# DEPARTMENTAL JOURNAL ON ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Department of Electronics and Telecommunication Engineering
Technique Polytechnic Institute
Panchrokhi, Sugandhya,
Hooghly, West Bengal
Pin-712102

# TECHNOTRONICS

## VOLUME: 4

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## TOPIC OF THE YEAR

## IoT, Free Space Optical Communication, Wireless Charging, Swarm Intelligence

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## Technique Polytechnic Institute

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# Swarm Intelligence (SI) & It's Application

**Madhurima Santra, Lecturer of Electronics & Tele-communication Engineering**
**Technique Polytechnic Institute**

**ABSTRACT: The inherent intelligence of swarms has inspired many social and political philosophers, in that the collective movements of an aggregate often derive from independent decision making on the part of a single individual.**

## Introduction

Swarm intelligence is the discipline that deals with natural and artificial systems composed of many individuals that coordinate using decentralized control and self-organization. Swarm intelligence is the emergent collective intelligence of groups of simple autonomous agents. Here, an autonomous agent is a subsystem that interacts with its environment, which probably consists of other agents, but acts relatively independently from all other agents. The autonomous agent does not follow commands from a leader, or some global plan. Swarm intelligence has a marked multidisciplinary character since systems with the above mentioned characteristics can be observed in a variety of domains.

**Two of the most important algorithms are:**

**Ant colony optimization:**

Ant colony optimization or ACO is a class of optimization algorithms modeled on the actions of an ant colony. Artificial 'ants' - simulation agents - locate optimal solutions by moving through a parameter space representing all possible solutions. Real ants lay down pheromones directing each other to resources while exploring their environment. The simulated 'ants' similarly record their positions and the quality of their solutions, so that in later simulation iterations more ants locate better solutions. One variation on this approach is the bees algorithm, which is more analogous to the foraging patterns of the honey bee.

**Particle swarm optimization:**

Particle swarm optimization or PSO is a global optimization algorithm for dealing with problems in which a best solution can be represented as a point or surface in an n-dimensional space. Hypotheses are plotted in this space and seeded with an initial velocity, as well as a communication channel between the

particles. Particles then move through the solution space, and are evaluated according to some fitness criterion after each timestamp. Over time, particles are accelerated towards those particles within their communication grouping which have better fitness values. The main advantage of such an approach over other global minimizationstrategies such as simulated annealing is that the large numbers of members that make up the particle swarm make the technique impressively resilient to the problem of local minima. In this study we will learn about some of the major applications of swarm intelligence.

**Why Do People Use ACO and PSO?**

- Can be applied to a wide range of applications
- Easy to understand
- Easy to implement
- Computationally efficient

## SWARM INTELLIGENCE ROUTING

### A. AntNet Algorithm:

In the AntNet algorithm, routing is determined by means of very complex interactions of forward and backward network exploration agents ("ants"). The idea behind this sub-division of agents is to allow the backward ants to utilize the useful information gathered by the forward ants on their trip from source to destination. Based on this principle, no node routing updates are performed by the forward ants. Their only purpose in life is to report network delay conditions to the backward ants, in the form of trip times between each network node. The backward ants inherit this raw data and use it to update the routing table of the nodes

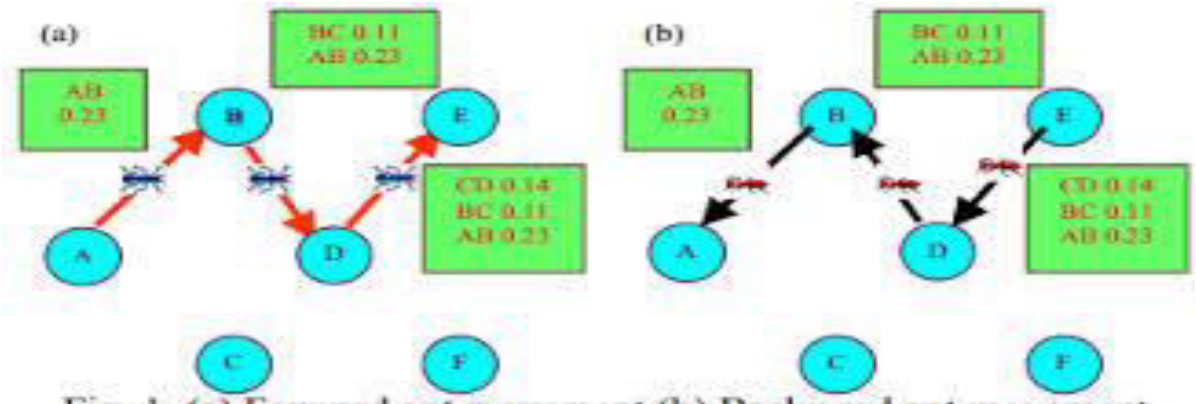


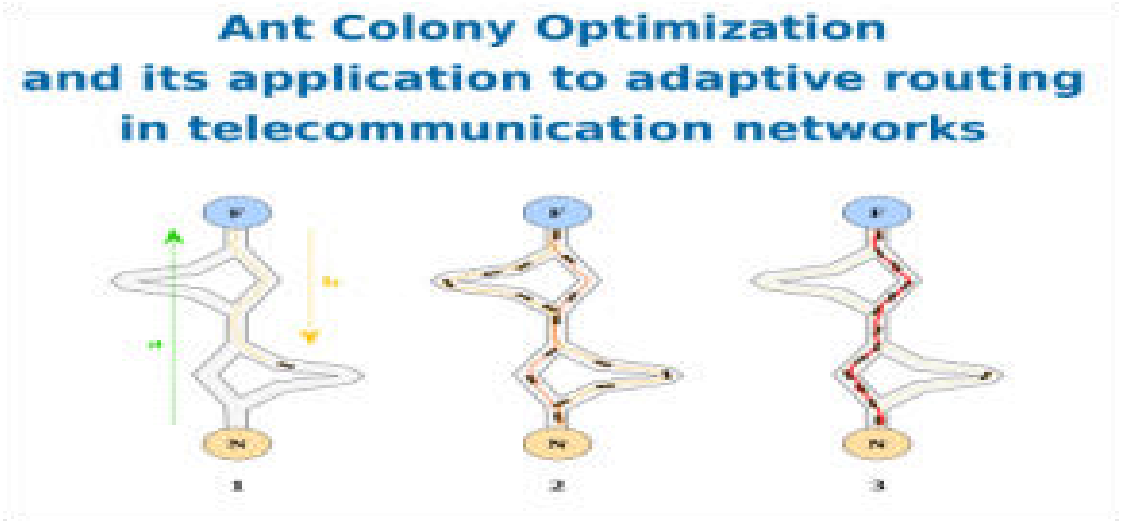

Fig. 1. (a) Forward ant movement (b) Backward ant movement

### B. Ant-Based Control:

Ant-based Control (ABC) is another successful swarm intelligence based algorithm designed for telephone networks. This algorithm shares many key features with AntNet, but has important differences. The basic principle shared is the use of a multitude of agents interacting using stigmergy. The algorithm is adaptive and exhibits robustness under various network conditions. It also incorporates randomness in the motion of ants. This increases the chance of discovery of new routes. In ABC, the ants only traverse the network nodes probabilistically, while the telephone traffic follows the path of highest probability .

### C. AntHocNet:

AntHocNet's design is inspired by ACO routing algorithms for wired networks. It uses ant agents which follow and update pheromone tables in a stigmergic learning process. Data packets are routed stochastically according to the learned tables. An important difference with other ACO routing algorithms is that AntHocNet is a hybrid algorithm, in order to deal better with the specific challenges of MANETenvironments. It is reactive in the sense that nodes only gather routing information for destinations which they are currently communicating with, while it is proactive because nodes try to maintain and improve routing information as long as communication is going on.




## SWARM ROBOTICS

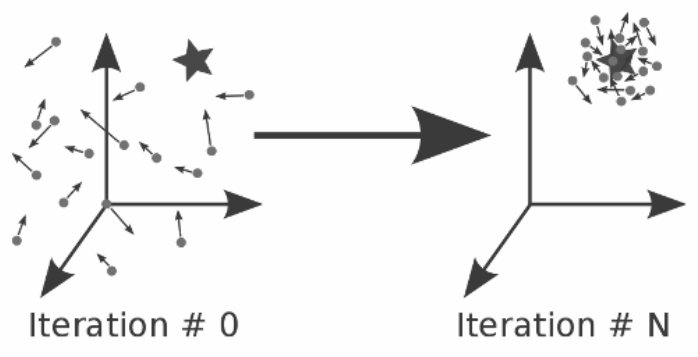
Swarm robotics is a field of multi-robotics in which large numbers of robots are coordinated in a distributed and decentralized way. Large number of simple robots can perform complex tasks in a more efficient way than a single robot, giving robustness and flexibility to the group. The collective behaviours of social insects, such as the honey-bee's dance, the wasp's nest-building, the construction of the termite mound, or the trail following of ants, were considered for a long time strange and mysterious aspects of biology. Researchers have demonstrated in recent decades that individuals do not need any representation or sophisticated knowledge to produce such complex behaviours. In social insects, the individuals are not informed about the global status of the colony. There exists no leader that guides all the other individuals in order to accomplish their goals. The knowledge of the swarm is distributed throughout all the agents, where an individual is not able to accomplish its task without the rest of the swarm.

Social insects are able to exchange information, and for instance, communicate the location of a food source, a favourable foraging zone or the presence of danger to their mates. This interaction between the individuals is based on the concept of locality, where there is no knowledge about the overall situation. The implicit communication through changes made in the environment is called stigmergy. Insects modify their behaviours because of the previous changes made by their mates in the environment. This can be seen in the nest construction of termites, where the changes in the behaviours of the workers are determined by the structure of the nest.

Organisation emerges from the interactions between the individuals and between individuals and the environment. These interactions are propagated throughout the colony and therefore the colony can solve tasks that could not be solved by a sole individual. These collective behaviours are defined as self-organising behaviours. Self-organisation theories, borrowed from physics and chemistry domains, can be used to explain how social insects exhibit complex collective behaviour that emerges from interactions of individuals behaving simply. Self-organisation relies on the combination of the following four basic rules: positive feedback, negative feedback, randomness, and multiple interactions

**CROWD CONTROL**

Crowd control focuses on creating a realistic smooth and flexible motion for virtual human beings by utilizing the computational facilities provided in Particle swarm optimization (PSO). In particular, we present a uniform conceptual model based on particle swarm optimization (PSO) to simulate the motion of all persons in a crowd according to the analogy between a swarm and a crowd. A person can be considered as a particle, which would like to find a way to reach the best solution. Although PSO does possess some characteristics of the crowd behavior, it is still incompatible with the use for crowd control. Firstly, the particle in PSO is absolutely free to fly through everywhere in the given multidimensional space. However, the environment for a crowd may have obstacles, and the pedestrians in the crowd must avoid collisions, including the collision with the given obstacles and the collision with the fellow pedestrians, where other pedestrians can be considered as dynamic obstacles. These dynamic obstacles are not predictable and may appear and disappear in the environment at any moment.




Steps followed by Particle swarm optimization:

- Initial

Set the position and the velocity of each particle. Evaluate Compute the objective value by the objective function.

- Update PBLS

Update the PBLS of each particle by its objective value.

- Update PBGS

Update the PBGS in the swarm.

- Update Velocity and Position

Update the velocity and the position of each particle.

**BLS:** Best local solution

**BGS:** Best global solution

Particle swarm optimization (PSO) is an optimization paradigm proposed in the field of evolutionary computation for finding the global optimum in the search space. The concept of PSO is easy to comprehend, and the mechanism is easy to implement. The ability of PSO to reach the position of the optimum creates the possibility to automatically generate non-deterministic paths of virtual human beings from one specified position to another. On the other hand, if the target is the best position, the movement of a person is a process to find a walkable path to the destination. For these essential reasons, we propose the model to work with the original PSO for path creation.

## INVERSE HEAT CONDUCTION PROBLEM

Solution of the inverse problem is much more difficult than solution of the direct heat conduction problem in which the initial and boundary conditions are known, only the temperature must be found. The Artificial Bee Colony and Ant Colony Optimization algorithms can be used for minimizing the functional representing thecrucial part of approach leading to the solution of the inverse heat conduction problem consisting in heat flux reconstruction.

In the inverse heat conduction problem with boundary condition of the third kind to be analyzed the distribution of temperature needs to be determined and the form of heat transfer coefficient appearing in boundary condition of the third kind reconstructed.

An important part of the procedure is minimization of the functional expressing the errors of approximate results.

Both swarm intelligence algorithms are useful for solving the considered problem; they give satisfying results for small numbers of individuals as well as for relatively small numbers of iterations. However, taking into account the number of calculations indispensable to obtain good results, which indicates the velocity of working of the algorithms, the ant algorithm appears to be slightly more efficient in solving this kind of problem. The number of iterations in the ACO algorithm execution, implying the number of direct heat conduction problems to be solved, is smaller by half in comparison with the ABC algorithm.

## APPLICATIONS IN SOFTWARE ENGINEERING

Software testing is an important and valuable part of the software development life cycle. Due to the time and cost constraints, it is not possible to test the software manually and fix the defects. Thus the use of test automation plays a very important role in the software testing process. Meta-Heuristic algorithms have been applied to three areas of software engineering: test data generation, module construction and cost/effort prediction. The process of test data generation involves activities for producing a set of test data that satisfied a chosen testing criterion.

Requirements for test case generation:

• Transformation of the testing problem into a graph.

• A heuristic measure for measuring the "goodness" of paths through the graph.

• A mechanism for creating possible solutions efficiently and a suitable criterion to stop solution generation.

• A suitable method for updating the pheromone.

Current research into the ACO is still at a nascent age. More potentially beneficial work remains to be done, particularly in the areas of improvement of its computation efficiency.

## IMAGE SEGMENTATION

Image segmentation plays an essential role in the interpretation of various kinds of images. Image segmentation techniques can be grouped into several categories such as edge-based segmentation, regionoriented segmentation, histogram thresholding, and clustering algorithms (Gonzalez & Woods, 1992). The aim of a clustering algorithm is to aggregate data into groups such that the data in each group share similar features while the data clusters are being distinct from each other. There are a number of techniques, developed for optimization, inspired by the behavior of natural systems (Pham &Karaboga, 2000). Experimental results showed that swarm intelligence can be employed as a natural optimization technique for optimizing both Kmeans and SCL (SIMPLE COMPETITIVE LEARNING) algorithms. The K-means algorithm often fails to realize clusters since it is heavily dependent on the initial cluster centres. The ACO-K-means and PSO-K-means algorithms provide a larger search space compared to the K-means algorithm. By employing these algorithms for clustering, the influence of the improperly chosen initial cluster centres will be diminished over a number of iterations. Therefore, these algorithms are less dependent on randomly chosen initial seeds and are more likely to find the global optimal solution.SI can help SCL find the global optima using the same parameter set and learning rate as those used in the SCL and recognize the clusters where the SCL fails to do, in some cases. This can be advantageous since for SCL to find the global optima the learning rate should be adjusted in the course of experimentation.

## DATA MINING

Data mining and particle swarm optimization may seem that they do not have many properties in common. However, they can be used together to form a method which often leads to the result, even when other methods would be too expensive or difficult to implement. A new clustering method based on PSO is proposed and is applied to unsupervised classification and image segmentation.

The PSO-based approaches are proposed to tackle the colour image quantization and spectral un-mixing problems. Visual data mining via the construction of virtual reality spaces for the representation of data and knowledge, involves Particle swarm optimization (PSO) combined with classical optimization

methods. This approach is applied to very high dimensional data from microarray gene expression experiments in order to understand the structure of both raw and processed data.

Cluster analysis has become an important technique in exploratory data analysis, pattern recognition, machine learning, neural computing, and other engineering. The clustering aims at identifying and extracting significant groups in underlying data.

The basic mechanism underlying this type of aggregation phenomenon is an attraction between dead items mediated by the ant workers: small clusters of items grow by attracting workers to deposit more items. It is this positive and auto-catalytic feedback that leads to the formation of larger and larger clusters. The general idea for data clustering is that isolated items should be picked up and dropped at some other location where more items of that type are present.

Therefore, various swarm intelligence algorithms can be used together to form a method which often leads to the result, even when other methods would be too expensive or difficult to implement.

**Limitation:-**

- biology makes compromises between different goals
- biology sometimes fails
- some natural mechanisms are not well understood
- well-defined problems can be solved by better means

## CONCLUSION

The complexity of an ant colony or the beautiful sight of a large swarm of birds surprises with the simplicity of the underlying rules. With ant colony optimization and particle swarm optimization two algorithms have been created which can solve difficult computational problems efficiently, while still being easy to understand. As there is a wide variety of swarm behaviours in nature, there is a great chance we will see more algorithms and systems modelled after social insects and other social animals. The challenge in designing such systems will be to define the correct rules for the interaction of the individuals, as it is not immediately evident which rules lead to the desired behaviour of the swarm. Swarm intelligence is a very active and exciting research field. As our technical systems become increasingly complex, swarm intelligence algorithms – which consist of many simple parts – become more and more useful as a solution to difficult computational problems. As the algorithms are parallel in nature, they are well adapted for the use on parallel hardware. On coming processor generations – which will feature a growing number of parallel processing units – this may lead to very efficient implementations of these algorithms.

# Smart Building Home System Using IoT

**Abhishek Dey, Lecturer of Electronics & Tele-communication Engineering**
**Technique Polytechnic Institute**

**ABSTRACT: Internet of Things (IoT) is an emerging technology that is making our world smarter. The idea of connected world cannot be imagined without IoT. An IoT based Smart Home is one such example. In IoT enabled Smart Home environment various things such as lighting, home appliances, computers, security camera etc. all are connected to the Internet and allowing user to monitor and control things regardless of time and location constraint. This paper describes Frugal Labs IoT Platform (FLIP) for building IoT enabled Smart Home. This paper discusses functions of Smart Home and its applications and introduces FLIP architecture with implementation of Smart Home services using FLIP through a proposed system. The proposed system presented in this paper is used for monitoring and controlling Smart Home environment.**

## INTRODUCTION

A smart home also referred to as a connected home or e-Home is an environment for living that has highly advanced automatic systems. A smart home appears "intelligent" because its daily activities are monitored by a computer. A smart home consists of many technologies via home networking for improving quality of living. A smart home is a place that has highly advanced automatic systems for controlling and monitoring lighting and temperature, home appliances, multi-media equipment, and security systems and many other functions. IoT plays an important role in building smart home. Through IoT almost every object of our daily life in a home can be connected to the Internet. IoT allows monitoring and controlling all of these connected objects regardless of time and location.

## MOTIVATION

As the consequence of digital India program, cities in India will soon be transforming into smart cities. A smart city in an environment and infrastructure which is highly depends upon Internet for communication and services. Thus IoT is a key factor for building smart cities. A smart home system, proposed in this paper, is a component of a smart city. The motivation behind this paper is to propose a smart home system that can be implemented in smart cities in India.

## FUNCTIONS OF SMART HOME

A smart home system consists of applications built on top of IoT infrastructure. The smart home applications can have following main functions -
The smart home system is able to sense its environment and accordingly send alerts to the user on registered device or account. The alert consists of information related to environmental data. This information may include level of different gases in the environment, temperature, humidity, light intensity etc. alert may be sent to user on regular basis at predefined time.

### *A. Alert*

The smart home system is able to sense its environment and accordingly send alerts to the user on registered device or account. The alert consists of information related to environmental data. This information may include level of different gases in the environment, temperature, humidity, light intensity etc. alert may be sent to user on regular basis at predefined time. Alert may be sent over email, as a text message, through tweets or through any other social media.

### *B. Monitor*

This is the most important function of smart home. A smart home is capable of monitoring its surrounding with the help of various sensors and camera feed. Monitoring is an important function as it keep track to every activity in a smart home which is the primary need on basis of which any further action can be taken or decision can be made. For example monitoring room temperature and sending alert to user to switch on air- conditioner if temperature is above threshold.

### *C. Control*

This function of smart home allows user to control different activities. The activities may include switching on/off lights, air-conditioner, and appliances, lock/unlock doors, open/close windows and doors and many more. User can control things from same place or from remote location. This function even allows user to automate activity such as automatically switch on/off air-conditioner when room temperature high/low.

### *D. Intelligence*

Intelligence or Home Intelligence (HI) is the most significant function of smart home and refers to intelligent behavior of the smart-home environment. This function is related to automatically making decision on occurrence of various events. HI depends upon the Artificial Intelligence (AI) mechanism built in the smart home environment. HI does not only give brain to smart home but it is also very important for security point of view in a home.

## SMART HOME APPLICATIONS

Although the application area of a smart home is only limited by human imagination, this paper illustrates some of them which are described below-

### *A. Smart Lighting*

Smart lighting is used for energy saving which can be achieved by adapting lighting to the ambient conditions and by switching on/off or dimming of lights according to user needs thus reducing the unnecessary use of energy. Saving energy also helps in reducing cost. The smart lighting can be implemented with Solid State lighting (LEDs) or IP-enabled lights (Internet or wireless controlled). The smart lighting works by sensing the occupancy, temperature/humidity and LUX level in the environment.

### *B. Smart Appliances*

Smart appliances are used for gathering status information of appliances and to easily control appliances from within the room or remotely. It is also used for scheduling tasks at predefined time and for runtime integration between appliances. Smart appliances save energy and time.

### *C. Intrusion Detection*

Intrusion detection is used for alerting user through email and text message. The intrusion detection application can also send detailed report with images or audio/video clip to the user. The main goal of this application is to monitor suspected activity in smart home and alert user and take necessary actions for

security purpose.

***D.Smoke/Gas Detection***

This application is used for sensing the smart home environment for healthy living and can also be used for security. This application is used for optical detection, ionization, and air sampling technique. It is capable of raising alert to nearby fire station in case of fire and smoke and to user via email/SMS informing them about health risks.

## FLIP ARCHITECTURE

FLIP developed by Frugal Labs Bangalore, India is an open source IoT platform aimed for developers, Hobbyists, and anyone interested to learn and work on IoT to transform their idea to "Proof of Concept". FLIP is a complete IoT platform and not just collection of devices and sensors or cloud services for building IoT infrastructure. FLIP architecture represented in Fig. 1.


Fig. 1. FLIP Architecture.

The FLIP architecture has four distinct layers device, gateway, cloud, and app & SDK.

***A.Device Layer***

Device layer consists of controller, communication module, sensors and actuators. In this layer FLIP base board is used as controller. FLIP base board is based on Arduino Nano. For smart home application this layer also uses FLIP smart home shield. The smart home shield stacked over base board to extend functionality of the base board. Smart home shield has temperature & humidity; light intensity (LDR) sensors attached to it and also allow connecting other sensors such as PIR and various gas and air quality sensors, sound sensors and many more. Smart home shield also has Alternating current (AC) relay which can be used to control anything up to 7 amps of current and 250 volts AC current. It enables to connect home appliances, home lighting etc. The FLIP smart home shield is displayed in Fig. 2

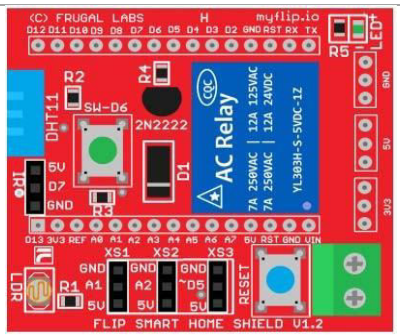



Fig. 2. FLIP Smart Home Shield.

For connectivity at device layer FLIP board uses Wi-Fi/Bluetooth module. Both modules can be connected to FLIP base board directly via 6- pin interface. Wi-Fi module, shown in Fig. 3, directly connect FLIP device to the Internet and Bluetooth module, shown in Fig. 4, connects FLIP device to Internet via gateway layer in the architecture.

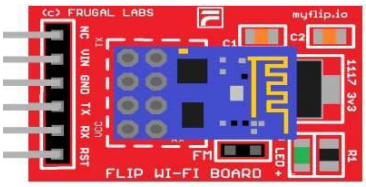



Fig. 3. FLIP WiFi Module.

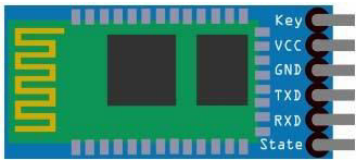



Fig. 4. FLIP Bluetooth Module

### *B.Gateway Layer*

Gateway layer consists of local processing unit which is based on Linux operating system. FLIP architecture uses Raspberry PI 3 as gateway device. Gateway device has Bluetooth connectivity which allows other devices to connect to it. In the architecture all the devices are connected to gateway and gateway is connected to the Internet. Gateway is connected to Internet through Ethernet or Wi-Fi.

### *C.Cloud Layer*

Cloud layer consists of broker and the database. Broker connects to all the devices and database stores the data coming from the devices. The cloud layer has three main structures MQTT broker named Mosquito, Mongo DB database and Node.js for backend processing.

### *D.App & SDK Layer*

The top layer is App & SDK layer. The app consists of web app and dashboard and is used for data visualization using widgets and graphs. Using dashboard devices can be monitored and controlled. SDK has rule engine based on python . The Python SDK has two scenarios one is to define logic to your device i.e. if temperature is this much then switch on air-conditioner, and second it can connect to social media or third party apps.

## PROPOSED SYSTEM

The proposed system discussed in this study is based on FLIP. The proposed system has four main

application modules smart lighting, smart appliances, intrusion detection, and smoke/gas detection as discussed in the previous section. Fig. 5 displays basic device setup diagram for smart home lighting control including temperature, humidity, light intensity and motion detection sensing capability.

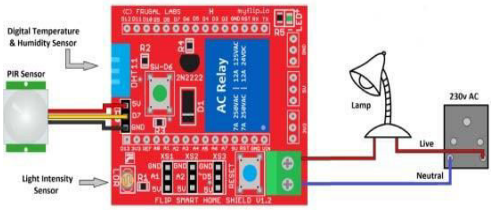



Fig. 5. Smart Home Device Setup.

The proposed smart home network structure is displayed in Fig. 6.

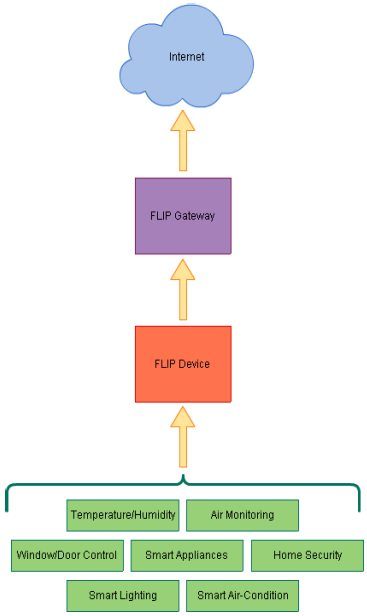



Fig. 6. Smart Home Network

In the proposed smart home system FLIP device is connected to sensors, lights, air- conditioner, camera, windows and door system, and various appliances. The flip device is connected to the Internet via gateway. Gateway in the proposed smart home network plays an important role as it add an extra security layer to the smart home network thus making the proposed system more secure. The proposed smart home system is capable of performing various functions such as monitoring environment for air quality and security purpose, controlling home appliances, locks, doors and windows from remote location, generating alerts and notifications at preset conditions, adjusting room lighting and temperature by sensing light intensity and temperature/humidity level in the room and thus automatically controlling lighting system and air-conditioner. Following C language firmware code, uploaded on one of the FLIP device, publishes temperature and humidity and light intensity data and also allows turning light on/off remotely. Currently the proposed system performs functions as described in this section but it is not limited. Any new functionality to the system can be easily added thus making system extensible.

## FUTURE SCOPE

The proposed IoT based smart home system can be implemented in future smart cities in India. Currently the proposed system performs various functions as described in above sections. In future, the proposed system can be extended to perform other functions such as water and waste management.

## CONCLUSION

With the rapid development of Internet and communication technologies today's homes also have strong computation and communication abilities. An IoT based smart home is emerging as an important part of the smart and intelligent cities which are being proposed and developed around the world. The purpose of a smart home is to improve living standard, security and safety as well as save energy and resources. The smart home plays an important role in development of society. The aim of this paper is to propose such system based on FLIP. The system presented in this paper is highly flexible and extensible for user needs with security concerns. The proposed system can be implemented as per user requirement.

# Free Space Optical Communication: A Review

**Subhajit Mukherjee, Lecturer of Electronics & Tele-communication Engineering**
**Technique Polytechnic Institute**

**ABSTRACT:** With the worldwide demand for larger bandwidth and greater mobility there is a rapid advancement of broadband wireless communications. The high capacity and low loss of optical fibre has seen its exploding growth in the last few decades in the LAN's and WAN's. Free space optical (FSO) wireless communication has emerged as a viable technology for bridging the gap in existing high date rate fibre network and as a temporary backbone for rapidly deployable mobile wireless communication infrastructure. Free space optical communication offers the potential to send large amount of data security over moderate distances without the expense of laying fibre optic cable. The technology is helpful where the physical connection of the transmitter and receiver locations is difficult. These robust systems which establish communication links by transmitting laser beams directly through the atmosphere, have matured to the point that mass produced models are now available. FSO system offers many features among them being the low-start up and operational cost, rapid development and high fibre-like bandwidth. It offers capacities in the range of 100Mbps to 2.5Gbps and demonstration systems report data rates as high as 160Mbps.It is a line-of-sight technology that currently enables optical transmission up to 2.5Gbps of data, voice and video communications through the air, allowing optical connectivity without deploying fibre-optic cables or securing spectrum licences. Even though FSOs provide high security as its laser beams cannot be determined with the devices like spectrum analyser or RF meters, there are some challenges (atmospheric turbulence, scintillation, object sway) in the implementation of it.

## INTRODUCTION

The proliferation of wireless communications stands out as one of the most significant phenomena in the history of technology. Wireless devices and technologies have become pervasive much more rapidly than anyone could have imagined thirty years ago and they will continue to be a key element of modern society for the foreseeable future. Today, the term "wireless" is used almost
synonymously with radio-frequency (RF) technologies as a result of the wide-scale deployment and utilization of wireless RF devices and systems. The RF band of the electromagnetic spectrum is however fundamentally limited in capacity and costly since most sub-bands are exclusively licensed. With the ever-growing popularity of data heavy wireless communications, the demand for RF spectrum is outstripping supply and the time has come to seriously consider other viable options for wireless communication using the upper parts of the electromagnetic spectrum. The increase demand of wireless links which are easier, faster and less expensive to deploy has renewed interest in the use of free-space optics in digital transmission of signal in the atmosphere.

Optical communication systems provide the highest available carrier frequencies and thus the fastest data rates possible today. FSO is designed to be a lower cost alternative to conventional fiber-optic cable-based communication links. FSO is especially attractive within a metropolitan environment where the costs for trenching, cable installation, and street repairs can run from $200K to easily over $1M per mile, depending on the urban location. The idea to use light for Free Space Optical (FSO) Communications is as old as the telephone. FSO is a maturing technology that offers significant enhancements over most

wireless technologies, including higher data rate, and the complete avoidance of any spectrum licensure costs. Its primary competition today is from existing fixed fiber installations. Today, a significant percentage of FSO sales are international. This has occurred due to the extensive USA fiber infrastructure that was installed in the 1990's slowing its expansion within the USA.

The most mature technology used in FSO equipment relies on low cost semiconductor lasers or LED's operating in the near infrared at wavelengths of 785 nm or 850 nm. In the past few years, systems operating at 1550 nm have also been developed. At first the vendors of these systems claimed that the 1550 nm wavelength had better propagation characteristics in severe weather than the 785 nm wavelengths. With further analysis and research those claims were withdrawn. Now there are claims that even longer wavelengths near 10 microns will solve the FSO link availability issues associated with severe weather. Hype about such magic wavelengths for FSO is both a disservice to the investors who will lose the money they are investing based on exaggerated claims, and to the rest of the FSO industry which should be creating realistic expectations for the capability of its equipment. In the weather conditions which normally cause the highest attenuation for FSO systems, namely coastal fog and low clouds, 10 microns offers no propagation advantage over shorter wavelengths.

**EVOLUTION OF FSO**

Optical communication in various forms, have been used for thousands of years. The ancient Greeks used a coded alphabetic system of signalling with torches .In the modern era, wireless solar telegraphs called heliographs were developed, using coded signals to communicate with their recipients. In 1880 Alexander Graham Bell and his assistant Charles Sumner Tainter created the Photophone, at Bell's newly established Volta Laboratory in Washington, DC. Bell considered it his most important invention. The device allowed for the transmission of sound on a beam of light. On June 3, 1880, Bell conducted the world's first wireless telephone transmission between two buildings, some 213 meters (700 feet) apart.Its first practical use came in military communication systems many decades later, first for optical telegraphy. German colonial troops used Heliograph telegraphy transmitters during the 1904/05 Herero Genocide in German South-West Africa (today's Namibia) as did British, French, US or Ottoman signals. The invention of lasers in the 1960s revolutionized free space optics. Military organizations were particularly interested and boosted their development. However the technology lost market momentum when the installation of optical fiber networks for civilian uses was at its peak. Many simple and inexpensive consumer remote controls use low-speed communication using infrared (IR) light. This is known as consumer IR technologies. A recently declassified 1987 Pentagon report reveals free-space lasers have been mounted on Israeli F-15 fighter jets for the purposes of surveillance, missile-tracking, and targeted weaponry. In 2008, MRV Communications introduced a free-space optics (FSO)-based system with a data rate of 10GB/s initially claiming a distance of 2 km at high availability.
This equipment is no longer available; before end-of-life, the product's useful distance was changed down to 350m.

In 2013, the company MOSTCOM started to serially produce a new wireless communication system that

also had a data rate of 10GB/s as well as an improved range of up to 2.5 km, but to get to 99.99% up-time the designers used an RF hybrid solution, meaning the data rate drops to extremely low levels during atmospheric disturbances (typically down to 10MB/s).

Recent advances in FSO technology have opened up mainstream communications uses, from short-term solutions for short distance network bridges to an attractive and viable alternative for service providers to deliver the promise of all-optical networks. As an optical technology, FSO is a natural extension of the metro optical network core, bringing cost-effective, reliable and fast optical capacity to the network's edge.

While fiber-optic communication has gained acceptance in the telecommunications industry, FSO communication is still relatively new. FSO enables similar bandwidth transmission abilities as fiber optics, using similar optical transmitters and receivers and even enabling WDM-like technologies to operate through free space.

**FSO-CHANNEL COMPARED TO RF- CHANNEL**

Before starting with the main advantages and differences of Free Space Optics (FSO) and RF-channels it must be mentioned that FSO is a much younger technology compared to RF. When in 1960 the LASER were investigated people had the idea to transmit high data rates through the atmosphere by light for long distances, but then they found out about the problem of fog and clouds for light transmission. Of course in relevance to the high carrier frequencies in optics we have the high usable bandwidth, that is a big advantage compared to RF, but the high frequency also means short wavelengths (some μm), and that means the same size like the small particles within the fog and clouds. So it is not a surprise that Optical Wireless is mainly influenced by fog and clouds. It is the same relation like in RF between RF wavelengths and the size of rain particles. In both cases the Mie- scattering is the main attenuator for the different technologies. Now it is clear, why in 1960 the scientists (in the optical field) searched for better fibres to use light transmission instead of using the atmosphere with the non-predictable weather conditions. But of course work also started in Optical Wireless (a few ambitious scientists still hoped for solving the problems by using high power laser sources and so on). Additional for Inter-satellite Links FSO is a perfect solution, because we have no fog and clouds higher than the troposphere. So the main limiter and attenuator do not exist between the satellites. It must also be mentioned that scientists starting on real channel modelling for FSO the last 10 years, before they only made some measurements on attenuations or they developed FSO-systems. So the channel-modelling in FSO is much younger than in RF. RF started with scientists like Hertz and Marconi 120 years ago and a lot of scientists studied the propagation of RF since this time. At first of course they started experiments and measurements and later they analysed. Now they have a lot of valid models for RF, but still they are evaluating them by newer results. In FSO we are 70 years behind, the LASER were developed in 1960. First single scientists started to work on FSO 30 years ago, and we know the first scientists in our WG3 started with FSO 15 or 20 years ago. Since the last 10 years this technology is becoming more important and much more scientists working in this field. That is also one reason, why we have still only a few models, which we can use for FSO. Additional we have different models for different atmospheric influences. As example in the FSO-field we have models for the attenuation (from fog, clouds, rain etc.) and we have additional models for atmospheric turbulences. The different models are necessary, because the atmospheric turbulences (the so called scintillations) have completely different influences on the transmitted light, they are disturbing the wave-front and they also cause beam-wandering or beam-spreading.

**PRINCIPLES AND PROPERTIES OF FSO**

FSO-links through the troposphere are mainly influenced by weather conditions. Therefore, some important characteristics of the atmosphere have to be discussed before describing the optical wireless systems in more detail. The lowest part of the atmosphere up to 10 km above the Earth’s surface is called

the troposphere or the weather sphere. It has a varying refraction index, which is dependent on the height above the Earth's surface. Normally the refraction index decrease with the height, but at weather inversion situations there is a different relationship. Atmospheric conditions degrade laser communications through the atmosphere in two ways. First, the atmosphere acts as a variable attenuator between the transmitting and receiving terminals. Second,
a free space laser link is subjected to scintillations. Attenuation is caused by the weather conditions along the transmission path. Generally, there is low atmospheric attenuation during clear days and high attenuation during foggy days. Rain does not influence optical transmissions heavily, because raindrops have the size of a few millimetres and are large compared to laser wavelengths (1.5 microns) and thus cause minimal scattering of the laser energy. Furthermore, water has minimal absorption at a 1550 nm laser wavelength. Therefore, it is not surprising that the optical transmission is not heavily impacted by rain (only about 3 dB/km). Similarly it is not astonishing that optical transmission is impacted dramatically by heavy fog (30 dB/km), because the fog aerosols have a comparable size as the usedwavelengths.

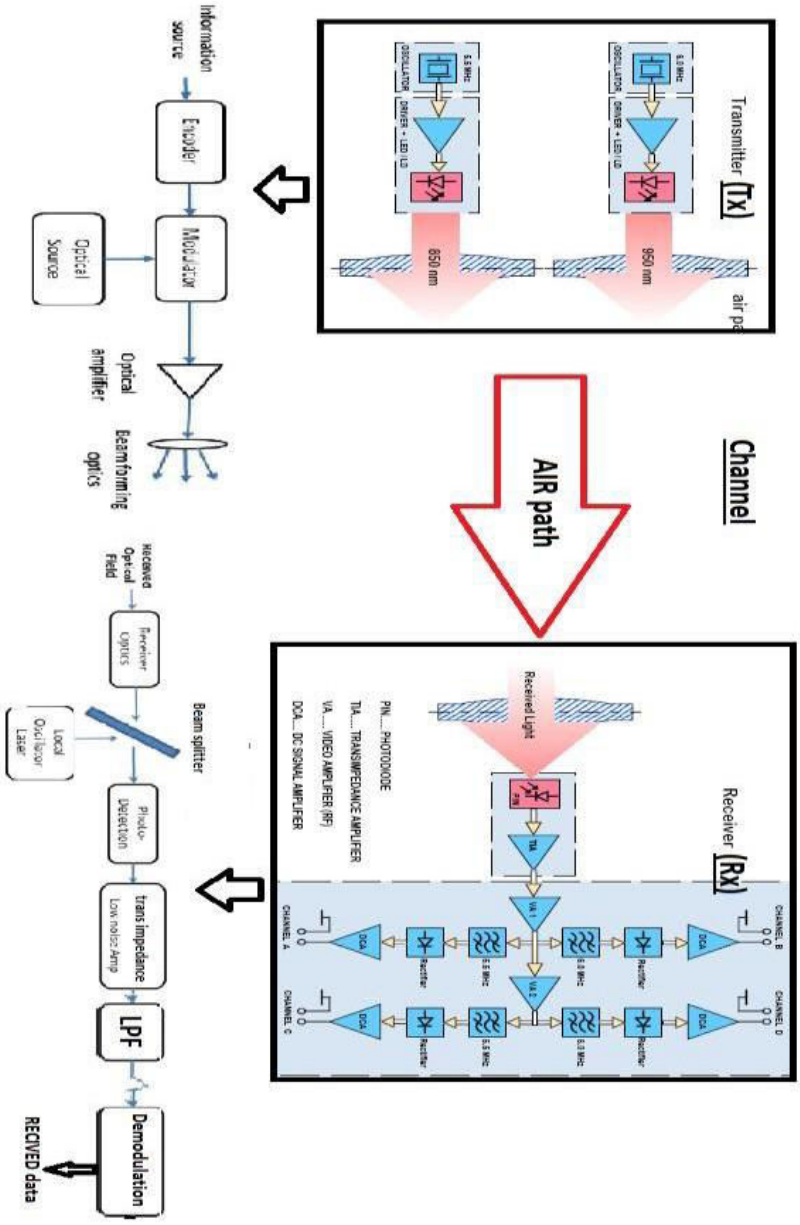



Fig -1: Different Subsystems of FSO

## APPLICATIONS OF FSO

Rather than major challenges due to atmospheric conditions (mainly in long distance communication), it has many great applications for short range communication.FSO systems are appealing for a wide range of applications some of which are elaborated in the following:

**Enterprise/campus connectivity:** Today's corporations and school/university campuses are experiencing a heterogeneous network traffic (i.e., voice, data, fax, multimedia traffic) that is overwhelming the typical connections. FSO systems can bridge multiple buildings in corporate and campus networks supporting ultra-high speeds without the cost of dedicated fiber optic connections.

**Video surveillance and monitoring:** Surveillance cameras are widely deployed in commercial, law enforcement, public safety, and military applications. Wireless video is convenient and easy to deploy, but conventional wireless technologies fail to provide high throughput requirements for video streams. FSO technology presents a powerful alternative to support high quality video transmission.

**Back-haul for cellular systems:** Wireline connections such as T1/E1 leased lines and microwave links are typically deployed between the base stations and the mobile switching center in a cellular system. The growing number of bandwidth-intensive mobile phone services now requires the deployment of technologies such as FSO which allow much higher throughput.

**Redundant link and disaster recovery:** Natural disasters, terrorist attacks, and emergency situations require flexible and innovative responses. Temporary FSO links can be readily deployed within hours in such disaster situations in which local infrastructure could be damaged or unreliable. A tragic example of the FSO deployment efficiency as a redundant link was witnessed after 9/11 terrorist attacks in New York City. FSO links were rapidly deployed in this area for financial corporations which were left out with no landlines.

**Security:** Today's cryptosystems are able to offer only computational security within the limitations of conventional computing power and the realization of quantum computers would, for example, make electronic money instantly worthless. Based on the firm laws of physics, quantum cryptography provides a radically different solution for encryption and promises unconditional security. Quantum cryptography systems are typically considered in conjunction with fiber optic infrastructure. FSO links provide a versatile alternative in cases where the fiber optic deployment is costly and/or infeasible.

**Broadcasting:** In broadcasting of live events such as sports and ceremonies or television reporting from remote areas and war zones, signals from the camera (or a number of cameras) need to be sent to the broadcasting vehicle which is connected to a central office via satellite uplink. The required high-quality transmission between the cameras and the vehicle can be provided by a FSO link. FSO links are capable of satisfying even the most.

## FACTORS AFFECTING FSO

Many factors affect the performance of the FSO system. It is important to keep the following factors and their effect on the system performance while designing the system to achieve maximum performance.
Scattering (Rayleigh scattering, Mie Scattering), Absorption, Snow, Fog, Visibility, Distance, Bandwidth, Scintillation effect.

## LIMITATIONS AND FUTURE SCOPE

Free Space Optics (FSO) has become a viable, high- bandwidth wireless alternative to fiber optic cabling. The primary advantages of FSO over fiber are its rapid deployment time and significant cost savings. The disadvantage of FSO over fiber is that laser power attenuation through the atmosphere is variable and difficult to predict, since it is weather airports, the link availability as a function of distance can be predicted for any FSO system. These availability curves provide a good indication of the reasonable link distances for FSO systems in a particular geographical area. The carriers and ISPs are another potential large user of FSO systems, especially for last-mile metro access applications. If FSO systems are to be used in telecommunication applications, they will need to meet much higher availability requirements. Carrier-class availability is generally considered to be 99.999% . An analysis of link budgets and visibility-limiting weather conditions indicates that to meet carrier-class availability, FSO links should normally be less than 140m (there are cities like Phoenix and Las Vegas where this 99.999% distance limitation increases significantly). This calculation is based on a 53 dB link budget. This concept is extended to the best possible FSO system, which would have a 10 W transmitter and a photocounting detector with a sensitivity of 1 nW. This FSO system would have a 100 dB link margin, which would only increase the 99.999% link distance to 286 m. A more practical solution to extending the high availability range would be to back up the FSO link with a lower data rate radio frequency (RF) link. This hybrid FSO/RF system would extend the 99.999% link range to longer distances and open up a much larger metro/access market to the carriers. It is important to realize that as the link range increases, there will be a slight decrease in overall bandwidth. To show the geographical dependence of FSO performance, the first map of FSO availabilities contoured over North America is presented. This map is the first step to developing an attenuation map for predicting FSO performance, which could be used in similar fashion to the International Telecommunication Union (ITU)/Crane maps for predicting microwave performance.

## CONCLUSIONS

In our survey, we observed that most of the applications of FSO are for short range communication. However with effective reduction in atmospheric turbulences using different modulation techniques the distance may be extended up to a larger extent.

# From here to infinity

**Antara Banarjee (Bhowmick), Lecturer of Electronics & Tele-communication Engineering**
**Technique Polytechnic Institute**

**What is Black hole?**

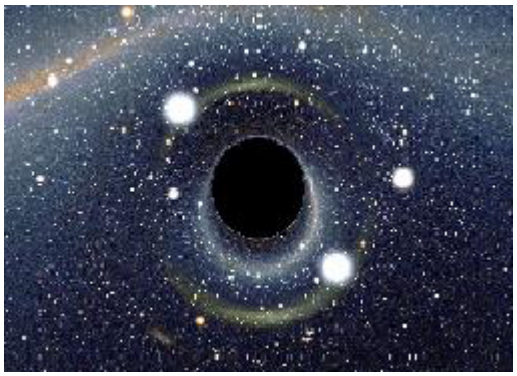


Fig -1: Black hole

The term black hole was first introduced into theoretical physics in 1967 by Wheeler, although the notion of black hole was defined at the end of the eighteenth century. This idea was based on Newton's theory of gravity which coincides with Einstein's General theory of relativity.

Most people think of a black hole as a voracious whirlpool in space, sucking down everything around it. But that's not really true. A black hole is a place where gravity has gotten so strong that the escape velocity is faster than light. But what does that mean, exactly?

Gravity is what keeps us on the Earth, but it can be overcome. If you toss a rock up in the air, it will only go up a little ways before the Earth's gravity slows it and pulls it back down. If you throw it a little harder, it goes faster and higher before coming back down. If you could throw the rock hard enough, it would have enough velocity that the Earth's gravity could not slow it down enough to stop it. The rock would have enough velocity to escape the Earth.But an object's escape velocity depends on its gravity more gravity means a higher escape velocity, because the gravity will "hold onto" things more strongly.

If you take an object and squeeze it down in size, or take an object and pile mass onto it, its gravity and escape velocity will go up. At some point, if you keep doing that, you'll have an object with so much gravity that the escape velocity is faster than light. Since that's the ultimate speed limit of the Universe, anything too close would get trapped forever. No light can escape, and it's like a bottomless pit: a black hole.

**How do black holes form?**

A common type of black hole is produced by certain dying stars. A star with a mass greater than about 20 times the mass of our Sun may produce a black hole at the end of its life.

In the normal life of a star there is a constant tug of war between gravity pulling in and pressure pushing out. Nuclear reactions in the core of the star produce enough energy and pressure to push outward. For most of a star's life, gravity and pressure balance each other exactly, and so the star is stable. However, when a star runs out of nuclear fuel, gravity gets the upper hand and the material in the core is compressed even further. The more massive the core of the star, the greater the force of gravity that compresses the material, collapsing it under its own weight.

For small stars, when the nuclear fuel is exhausted and there are no more nuclear reactions to fight gravity, the repulsive forces among electrons within the star eventually create enough pressure to halt further gravitational collapse. The star then cools and dies peacefully. This type of star is called a "white dwarf."
When a very massive star exhausts its nuclear fuel it explodes as a supernova. The outer parts of the star are expelled violently into space, while the core completely collapses under its own weight.
If the core remaining after the supernova is very massive (more than 2.5 times the mass of the Sun), no known repulsive force inside a star can push back hard enough to prevent gravity from completely collapsing the core into a black hole.

From the perspective of the collapsing star, the core compacts into a mathematical point with virtually zero volume, where it is said to have infinite density. This is called a singularity.
Where this happens, it would require a velocity greater than the speed of light to escape the object's gravity. Since no object can reach a speed faster than light, no matter or radiation can escape. Anything, including light, that passes within the boundary of the black hole -- called the "event horizon" -- is trapped forever.

**What is inside a black hole?**

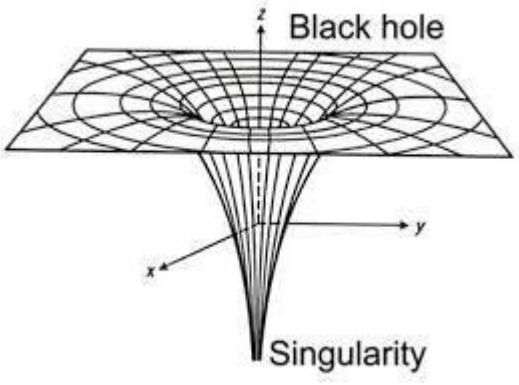



Fig -2: Relativity of Black hole

Nobody really knows, but it is almost certainly not a bookshelf. General relativity predicts that inside the black hole is a singularity, a place at where tidal forces become infinitely large, and that once you cross the horizon, you cannot avoid crashing into the singularity. Alas, General Relativity is not good to use in this region because we know that the theory breaks down. To be able to tell what is inside a black hole we would need a theory of quantum gravity. It is generally believed that this theory would replace the singularity with something else.

**What happens when you fall into a black hole?**

Let's assume that you start outside the event horizon of the black hole. As you look toward it, you see a circle of perfect darkness. Around the black hole, you see the familiar stars of the night sky. But their pattern is strangely distorted, as the light from distant stars gets bent by the black hole's gravity.

As you fall toward the black hole, you move faster and faster, accelerated by its gravity. Your feet feel a stronger gravitational pull than your head, because they are closer to the black hole. As a result, your body is stretched apart. For small black holes, this stretching is so strong that your body is completely torn apart before you reach the event horizon.

If you fall into a supermassive black hole, your body remains intact, even as you cross the event horizon. But soon thereafter you reach the central singularity, where you are squashed into a single point of infinite density. You have become one with the black hole. Unfortunately, you are unable to write home about the experience.

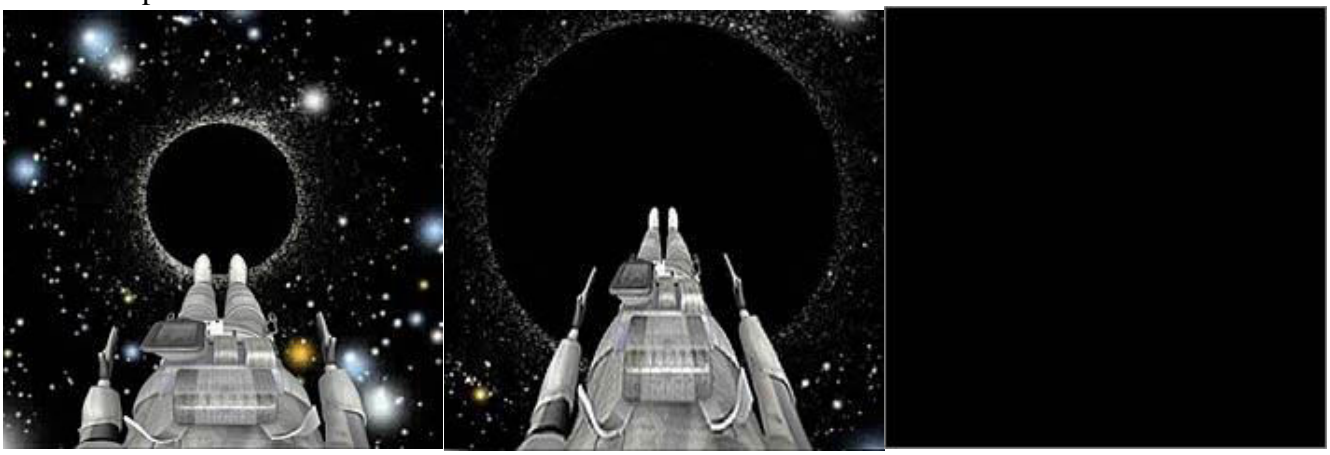


Fig -3:Free Space to Black hole

**If black holes are black, how can we find them?**

A black hole can not be seen because strong gravity pulls all of the light into the middle of the black hole. But scientists can see how the strong gravity affects the stars and gas around the black hole. Scientists can study stars to find out if they are flying around, or orbiting, a black hole.

When a black hole and a star are close together, high-energy light is made. This kind of light can not be seen with human eyes. Scientists use satellites and telescopes in space to see the high-energy light.

**Can black holes be used to travel through spacetime?**

Dive into one, the story goes, and you can pop out somewhere else in the Universe, having travelled thousands of light years in the blink of an eye.

But that’s fiction. In reality, this probably won’t work. Black holes twist space and time, in a sense punching a hole in the fabric of the Universe. There is a theory that if this happens, a black hole can form a tunnel in space called a wormhole If you enter a wormhole, you’ll pop out someplace else far away, not needing to travel through the actual intervening distance. While wormholes appear to be possible mathematically,they would be violently unstable, or need to be made of theoretical forms of matter which may not occur in nature. The bottom line is that wormholes probably don’t exist. When we invent interstellar travel, we’ll have to go the long way around.

## Could a Black Hole Destroy Earth?

Black holes do not go around in space eating stars, moons and planets. Earth will not fall into a black hole because no black hole is close enough to the solar system for Earth to do that. There are probably millions of black holes in our Milky Way Galaxy alone. That may sound like a lot, but the nearest one discovered is still 1600 light years away— a pretty fair distance, about 16 quadrillion kilometres. That's certainly too far away toaffect us. The giant black hole in the centre of the Galaxy is even farther away: at a distance of 30,000 light years, we're in no danger of being sucked in to the vortex. For a black hole to be dangerous, it would have to be very close, probably less than a light year away. Not only are there no black holes that close, there aren't any known that will ever get that close. So don't fret too much over getting spaghettified anytime soon.

# Wireless Charging: Fuel of the Future

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Wireless charging will increase mobility for users of *Internet* of Things (IoT) devices. This article explores the technology and its applications, challenges to overcome while designing and the latest advances in this field.

Wireless charging eliminates the requirement of charging cables and allows charging of multiple devices in parallel. There are no charging cable incompatibility issues. Basically, wireless charging works on the principle of electromagnetic induction. Time-varying magnetic field induces current in a closed loop of wire to transfer power from the transmitter to the receiver without requiring physical connection.

Wireless charging allows auto shutdown when charging is complete. As it does not require mechanical connectors, manufacturing cost is less. Embedding this technology in mobiles will allow mobile manufacturers to do away with power supply sockets, which allow entry to water, dust and other corrosive materials.

**Application Areas**

Apple announced its wireless charging mat AirPower, which is capable of charging iPhone, Apple Watch and AirPods simultaneously. Ikea provides a wide range of wireless charging furniture that support Qi standard. Wireless charging-compatible devices include notebooks, tablets, smartphones, wearables, multicopters, electric toys, cameras, speakers, power tools, service robots such as vacuum cleaners, in-car chargers, electric vehicles, medical devices, etc. Wireless charging can also be used to recharge embedded medical devices via a magnetic field through the skin, avoiding the risk of infection.

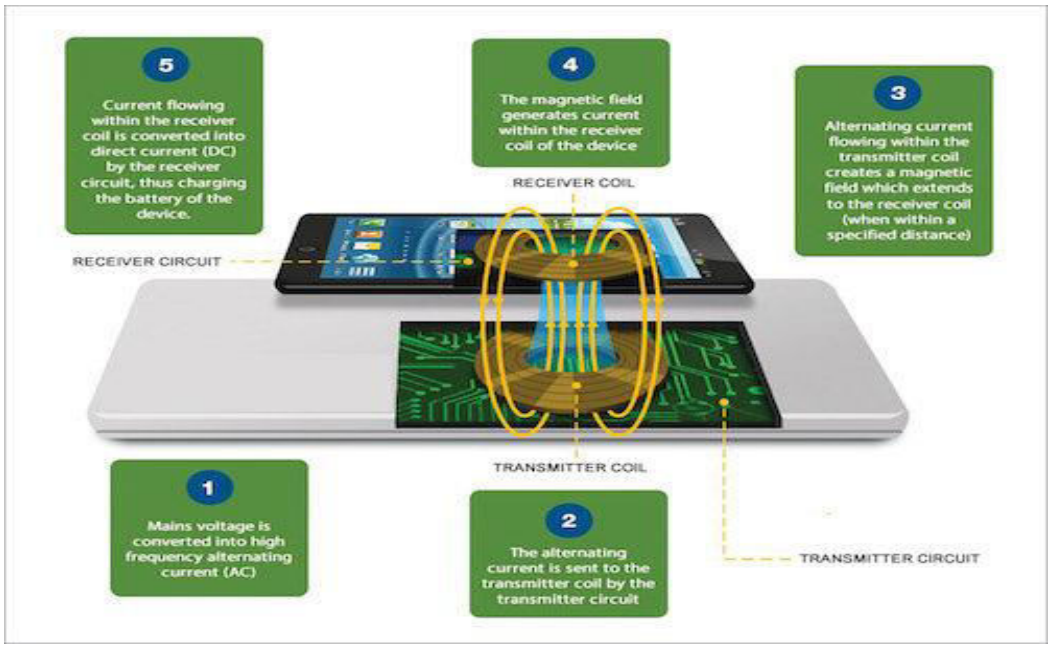


Fig-1: Work flow of a wireless charger (Image source: http://electronicstrick.blogspot.in)

Mediatek principal engineer Sandeep Arya informs that their company provides multi-mode resonant wireless charging solutions for most of the afore-mentioned applications. Their smart receiver resonator architecture simplifies design and delivers seamless charging across different pads. Mediatek manufactures wireless charging integrated circuit (IC) chipsets. Pump Express 4.0 is the latest advance in MediaTek's family of charging innovations that cuts the charging time by half.

**How the technology works?**

To charge your device, you need a wireless charger or a wireless charging case with Qi integrated. The charger uses an induction coil to create an alternating electromagnetic field, which induces current to be fed into the battery by the receiver coil in the phone.

Wireless charging works by converting mains voltage into high-frequency alternating current (AC). This AC current is sent to the transmitter coil by the transmitter circuit. AC current flowing within the transmitter coil creates a magnetic field, which extends to the receiver coil. The magnetic field generates current within the receiver of the coil, thus transferring energy from the charger to a receiver in the back of the phone via electromagnetic induction. The receiver circuit converts the current flowing within the receiver coil into direct current (DC), thus charging the battery of the device. Both your smartphone and the charging pad have an LED indicator, which glows while charging.

**Latest technology trends**

There are two major standards for wireless power charging: Qi (Chee) from Wireless Power Consortium (a group of companies) and PowerMat from AirFuel Alliance. Both products utilise resonant inductive coupling technology. PowerMat has installed thousands of charging spots in European cafes, hotels and airports. Airfuel has announced wireless charging installation at McDonald's restaurants. PowerMat has joined the Wireless Power Consortium. So it's now one of the companies supporting Qi standard alongside Apple, Samsung, LG and more.

Fig-2: Energous wireless charger (Image source: www.digitaltrends.com)

The new platform charging spot 4.0 is easy to install and compatible with many devices. You can find the closest charging station by downloading the app. You just need to walk into a charging station and set your phone on the table to begin wireless charging. For non-compatible smartphones, the company offers

a PowerMat ring. When plugged into the smartphone, it starts power transfer wirelessly. It can be easily placed under the table without drilling through it and can transfer power through 1.3 to 3.8cm (0.5 to 1.5inch) thick surfaces. There can be eight charging spots installed on a table that supports zero to 40 watts of charging power on a single platform and is also compatible with Qi.


Fig-3: Ossia wireless charger (Image source: www.digitaltrends.com)

**Design tips for engineers**

To overcome wireless charging issues like low efficiency, heat dissipation, cost and short-distance transmission, manufacturers need semiconductor solutions. Efficient and easy-to-design transmitter solutions top the list.

Smart heat management keeps the transmitter and surface at working temperature range, keeping the device battery from heating during charging. Design should be compact and easy to carry. Faster charging speed can be achieved by lowering switching and conduction losses.

In place of GaN, Infineon uses mature and reliable silicon technology to achieve a high performance. It is currently working on boosting the performance further with medium-voltage GaN solutions that have the same maturity level as silicon devices.

# Spintronics: Fundamentals and Applications.

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**ABSTRACT:** Spintronics, or spin electronics, is an emerging field of basic and applied research in physics and engineering that aims to exploit the role played by electron spin in solid state materials. Spintronic devices make use of spin properties instead of, or in addition to electron charge to carry information, thereby offering opportunities for novel micro and nano electronic devices. This article reviews the background and current status of this subject, and also some of the applications of Spintronics.

## Introduction

The spin electronics also called Spintronics, where the spin of an electron is controlled by an external magnetic field and polarize the electrons. These polarized electrons are used to control the electric current. The goal of Spintronics is to develop a semiconductor that can manipulate the magnetism of an electron. Once we add the spin degree of freedom to electronics, it will provide significant versatility and functionality to future electronic products. Magnetic spin properties of electrons are used in many applications such as magnetic memory, magnetic recording (read, write heads), etc.

The realization of semiconductors that are ferromagnetic above room temperature will potentially lead to a new generation of Spintronic devices with revolutionary electrical and optical properties. The field of Spintronics was born in the late 1980s with the discovery of the "giant magnetoresistance effect". The giant magnetoresistance (GMR) effect occurs when a magnetic field is used to align the spin of electrons in the material, inducing a large change in the resistance of a material. A new generation of miniature electronic devices like computer chips, light-emitting devices for displays, and sensors to detect radiation, air pollutants, light and magnetic fields are possible with the new generation of Spintronic materials.

In electronic devices, information is stored and transmitted by the flow of electricity in the form of negatively charged subatomic particles called electrons. The zeroes and ones of computer binary code are represented by the presence or absence of electrons within a semiconductor or other material**.** In Spintronics, information is stored and transmitted using another property of electrons called spin. Spin is the intrinsic angular momentum of an electron, each electron acts like a tiny bar magnet, like a compass needle, that points either up or down to represent the spin of an electron**.** Electrons moving through a nonmagnetic material normally have random spins, so the net effect is zero. External magnetic fields can be applied so that the spins are aligned (all up or all down), allowing a new way to store binary data in the form of one's (all spins up) and zeroes (all spins down). The effect was first discovered in a device made of multiple layers of electrically conducting materials: alternating magnetic and nonmagnetic layers. The device was known as a "spin valve" because when a magnetic field was applied to the device, the spin of its electrons went from all up to all down, changing its resistance so that the device acted like a valve to increase or decrease the flow of electrical current, called Spin Valves.

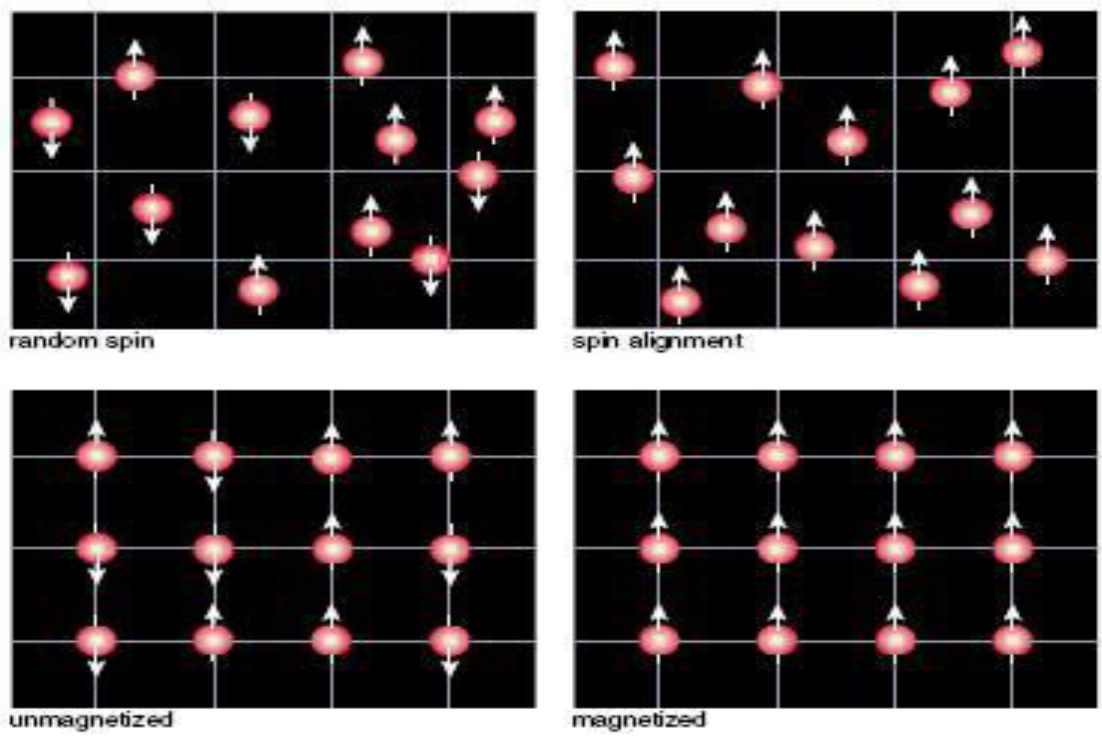


Figure-1. Spins can arrange themselves in a variety of ways that are important for Spintronics devices. They can be completely random, with their spins pointing in every possible direction and located throughout a material in no particular order (upper left). Or these randomly located spins can all point in the same direction, called spin alignment (upper right). In solid state materials, the spins might be located in an orderly fashion on a crystal lattice (lower left) forming a nonmagnetic material. Or the spins may be on a lattice and be aligned as in a magnetic material (lower right).

The first scheme of Spintronics device based on the metal oxide semiconductor technology was the first field effect spin transistor proposed in 1989 by Suprio Datta and Biswajit Das of Purdue University. In their device, a structure made from indium–aluminium arsenide and Indium gallium arsenide provides a channel for two dimensional electron transport between two ferromagnetic electrodes. One electrode acts as an emitter and the other as a collector**.** The emitter emits electrons with their spins oriented along the direction of electrodes magnetization, while the collector acts as a spin filter and accepts electrons with the same spin only. In the absence of any change to the spins during transport, every emitted electron enters the collector. This device is explained in further detail under the topic of spin transistors.

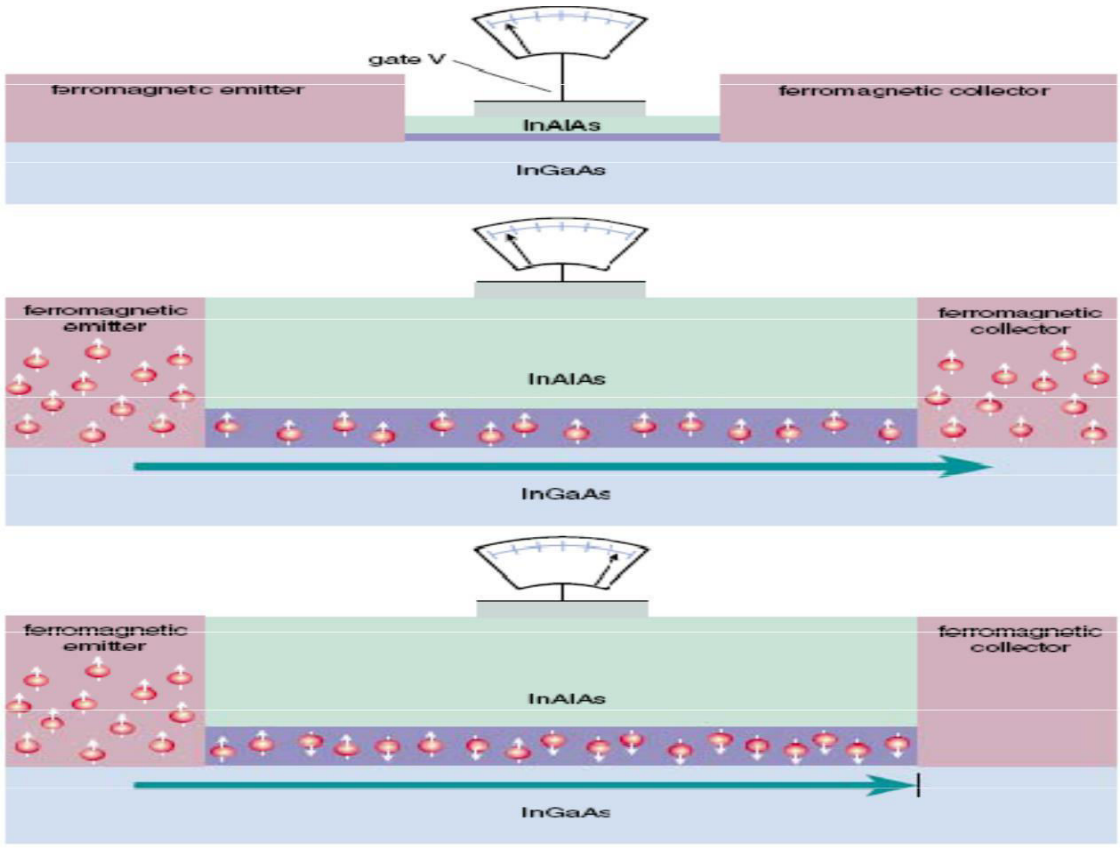


Figure-2. Datta Das spin transistor was the first Spintronic device to be proposed for fabrication in a metal oxide semiconductor geometry familiar in conventional microelectronics. An electrode made of a ferromagnetic material (purple) emits spin aligned electrons (red spheres), which pass through a narrow channel (blue) controlled by the gate electrode (gold) and are collected by another ferromagnetic electrode (top). With the gate voltage off, the aligned spins pass through the channel and are collected at the other side (middle). With the gate voltage on, the field produces magnetic interaction that causes the spins to precess, like spinning tops in a gravity field. If the spins are not aligned with the direction of magnetization of the collector, no current can pass. In this way, the emitter collector current is modulated by the gate electrode. As yet, no convincingly successful application of this proposal has been demonstrated.

## Spintronic Devices:

Recording devices, such as computer hard disks, already employ the unique properties of magnetic materials. Data are recorded and stored as tiny areas of magnetized iron or chromium oxides. A "read head" can read this information by detecting minute changes in the magnetic field as the disk rotates underneath it. This induces changes in the head's electrical resistance – also known as magneto resistance. Spintronic devices, also known as magneto electronics, are expected to become the ideal memory media for computing and main operating media for future quantum computing. The first widely acknowledged breakthrough in Spintronics was the use of GMR, used in read heads of most hard drives already mentioned above. A "popular" device that exploits the Spintronics is, for example, the Apple iPod 60 GB. Measuring a little more than half an inch in thickness, this pocket filling device has a Spintronics based "read head"!

Recent discovery of Tunneling Magnetoresistance (TMR) has led to the idea of a magnetic tunnel junction that has been utilized for the MRAM (Magnetic Random Access Memory). Here, one has two magnetic layers separated by an insulating metal oxide layer. Electrons are able to tunnel from one layer to the other only when magnetizations of the layers are aligned in the same direction. The resistance is otherwise very high, in fact, 1000 times higher than in the standard GMR devices, known as "spin valves". Spintronic devices, combining the advantages of magnetic materials and semiconductors, are expected to be fast, non volatile and consume less power. They are smaller than 100 nanometers in size, more versatile and more robust than the conventional ones making up silicon chips and circuit elements. The potential market is expected to be worth hundreds of billions of dollars a year.

**Why Spintronics?**

The miniaturization of microelectronic components by roughly a factor of 40 has taken place from the early days of integrated circuits, starting around 1970. Over this time, microelectronics has advanced from the first integrated circuits to present day computer chips containing 100 million transistors. It is now well recognized that further shrinking of the physical size of semiconductor electronics will soon approach a fundamental barrier. The fundamental physical laws that govern the behavior of transistors will preclude them from being shrunk any further and packed in even greater number on computer chips. The continual shrinking of transistors will result in various problems related to electric current leakage, power consumption and heat.

On the other hand, miniaturization of semiconductor electronic devices is making device engineers and physicists feel the looming presence of quantum mechanics – a brilliant physics concept developed in the last century – where counterintuitive ideas such as wavelike behavior, is more dominant for 'particles' such as the electron. Electron spin is, after all, a quantum phenomenon. Many experts agree that Spintronics, combined with nanotechnology would offer the best possible solution to the problems associated with miniaturization mentioned above. Nanoscience and nanotechnology involve the study of extremely tiny devices and related phenomena on a spatial scale of less than one thousandth the diameter of a human hair or roughly half the diameter of a DNA molecule.

**Semiconductor Spintronics:**

In spite of the rapid advances in metal based Spintronics devices (such as GMR devices), a major focus for researchers has been to find novel ways to generate and utilize spin polarized currents in semiconductors. These include the investigation of spin transport in semiconductors and the exploration of possibilities for making semiconductors function as spin polarizers and spin valves. This is important because semiconductor based Spintronics devices can easily be integrated with traditional semiconductor technology; they also can serve as multi functional devices. Further, spins in such as semiconductors can be more easily manipulated and controlled. Visionaries claim that a merger of electronics, photonics, and magnetics will provide novel spin based multifunctional devices spin FETs (field effect transistors), spin LEDs (light- emitting diodes), spin RTDs (resonant tunneling devices), optical switches operating at terahertz frequencies, modulators, quantum computation, etc., just to name a few. The progress in these developments of course, crucially depends on our understanding and control of the spin degrees of freedom in semiconductors, semiconductor heterostructures, and ferromagnets.

**Spin Transistor:**

The basic idea of a spin transistor, as proposed by Suprio Datta and Biswajit Das (Purdue University, USA) is to control the spin orientation by applying a gate voltage. A spin-FET, as depicted below, consists of ferromagnetic electrodes and a semiconductor channel that contains a layer of electrons and a gate electrode attached to the semiconductor. The source and drain electrodes are ferromagnetic (FM) metals.

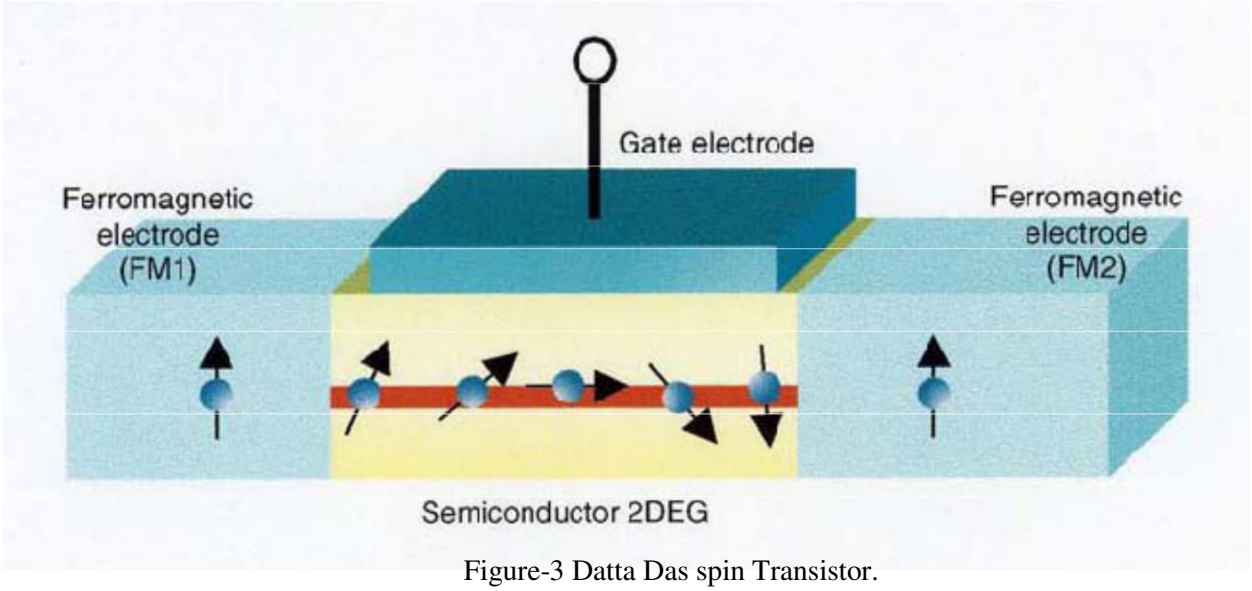


Figure-3 Datta Das spin Transistor.

The spin polarized electrons are injected from the FM source electrode (FM1), and after entering the semiconductor channel they begin to rotate. The rotation is caused by an effect due to "spin orbit coupling" that occurs when electrons move through the semiconductor crystal in the presence of an electric field. The rotation can be controlled, in principle, by an applied electric field through the gate electrode. If the spin orientation of the electron channel is aligned to the FM drain electrode, electrons are able to flow into the FM drain electrode. However, if the spin orientation is flipped in the electron layer (as in the figure above), electrons cannot enter the drain electrode (FM2). In this way, with the gate electrode the rotation of the electron spin can be controlled. Therefore, in a spin FET the current flow is modified by the spin precession angle. Since the spin FET concept was published in 1990, there has been a world wide effort to develop such a transistor. The success of such a project crucially depends on efficient injection of spin currents from a ferromagnetic metal into a semiconductor, a seemingly formidable task. Intense research is under way to circumvent this problem by using (Ferro) magnetic semiconductors such as GaMnAs.

## Quantum dots: Spin based computers

Modern nanofabrication techniques and materials engineering have reached a level where it is now possible to fabricate advanced semiconductor devices at atomic scales. The most remarkable ones are the 'quantum dots' in which electron motion is quantized along all directions and conducting electrons are confined within the nanometer distances. The dots contain typically one to several hundred electrons and experiments have shown effective control over both the charge and spin degree of freedom of these confined electrons. Quantum dots have been found to be very useful as electronic and optical devices such as the quantum dot laser, memory chips, and in quantum cryptography, quantum computer, etc. It has been proposed that the spin of an electron confined to quantum dots can be used as quantum bits and

an array of quantum dots could serve as a quantum computer. In principle, a computer that processes the quantum states instead of conventional classical information will be able to solve problems for which there is no efficient classical algorithm. Quantum operations in the quantum dots would be possible by coupling electron spins in neighboring quantum dots. Fundamental understanding of the role of electron spins in quantum confined structures is crucial in this effort, and my research group is actively involved in this endeavor.

**Electron (spin) transport in DNA:**

Why DNA? – As mentioned above, in the face of continued miniaturization of components and circuitry in microelectronics, conventional semiconductor microelectronics is rapidly approaching its useful miniaturization limits due to some fundamental limitations of large scale photolithography and the expected failure of semiconductor physics in nanometer scale components. For an alternative approach, one might look in nature, in particular in biology, where biological molecules are known to self assemble with nanometer scale resolution and possess some unique qualities that might be crucial for nanoscale fabrication: these include

(I) Highly effective molecular recognition processes.
(II) Selfassembly processes coupled to mechanisms that are responsible for proof-reading during the construction process.
(III) Billions of years of evolution that has optimized the efficient assembly processes.

DNA, the molecule of life is particularly attractive in this respect. In humans, the DNA molecule consists of two ribbon like strands (double helix) that wrap around each other, resembling a twisted ladder.

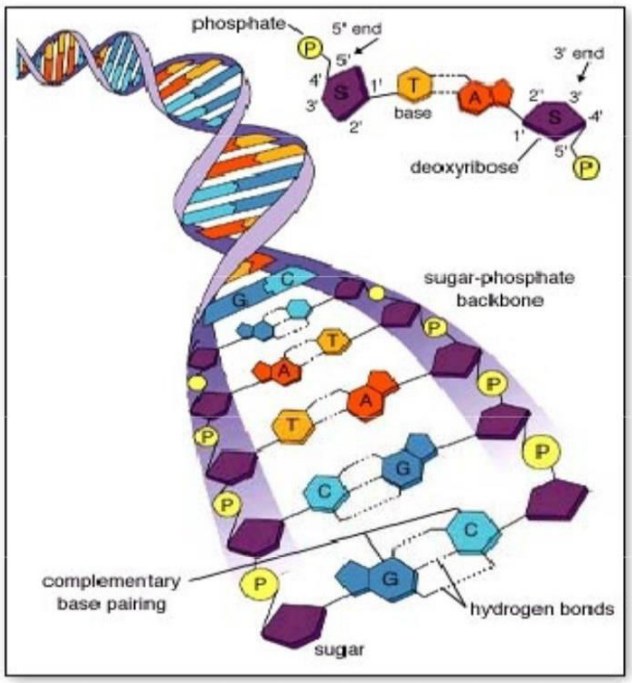


Figure-4 A diagram of the general structure of DNA. It shows the famous overall double helix. And it shows the four bases (A, T, G and C) which are the "information". At each rung along the DNA ladder is a base pair. Each pair is either A with T or G with C; that is, one strand precisely determines the other strand and that indeed is the key to how DNA replicates.

The steps of the ladder are made of four bases A (adenine), T (thymine), G (guanine) and C (cytosine). Bases of DNA come as a pair and always 'A' pairs with 'T' and 'G' with 'C'. Base pairs are held together by hydrogen bonds. The AT pair has two hydrogen bonds while the GC pair contains three hydrogen bonds. The sugar phosphate backbones form the sides of the ladder. Double stranded DNA has a diameter of ~2nm and a helical pitch of 10.5 bases with 0.34 nm separation of the plane in which adjacent base pairs are located. Each phosphate group in the sugar phosphate backbone of the DNA carries a negative charge. In fact, the DNA double helix is one of the most highly charged polymers with a base charge density of one charge per 0.17 nm. In recent years, electronic transport through DNA has been the subject of intense research activity. The reason is twofold: understanding of charge migration in DNA is important because of its biological implications, in particular, for oxidative damage and repair of DNA and the other is the potential application of DNA as an important part in molecular electronics.

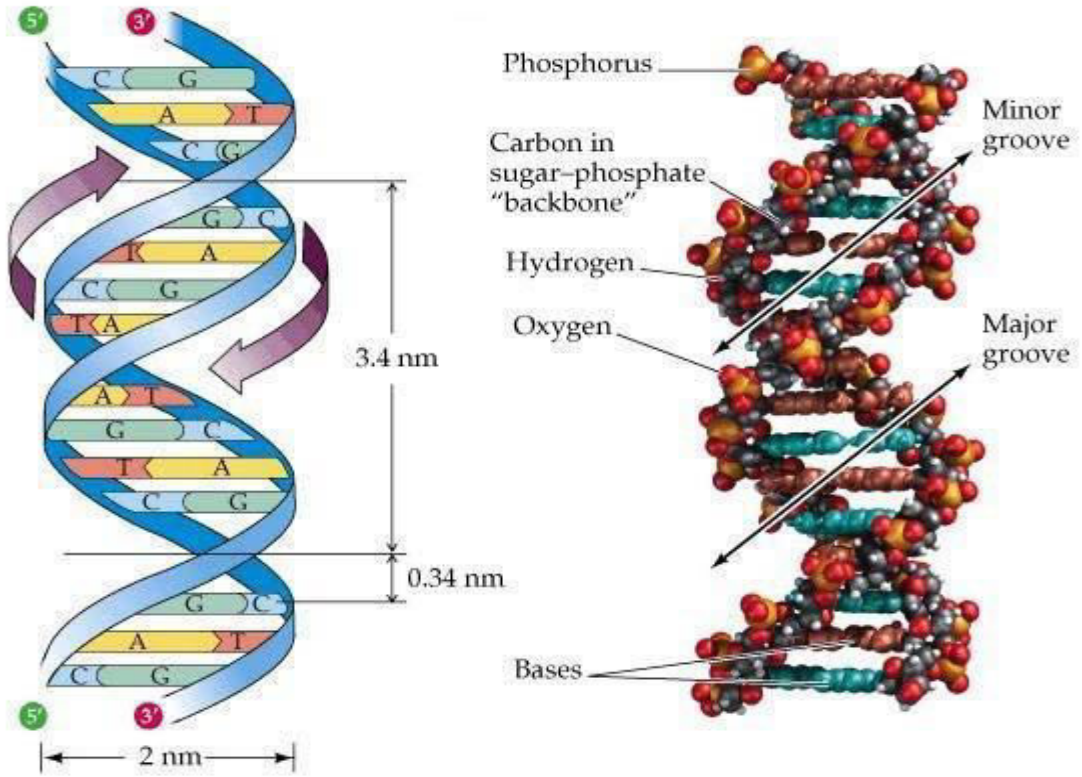


Figure-5 Structure of DNA with dimensions.

Compared to semiconductor materials, electron transport in DNA would be faster because of less scattering events which will lead to longer spin lifetime. This would be particularly useful for spin transport in DNA. It is already established that electron transfer along DNA occurs on length scales of up to a few nanometers. The conductivity of DNA on larger length scales has been an active area of research study because here the goal is to manipulate DNA in the atomic scale and make DNA devices using currently available techniques. Electronic properties of DNA, the charge and also the spin transport in DNA are topics of major activity in my research group.

**Expectation for the future:**

Spintronics is one of the most challenging and fascinating areas in nanotechnology. Its impact is felt both in fundamental scientific research and industrial applications. To cope with its rapid progress in pure and

applied science, coordinated efforts by researchers from diverse fields including physics, chemistry, biology, materials science and engineering are absolutely necessary. From today's read heads to quantum information processing in the future, the electron spin has exhibited the limitless potential to impact our lives as we look through the magical quantum world at the nanoscale, a world that is not much different from an Alice- in- wonderland world that plays by its own rules. We are yet to understand fully most of those rules, but we are making significant progress through research in Spintronics**.**

**Conclusion**

The GMR is the background to switch from the "traditional" electronic to the spin based electronics. Spintronic has great potentiality for applications and it is the beginning of its journey. The realization of semiconductors that are ferromagnetic above room temperature will potentially lead to a new generation of spintronic devices with revolutionary electrical and optical properties.

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# Artificial Intelligence Will Take a Leap Forward, without Human Data

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**Technique Polytechnic Institute**


Fig-1 Artificial Intelligence

2017 was the year that AlphaGo Zero taught itself the game of Go and within 40 days became better than any human or artificial player ever existed. It did so without any human data as input and purely played against itself. As a result, it taught itself strategies and moves no human has ever thought of and arguably progressed the evolution of the game of Go exponentially in a very short timeframe. This achievement marks a significant milestone in the development of artificial intelligence.

In 2018, this will only continue and we will see more examples of artificial intelligence that will behave in unexpected ways, as it already did so this year. In 2017, for example, AI developers from Google built algorithms that had to compete for scarce resources, resulting in increasingly advanced strategies to beat the component. Google Brain developed algorithms that created new encryption methods, unlike any seen before, to protect information from other neural networks. Finally, Facebook had to shut down two algorithms that created its own secret language, unsolicited and used advanced strategies to get what it wanted. If one thing becomes clear from these developments, it is that artificial intelligence will be fundamentally different to human intelligence.

With the AI arms race in full swing, governments and organisations are increasing their investments in the development of ever more intelligent AI. In September 2017, Putin said that "whoever becomes the leader in this sphere will become the ruler of the world", signalling that Russia will intensify its AI activities. On the other side of the world, China aims to outsmart the USA in AI, with Europe

unfortunately nowhere to be seen. The AI arms race seriously scares well-known entrepreneurs such as Elon Musk and Stephen Hawking and a solution for the existential threat of AI is still far away.

The combination of an AI arms race and developments where artificial intelligence can be trained without human data will likely result in massive steps forward in 2018. As AI becomes smarter, more money will flow into it. However, ordinary organisations, as well as small and medium enterprises, are likely to miss out, as the power of AI will consolidate among just a few players and countries.

**Our Privacy Continues to Be Threatened, but a Solution is Coming**

Fig-2 Privacy

All those new technologies, platforms and services gobble up massive amounts of data and more often than not, this data is not very well protected. For the past years, we have seen thousands of data breaches, with, in 2017, the data breach of Equifax as a new low point. Unfortunately, 2018 will not be any different. The more devices we will connect to the internet, the more data we create, the more security breaches we will see. IoT devices are remarkably insecure, thereby continuing to threaten our privacy. Consumers are aware of this as 90% of consumers lack the confidence that their IoT devices are secure.

As long as organisations that develop internet connected devices do not take security seriously, and develop products such as cardiac devices that can be hacked or CCTV cameras with serious bugs, this trend will only get worse. However, not only IoT devices are prone to hacks, but also large organisations such as Uber or Verizon were hacked in 2017. Even Apple's latest security feature, Face ID has already been easily bypassed several times. We have reached a point in time where any organization can and will be hacked and if you are not hacked, you are simply not important enough.

Fortunately, there is a bit of light at the end of the tunnel. With the hype around blockchain, startups are also working on a new technology called Zero Knowledge Proof (ZKP). Zero Knowledge Proof is a method used in cryptography to prove ownership of a specific piece of knowledge without revealing the content of that knowledge. Zero Knowledge Proof enables trustless transactions that safeguard users' privacy using mathematics. As such, ZKP improves verification processes to such an extent that one party can prove to another party that a given statement is true, without revealing any information about that statement. 2018 will see continued development of Zero-Knowledge Proof, making our society slowly a little bit more private again.

# Electronic Security System

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Electronic security system refers to any electronic equipment that could perform security operations like surveillance, access control, alarming or an intrusion control to a facility or an area which uses a power from mains and also a power backup like battery etc. It also includes some of the operations such as electrical, mechanical gear. Determination of a type of security system is purely based on area to be protected and its threats.

**Role of Electronic Security System**

Electronic security relates to leveraging innovation in defensive holding by anticipating unapproved access to individuals and property. The government is a universal and major customer of such security administrations and business sections also utilizes the security systems for their workers for giving security. These days, one can witness their usage in range like domestic application and small stores moreover.

The electronic security systems extensively comprises of alarms, access controls & CCTVs, which are prominently and broadly utilized. CCTVs have picked up additional significance from all of these products.

**Importance of Electronic Security System**

The electronic security systems are broadly utilized within corporate work places, commercial places, shopping centres and etc. These systems are also used in railway stations, public places and etc. The systems have profoundly welcomed, since it might be worked from a remote zone. And these systems are also utilized as access control systems, fire recognition and avoidance systems and attendance record systems. As we are know that the crime rates are increasing day by day so most of the people are usually not feeling comfort until they provide a sure for their security either it may be at office or home. So we should choose a better electronic system for securing purpose.

**Classification of Electronic Security System:**

Classification of security system can be done in different ways based on functioning and technology usage, conditions of necessity accordingly. Based on functioning categorizing electronic security system as follows:

- CCTV Surveillance Security System
- Fire Detection/Alarming System
- Access Control/Attendance System

**CCTV Surveillance Systems:**

It is the process of watching over a facility which is under suspicion or area to be secured; main part of the surveillance electronic security system consists of camera or CCTV cameras which forms as eyes to surveillance system. System consists of different kinds of equipment which helps in visualizing and saving of recorded surveillance data. The close-circuits IP cameras & CCTVs transfers image information to a remote access place. The main feature of this system is that, it can use any place where we watch the human being actions. Some of the CCTV surveillance systems are cameras, network equipment, IP cameras and monitors. In this system, we can detect the crime through the camera, the alarm rings after receiving the signal from the cameras which are connected CCTV system; to concern on the detection of interruption or suspicion occurrence on a protected area or capability, the complete operation is based on the CCTV surveillance system through internet. The figure below is representing the CCTV Surveillance systems.

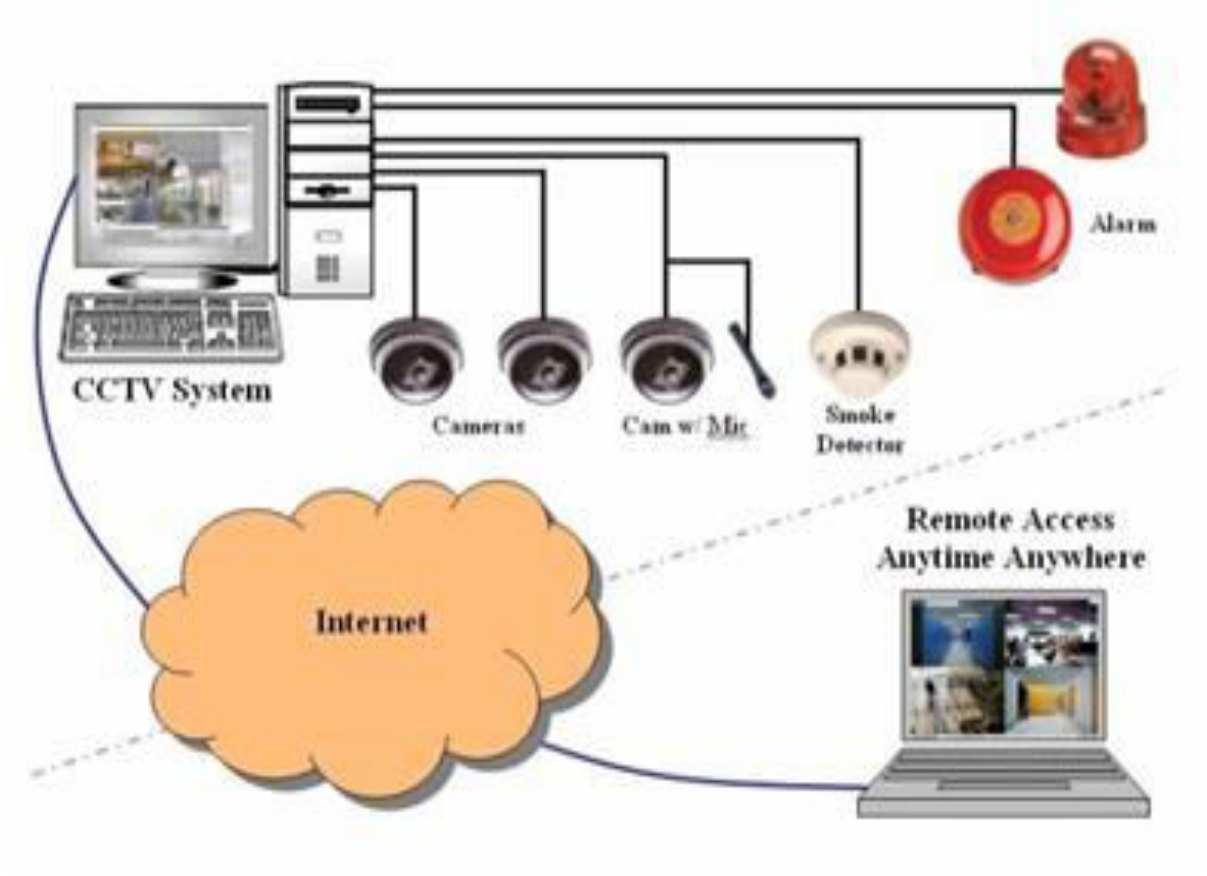


Fig-1 Wireless CCTV System

**IP Surveillance System:**

The IP-Surveillance system is designed for security purpose, which gives clients capability to control and record video/audio using an IP PC system/network, for instance, a LAN or the internet. In a simple way, the IP-Surveillance system includes the utilization of a system Polaroid system switch, a computer for review, supervising and saving video/audio, which shown in figure below.

In an IP-Surveillance system, a digitized video/audio streams might be sent to any area even as far and wide as possible if wanted by means of a wired or remote IP system, empowering video controlling and recording from anyplace with system/network access.


Fig-2 IP Surveillance System

**Fire Detection and Alarming Systems:**

It can also referred as a detection & alarming system as it gives an alarming alert to concern on detection of interruption or suspicion happening on a protected area or facility. System generally consists of detector using a sensor followed by an alarm or an alerting circuit. The main function of this system is to rapidly extinguish an advancing fire and alarm tenants preceding impressive harm happens by filling the secured zone with a gas or concoction smothering operator. Different types of sensors are available for

detection but usage of sensor is purely based on application requirement, like home automation, ware house fire detection, intrusion alert etc.

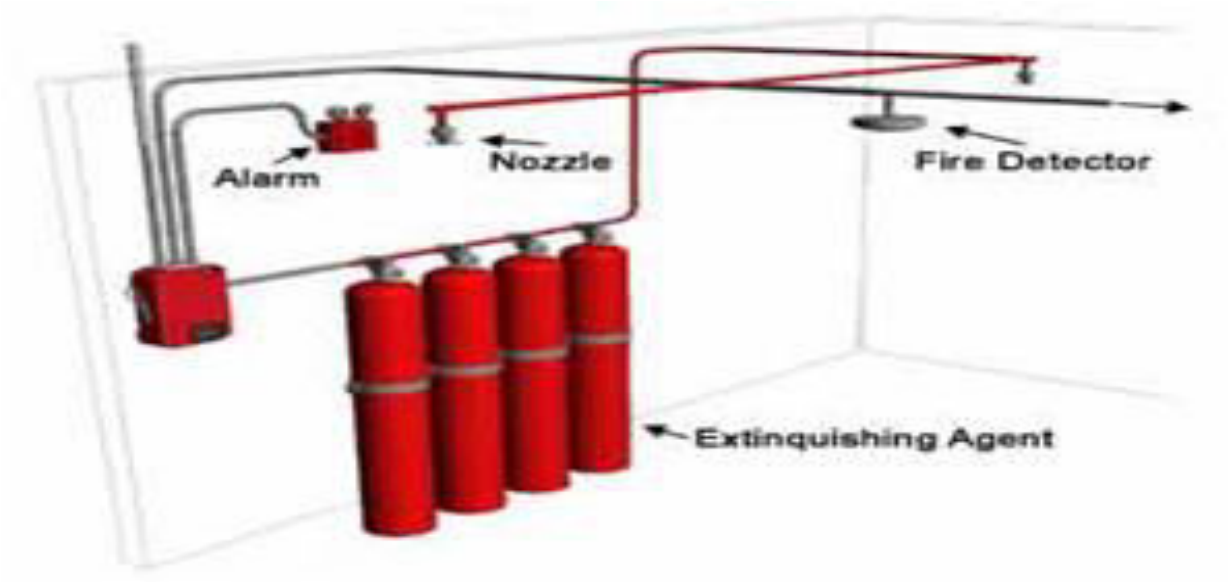


Fig-3 Fire Detection and Alarming Systems

**Attendance and Access Control System:**

System which provides a secured access to a facility or another system to enter or control it can be called as an access control system. It can also act as attendance providing system which can play a dual role. According to user credentials and possessions access control system is classified, what a user uses for access makes system different, user can provide different types like pin credentials, biometrics or smart card. System can even use all possessions from user for a multiple access controls involved. Some of the attendance and access control systems are:

- **Access Control System**


Fig-4 Access Control System

- **RF based access control and attendance system:**


Fig-5 RF based access control and attendance system

**Applications of Electronic Security System:**

Electronic security system extends its application in various fields like home automation, residential (home & apartments), commercial (offices, bank's lockers), industrial, medical & transportations. Some of the applications using electronic security system are electronic security system for railway compartment, electronic eye with security, electronic voting system are the most commonly used electronic security system.

**One of the examples related to electronic security system:**

From the block diagram, the system is mainly designed based on Electronic eye (LDR sensor); we use this kind of systems in bank lockers, jewellery shops. When the cash box is closed, the neither buzzer nor the binary counter/divider indicates that box is closed. If anyone tries to open the locker door then

automatically a light falls on the LDR sensor then the resistance decreases slowly this cause buzzer to alert the customer. This process continues until the box is closed.

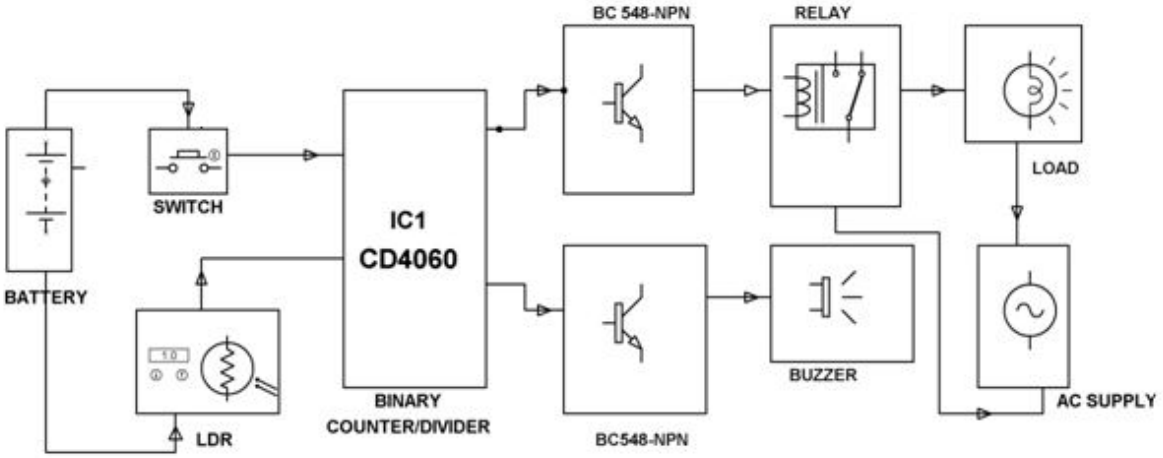


Fig-6 Electronic-eye-controlled-security

# SQL Slammer Worm

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**Technique Polytechnic Institute**

Who don't know about this one of the most important problem of this days I want to make them familier with this term "Slammer Worm".

Mainly slammer is a worm that targets unpatched Microsoft SQL 2000 servers. The worm spreads between servers, increasing traffic on UDP port 1434 and causing heavy network traffic that can slow down network performance and lead to denial of service. SQL slammer does not carry a destructive payload. It does not effect PCs. Slammer worm is infamously known for its DoS (Denial of service) attack on various internet hosts.

The attack occurred on January 26 , 2003 at 5:30 pm. Infecting more than 75000 machines within ten minutes. Despite the name the Slammer worm didn't use the SQL language as its method exploitation : instead, it exploited a buffer overflow condition in the Microsoft branded SQL sever and other database products.

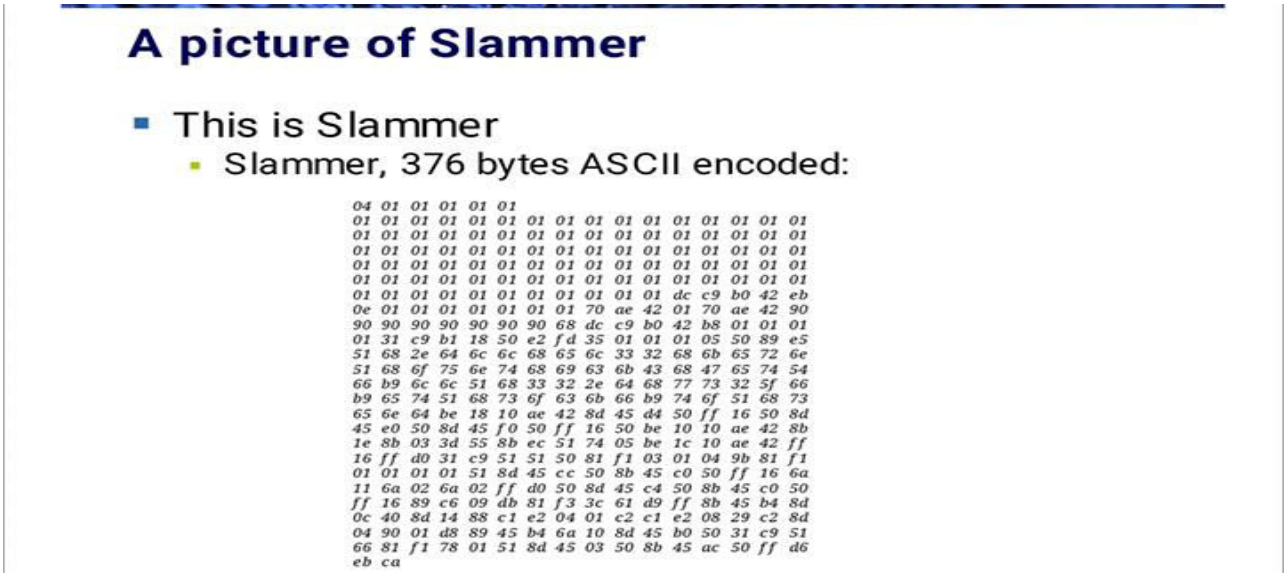


Fig-1 Slammer

A news agency in south korea reported that several internet services world wide were shut down for sometime on 43anuary 26 . 2003. The slammer worm was also detected throughout most of North America, Asia and Europe. The overall impact was somewhat mitigated by the fact that the worm struckover the weekend.


Fig-2 Slammer area


Fig-3 Slammer area after effect

**How the slammer worm propagated**

According to several analysis of the worm its propagation followed an exponential path with a doubling rate of 8.5 sec in the earlier stages of the attack. This was only reduced by the failure of several networks due to the DoS attack caused by the all of tha Slammers traffic. A router is designed to delay when it

becomes to much to handle. The slammer worm caused these routers to crash instead forcing neighbouring routers to remove them from their routing table. The process spread from router to router causing other routers fail. The routers were soon restarted. After that large portion of internet band width were consumed as the routers were in constant communication with one another trying to update their tables. Because the slammer worm was small in size it was able to get through the network putting the internet stand still.

**Attack on Networks**

The slammer worm was more of a network scare than a threat to users. It is small it contains no code that allows it to be written to a hard disk. Symantec corporation and other security vendors offer free utilities that effectively remove the worm.

Slammer worm is the first known example of Warhol worm.

# 5G Technology of Mobile Communication

**Shreya Sengupta, Student of 2nd Year Electronics & Telecommunication Engineering**

**Technique Polytechnic Institute**

**ABSTRACT:** 5G ( 5th generation mobile networks or 5th generation wireless systems ) is a name used in some research papers and projects to denote the next major phase of mobile telecommunications standards beyond the upcoming 4G standards (expected to be finalized between approximately 2011 and 2013).

Currently, 5G is not a term officially used for any particular specification or in any official document yet made public by telecommunication companies or standardization bodies such as 3GPP, WiMAX Forum or ITU-R. New 3GPP standard releases beyond 4G and LTE Advanced are in progress, but not considered as new mobile generations. The implementation of standards under a 5G umbrella would likely be around the year of 2020 .

5G Technology stands for 5th Generation Mobile technology . 5G technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future.

## INTRODUCTION OF 5G WIRELESS SYSTEM

5G technology going to be a new mobile revolution in mobile market. Through 5G technology now you can use worldwide cellular phones and this technology also strike the china mobile market and a user being proficient to get access to Germany phone as a local phone. With the coming out of cell phone alike to PDA now your whole office in your finger tips or in your phone. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days 5G technology takes over the world market.

5G Technologies have an extraordinary capability to support Software and Consultancy. The Router and switch technology used in 5G network providing high connectivity. The 5G technology distributes internet access to nodes within the building and can be deployed with union of wired or wireless network connections. The current trend of 5G technology has a glowing future.

The 5G terminals will have software defined radios and modulation schemes as well as new error-control schemes that can be downloaded from the Internet. The development is seen towards the user terminals as a focus of the 5G mobile networks. The terminals will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. The vertical handovers should be avoided, because they are not feasible in a case when there are many

technologies and many operators and service providers. In 5G, each network will be responsible for handling user-mobility, while the terminal will make the final choice among different wireless/mobile access network providers for a given service. Such choice will be based on open intelligent middleware in the mobile phone.

## CHALLENGES IN MIGRATION FROM 4G

**A. Multi mode user terminals**

By means of 4G, there will be a necessity to design a single user terminal that can operate in different wireless networks and conquer the design troubles such as restrictions on the size of the device, its cost and power utilization. This trouble can be solved by using software radio approach.

B. **Choice among various wireless systems**.

Every wireless system has its distinctive characteristics and roles. The choice of most appropriate technology for a specific service at a specific place and at specific time. This will be applied by making the choice according to the best possible fit of consumer QoS (Quality of Service) requirements.

**C. Security**

Reconfigurable, adaptive and lightweight protection mechanisms should be designed.

**D. Network infrastructure and QoS support**

Integrating the current non-IP and IP-based systems and providing QoS assurance for end-to-end services that engage different systems is a challenge.

**E. Charging and Billing**

It is hard to accumulate, handle and accumulate the Consumers' account information from many service providers. In the same way Consumers' billing is also a difficult task.

F. **Attacks on Application Level**

Software applications which will offer an new feature to the consumer but will commence new bugs.

**G. Jamming and spoofing**

Spoofing is fake GPS signals being sent out, in which case the GPS receiver considers that the signals arrives from a satellite and computes the wrong coordinates. Criminals can make use of such techniques. Jamming occurs when a transmitter sending out signals at the same frequency shifts a GPS signal.

**H. Data Encryption**

If a GPS receiver will communicate with the main transmitter then the communication link between these two is not tough to break and consumer must use encrypted data.

## CONCEPT OF 5G TECHNOLOGY

### A. Physical/MAC layers

Physical and Medium Access Control layers i.e. OSI layer 1 and OSI layer 2, define the wireless technology. For these two layers the 5G mobile networks is likely to be based on Open Wireless Architecture.

### B. Network layer

The network layer will be IP (Internet Protocol), because there is no competition today on this level. The IPv4 (version 4) is worldwide spread and it has several problems such as limited address space and has no real possibility for QoS support per flow. These issues are solved in IPv6, but traded with significantly bigger packet header. Then, mobility still remains a problem. There is Mobile IP standard on one side as well as many micro-mobility solutions (e.g., Cellular IP, HAWAII etc.). All mobile networks will use Mobile IP in 5G, and each mobile terminal will be FA (Foreign Agent),keeping the CoA (Care of Address) mapping between its fixed IPv6 address and CoA address for the current wireless network.

### C. Open Transport Protocol (OTA) layer

The mobile and wireless networks differ from wired networks regarding the transport layer. In all TCP versions the assumption is that lost segments are due to network congestion, while in wireless network losses may occur due to higher bit error ratio in the radio interface. Therefore, TCP modifications and adaptation are proposed for the mobile and wireless networks, which retransmit the lost or damaged TCP segments over the wireless link only. For 5G mobile terminals will be suitable to have transport layer that is possible to be downloaded and installed.

### D. Application layer

Regarding the applications, the ultimate request from the 5G mobile terminal is to provide intelligent QoS management over a variety of networks. Today, in mobile phones the users manually select the wireless interface for particular Internet service without having the possibility to use QoS history to select the best wireless connection for a given service. The 5G phone shall provide a possibility for servicequality testing and storage of measurement information in information databases in the mobile terminal.

## FEATURES

1. 5G technology offers high resolution for crazy cell phone user and bi- directional large bandwidth shaping.
2. The advanced billing interfaces of 5G technology make it more attractive and effective.
3. 5G technology also providing subscriber supervision tools for fast action.

4. The high quality services of 5G technology based on Policy to avoid error.
5. 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.
6. 5G technology offers a transporter class gateway with unparalleled consistency.
7. The traffic statistics by 5G technology makes it more accurate.
8. Through remote management offered by 5G technology a user can get a better and faster solution.
9. The remote diagnostics also a great feature of 5G technology.
10. The 5G technology is providing up to 25 Mbps connectivity speed.

# Electronics Paper Display

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**ABSTRACT:** It is also called e-paper, Electronic ink or e-ink, is a display technology using organic electronics designed to mimic the appearance of regular ink on paper. Unlike a conventional flat panel display, which uses a backlight to illuminate its pixels, electronic paper reflects light like ordinary paper and is capable of holding text and images indefinitely without drawing electricity or using processor power, while allowing the paper to be changed. One important feature needed is that the pixels be bistable so that the state of each pixel can be maintained without a constant supply of power.

**Introduction:**

An Electronic Paper Display is also known as EPD.It is a display device that possess a paper-like high contrast appearance, ultra-low power consumption, and a thin, light form. It gives the viewer the experience of reading from paper, while having the power of updatable information.

**History:**

Electronic paper was first developed in the 1970s by Nick Sheridon at Xerox's Palo Alto Research Center. The first electronic paper, called Gyricon, consisted of tiny, statically charged balls that were black on one side and white on the other. The "text" of the paper was altered by the presence of an electric field, which turned the balls up or down. In the 1990s another type of electronic paper was invented by Joseph Jacobson, who later co-founded the corporation E Ink which formed a partnership with Philips Components two years later to develop and market the technology.

**Technologies Used:**

The basic material used in the electronic paper display is ELECTRONIC INK. Electronic ink is a proprietary material that is processed into a film for integration into electronic displays. Although revolutionary in concept, electronic ink is a straightforward fusion of chemistry, physics and electronics to create this new material.

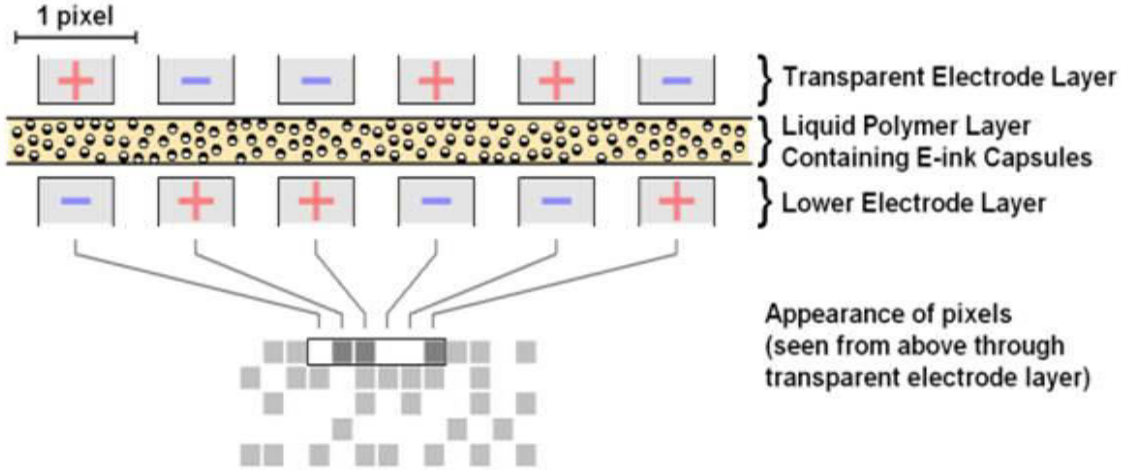


Fig-1 Block Diagram

The principal components of electronic ink are millions of tiny microcapsules, about the diameter of a human hair. In one incarnation, each microcapsule contains positively charged white particles and negatively charged black particles suspended in a clear fluid. When a negative electric field is applied, the white particles move to the top of the microcapsule where they become visible to the user. This makes the surface appear white at that spot.

At the same time, an opposite electric field pulls the black particles to the bottom of the microcapsules where they are hidden. By reversing this process, the black particles appear at the top of the capsule, which now makes the surface appear dark at that spot. To form an E Ink electronic display, the ink is printed onto a sheet of plastic film that is laminated to a layer of circuitry.

The circuitry forms a pattern of pixels that can then be controlled by a display driver. These microcapsules are suspended in a liquid "carrier medium" allowing them to be printed using existing screen printing processes onto virtually any surface, including glass, plastic, fabric and even paper. Ultimately electronic ink will permit most any surface to become a display, bringing information out of the confines of traditional devices and into the world around us.

**Advantages:**

- Paper-like readability.
- Sunlight and non-uniform light visibility.
- High reflectivity , high contrast & resolution.
- Viewing angle ~180 degree.
- Highly flexible.
- Ultra Low Power Consumption.
- Long-term Bi-stable Image content preserved without power.
- Prolonged battery life.
- Capable of color & video

**Applications:**

- EPDs are ideal for many consumer and industrial applications where the reading experience and range of lighting and viewing angles are of the utmost importance. Transportation signage can be utilized in a myriad of locations previously impossible due to sunlight or viewing angle.

- eBooks that strained the eye with their emissive light can now give the reader the true book-like experience. Cell phone screens that had to be shaded and turned continuously for a glimpse of the numbers now have high contrast and brightness in the widest of lighting conditions. EPDs give power to product designers to use their imagination in ways never before possible.

Beyond today's generation of technology which offers the visual look of paper (in terms of contrast, brightness and viewing angle), future versions will integrate E Ink's flex-ready products with plastic electronics [link to flexible displays page] being developed by several companies including a Philips spin-off called Polymer Vision, Epson, and UK-based Plastic Logic. The integration of these two technologies will allow something that not only has the look of paper, but is also much closer to its form - thin, light, flexible.

# Solar Energy

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**Introduction to Solar Energy:**

Energy produced and radiated by sun is known as solar energy. This solar energy can be converted directly or indirectly into other forms of energy such as heat and electricity.

Now it has been proved that the solar energy can be stored by either of these methods:

i. By producing hydrogen and storing it.
ii. By storing it in mechanical or electrical devices.
iii. By storing it in containers of chemicals called eutectic or phase changing salts.

Most of the energy is received from the Sun in the form of short wave radiations of light. When this radiation strikes a solid or liquid, it gets absorbed and transformed into heat energy. This heat energy is either stored (warming the material) or is conducted to the surrounding materials (air, water etc.) or is re-radiated (in the form of a long wave radiation) to the other material having relatively lower temperature

Glass possess very little interference to the incoming solar energy i.e. it easily transmits short wave radiation whereas it is a very poor transmitter of long wave radiation i.e. once the solar energy has passed through the glass and has been absorbed by some material (black painted surface) inner to it, then the heat will not be re-radiated back, out of the glass (thus glass acts as a heat trap).

This is the physical principle for the conversion of solar energy into heat energy.

**Advantages of Solar Energy:**

i. It is a renewable source of energy.
ii. It is available at all parts of the world
iii. It is free source of energy.
iv. It is non-polluting source of energy.

**Disadvantages of Solar Energy:**

i. It is intermittent in nature
ii. Variable in nature.
iii. Its require large area for collection and storage.

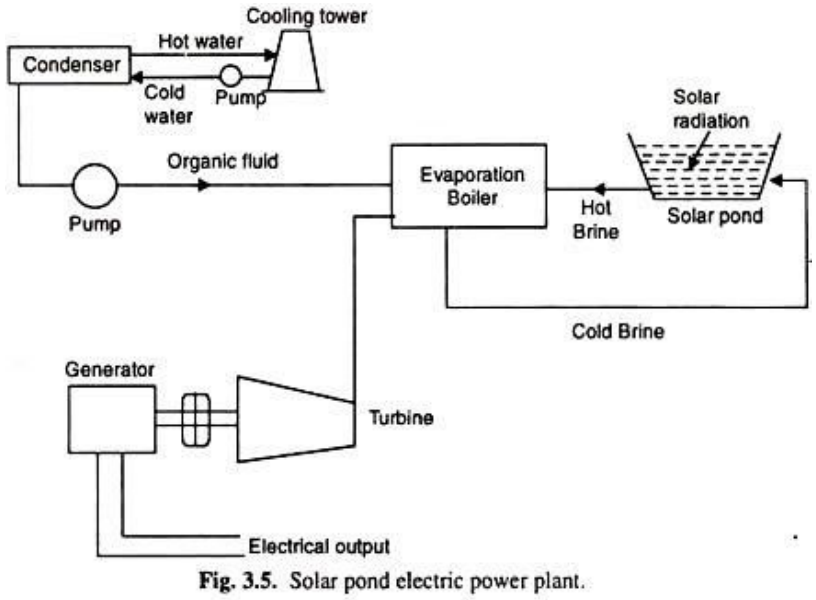


**Fig. 3.5.** Solar pond electric power plant.

Fig-1 Solar Pond Electronic Power Plant

India received 5000 trillion KW/h sum in a year. India receives abundant sunshine with about 1648-2108 kWh/$m^2$/yr. with nearly 250- 300 days of useful sun shine in a year. The daily solar energy incidence is between 4 to 7 kWhr/$m^2$. Solar energy received in the form of radiation can be converted to other forms of energy such as heat and electricity. Energy radiated by the sun as electrble rays and 44% as infra-red radiation. The enormous solar energy resource may be converted in to other forms of energy through thermal photovoltaic conversion routes. The solar thermal route uses radiation in the form of heat in turn may be converted to mechanical, electrical on chemical energy.

Sun gives us 1000 times more power then we need and if only a small amount of this form of energy could be used, it will be one of the most important supplies of energy. Received in the form of radiation, solar energy can be converted directly or indirectly into other forms of energy (heat and electricity) which can be utilised by man.

The sun is an inexhaustible source of useful energy but it has a few drawbacks namely:

i. Uncertainty of availability of solar energy due to clouds, wind, haze etc.
ii. Large spaces required for the collection of solar energy at a useful rate.

In India sunlight is abundant for a major part of the year and so the utilisation of solar energy is of great significance to India. Earlier, the utilisation of solar energy was limited owing to two drawbacks-firstly was the fact that solar energy was believed to be incapable of storage and secondly it was considered to be a dilute form of energy.

## Applications of Solar Energy

### Solar Water Heating

A solar water heating unit comprises a blackened flat plate metal collector with an associated metal tubing facing the general direction of the sun. The plate collector has a transparent glass cover above and a layer of thermal insulation beneath it.

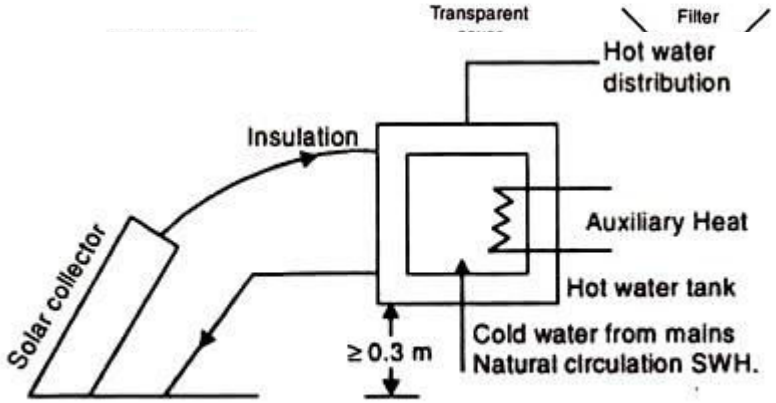


**Fig 3.6. Solar Collector.**

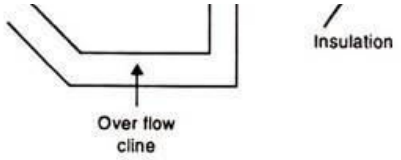


**Fig. 3.7.** Solar distillation.

Fig-1 Solar Distillation

The metal tubing of the collector is connected by a pipe to an insulated tank that stores hot water during cloudy days. The collector absorbs solar radiations and transfers the heat to the water circulating through tubing either by gravity or by a pump.

This hot water is supplied to the storage tank via the associated metal tubing. This system of water heating is commonly used in hotels, guest houses, tourist bungalows, hospitals, canteens as well as domestic and industrial units.

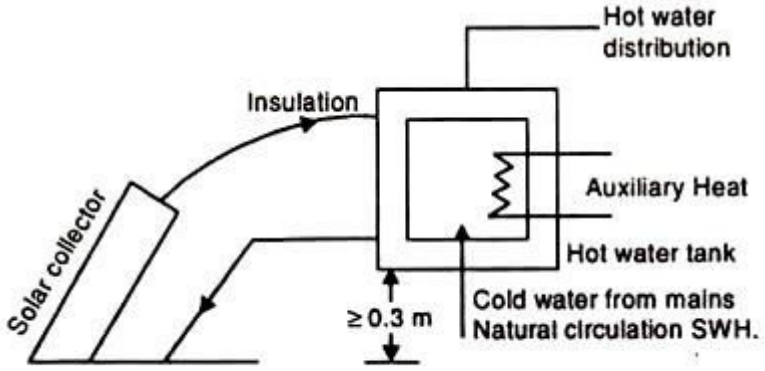


**Fig 3.6. Solar Collector.**

Fig-2 Solar Collector

**Solar-distillation**

In arid, semi-arid or coastal areas there is scarcity of potable water. The abundant sunlight in these areas can be used for converting saline water into potable distilled water by the method of solar distillation.In this method, solar radiation is admitted through a transparent air tight glass cover into a shallow blackened basin containing saline water. Solar radiation passes through the covers and is absorbed and converted into heat in the blackened surface causing the water to evaporate from the brine (impure saline water). The vapours produced get condensed to from purified water in the cool interior of the roof.

**Solar Thermal Power Production**

Solar thermal power production means the conversion of solar energy into electricity through thermal energy. In this procedure, solar energy is first utilised to heat up a working fluid, gas, water or any other volatile liquid. This heat energy is then converted into mechanical energy in a turbine. Finally a conventional generator coupled to a turbine converts this mechanical energy into electrical energy.

**Environmental Implications of Solar Energy:**

The use of solar energy, from the environmental view point, is a completely benign operation. In case of solar thermal route, apart from land use, there exist absolutely no environmental consequences of producing energy from these sources.

i. However, the sites for larger installations of solar power plants should be selected without reducing the forest cover.

ii. Cadmium used in fabricating thin film solar cells, is both poisonous and a possible carcinogen. Since only small quantities of cadmium are released from discarded PV panels, the dangers involved are not so serious.

iii. Carbon dioxide produced while forming silicon from silica may increase the atmospheric temperature causing green-house effect.

iv. Silicon dust is also an important occupational hazard.

# Touch Screen Technology – Definition, Working, Types & Applications

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**Introduction**

Touch screen technology is the direct manipulation type gesture based technology. Direct manipulation is the ability to manipulate digital world inside a screen. A Touch screen is an electronic visual display capable of detecting and locating a touch over its display area. This is generally referring to touching the display of the device with a finger or hand. This technology most widely used in computers, user interactive machines, smart phones, tablets etc. to replace most functions of the mouse and keyboard.

Touch screen technology has been around for a number of years but advanced touch screen technology has come on in leaps and bounds recently. Companies are including this technology into more of their products. The three most common touch screen technologies include resistive, capacitive and SAW (surface acoustic wave). Most of low end touch screen devices contain on a standard printed circuit plug-in board and are used on SPI protocol. The system has two parts, namely; hardware and software. The hardware architecture consists of a stand-alone embedded system using an8-bit microcontroller, several types of interface and driver circuits. The system software driver is developed using an interactive C programming language.

## Types of Touch Screen Technology:

The Touch screen is a 2-dimensional sensing device made of 2 sheets of material separated by spacers. There are four main touch screen technologies: Resistive, Capacitive, Surface Acoustical wave (SAW) and infrared (IR).

**Resistive:** Resistive touch screen is composed of a flexible top layer made of polythene and a rigid bottom layer made of glass separated by insulating dots, attached to a touch screen controller. Resistive touch screen panels are more affordable but offering only 75% of light monitor and the layer can be damaged by sharp objects. Resistive touch screen is further divided into 4-, 5-, 6-, 7-, 8- wired resistive touch screen. The construction design of all these modules is similar but there is a major distinction in each of its method to determine the coordinates of touch.

**Capacitive:** A capacitive touch screen panel is coated with a material that stores electrical charges. The capacitive systems can transmit up to 90% of light from the monitor. It is divided into two categories. In Surface-capacitive technology only one side of the insulator is coated with a conducting layer.Whenever a

human finger touches the screen, conduction of electric charges occurs over the uncoated layer which results in the formation of dynamic capacitor. The controller then detects the position of touch by measuring the change in capacitance at the four corners of the screen.

In projected capacitive technology, the conductive layer (Indium Tin Oxide) is etched to form a grid of multiple horizontal and vertical electrodes. It involves sensing along both the X and Y axis using clearly etched ITO pattern. For increasing the accuracy of the system, the projective screen contains a sensor at every interaction of the row and column.

**Infrared:** In infrared touch screen technology, an array of X and Y axis is fitted with pairs of IR Leds and photo detectors. Photo detectors will detect any image in the pattern of light emitted by the Leds whenever the user touches the screen.

**Surface Acoustic wave:** The surface acoustic wave technology contains two transducers placed along X-axis and Y-axis of the monitor's glass plate along with some reflectors. When the screen is touched, the waves are absorbed and a touch is detected at that point. These reflectors reflect all electrical signals sent from one transducer to another. This technology provides excellent through put and quality.

## Components and working of touch screen:

A basic touch screen is having a touch sensor, a controller, and a software driver as three main components. The touch screen is needed to be combined with a display and a PC to make a touch screen system.

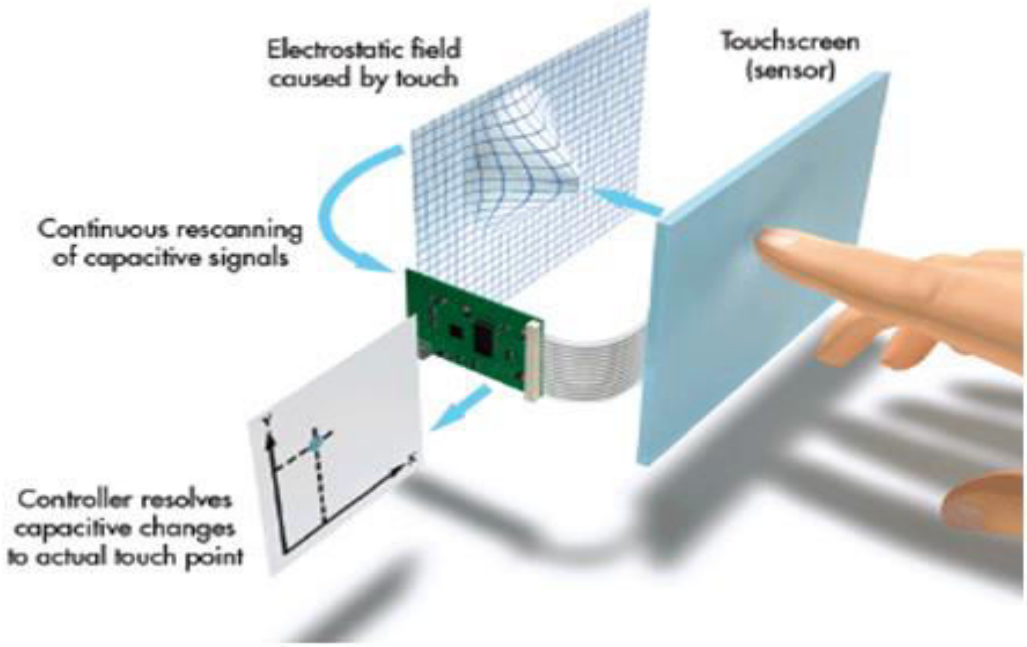


Fig-1 A Touch Screen

**Touch sensor:** The sensor generally has an electrical current or signal going through it and touching the screen causes a change in the signal. This change is used to determine the location of the touch of the screen.

**Controller:** A controller will be connected between touch sensor and PC. It takes information from sensor and translates it for understanding of PC. The controller determines what type of connection is needed.

**Software driver:**It allows computer and touch screen to work together. It tells OS how to interact the touch event information that is sent from the controller.

## Application – Remote control using Touch screen technology:

The touch screen is one of the simplest PC interfaces to use, for larger number of applications. A touch screen is useful for easily accessing the information by simply touching the display screen. The touch screen device system is useful in ranging from industrial process control to home automation.

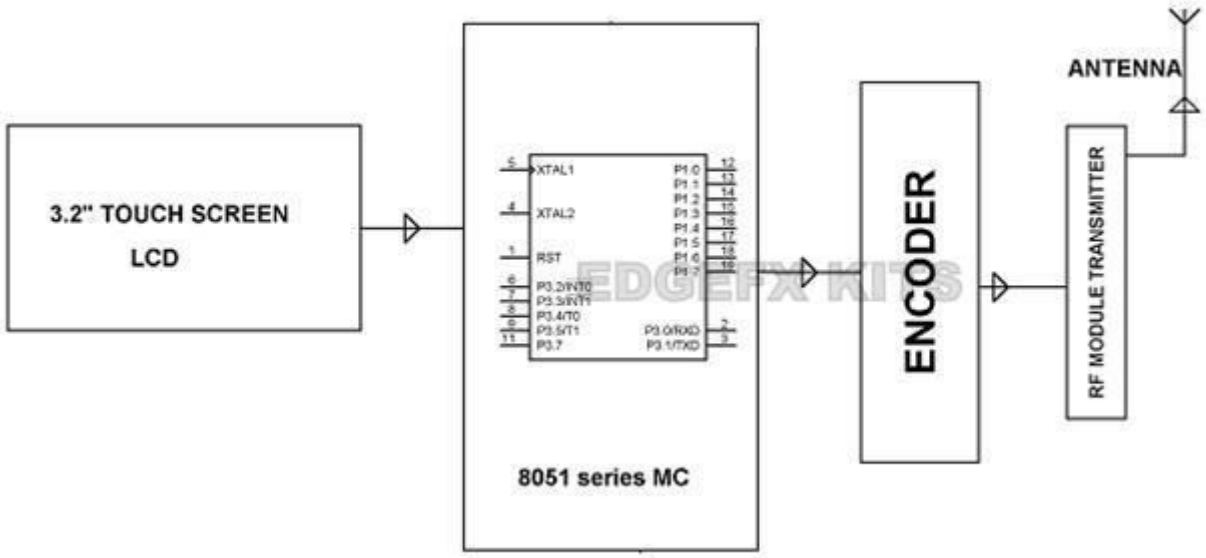


Fig-2 Block Diagram

In real time by simply touching the touch screen and with a graphical interface, everyone can monitor and control complex operations.

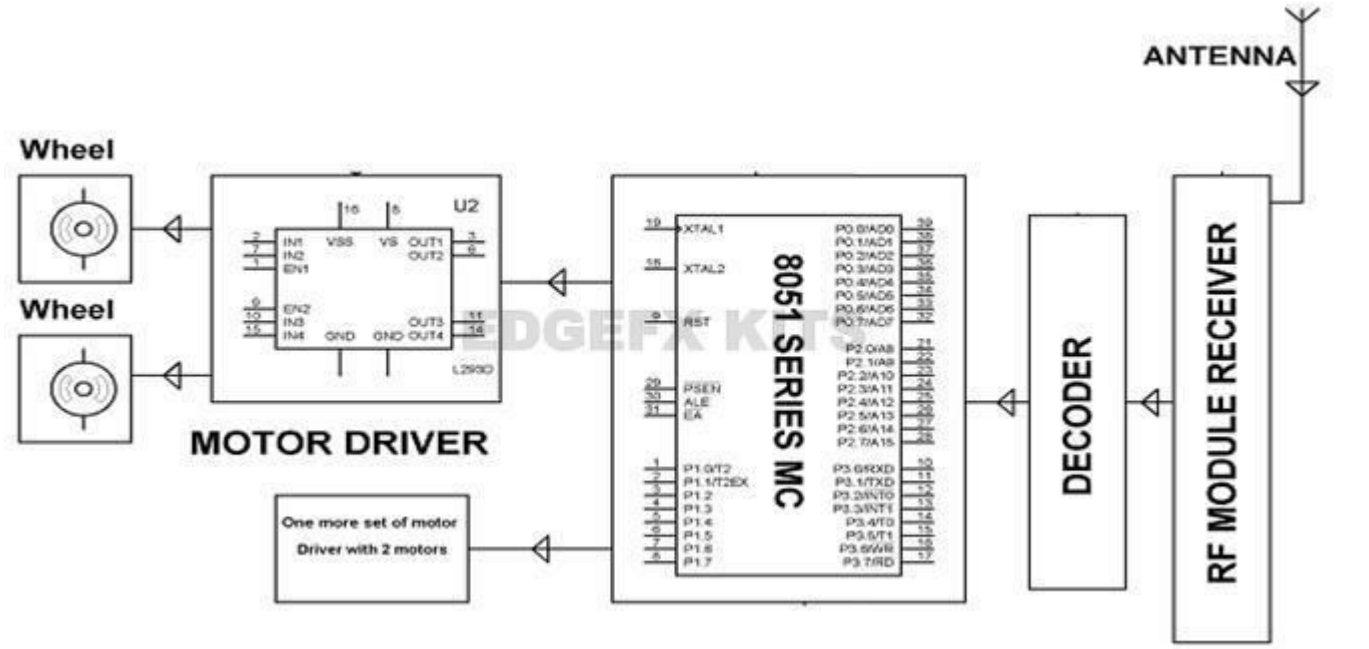


Fig-3 Block Diagram of Receiver

At the transmission end using a touch screen control unit, some directions will send to the robot for moving into a specific direction like forward, backward, rotating left and rotating right. At the receiving end four motors are interfaced with the microcontroller. Two of them will be used for Arm and grip movement of the robot and other two are used for body movement.

Some remote operations can be done with touch screen technology using wireless communication for answering calls, locating and communicating with staff, and operating vehicles and robots. For this purpose, RF communication or infrared communication may be used.

## A real time Application: Controlling home appliances using Touch Screen Technology

It is possible to control the electrical appliances at home using touch screen technology. The whole system works by sending input commands from the touch screen panel through the RF communication which are received at the receiver end and control the switching of loads.

At the transmitter end, a touch screen panel is interfaced to the Microcontroller through a touch screen connector. When an area on the panel is touched, the x and y coordinates of that area are sent to the Microcontroller which generates a binary code from the input.

This 4bit binary data is given to the data pins of the H12E encoder which develops a serial output. This serial output is now sent using a RF module and an antenna.

At the receiver end, the RF module receives the coded serial data, demodulates it and this serial data is given to the H12D decoder. This decoder converts this serial data into the parallel data which pertains to

the original data sent by the microcontroller at transmission end. The microcontroller at the receiver end receiver end, receives this data and accordingly sends a low logic signal to the corresponding opt isolator which in turn switches on the respective TRIAC to allow AC current to the load and the respective load is switched on.

**Photo Credit**

- Operation using the touch screen panel by complete tab
- Controlling of vehicles and robots using touch screen based remote by Direct Industry