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Applications of Nanotechnology in Communication Engineering

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***ABSTRACT**: we report an update status of nanotechnology developments in electronics and communication engineering by providing advantages of implementing the nanotechnology in these areas. This paper presents an insight into some of recent breakthroughs in nanotechnology which includes various devices like nano transistors, paper battery, nano robotics, nano sensors, Wireless technology, Nano communication and networks. Nanotechnology is therefore expected to enable the production of smaller, cheaper and powerful devices with increasing efficiency.*

***KEYWORDS**: Nanotechnology, transistors, paper battery, nano robotics, nano sensors, wireless technology.*

I. INTRODUCTION

Nanotechnology is the study of phenomena and fine-tuning of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale. Nanotechnology is also defined as the study of structures which are in size between 1 to 100 nm. Nanotechnology is changing significantly in the field of electronics, especially in regard to computers, telecommunications and optics [1], [2], [3], [6]. In some sense, electronic miniaturization has been the true driving force for nanotechnology research and applications. The main aim in this area is to understand nanoscale rules and mechanism in order to implement new ICT (Information and communication technology) systems more economic, little and reliable. Nanotechnology has application in drug delivery, i.e. most harmful side effects of treatment such as chemotherapy are a result of drug delivery methods which do not pin point their intended target cells accurately. Nanoparticles of iron can be effective in the cleanup of chemicals in groundwater because they react more efficiently to those chemicals than larger iron particles.Nano sized particles of carbon like nanotubes and bucky balls are composed of only carbon and they are very strong. A T-shirt weight bullet proof vests made out of carbon nanotubes is the best example that shows how much strong will be the nanosized particles of carbon. This is because their strength comes from special characteristics of the bonds between carbon atoms. Nano-sized particles of titanium dioxide and zinc oxide are used in many sunscreens to block UV radiation more effectively.

Nanotechnology may offer new ways of working for electronics. Nanotechnology science is developing new circuit materials, new processors, new means of storing information and new manners of transferring information. Nanotechnology improve the capabilities of electronic components like by reducing the size of transistors used in integrated circuits, researchers are developing a type of memory chip with projected densityof one tera byte of memory per square inch and this increases the density of memory chips. By improving display screens on electronics devices and this reduces power Consumption and also the weight and thickness of the screens.

In communication system based on nanotechnology is discovering new materials on the nanometer length scale expected to play an important role in future challenges in the field of communication systems such in devices of ultra-high-speed for long and short range communications links, power efficient computing devices, high density memory and logics, and ultra-fast interconnects [5]. Also the use of molecules, instead of electromagnetic or acoustic waves, to encode and transmit the information represents a new communication paradigm that demands novel solutions such as molecular transceivers, channel models or protocols for Nano networks.[6], [7]

II. APPLICATIONS OF NANOTECHNOLOGY IN ELECTRONICS

Nanotechnology is like a toolkit for the electronics industry and it gives us tools that allow us to make nonmaterial with special properties modified by ultra fine particle size crystalline and structure. These will become commercially important when they give a cost and performance advantage over

existing products or allow us to create new products.

NANOSCALE TRANSISTORS:

A nanotransistor is a transistor, the component that acts as an electronic signal with an amplifier that is near the scale of a billionth of a meter in size (nano scale) [4]. These nano-transistors are expected to have a gate or control electrode as short as 70nm and a gate oxide, which separates the control electrode from the current-carrying channels thin as about 1nm. The semiconductor industry can manufacture logic that incorporates more than 40million MOSFET (Metal oxide semiconductor field effect transistors) in to a single circuit and in coming years at the same cost the semiconductor industry will manufacture logic chips that will nearly a half billion nanometer scale MOSFETs(nano transistors) packing about 5-10 nanotransistors/μm^2. The smaller transistors, the more atomic scale variations in their size and structure affect their performance and thus the reliability of a whole circuit. The focus is to develop new design tools and methodology for transistors and circuits at the nanoscale which will enable the manufacturing of reliable, low cost, low electromagnetic interference, high yield complex silicon chips and corresponding products using unreliable and variable devices. Lead semiconductor manufacturer is producing microchips with transistors less than 30 nanometers in size by comparison a human hair is around 10^5 nanometers wide. From fig.1.Nanotransistors which are billion times faster , pairs of metal contacts (thick bars) lie a top printed carbon nanotubes (thin lines), forming transistors visible only in the electron microscope image.

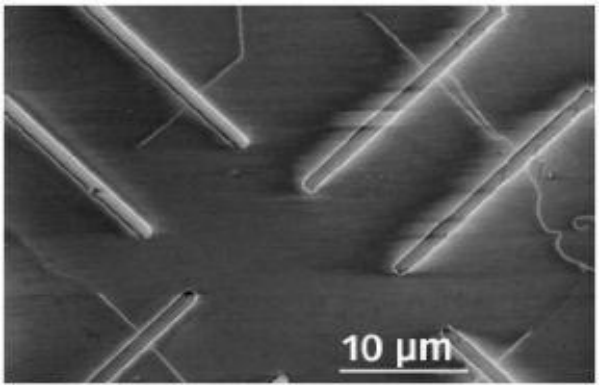

Fig.1.Nano-transistors

PAPER BATTERY:

A paper battery is flexible, ultra-thin energy storage and production device formed by combining two things carbon nanotube and nano composite paper (conventionalsheet of cellulose based Paper). A paper battery acts as both a high energy battery and super capacitor combining two components that are separate in traditional electronics [2], [3]. Nano composite paper is a hybrid energy storage device made of cellulose, which combines the features of super capacitors and batteries. It takes the high- energy storage capacity of the battery and high-energy density of the super capacitor producing the bursts of extreme power.A carbon nanotube material is a cylinder shaped material, made of carbon. These tubes have different structures that differ in thickness, length, type and number of layers. Carbon nanotubes are characterized into different types based on their structure. They are single walled carbon nanotube, double-walled carbon nanotube, triple-walled carbon nanotube and multi- wall carbon nanotube. The devices are formed by combining cellulose with an infusion of aligned carbon naotubes that are each approximately one millionth of a centimeter thick. This combination permits the battery to provide both long term, bursts of energy, steady power and production. Paper batteries have the potential to power the next generation of medical devices, electronics and hybrid vehicles. Paper batteries can be folded, twisted, molded, crumpled, shaped and cut for various applications without any loss of efficiency. Paper batteries can function between -75 and 150 degree Celsius.A conventional battery or Rechargeable battery contains a number of separate components that produce electrons through a chemical reaction between the metal and the electrolyte of the battery. The Paper battery works when the paper is dipped in the ion-based liquid solution; next a chemical reaction occurs between the electrodes and liquid. The electrons move from the cathode to anode to generate electricity. The paper electrode stores energy while recharging within 10 seconds because the ions flow through the thin electrode quickly. The best method to increase the output of the battery is to stack different paper batteries one over the other.

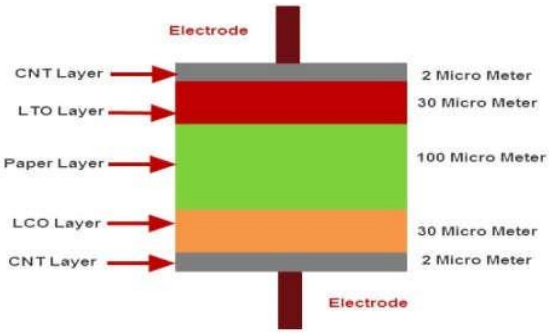

Fig.2.1.Paper battery Structure

Fig.2.2.Paper battery Image

NANO ROBOTICS:

The engineering of molecular products needs to be carried out by robotic devices, which have been termed nanorobots. A naorobot is essentially a controllable machine at the nano meter or molecular scale that is composed of nano scale dimensions. Typically, an atom has a diameter of a few nanometers, a molecules size is a few nm, and clusters or nanoparticles formed by hundreds or thousands of atoms have sizes of tens of nm [5], [6]. Therefore, Nanorobotics is concerned with interactions with atomic and molecular sized objects and is sometimes called molecular robotics.Nanorobots hold great potential in the field of medicine. This is largely due to the possibility of high targeted delivery of medical payloads, an outcome that could lessen side effects and negate the need for invasive procedures. But how these microscopic particles can best navigate the body's fluids is a huge area of focus for scientists. Researchers are now reporting a new technique whereby nanorobots are made to swim swiftly through the fluids like blood to reach their destination. Nanorobots hold great potential in the field of medicine. This is largely due to possibility of the use of practical nanorobots for health care and surgery instrumentation is an emerging technology considered as an advanced product currently in development to reach the market place in the coming years with potentially broad biomedical applications. The ongoing developments of molecular scale electronics, sensors and motors are predicted to enable microscopic robots with dimensions comparable to bacteria. Recent developments on the field of biomolecular computing and nano electronics circuitry have demonstrated positively the feasibility of processing logic tasks by bio computers, which are promising steps to enable nano processors with increasing complexity. Nanorobots are implemented by using several components such as sensors, actuators, control, power, communication and by interfacing cross special scales between organic inorganic systems. The combination of nanotechnology, photo-lithography and new biomaterials, can be considered as a possible way required for designing technology to develop nanorobots for medical applications such as diagnosis and drug delivery. This realistic approach in designing nanorobots is a methodology which is used in the electronic industries. Surgical nanorobots are introduced into the human body through vascular systems and other cavities. Surgical nanorobots act as semi-autonomous on-site surgeon inside the human body and are programmed or directed by a human surgeon. Medical nanorobots are used for the purpose of diagnosis, testing and monitoring of microorganisms, tissues and cells in the blood stream. Nanorobots are also applicable in treating genetic diseases, by relating the molecular structures of DNA and proteins in the cell.

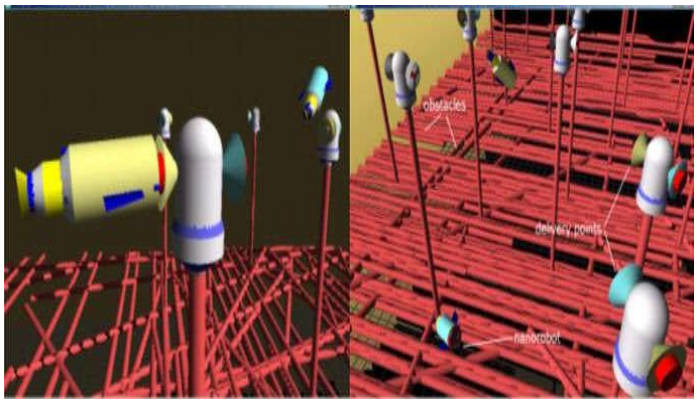

Fig.3. Nanorobots as drug delivery

III. APPLICATION OF NANOTECHNOLOGY IN COMMUNICATION

Nanotechnology plays an important role in field of telecommunication engineering, and makes a great revolution in many aspects deal with communication technologies and features. Nanotechnology has a wide range of applications and has impacted the telecommunications industry in several ways.

WIRELESS TECHNOLOGY:

The telecommunication enterprise will radically get changed into the brand new Nanotechnology. Nanotechnology effect in operation of both cellular as well as core network, and by addition perfection in security and the better effect on the sensor make the nanotechnology the hugest from previous traditional technologies. Devices that use wireless communication range from RFID tags to TV receivers, and satellites to mobile phones [7], [8]. The availability of internet access from tablets and mobile phones is growing at an exponential rate, causing increasing demands on the performance of wireless networks and mobile devices.

Wireless technology industries have promised at the implementation of the intelligent operations that allows to ensuring that the computation and communication are to be had as desired. The advent of intelligent and Nano technology concepts in the mobile devices will assist in embedding the devices inside the human environments that can create a brand new platform on the way to permit the ever present sensing, and computing. The Nano devices may be loaded to achieve some capabilities like self-powering, sensible to the environment or smart interaction with other systems. In Cellular phones the enhanced in the carbon nanotube will be added soon which comes below the nanotechnology. The graphene-based IC was especially developed for wireless communications and can be used for a wide range of applications. At present day conventional frequencies, transceiver and cell phone signals can be improved enabling phones to work where they cannot. At higher frequencies, medical and military personnel can view hidden weapons and perform medical imaging without the radiation exposure dangers of X-rays.

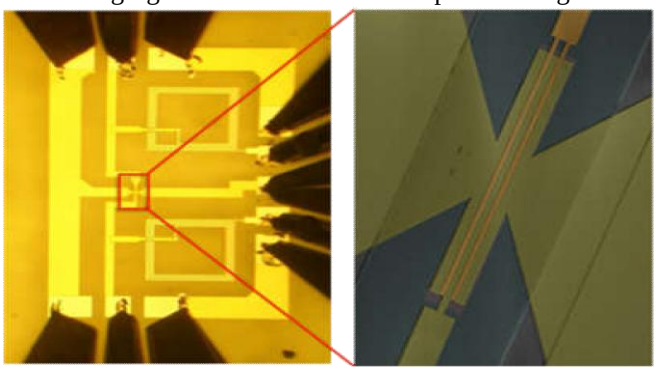

Fig.4.Graphene-based integrated circuit for wireless communications created by IBM

NANOSENSORS:

Nanosensors are chemical or mechanical sensors that can be used to detect the presence of chemical species and nanoparticles or monitor physical parameters such as temperature, pressure on the nanoscale. Nanosensors have applications in defense, the medical and healthcare world and consumer products [2], [3].Nano sensors and nano devices are providing new solutions for many aspects such in environmental and biological sensing that offers a high degree of detection sensitivity, and availability in static or dynamic situation in many applications such as health, safety, and monitoring. Due to the

increasing in many applications of industrial facilities and its global distributions, there is an urgent need to develop new type of sensors and devices that are able to detect and identify rapidly the source of pollutant, and other threat agents at any point. From other side taking deep concept, it's also required to develop sensors and devices that are able to interact with other machines in manufacturing areas, to detect many types of fluctuations during industrial process. Other important application such in healthcare is also becomes an important area that required to develop a new generation of nano sensors and nano devices with rapid response and high sensitivity in nano scale areas may be inside the human body.

Nanosensors harness the change in electrical conductivity that occurs when molecules bond to nanowires made from semiconducting materials such as zinc oxide. One application is detecting excess levels of carbon monoxide, and also utilize changes in electrical conductivity, in this case that of carbon nanotubes to which an antibody is bonded. When a matching bacteria or virus attaches to the antibody a change in conductivity can be measured. Reducing the size of a sensor has many benefits like faster response, better signal-to-noise, more accurate data, and increased data density.

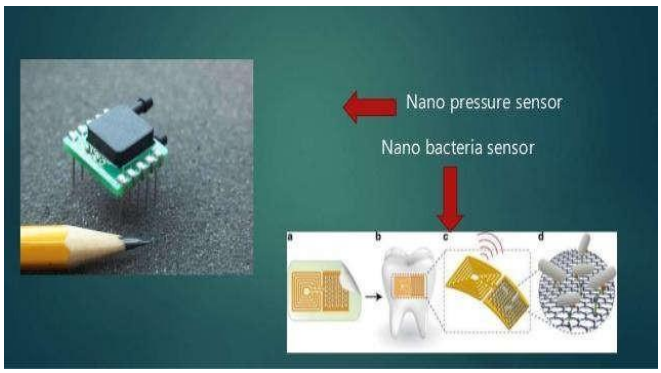

Fig.5.Electromagnetic nanosensors.

NANO COMMUNICATION AND NETWORKS:

Nano communications is the area of research for finding efficient means of communication for the future nanodevices. These devices are planned to have a wide range of application ares. Nano machine is described as mechanical devices that rely on upon nanometer scale parts. The term of nuclear machine is known as a mechanical device that plays out an accommodating limit using fragments of nanometer scale and described sub nuclear structure able conveying, processing, information , detecting or potentially activation other system [9], [10]. Nano communications is divided into two main streams; They are EM nano communications and Molecular Nano communications. EM based Nano communications uses electromagnetic waves as information carriers similar to classical methods cannot be directly applied to nano domain due to extreme scarcity of resources and techniques need to be utilized.CNTs are the most famous and promising material for nano communications. Molecular communications is the natural communication technique used by living organisms and is envisioned to become available method for future nano devices. Concentration of the molecule at close proximity of the receiver may be used to understand the molecular bit transmitter sent.

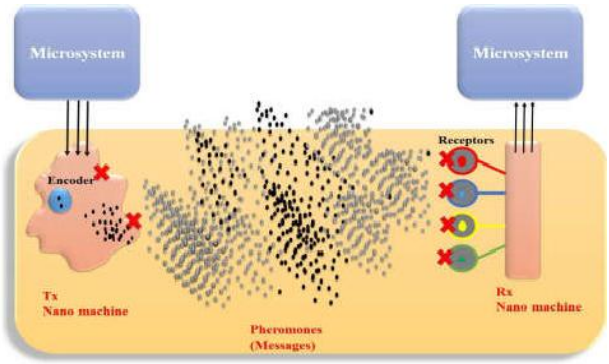

Fig.6. Molecular communication based on pheromones encoding.

IV. CONCLUSION

In this paper, Application of nanotechnology in electronics and communication engineering is discussed. Nanotechnology improve the capabilities of electronic components by reducing the size of transistors used in integrated circuits, researches are developing a type of memory chip with a projected density of one terabyte of memory per square inch and this increases the density of memory chips. The paper battery which is made of with nanotechnology integrates all of the battery components in a single structure and making it more energy efficient. The battery will currently provide a low, steady power output as well as a supercapacitor's quick burst of energy.The future of nanorobots is bright and We are at the dawn of a new era in which many disciplines will merge including robotics, mechanical, chemical and biomedical engineering, chemistry, biology, physics and mathematics so that fully functional systems will be developed.The use of wireless communication system is increasing very rapidly and nanotechnology in wireless communications are improved performance as smaller power consumption, smaller size and new features. Wireless sensors and sensor networks have applications in logistics, security systems, health and environment monitoring.

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