by 2020. Ciena and BSNL intend to jointly evaluate fronthaul, midhaul and backhaul transport-based use cases and scenarios to address resilience requirements and latency concerns

## Conclusion

5G networks are cellular networks, for which the service area is divided into small geographical cells. The 5G wireless devices in a cell communicate over RF in the cell, over frequency channels assigned by the base station. Each cell comprises of a base station and remote radio heads (antennas), The base stations, termed as gNBs, are connected through the 5G Core to switching centers in the telephone network and routers for Internet access by high-bandwidth optical fiber or wireless backhaul connections. As in other cell networks, a mobile device moving from one cell to another is automatically handed off seamlessly to the current cell. 5G can support up to a million devices per square kilometer, while 4G supports only one-tenth of that capacity.

# HISTORY OF NEUMANN MICROPHONE

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## Introduction

A microphone, colloquially called a mic or mike is a device a transducer that converts sound into an electrical signal. Microphones are used in many applications such as telephones, hearing aids, public address systems for concert halls and public events, motion picture production, live and recorded audio engineering, sound recording, two-way radios, megaphones, radio and television broadcasting. They are also used in computers for recording voice, speech recognition, VoIP, and for non-acoustic purposes such as ultrasonic sensors or knock sensors. Several types of microphone are used today, which employ different methods to convert the air pressure variations of a sound wave to an electrical signal. The most common are the dynamic microphone, which uses a coil of wire suspended in a magnetic field; the condenser microphone, which uses the vibrating diaphragm as a capacitor plate; and the contact microphone, which uses a crystal of piezoelectric material. Microphones typically need to be connected to a preamplifier before the signal can be recorded or reproduced. Among all this neumann microphone is professional recording microphone

Neumann Microphones Company founder Georg Neumann was born on October 13, 1898 in a small town just outside of Berlin. He received his vocational training at the firm of Mix Genest in Berlin, and later worked in a research laboratory at AEGs Oberspree Cable Works. His work there was focused on building amplifiers, but the director of this laboratory, Eugen Reisz, founded his own firm a few years later and took Georg Neumann as an employee.

## Early Years

While working with Eugen at his new firm, Georg Neumann helped to create higher quality microphones. At the time, microphones used for sound recordings were carbon microphones that had very low quality. When Georg studied these microphones, he tried putting powdered carbon on a marble slab, introduced a direct current, and inserted two electrodes. This gave a very thin sound, so Georg tried stretching some rubber membrane over the contraption. With the new membrane installed, low frequencies were finally present and Georg Neumanns first microphone was born.

It was called the Reisz-microphone, and it gave birth to the first German station in 1923. This microphone had a linear frequency response between 50 Hz and 1 kHz, and it had an excess of 10 dB up to 4 kHz. Shortly after Neumanns creation, he decided to leave Reisz and start his own firm so that he could mass produce a microphone using the capacitive transducer principle. Once Neumann started his own firm he created the CMV 3. This was the first ever mass produced condenser microphone, and it was also far superior to the Reisz microphone.

## End of the Fifties

Fig. 1: U87 condenser microphone,(courtesy of neumann.com)

At the end of the 1950s, the Telefunken VF 14 vacuum tube on which the circuitry of the U 47 and U 48 had been based, was discontinued, so Neumann came under pressure to develop a successor. They decided to offer all three of those two models' directional patterns in a single microphone. In the meantime, the rock 'n' roll era had begun and some engineers were recording loud vocals with singers singing directly into microphones at very close range; when the U 47 or U 48 were used in this way, the result was considered by many engineers at the time to sound unacceptably harsh. (This could be considered ironic, since the U 47 and U 48 have a cult following today specifically for use in close-up vocals, with some engineers seeming to fancy that they are re-creating a "vintage" soundwhereas in fact, they are creating a sound quality that was specifically abhorred by many of the "golden ears" of the eranotable exceptions being Beatles producer George Martin and engineers Norman Smith and Geoff Emerick.) The result was the U 67, a microphone with less emphasis in its upper midrange response, giving it less of a "forward" tone color. The U 67 uses a new capsule, the K 67. Unlike the K 47, the K 67 utilizes a two-piece backplate, allowing the diaphragms to be tuned separately and then matched to achieve the same front/rear response.

**The Eighties and beyond**

Fig. 2: U47 tube, (courtesy of neumann.com)

In 1983 Neumann began to introduce microphones with balanced outputs but no output transformer, starting with the model TLM 170. Eventually this "fet 100" or "transformerless" series was expanded to include the KM 100 modular series of small microphones (with seven different ”active capsules” for various directional patterns), the cardioid TLM 193 (using the capsule of the U 89 and TLM 170), the small-diaphragm KM 180 series, the large-diaphragm cardioid TLM 103, the variable-pattern TLM 127 and the TLM 49 cardioid vocal microphone.

Beginning in 1995 the company introduced a series of vacuum tube microphones with transformerless output circuitry: the multi-pattern M 149 Tube, the cardioid M 147 Tube, and the omnidirectional M 150 Tube (based on the classic M 50 design, with the pressure transducer mounted in the surface of a sphere inside the capsule head).

In 2003 Neumann introduced their first microphone with built-in analog-to-digital conversion, the Solution-D D-01. In 2006, the D-01 was followed with a modular, small-diaphragm series of digital microphones, KM D, based on the KM 100/180 series.

In 2005, Neumann began production of its first dynamic microphone, the BCM 705, for the broadcast industry.

Neumann was acquired by Sennheiser Electronic GmbH in 1991. Production of Neumann microphones was moved into a newly built level 100 cleanroom factory in Wedemark, near Hanover. The company maintains its official headquarters in Berlin.

In 2010, Neumann introduced the ”KH Line” of studio monitors, based on products from Klein + Hummel, a company from Stuttgart founded by Horst Klein and Walter Hummel in 1945, and bought by Sennheiser in 2005.

In 2019 their first headphones were introduced, the NDH 20.

**Conclusion**

In fact, these microphones can still be seen in studios today across the globe. The microphone has a double diaphragm capsule, both of which can be polarized with the same voltage. This means that both the omnidirectional and cardioid polar patterns were adjustable. After the creation of the U 47, Neumann had proven to be the leader in recording technology and kept creating better products. He would later release the KM series of microphones, which are some of the first pencil condenser microphones and are still largely popular today .After that, Neumann continued to improve on his microphones for years to come. He would even introduce the world to binaural stereo recording in the 1970s. This was just a dummy head that had two strategically placed pencil microphones in it, which gave engineers the option to record a sound how people actually perceive it. Its no doubt that Georg Neumann made a huge impact on the audio engineering world, and this brief look back in history shows why.

# DARQ TECHNOLOGY

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The world is rapidly moving near a post-digital era, where leaders will need to set their sights beyond their ongoing digital transformations. With digital capabilities alone no longer serving as a differentiator, future-minded corporate leaders will need more in their technology arsenals to succeed.

That means acceptance a group of emerging technologies to drive the next waves of innovation and growth. Specifically, they will need to attain mastery of the set of new technologies we call DARQ: discrete ledger technology, artificial intelligence, extended reality and quantum computing.

”Distributed ledgers, AI, extended reality and quantum computing are the next big technology catalysts for change.”

In fact, specific DARQ technologies are already making a difference across industries today. AI plays a critical role in optimizing processes and influencing strategic decision-making. XR, an immersive technology, makes entirely new ways for people to practice and engage with the world around them. Distributed ledgers are perhaps best known in the context of cryptocurrencies, but they are increasing networks and capabilities by eliminating the need for trusted third parties. And significant computing, the DARQ technology that remains the most experimental, will usher in novel ways to approach and solve the hardest computational problems.

But collectively, the DARQ technologies will also control the invention and opportunity uniquely associated with the coming post-digital era. As the business landscape transitions into a combination of digital natives and productions well into their digital transformations, DARQ is the key that will open unimagined new pathways into the future.

## What DARQ will do

History has shown that when sets of technologies like these converge over a short period of time, they can spark a huge change, letting businesses reimagine entire industries. DARQ will have the same game-changing effects.

Companies already identify the power of DARQ. Eighty-nine percent of businesses are currently experimenting with one or more DARQ technologies, expecting them to be key differentiators, and are substantially increasing their DARQ investments.

While each of the individual developing technologies that make up DARQ are at a different point on the adoption curve, its clear that the first wave of companies using DARQ technologies to drive differentiation is already here. Once the collective power of DARQ begins to manifest itself, it might be too late for adopters who lag behind to catch up.

DARQ will let leaders in the post-digital era reimagine their businesses. Being ready to harness the full power of DARQ in that post-digital future means beginning the journey today.

## ADVANTAGES

- DARQ technologies provide, insurance businesses must start to explore their potential in earnest.
- When all four technologies are viable at scale, their impact will accelerate significant change.

## DISADVANTAGES

- Enterprises must realise that only a strong digital foundation will help them pilot DARQ technologies to their advantages.
- All of advanced technologys benefits come with costs, some plain, other long-term and hidden.

## CONCLUSION

its impossible to predict when the post digital era will actually beginand its birth date will likely only be known in hindsight. If you wait to test with and integrate DARQ technologies, your company may have to play catch-up for years. You dont want to simply meet your clients expectation you want to be the company that changes their daily life and their interactions with the world.

# INTERNET OF THINGS

# Internet of Robotic Things in Smart Domains: Applications and Challenges

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Smart services are getting more and more essential with the development of the fourth stage of industrialization, also addressed as Industry 4.0, in which new disruptive technologies are converting both industrial and research fields. During the primary 3 business revolutions, there has been a development of productivity thanks to the introduction of new mechanical, electric, and digital technology. In the last few years, the necessity for an improvement in human life quality has steer to realize more and more production models of customized and digital services. The predominant result of the existing fourth commercial revolution lies in the development and rapid spreading of the Cyber-Physical Systems (CPSs). CPS technologies cover a wide range of programs, inclusive of electrical energy grids, transportation structures, fitness-care devices, gasoline distribution etc. In CPS, the interaction with the physical structures causes via networks, running complicated analysis while extracting information. Both IoT and CPS lay a robust basis for the improvement of a brand new research location: the Internet of Robotic Things (IoRT). It pursuits at improving the current IoT with lively sensing and actuation from robotics. IoRT represents the core of robotics-embedded IoT systems, in which cloud computing and networking may be applied to accomplish elaborated duties, allowing robots to proportion, community, and gather one-of-a-kind forms of information among each machines and things. A scheme of robotics, cloud computing, and IoT integration may be located in Figure 1.

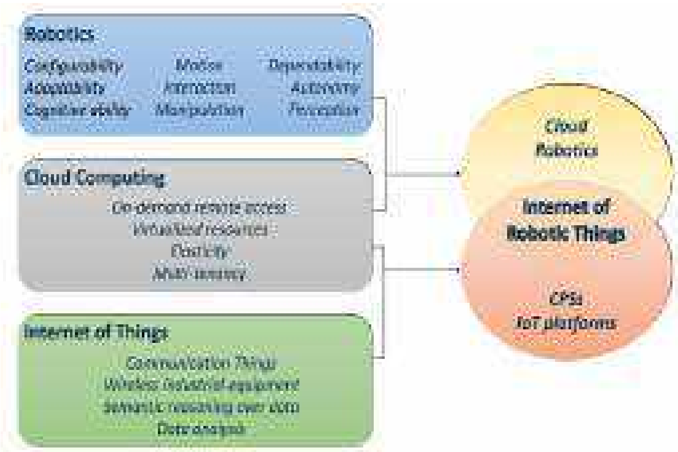


Fig. 1: A scheme of robotics, cloud computing, and IoT integration,(courtesy of mdpi.com)

## Smart Technologies in Industry 4.0

The fourth industrial revolution, commonly known as Industry 4.0, can be defined as the next level of manufacturing, where digital integration and intelligent engineering are used to transform the way machines communicate with each other and humans. The growth of Industry 4.0 has steer to an improvement of the entire manufacturing industry. The principal function of Smart Spaces is to monitor processes and applications, such as power consumption or state of sensors and actuators, in a defined controlling area. Industrial robots play a predominant role in the Smart Manufacturing environment, where operations such as assembling, welding, spray painting, and so on are merged with IoT technologies to guarantee interaction among multiple robots and devices, assuring reliable and efficient production.

One of the most important factors related to Industry 4.0 is the so-called Cyber-Physical System (CPS). With the continuous development of various technology domains, CPS applications have become fundamental, as they handle to connect all physical devices to the Internet, merging virtual and physical worlds to attain smart production and products. The application of CPS in production scenarios, where sensors, machines, and actuators are linked to gain the highest efficiency in terms of production, which leads to the concept of Cyber-Physical Production System (CPPS). CPPS can be beneficial in improving the flexibility of IoRT-based production systems in smart domains, such as manufacturing, agriculture, medical surgery, and elder care. Specifically, HumanRobot Interaction (HRI), where robots and humans work together, can be applied in these fields just mentioned, particularly in manufacturing. In industrial settings, the architecture of CPS is characterized by five different levels that are Smart Connection level, Conversion level, Cyber level, Cognition level, Configuration level. Five-layer architecture of CPS implemented in industrial settings.

## Internet of Robotic Things

The most progressive idea in terms of robotics lies in IoRT, where CPSs are used to play a powerful foundation in boosting IoT itself. In IoRT systems, modern robotic technologies have been combine with networking and cloud computing, integrating CPSs and IoT protocols to flourish new technologies. As a result of such integration, smart devices become capable to monitor events, merge sensor data from a variety of sources, and use local and distributed intelligence to determine the optimal course of action. The principal architecture of the IoRT systems, as shown in Figure 2. It consists of three main layers: (1) Physical layer, (2) Network and Control layer, and (3) Service and Application layer.

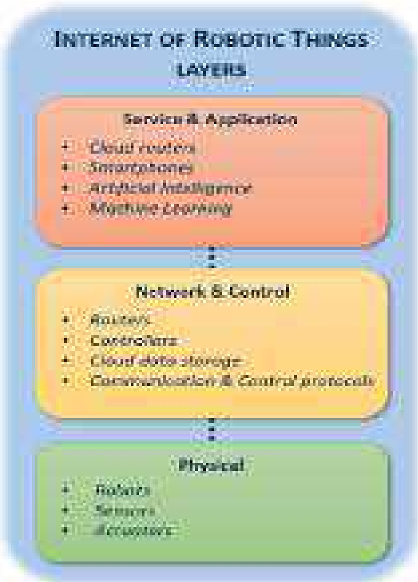


Fig. 2: The principal architecture of the IoRT systems,(courtesy of mdpi.com)

The Physical layer defines the lowest level of the IoRT architecture. It consists of robots, sensors, and actuators. Generally, the word robot refers to vehicle, drones, unmanned vessels etc. Network and Control layer, where various components can depend on certain protocols to communicate and control processes.

The Network and Control of the IoRT architecture consists of servers, controllers, routers, and different communication and control protocols. The third layer illustrate the top level of the IoRT architecture. It contains the implementation of programs in order to control, process, and examine both environmental parameters and agents in smart environments.

### Smart Domains and Applications in the IoRT Systems

- **Manufacturing:** Smart manufacturing involves system flexibility, monitoring, and adaptation to replace. Specifically, additive production is a critical process in terms of manufacturing methods. In fact, innovations in digital technologies that are occurring during the 4th Industrial Revolution want to keep up with advancements in manufacturing materials and processes.
- **Agriculture:** Advanced technology in Industry 4.0 has brought a prominent innovation in agriculture. The particular vulnerability of agriculture to climate change results to the primary smart agriculture concepts: Climate Smart Agriculture (CSA) and Sustainable Intensification (SI). The main purpose of CSA is to increasing incomes and food security, while decreasing green-house gas emissions. In agriculture, robotic systems can be decisively useful in attaining both high quality and quantity products, as human abilities and agricultural machinery are deeply confined with respect to robots expertise.
- **Further Domains-Health-Care, Education, and Surveillance:** The integration of robots with sensors and IoT devices gives several advantages in contributing real-time health information and diagnosing patient conditions, aiming to decrease the risk of human errors such as diagnosing wrong drugs, doses, and procedures. Concentrating on the education domain, robots require using appropriate and adaptive behaviours to attain and maintain adequate social interactions with people, aiming to become exploitable in assistance services such as homework and teaching. The integration and development of the IoRT applications in surveillance appear to be the most suitable option in surveillance contexts, as the IoRT systems can be programmed and implemented to be speedy and work efficiently, overlaying larger areas in order to make secure a certain space.

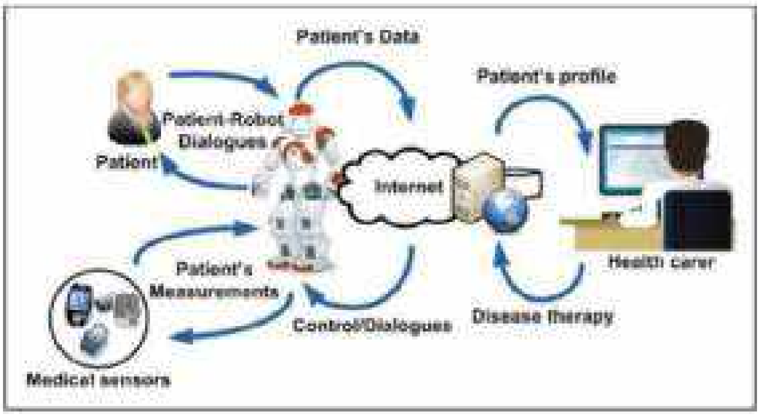


Fig. 3: IoRT application in health care,(courtesy of mdpi.com)

### Advantages

- Robots at distribution centers can examine item quality, check for item harms, and furthermore assist with put-aways. Without people assuming any part, robots can investigate the environmental elements with the IoT information and react to circumstances on a case by case basis.
- A robot can successfully assume the part of a direction official and help clients with parking spot

accessibility. By checking the parking areas, robots can help clients with the opportune spot to leave their vehicles.
- Robots can computerize the work serious and dangerous positions at a building site. Directly from platform to stacking and dumping weighty development gear, robots can deal with each on location task capably. With the assistance of canny robots, development designers and directors can guarantee improved laborer wellbeing and security.
- Understanding the significance and advantages of the Internet of Robotic Things, a few ground breaking organizations are putting altogether in this innovation. Industry behemoth, Amazon Robotics has conveyed cooperative mechanical robots to robotize the exercises in a stockroom satisfaction focus. The Market and Markets report expresses the market of Internet of Robotic Things is relied upon to arrive at 21.44 billion US dollars by 2020. These numbers obviously mirror the guarantee of this innovation.

## Disadvantages

- IoRT technology presents a huge challenge to standardization and legal bodies that requires a new approach to standardization, certification, and legislation within a common global policy framework consistent with the standardization work in different enabling technologies domains.
- The future IoRT standardization activities need to focus on technical standards that address interoperability, functionality and safety aspects of IoRT technologies and applications, based on the needs of industry, regulators, users, in areas such as data format for information exchange between IoRT devices/platforms, security, privacy, validation, testing certification of IoRTs, covering physical/virtual validation, reliability, functional safety, fail-operational, emergency operation of IoRTs, perception of the IoRT's devices external environment, human IoRT devices interfaces, human factors and ethical aspects.

## Conclusion

Web of Robotic Things permits robots or automated frameworks to associate, share, and scatter the appropriated calculation assets, business exercises, setting data, and ecological information with one another, and to get to novel information and specific abilities not acquired by themselves, all under a hood of refined compositional structure. This opens another skyline in the area of associated advanced mechanics that we accept will prompt interesting cutting edge improvements. It undoubtedly permits adjusting into associated environment where asset requirement arrangement of modest robots will be utilized by heterogeneous advancements, be it, correspondences organization, handling units, distinctive class of gadgets, or mists administrations. Huge improvements could be predicted to get profited from the IoRT approach such, SLAM, getting a handle on, route, and a lot more that are past the conversation.

## Acknowledgement

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

# Internet of Things (IoT) : Research Challenges and Future Applications

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Internet of Things (IoT) is an interconnected system of specifically addressable physical objects with several degrees of processing, sensing, and actuation capabilities that share the capability to coordinate and communicate through the Internet as their joint platform. Addressable devices with various degrees of processing, sensing, and actuation capabilities. These devices have the capability to interoperate and communicate through a joint platform called the internet. The main objective of the Internet of Things is to make it possible for objects to be connected with other objects or individuals at any time or anywhere using any network, path, or service. IoT makes it possible for ordinary devices to be linked to the internet. As the internet continues to evolve, it has become a network of various devices. Devices like smartphones, vehicles, industrial systems, cameras, toys, buildings, home appliances, industrial systems, and numerous other devices can share information over the Internet. Irrespective of their sizes and functions, these devices can accomplish smart reorganizations, tracing, positioning, control, real-time monitoring, and process control. The most significant commercial effect of IoT has been observed in the consumer electronics field. Particularly the revolution of smartphones and the interest in wearable devices (watches, headsets, etc.).As the internet continues to evolve, it has become more than a simple network of computers, but rather a network of various devices, while IoT serves as a network of variousconnected devices a network of networks as shown in Fig. 1.

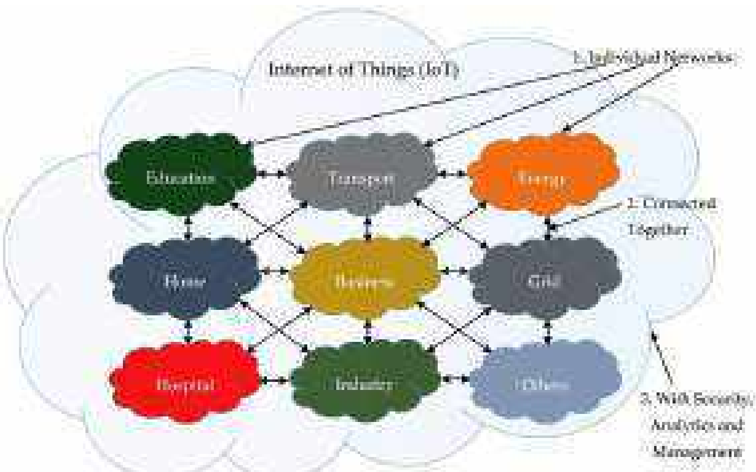


Fig. 1: IoT can be viewed as a Network of Networks, (courtesy of SAI)

**Potential Application Domains of IoT**

Applications of IoT cover broad areas including manufacturing or the industrial sector, health sector, agriculture, smart cities, security, and emergencies among many others.

### 1. Smart Cities

The IoT plays a crucial role in improving the smartness of cities and enhancing general infrastructures like intelligent transportation systems, smart buildings, traffic congestion, waste management, smart lighting, smart parking, and urban maps. This includes different functionalities such as; monitoring available parking spaces within the city, monitoring vibrations, material conditions of bridges and buildings, putting in place sound monitoring devices in sensitive parts of cities, as well as monitoring the levels of pedestrians and vehicles. Artificial Intelligence (AI) enabled IoT can be utilized to monitor, control, and reduce traffic congestions in Smart Cities. IoT also allows the installation of intelligent and weather adaptive street lighting. It also helps in the detection of waste and waste containers by keeping tabs on trash collection schedules. Intelligent highways provide warning messages and important information about access to diversions depending on the climatic conditions or unexpected occurrences of traffic jams and accidents.

### 2. Healthcare

Additional technology that can assist various operations like report sharing to multiple individuals and locations, record-keeping, and dispensing medications would go a long way in changing the healthcare sector. A lot of aid that IoT applications offer in the healthcare sector are mostly categorized into the tracking of patients, staff, and objects, identifying, as well as authenticating, individuals, and the automatic gathering of data and sense. Hospital workflow can be notably upgraded once patients flow is tracked. Additionally, authentication and identification reduce events that may be injurious to patients, record maintenance, and fewer cases of mismatching infants. Sensors can be used for outpatient and inpatient patients, dental Bluetooth devices, and toothbrushes that can give information after they are used and patients surveillance. Other elements of IoT in this capacity include; RFID, Bluetooth, and Wi-Fi among others. These will greatly help in monitoring critical functions like blood pressure, temperature, heart rate, blood glucose, cholesterol levels, and many others. The applications of the Internet of Things (IoT) and Internet of Everything (IoE) is further being expanded through the materialization of the Internet of Nano-things (IoNT). The idea of IoNT, as the name implies, is being engineered by integrating Nano-sensors in multiple objects (things) using Nano networks. Medical application, as shown in Fig. 2.

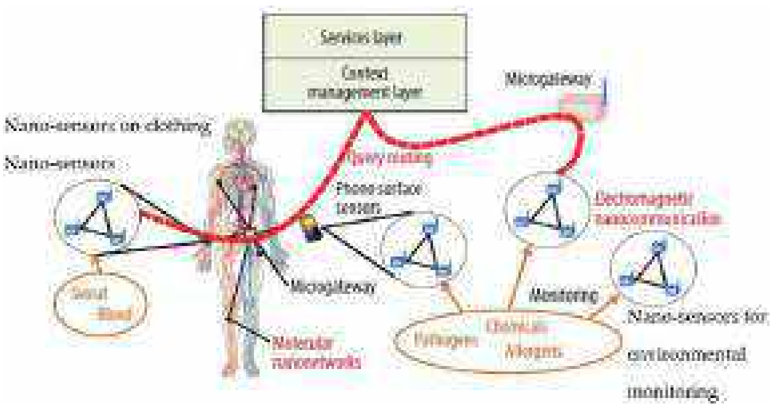


Fig. 2: The internet of nano things, (courtesy of SAI)

### 3. Smart agriculture and water management

The IoT will allow us to control and maintain the amount of vitamins found in agricultural products, and to control low-lying climates to make the most of vegetable and fruit production and their quality. In addition, studying the weather conditions allows us to predict office details, drought, climate change, rain or snow, thus regulating temperature and humidity to prevent mildew and other bacterial contamination. The IoT can help identify open-air predators, detect harmful gases from animal feces on farms, and control breeding conditions to increase life chances and survival, and so on. In water management, the role of IoT includes studying the suitability of seawater and rivers for drinking and agricultural use, detecting pressure differences in pipelines, and the presence of fluids outside tanks and levels to monitor water, river and lake water diversity. These IoT applications use wireless network networks. Examples of IoT applications available on this domain include; SiSviA, GBROOS, and SEMAT.

### 4. Retail and logistics

Doing IoT in Supply Chain or Store Management has many benefits. Some include; viewing the final conditions throughout the supply chain, product tracking to enable tracking purposes, processing payment by location or time of public transport, theme parks, gyms and others. Within the retail space, IoT can be used for a variety of applications such as store guidance based on pre-selected lists, quick payment processes such as automated testing with biometric help, detection of potential allergen products, and control of product rotation on shelves and warehouses to implement recycling processes. The use of IoT also helps with repairs and maintenance because systems can be programmed to predict equipment malfunctions and at the same time automatically configure repair services from time to time before equipment fails. This can be achieved by installing sensors inside machines or equipment to monitor their performance and occasionally send reports.

### 5. Smart living

In this domain, IoT can be used on remote control devices where one can remotely switch internal and external devices and thus prevent accidents and energy saving . Other smart home appliances include refrigerators equipped with LCD screens (Liquid Crystal Display), which enable one to know what is inside, what is excessive and almost outdated and what needs to be replaced. This information can be linked to a smartphone app that allows a person to access it while out of the house and therefore purchase the necessary equipment. well. In terms of home security, IoT can be used with alarm systems and cameras can be installed to monitor and detect openings of windows or doors which is why it prevents intruders.

### 6. Smart Environment

Intelligent environment strategies integrated with IoT technology should be designed to detect, track, and explore natural resources that offer potential benefits of achieving sustainable livelihoods and a greener world. IoT technology allows for the viewing and management of air quality through data collection from remote sensors in cities and provides universal coverage to achieve better traffic management practices in major cities. In addition, IoT technology can be used to measure water pollution levels and therefore enlighten decisions on water use. In waste management, which contains various types of waste, such as chemicals and pollutants that are harmful to the environment and humans, animals, and plants, IoT can also be used.

### Research Challenges

For all the above potential applications of IoT, there should be proper feasibility into different domains to ascertain the success of some applications and their functionality. Like any other form of technology or innovation, IoT has its challenges and implications that must be sorted out to enable mass adoption.

#### 1. Privacy and security

More research needs to be conducted on cryptographic security services that have the capability to operate on resource-constrained IoT devices. This may enable differently skilled users to securely use and deploy IoT systems regardless of the inadequate user interfaces that are available with almost all IoT devices.

#### 2. Processing, analysis, and management of data

Most systems utilize centralized systems for offloading data and carrying out computationally intensive tasks on an international cloud platform. There is a concern about conventional cloud architectures not being effective in terms of transferring the massive volumes of data that are produced and consumed by IoT-enabled devices and to be able to further support the accompanying computational load and simultaneously meet timing constraints.

#### 3. Monitoring and sensing

Sensors and tags are normally expected to be active constantly in order to obtain instantaneous data. This aspect makes it essential for energy efficiency especially in life extension. Simultaneously, new advancements in nanotechnology/biotechnology and miniaturization have allowed the development of actuators and sensors at the Nano-scale.

### Advantages

The main advantage of IoT is that it improves the productivity of staff by reducing human labor. Other advantages include

- Efficient operation management
- Improved usage of resources
- Cost-effective operation
- Better work safety

### Disadvantages

- Flaws in security
- The initial cost of installation
- Power supply and network dependency

## Conclusion

The IoT can be described as a CAS (Complex Adaptive System) that continues to evolve. Hence it requires new and innovative forms of software engineering, systems engineering, project management, and numerous other disciplines to develop it further and manage it. The application areas of IoT are quite diverse to enable it to serve different users, who in turn have different needs. The technology serves three categories of users, individuals, society or communities, and institutions. The IoT has the massive capacity to be a tremendously transformative force, which will positively impact millions of lives worldwide. IoT is so expansive and affects practically all areas of our lives, which makes it a significant research topic for studies in various related fields such as information technology and computer science.


## Acknowledgement

We 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.

# EDGE COMPUTING

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Edge computing is a distributed computing paradigm that brings computation and data storage closer to the sources of data. This is expected to improve response times and save bandwidth. ”A common misconception is that edge and IoT are synonymous. Edge computing is a topology- and location-sensitive form of distributed computing, while IoT is a use case instantiation of edge computing”. The term refers to an architecture rather than a specific technology. The origins of edge computing lie in content distributed networks that were created in the late 1990s to serve web and video content from edge servers that were deployed close to users. In the early 2000s, these networks evolved to host applications and application components at the edge servers, resulting in the first commercial edge computing services that hosted applications such as dealer locators, shopping carts, real-time data aggregators, and ad insertion engines.

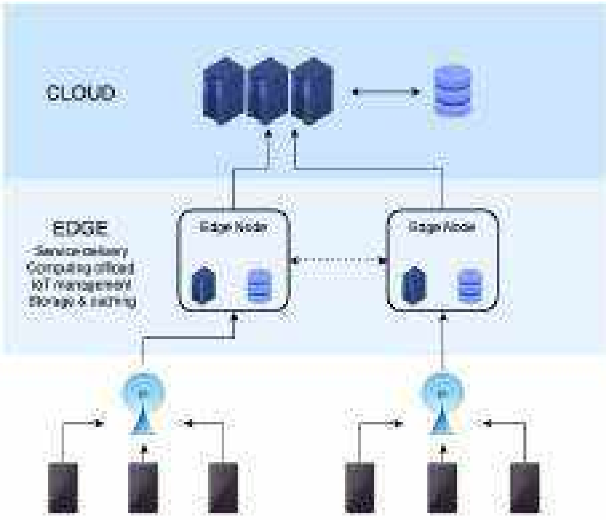


Fig. 1: Edge Computing Infrastructure, (courtesy of cloudflare)

## Working of Edge Computing

The edge computing concept is not entirely new; it dates back to decades associated with remote computing. For example, branch offices and remote workplaces placed computing resources at a location where they can reap maximum benefits instead of relying on a central location.

In traditional computing, where data was produced at the client-side (like a users PC), it moved across the internet to corporate LAN to store data and process it using an enterprise app. Next, the output is sent back, traveling through the internet, to reach the clients device.

Now, modern IT architects have moved from the concept of centralized data centers and embraced the edge infrastructure. Here, the computing and storage resources are moved from a data center to the location where the user generates the data (or the data source).

This implies that you are bringing the data center close to the data source, not the other way around. It requires a partial gear rack that helps operate on a remote LAN and collects the data locally to process it. Some may deploy the gear in shielded enclosures to safeguard it from high temperature, humidity, moisture, and other climatic conditions.

The edge computing process involves data normalization and analysis to find business intelligence, sending only the relevant data after analysis to the main data center. Furthermore, business intelligence here can mean:

- Video surveillance in retail shops
- Sales data
- Predictive analytics for equipment repair and maintenance
- Power generation
- Maintaining product quality
- Ensure proper device functioning and more.

### Types of Edge Computing

There are four types of edge computing.

- **Cloud**

  The first type of edge computing is Cloud. It refers mainly to large data centers run by cloud companies such as AWS, Azure, and GCP. Which may include VMware Cloud on AWS and other cloud or provide for too. The clouds key attributes centralized and runs at scale. The downside is you have very high availability of infrastructure. And also, access to a lot of facilities, and an unlimited amount of money.
  The downside clustered. There is no guarantee of network access to sensors or computers at the edge and high latency. Internet traffic to and from the cloud also most likely entails an expense.

- **Device Edge**

  The second type of edge computing is the Device edge. This consists of one or more tiny servers and also known as a nano DC. It would consist only of one or a few customize and would have limited processing power. Databases in this segment would likely not mounted on a rack. And also, we would need to be able to run without refrigerating.

  These are also located in places that are not typically associates in data centers. Such as warehouses, wind generators, and durable to cope with harsh weather. They positioned right next to IoT sensors, so there limit issues in latency, bandwidth, or communication. The downside is that these small devices can only have low power and facilities.

- **Compute Edge**

  The third type of edge computing is the Compute edge. It is also a micro-DC. Anyway, it is a small data center consisting of everything from a few up to many server racks. They are usually located near or next to IoT devices, and may also be needed for reasons of local enforcement. The point is that these server farms have ventilation and so on, and have regular servers installed on racks.

In these data centers, you will have quite a lot of resources. If, not the same variety of facilities and capabilities as in the cloud. One advantage is that system latency at the edge would be less relative to the cloud. So network bandwidth should be higher but more efficient.

- **Sensor**

  The final type of edge computing is the sensor. IoT sensors are instruments that either collect data or monitor things. Some sensors around the world like a surveillance camera, clock, light bulb, etc. Depending on the bandwidth, latency, or communication requirements, they would usually not include any computing power in themselves. And also, it will instead communicate with the system edge, network edge, or cloud.

### Advantages of Edge Computing

- **Speed**
  Edge computings most significant benefit is its ability to increase network performance by reducing latency. Since IoT edge computing devices process data locally or in nearby edge data centers, the information they collect doesnt have to travel nearly as far as it would under a traditional cloud architecture.

- **Security**
  One major concern about IoT edge computing devices is that they could be used as a point of entry for cyberattacks, allowing malware or other intrusions to infect a network from a single weak point. While this is a genuine risk, the distributed nature of edge computing architecture makes it easier to implement security protocols that can seal off compromised portions without shutting down the entire network.

- **Scalability**
  Edge computing offers a far less expensive route to scalability, allowing companies to expand their computing capacity through a combination of IoT devices and edge data centers. The use of processing-capable edge computing devices also eases growth costs because each new device added doesnt impose substantial bandwidth demands on the core of a network.

- **Versatility**
  The scalability of edge computing also plays into its versatility. By partnering with local edge data centers, companies can easily target desirable markets without having to invest in expensive infrastructure expansion.

- **Reliability**
  Given the security advantages provided by edge computing, it shouldn’t come as a surprise that it offers better reliability as well. With IoT edge computing devices and edge data centers positioned closer to end-users, there is less chance of a network problem in a distant location affecting local customers. Even in the event of a nearby data center outage, IoT edge computing devices will continue to operate effectively on their own since they handle vital processing functions natively.

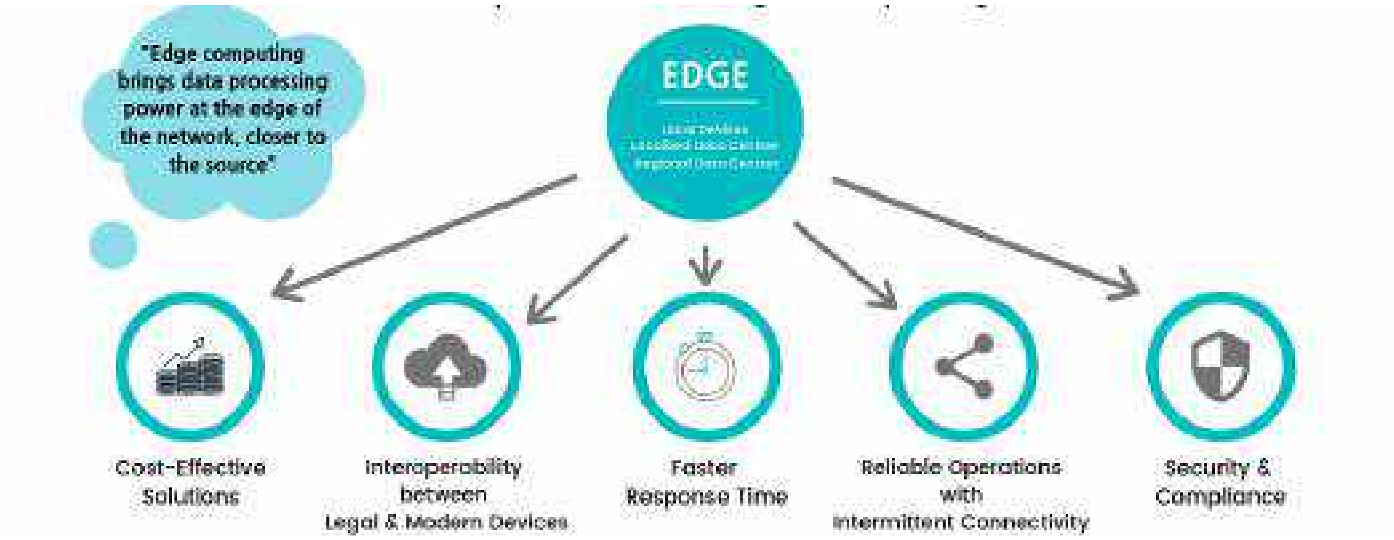


Fig. 2: Benefits of Edge Computing, (courtesy of cloudflare)

**Disadvantages of Edge Computing**

Following are the drawbacks or disadvantages of Edge Computing:

- It is less scalable than fog computing.
- No cloud aware
- It's operations can not be extended to IT/OT team.
- It can not perform resource pooling.
- It is interconnected through proprietary networks with custom security and little interoperability.
- It is limited to smaller number of peripheral layers.

**Application of Edge Computing**

Edge computing finds applications in various industries. It is used to aggregate, process, filter, and analyze data near or at the network edge. Some of the areas where it is applied are:

- **IoT Devices**

  Its a common misconception that edge computing and IoT are the same. In reality, edge computing is an architecture, whereas IoT is a technology that uses edge computing.

- **Optimizing Network**

  Edge computing helps optimize the network by measuring and improving its performance across the web for users. It finds a network path with the lowest latency and most reliability for user traffic. In addition, it can also clear out traffic congestion for optimal performance.

- **Healthcare**

  A vast amount of data is generated from the healthcare industry. It involves patient data from medical equipment, sensors, and devices.

- **Retail**

  Using edge computing enables people to collect and analyze this data and find business opportunities like sales prediction, optimizing vendor orders, conducting effective campaigns, and more.

- **Energy**

  Edge computing is useful in the energy sector as well to monitor safety with gas and oil utilities.

## Conclusion

Starting with an introduction on edge computing, working of edge computing, its types, advantages, disadvantages and applications that we identified are discussed.

## 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.

# Quantum Computing

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## INTRODUCTION

Quantum computing began in 1980 when physicist Paul Benioff proposed a quantum mechanical model of the Turing machine.The spark of quantum computing is given byRichard Faynman because of evolution of quantum system and particles and later foundation was made by Peter Short when he developed an algorithm in quantum computer to factorize large integers exponentially (300 digit number).In 1996,Lov Grover invented quantum database search engine to increase speed of problem solving 4X.In 1996,first working quantum computer was build and named 2-qubit quantum computer. In 2017,IBM made first commercially usable quantum computer.

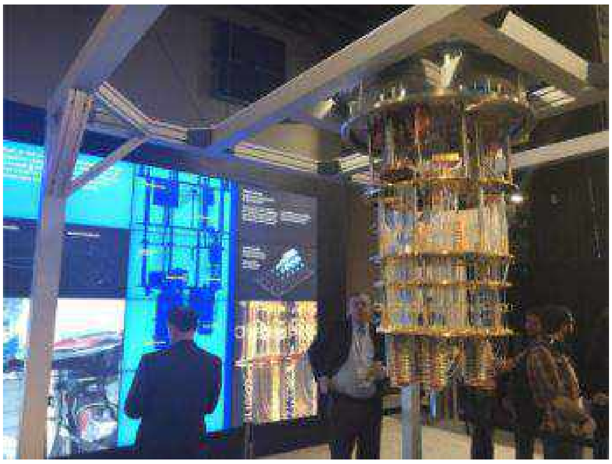


Fig. 1: 50qbit quantum computer, (courtesy of quantumcomputinginc.com)

Quantum computing is a type of computation that harnesses the collective properties of quantum states, such as superposition, interference, and entanglement, to perform calculations. The devices that perform quantum computations are known as quantum computers.Definition quantum computer- A quantum computer is a machine that performs calculations based on quantum principles and mechanics.

The Quantum computers make use of qubits or quantum bits which is quantum number to perform calculations.A single qubit is represented by Bloch Sphere.

## QUANTUM ALGORITHMS

Progress in finding quantum algorithms typically focuses on this quantum circuit model, though exceptions like the quantum adiabatic algorithm exist. Quantum algorithms can be roughly categorized by the type of speedup achieved over corresponding classical algorithms.

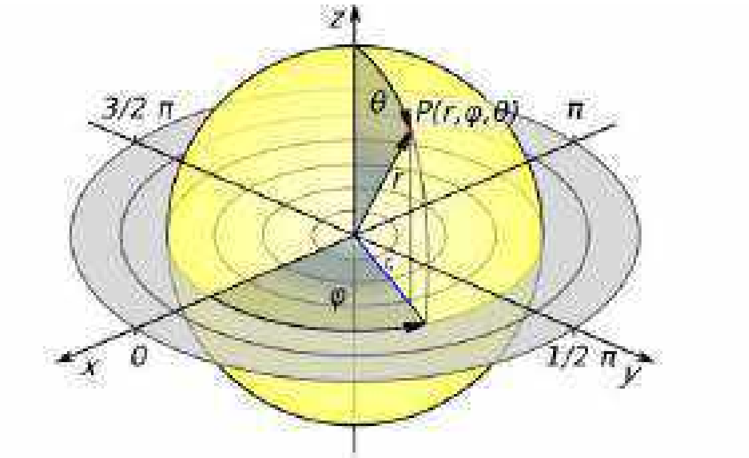



Fig. 2: Fig1. Bloch Sphere representation, (courtesy of quantumcomputinginc.com)

Quantum algorithms that offer more than a polynomial speedup over the best known classical algorithm include Shor's algorithm for factoring and the related quantum algorithms for computing discrete logarithms, solving Pell's equation, and more generally solving the hidden subgroup problem for abelian finite groups. These algorithms depend on the primitive of the quantum Fourier transform. No mathematical proof has been found that shows that an equally fast classical algorithm cannot be discovered, although this is considered unlikely. Certain oracle problems like Simon's problem and the BernsteinVazirani problem do give provable speedups, though this is in the quantum query model, which is a restricted model where lower bounds are much easier to prove and doesn't necessarily translate to speedups for practical problems.

Other problems, including the simulation of quantum physical processes from chemistry and solid-state physics, the approximation of certain Jones polynomials, and the quantum algorithm for linear systems of equations have quantum algorithms appearing to give super-polynomial speedups and are BQP-complete. Because these problems are BQP-complete, an equally fast classical algorithm for them would imply that no quantum algorithm gives a super-polynomial speedup, which is believed to be unlikely. Some quantum algorithms, like Grover's algorithm and amplitude amplification, give polynomial speedups over corresponding classical algorithms. Though these algorithms give comparably modest quadratic speedup, they are widely applicable and thus give speedups for a wide range of problems. Many examples of provable quantum speedups for query problems are related to Grover's algorithm, including Brassard, Hyer, and Tapp's algorithm for finding collisions in two-to-one functions, which uses Grover's algorithm, and Farhi, Goldstone, and Gutmann's algorithm for evaluating NAND trees, which is a variant of the search problem.

**SPEED OF QUANTUM COMPUTERS**

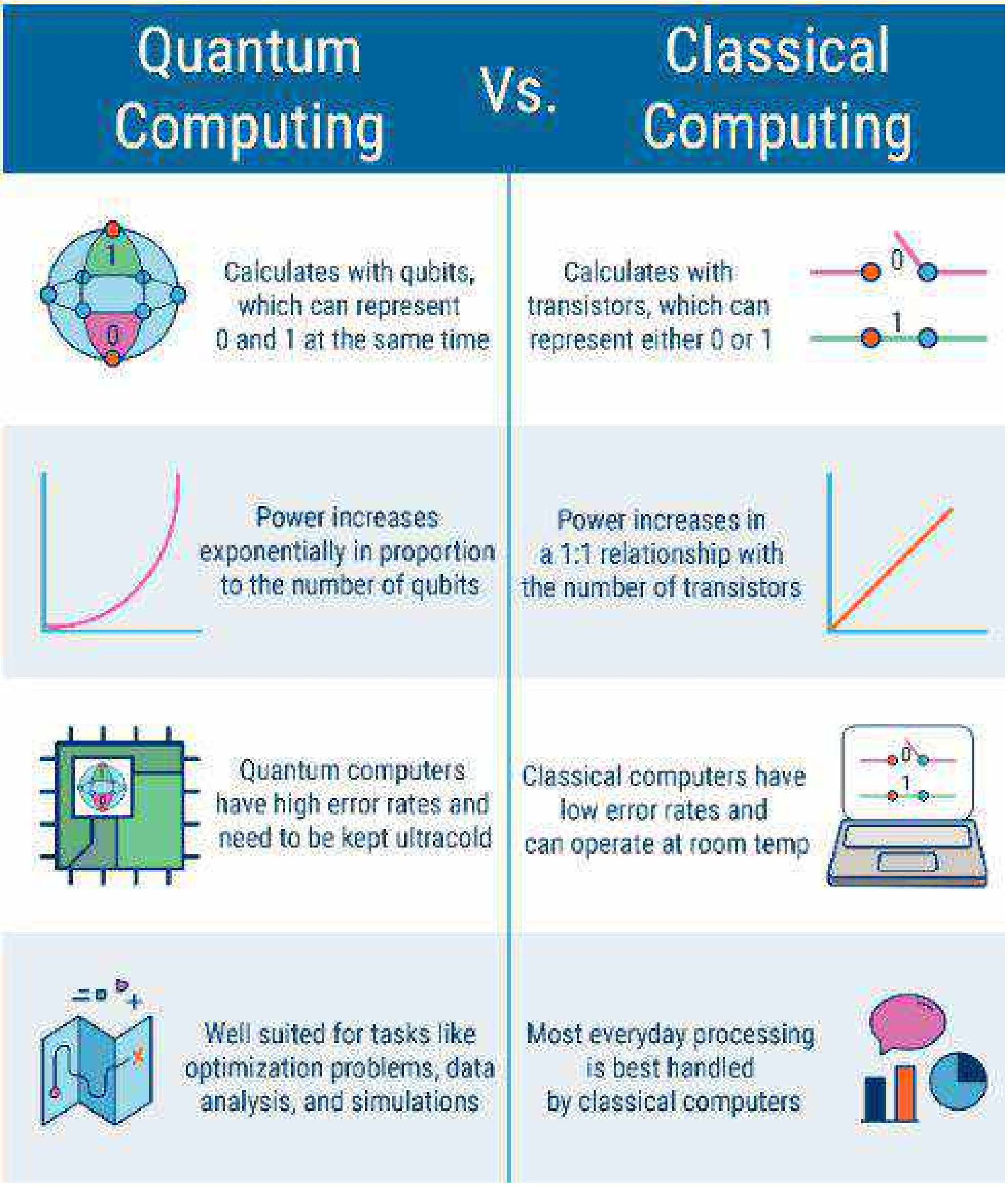
Quantum algorithms take a new approach to these sorts of complex problems – creating multidimensional spaces where the patterns linking individual data points emerge. In the case of a protein folding problem, that pattern might be the combination of folds requiring the least energy to produce. That combination of folds is the solution to the problem.

Classical computers can not create these computational spaces, so they can not find these patterns. In the case of proteins, there are already early quantum algorithms that can find folding patterns in entirely new, more efficient ways, without the laborious checking procedures of classical computers. As quantum hardware scales and these algorithms advance, they could tackle protein folding problems too complex for any supercomputer.

Quantum algorithms take a new approach to these sorts of complex problems – creating multidimensional spaces where the patterns linking individual data points emerge. Classical computers can not create these computational spaces, so they can not find these patterns. In the case of proteins, there are already early quantum algorithms that can find folding patterns in entirely new, more efficient ways, without the laborious checking procedures of classical computers. As quantum hardware scales and these algorithms advance, they could tackle protein folding problems too complex for any supercomputer.

Quantum computers are elegant machines, smaller and requiring less energy than supercomputers. An IBM Quantum processor is a wafer not much bigger than the one found in a laptop. And a quantum hardware system is about the size of a car, made up mostly of cooling systems to keep the superconducting processor at its ultra-cold operational temperature.

## DIFFERENCE BETWEEN CLASSICAL AND QUANTUM COMPUTERS



## ADVANTAGES

- **Cryptography**-Increases data security.
- **Aviation**- To aid routing,scheduling aircrafts.
- **Data Analysis**-To compute large chunks of data.
- **Forecasting**-Increases the efficiency of predicting weather since more inputs can be computed.
- **Artificial intelligence and machine learning**- technical efficiency can improved. And many more.(agriculture,

## DISADVANTAGES

Quantum computer will be unstable and have errors because it needs lots of space and requires many maintainance for smooth working.The quantum computers also needs large manpower and intellect to manufacture and it requires large quantities of funds..

## CONCLUSION

Quantum computer is still not invented fully.It has enormous processing power than classical computers and changes the phase of computing from vacuum pump to integrated circuits.Till now every country is in verge of developing its own model quantum computer and surprisingly CHINA surpasses GOOGLE to develop a large quantum computer that is capable of performing at least one task 100 trillion times faster than the world's fastest supercomputers.INDIA develops its first quantum computer simulator toolkit by IIT-Roorkee,IISC Banglore.The race is still on and data revolution begins.

# NANO TECHNOLOGY

# COMPUTERS GETTING SMALLER

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Modern technology has propelled us forward to create smaller and smaller gadgets especially since the microchip appeared. Figure 1 is the image of the first ever computer named ENIAC in full Electronic Numerical Integrator and Computer, the first programmable general-purpose electronic digital computer, built during World War II by the United States. Under contract to the army and under the direction of Herman Goldstine.It was the worlds first general purpose electronics computer but it took several days to program.ENIAC weighed more than 30 tons,ENIAC uses more than 17000 vacuum tubes for the operations. The disadvantage was that it took days to rewire the machine for each new problem. By the invention of the transistor,a small device which controls the electronic signals, it replaced vacuum tubes. By this the size and weight of the device can be reduced.Day by day the sizes are reducing. Today's computers keep getting smaller and smaller. Large desktop computers gave way to laptops,Laptops have changed into a wide variety of even smaller computing devices, such as notbooks and tablet computers One of the most advanced areas in the tech industry is tiny computers. While most people are used to seeing a computer on their desktop, a laptop, or even a smartphone, these devices are simply massive compared to the smallest functioning computers in the world.

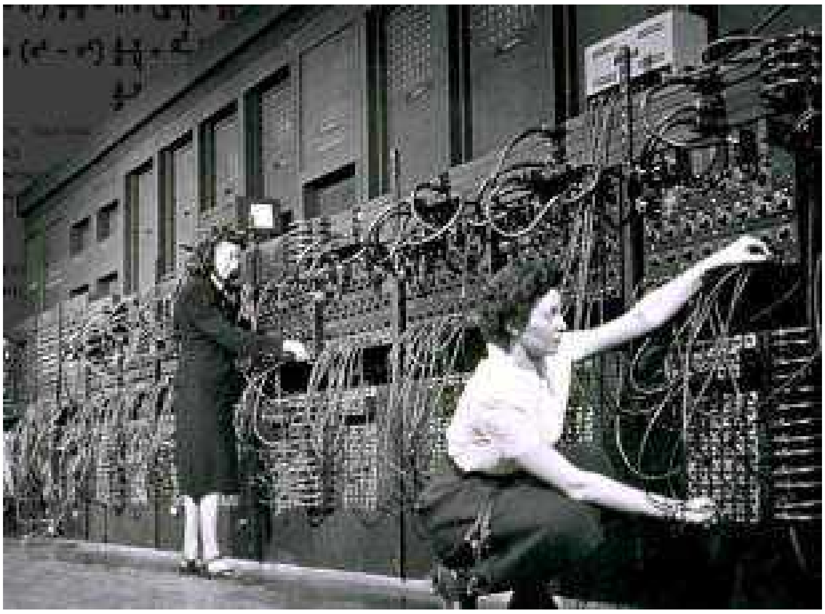

Fig. 1: ENIAC, (courtesy of qz.com)

**Worlds Smallest Computer-M3**

In March of 2018, IBM released a computer that was 1 mm x 1 mm in size, breaking the record, it is named as Michigan Micro Mote. Just recently, the University of Michigan reclaimed their title with the announcement of a computer ten times smaller than IBMs. This computer, which is just .3mm x .3mm. To give some scale, you could fit dozens of them on the edge of a piece of rice.The main reason for the reduction of size of computer is that small computers can fit into small spaces. In addition, they have greater functionality than a simple sensor. A computer this small is possible to be placed inside the eye to detect pressure and gather information. The University of Michigan also mentioned that these computers could potentially be placed inside tiny snails to help improve research.

Fig. 2: Michigan Micro Mote(M3), (courtesy of qz.com)

**Features Of M3**

**Its Smaller Than A Grain Of Rice** The new tiniest computer in the world, M3 only measures just 0.33mm on each side.

**Can Be Used For Audio Video Surveillance** The smallest computer can be used as a part of the audio components of a video surveillance camera.

**Comes With Processor, RAM, Transmitters Receiver** Comes with all the required components like processor, RAM, wireless transmitters and receivers

Due to the fact that small computers are much smaller in size, they are known to be inexpensive. Mini computers are nothing but a smaller version of a traditional computer. microcomputers are also very small and compact in size. All the work can be simply done while roaming around. Moreover, due to their size a microcomputer requires very less amount of space,the fig. shows a microcomputer compared to a grain of rice. Creating tiny computers requires engineers to come up with new ways to design circuits and use less power. What is learned here will be used in the designs of many future computing systems.

The more learned about tiny computing, the more advancements we will see in the future of smartphones. As well as other devices that require advanced technology in smaller spaces.The point here is that no matter how small a computer can get, it has to serve a function in order to be useful. Fortunately, there are endless ways that small computers can be used, and as they get more and more advanced. With the size of this computer, it is easy to see how computers could be put inside the human body to monitor different aspects of your health.

**Conclusion**

As these computers become more powerful (they are still extremely limited compared to a traditional device), they will be able to serve more and more functions. Tiny computers are programmed with very specific tasks so they can only really do a small number of things. Of course, it just takes having different code developed and loaded on to change the tasks that are possible.

# CLAYTRONICS

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Programmable matter is a technology that allows us to control and manipulate 3- dimensional physical artifacts, in a similar way how we already control and manipulate two-dimensional images with computer graphics. In other words, programmable matter will allow us to take a big step beyond virtual reality, to synthetic reality, an environment in which all the objects in a users environment (including the ones inserted by the computer) are physically realized.

Claytronics is an instance of programmable matter, a system which can be used to realize. 3D dynamic objects in the physical world. This technology not only realizes pario and synthetic reality, it also serves as the basis for a large scale modular robotic system.The Claytronics system is essentially an embedded system, consisting of hardware and Software parts, brought together for achieving a special purpose.

The hardware machine is known as Catoms. Each catom is a self-contained unit with a CPU, an energy store, a network device, a video output device, one or more sensors, a means of locomotion, and a mechanism for adhering to other catoms.

The software part, on the other hand, is taken care by Meld is a declarative language, which based on P2, a logic-programming language originally designed for programming overlay networks. It greatly simplies the thought process needed for programming large ensembles. Initial experience shows that this also leads to a considerable reduction in code size and complexity. Here shows in the Figure 1 about the evolution of the claytronics broadcast occurrence.

Fig. 1: Claytronics,(courtesy of statnano.com)

One of the novel applications of the Claytronics project is 3D printing and Fax machine- which exploits inter-module communication and computation without requiring self- reconguration. As a result, this application may be feasible sooner than applications which depend upon modules being able to move themselves.

Claytronics is a form a programmable matter that takes the concept of modular robots to a new extreme. Claytronics is our name for an instance of programmable matter whose primary function is to organize itself into the shape of an object and render its outer surface to match the visual appearance of that object. Claytronics is made up of individual components, called catoms for Claytronic atoms that can move in three dimensions (in relation to other catoms), adhere to other catoms to maintain a 3D shape, and compute state information (with possible assistance from other catoms in the ensemble). The claytronics project combines modular robotics, systems nanotechnology and computer science to create the dynamic, 3Dimensional display of electronic information.

The enabling hardware technology behind synthetic reality is Claytronics, a form of programmable matter that can organize itself into the shape of an object and render its outer surface to match the visual appearance of that object. Claytronics is made up of individual components, called catoms for Claytronic atoms that can move in three dimensions (in relation to other catoms), adhere to other catoms to maintain a 3D shape, and compute state information (with possible assistance from other catoms in the ensemble). A Claytronics system forms a shape through the interaction of the individual catoms. For example, suppose we wish to synthesize a physical copy of a person. The catoms would rst determine their relative location and orientation.

One of the primary goals of claytronics is to form the basis for a new media type, Pario, a logical extension of audio and video, is a media type used to reproduce moving 3D objects in the real world.

**Types of Claytronics**

There are four types of claytronics.

- **Planar catoms**

  Planar catoms test the concept of motion without moving parts and the design of force effectors that create cooperative motion within ensembles of modular robots.

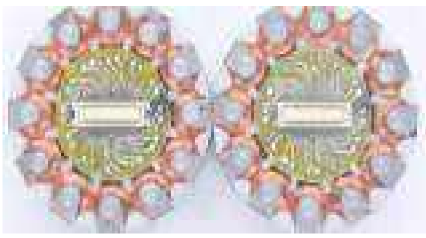

Fig. 2: Planar catoms,(courtesy of statnano.com)

- **Electrostatics Latches**

  Electrostatic latches model a new system of binding and releasing the connection between modular robots, a connection that creates motion and transfers power and data while employing a small factor of a powerful force.

- **Stochastic Catoms**

  Stochastic Catoms integrate random motion with global objectives communicated in simple computer language to form predetermined patterns, using a natural force to actuate a simple device, one that cooperates with other small helium catoms to fulfill a set of unique instructions.

- **Gaint Helium Catoms**

  Giant Helium Catoms provide a larger-than-life, lighter-than-air platform to explore the relation of forces when electrostatics has a greater effect than gravity on a robotic device, an effect simulated with a modular robot designed for self-construction of macro-scale structures.

- **Cubes**

  Cubes employ electrostatic latches to demonstrate the functionality of a device that could be used in a system of lattice-style self-assembly at both the macro and nano-scale.The Cube (pictured below, right) also models the primary building block in a hypothetical system for robotic self-assembly that could be used for modular construction and employ Cubes that are larger or smaller in scale than the pictured device.

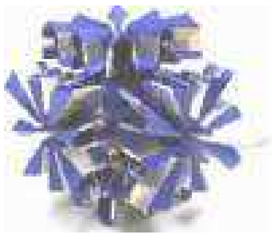

Fig. 3: Cube catoms ,(courtesy of statnano.com)

- **Millimeter Scale Catoms**

  Realizing high-resolution applications that Claytronics offers requires catoms that are in the order of millimeters. In this work, we propose millimeter-scale catoms that are electrostatically actuated and self contained. As a simplified approach we are trying to build cylindrical catoms instead of spheres.

Claytronics is one instance of programmable matter, a system which can be used to realize 3D dynamic objects in the physical world. While our original motivation was to create the technology necessary to realize pario and synthetic reality, it should also serve as the basis for a large scale modular robotic system. At this point we have constructed a planer version of claytronics that obeys our design principles. We are using the planer prototype in combination with our simulator to begin the design of 3D claytronics which will allow us to experiment with hardware and software solutions hat realize full-scale programmable matter, e.g., a system of millions of catoms which appear to act as a single entity, in spite of being composed of millions of individually acting units.

The report told you about the advances made in the eld of programmable matter and the claytronics system. The scientists at Carneige Mellon University, in association with Intel is doing research on this eld of technology and striving to make Catoms of Micro and Nano scale, which follows the principles laid by the phenomena of programmable matter. The Massachusetts Institute Of Technology have also made contribution in the eld of designing of programmable matter.

### Advantages

Following are the advantages of clyatronics:

- Surgeons to perform intricate surgery on enlarged claytronic replicas of organs, whilst the actual organs are being worked upon by a claytronic replica of the surgeon.
- A 3-D Fax machine is a new approach to 3D faxing, a large number of submillimeter robot modules form an intelligent clay which can be reshaped via the external application of mechanical force.
- This technology would enable engineers to work remotely in physically hostile environments
- It might be useful for producing 3-D shapes in the computer-aided design process.

### Disadvantages of Claytronics

Following are the drawbacks or disadvantages of Claytronics:

- With so many catoms, the system will have to compensate for the inevitable failure of individual catoms. Computers don't deal well with failure.
- Algorithm and programming the combined motion of catoms to form a 3D shape is a very ridiculous task.
- Even the nodes of the Internet have some addresses and accessing them is hard. Accessing each catom without any address is a very difficult task
- At present, only four individual catoms are made to communicate with each other. But, the thought of making billionsof catoms to communicate may take a few decades.
- Claytronics cell phone might grow a full-size keyboard, or expand its video display as needed.
- 3D Video conferencing.

### Conclusion

With the advancement in technology, development of simpler and intuitive programming language along with consolidation and miniaturization of memory and other functional parts of Catoms, we can see a day in the future, when the images we see in the television will take physical forms and occupy the space, we live in. Not only can that, these completely realistic representations will interact with us in ways the real counterpart does.

### Acknowledgement

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# EMBEDDED SYSTEM

# SMART SHOPPING TROLLEY

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Today the grocery shopping became as the most common activities of the adult population. According to the time use Institute, 32 million adults shop at a grocery store or supermarket on any given day, one out of every seven adults nationwide ”It’s important for grocery stores and supermarkets to focus on developing excellent customer experiences today,” said Brian Jones, vice president of Grocery and Customer Packaged Goods at Empathica. In particular, often the supermarket chains maintain similar prices and offerings. Experiences are what differentiate one retailer from the next. Under-standing the key elements of the experience that drive loyalty can give a supermarket the edge, enabling them to build out better offerings

## STORES IN PAST AND PRESENT

In the past majority have no idea abouthow much you have bought exactly or not knowing about daily offers, can cost extra money. It may cost also extra work and time consuming once you will be obliged to return the items that you don’t need or in case if you surpass your budget limits.The other issues that , waiting in a long queue, finding a product without knowing its own price and also searching for code reader to find out the real price of a specific item is not always easy task in giant grocery. During shopping, it is often impossible to understand the price of the product, or whether it is on sale, because there was no time to update its price tag due to the untold daily variations and also the on board commercial message is almost ineffective.The data for each shopping cart cannot be qualified with the customer’s data (age, profession, other information) and hence they are not useful for the purposes of a specific market research about customers (identifying the stereotype customer for that product).Therefore, the traditional shopping process is not convenient at all by increasing the amount of wasted time customers spend in shopping and at the same time declining the quality of service.Fig 1 shows the features of smart trolley.

## SMART TROLLEY

Customers in supermarkets will use a code bar reader which is integrated in tablet computer to scan products as they do their shopping. This self-scanning option will help them to know more about the item, for example its’ price, product reviews nutritional contents, ingredients,and expiration date.Here the advertising information will be display in the touch screen, tablet or computer. Introduces another system, In-store Navigation. Herecustomers will find products more easily while in a store, there will be no need to search for staff to ask where needed items are. Smart shopping cart can be described as a system that can simplify a shopping process in big stores or center shopping centers by using a computerized shopping cart. This system comprises main server and at least one computerized shopping cart tablet computer with RFID reader designed for scanning the information from bar codes of the good loaded on the cart. With the help to the communication link with the said server customers will be able to perform many tasks included in the main functionality of touch screen tablets. For instance search for products, self-scanning prices, daily -deals, the result will be shown on the display. With the help to the


Fig. 1: Features, (courtesy of engpaper.com)

communication link with the said server customers will be able to perform many tasks included in the main functionality of touch screen tablets. For instance search for products, self scanning prices, daily -deals, the result will be shown on the display. In this way smart shopping cart will assist a shopper during his visit to a store., it will enable a shopper to check himself out of the store. Cart includes (tablet computer) touch screen display, equipped with scanner and bar code reader.The tablet will display product specification and information such as the identity of an item selected for purchase and its price, nutritional contents, ingredients, expiration date, product reviews, daily offers, real time statue of cashiers and how many people are waiting in the queue, it will display also advertisements, promotional materials and surveys.There will be as well playing video and games option especially for people who have kids. While kids they may watching video or play games , their parents could make their shopping peacefully without being disturbed.

**Advantages of Smart trolley**

- The system will help to meet customer needs for information and services,by using mobile technology.
- By providing relevant information to customers between the point of sale and purchase decisions will increase the chances of buying process, in simple words better information means more sales.
- Increase customer satisfaction and loyalty: Happy and satisfied customers will re-ward retailers who best meet their needs for information and services.
- Helps the retailers to achieve lower costs of selling and hence increase repeat purchases from existing customers .
- improve brand equity or price premium, employee productivity, satisfaction, and retention.

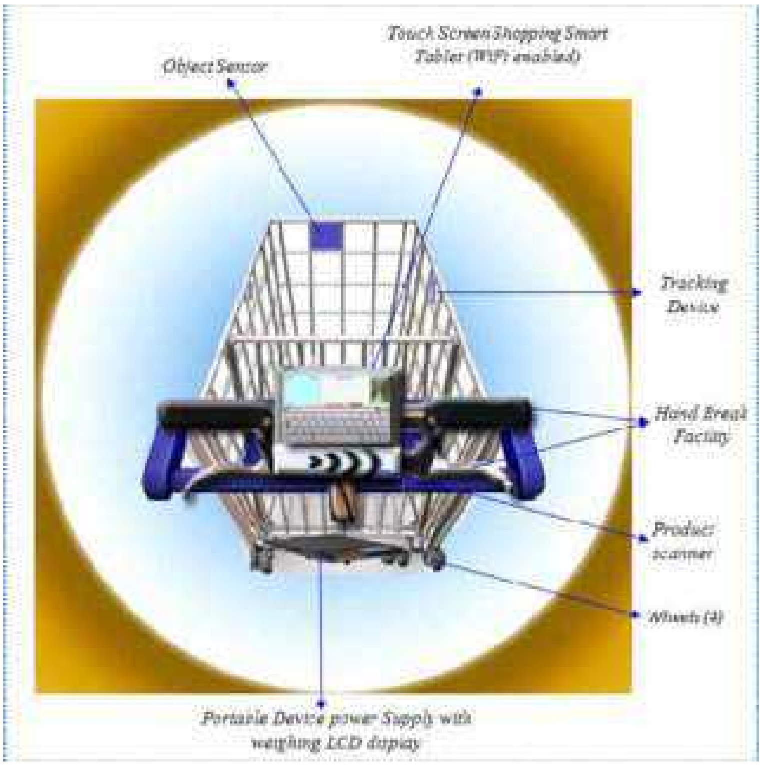


Fig. 2: Trolley design, (courtesy of engpaper.com)

**Disadvantages of Smart trolley**

- Can read only single item in this prototype

**Application of Smart trolley**

- Supermarkets
- Shopping mall

**Conclusion**

By integrating mobile technologies there is huge potential to be gained into retail and specifically into in-store environments. Using smart shopping cart as system including mobile phone, or internet tablet or smart cart will definitely change our way of shopping and speed up the shopping process. The retailers will benefit from this system economically without losing the most important element in shopping - being in direct touch with their customers and moreover offering the best customer service to their delighted customers. In order to develop an efficient system, it will need a real collaboration from all sides of this equation (retailers, Product Manufacturers, mobile operators and handset manufacturers). Smart shopping cart as a system will be an innovation that is able to be adapted according to the necessity of its own environment in order to satisfy the needs of both customers and retailers in almost perfect balance and harmony..

**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.

# ROBOTICS

# Machine Learning and Soft Robotics

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**INTRODUCTION**

Soft robotics is the design and construction of robots with physically flexible bodies and electronics.Robotics is attaining new and extensive application fields and becoming inescapable in daily life. In soft robotics, the robot body is composed of flexible and soft materials which allows it to adapt its shape to the environment for various tasks such as knob twisting, pick and place which are difficult for hard robots with rigid bodies. A soft robotic system is less complex and less expensive therefore it has an extensive number of advantages. Machine learning has played a crucial role in improving controls and increasing the number of applications. It is involved in controlling soft robotics which is used to make sure that robots understand emotions of human beings just by the virtue of a simple touch. Robotics is attaining new and extensive application fields and becoming inescapable in daily life.

**Soft grippers**

Soft grippers are more adaptive as compared to the rigid robotic grippers. Hard robots have difficulties in grabbing delicate items. The basic factors that limit a robot in functioning like a human are gripping and manipulation. The human hand is an extraordinary system with 27 DOF, opposable thumbs and it can realize the pressure, temperature, weight and applied force. So for safe and useful working of robots, they need to imitate the function of human hands to perform tasks with high precision. These days such robotic hands are manufactured and among these some are anthropomorphic hands, where they look like the pentadactylus structure of the human hand and other hands are designed based on various pioneering design perceptions. Problems faced by industries using robotic hands is the insufficient capacity to deal with flexible size and shape of objects for the application used. So the ultimate goal is to manufacture a robotic hand with a high level of dexterity.

In the real world the use for soft robotic hands is to do the basic tasks such as grasping objects, pick and place etc. Two principles focused for developing such hands are under actuation and passive mechanical adaptation. Few practical designs of Anthropomorphic robotic hands and grippers are Dexterous Hand, Hand-Lite(another version of dexterous hand),Barrett Hand, Wessling Robotic hand etc. Dexterous Hand is pentadactylus and it consists of 20 actuated degrees of freedom (DOF), 4 under-actuated movements, together they make 24 joints and 129 sensors. It can perform a wide range of movements and includes force sensing, tactile sensing, temperature sensing, motor current and voltage sensing. Hand Lite is a small-scale version of Dexterous hand with 13 DOF and 16 joints along with the 16 joint position sensors. Due to the advent of improved sensors similar to BioTac tactile sensors, robotic hand structures can easily perform human-like tasks. Example gripping a soft structure without damaging it. Figure below is the dexterous hand model.

**Barrett hand**

Barrett hand is a three fingered programmable gripper was produced from the AI laboratory of MIT in 1990. Anthropomorphic hands are also being developed by DLR, a German aerospace centre. Wessling Robotic hand produced by wessling robotics. Recently introduced soft robotic grippers are using the pneumatic control for actuated polymer fingers and they can grasp a wide variety of objects with different shapes, size and weights.

Fig. 1: Robotic Hand,(courtesy of mdpi.com)

Soft materials for the robotic hands are synthetic rubber, elastomer, natural rubber, nano-particulate polymer composite and polymer composite. These are existing soft materials to design hands in a simpler, lighter and universal manner. Shimoga and Goldenberg studied working of 6 different materials and concluded sponge is best out of it.

**Machine learning**

Medical robots, assistive robots, entertainment and search and rescue robots are soft robots which play a vital role in helping human beings in various areas. But still best control and model is required. The controls are different for soft robots compared to traditional rigid-bodied robots. Technologies like Machine learning and Information perception are used to better handle the soft robotic hands. ML controls the soft robot either by an approximation of the dynamic model or by the direct learning of controllers for a provided behavior. K-Nearest Neighborhood (KNN) technique was used to improve the communication between humans and robots in 1999. In 1992 Michael I. Jordan and David E. Rumelhart developed Distal Supervised learning(DSL) approach which helped in finding the inverse of non-linear many-to-one mapping. Using DSL James M.Bern developed an algorithm to control and plan the movement of robotic hands. In 2017 Shimoe used a Neural Network (NN) based model which consisted of supervised and unsupervised stages to develop the artificial haptic models. In 2020 Huang performed the recognition of gestures, size, weight, and object shape using various ML techniques also using the basic techniques. From this more accuracy was obtained using ML techniques.

**Applications**

Major applications of soft robotics are smart prosthetic hands, Super Pick and BionicSoft Hand. Smart hands are used for those who have lost their hands. Chen designed this prosthetic hand which uses the hybrid technology of fuzzy logic and proportional derivative (PD). SuperPick robots are trained to pick, scan, and even deliver the identified object depending on its dimensions, weight, and fragility. BionicSoftHand is developed by Festo, it is capable of fulfilling the given goal through the trial and error method. Many soft robots are designed and trained to work in medical fields and various other fields.

**Conclusion**

Further research for the advancement of soft robotics is still in need in terms of materials and techniques.

There are still many challenges to be faced in this field. Safe and simple techniques and materials should be developed for real world scenarios and this should be the main focus of the researchers.

**Acknowledgement**

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

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