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Nanotechnology in Communication Engineering: Issues, Applications, and Future Possibilities

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ABSTRACT

Nanotechnology nowadays became the most amazing studies developed and an active research areas in many fields including civil, chemical engineering, electronics, and medicine, also in materials. In modern sciences, nanotechnology is considered as the next industrial revolution which it may give more possibilities exceed our expectations in many fields. In telecommunication engineering nanotechnology could provide effective solutions for power efficient computing, sensing, memory enlargement, and human machine interaction. Nanotechnology in communication systems also provides ability for manufacturers to produce computer chips and sensors that are considerably smaller, faster, more energy efficient, and cheaper to manufacture than their present-day modules. In this paper an overview of many issues related to nanotechnology in communication systems are discussed, and also paper will provides a brief ideas of the potential application of various nanotechnology developments in the communication systems and the potential for future possibilities researches that may lead to improved communication systems.

***Keywords*:** Nanotechnology, Molecular Nano Technology (MNT), Molecular communication, Nano machines, Nano-communications

1. INTRODUCTION

Next generations of telecommunication systems expected to be built in nanotechnology modules, especially in electronics fields and interactive processes. For mobile communication systems the application of Nano science is used to make the control process to a Nano meter scale which will be in Nano scale range. Nanotechnology known as Molecular Nano Technology (MNT), represents Atom by atom and molecule by molecule based control of the structure of matter. The impact of mobile and core network capsulated together in mode of operation of the nanotechnology as well as perfection in security and the better impact on the sensor makes the nanotechnology the most significant technology in these areas [1].

Other issue 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. 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 [2].

Molecular transceivers will be easy to integrate in Nano-devices due to their size and domain of operation. These transceivers are able to react to specific molecules and to release others as a response after performing some type of processing. Recent advancements in molecular and carbon electronics have applied a new generation of electronic Nano-components such as Nano batteries, Nano-memories, logical circuitry in the nanoscale and even Nano-antennas [3].

This paper focus on the nanotechnology issues in telecommunication engineering and also provides a review of applications and future technologies in field of telecommunication based on nanotechnology. The rest of the paper is organized as follows. In section 2, a nanotechnology in communication systems is reviewed, provides details on many issues related to nanotechnology in Nano communication systems. Section 3 provides a review of the most important applications of nanotechnology used in field of communication systems. Finally the future possibilities of nanotechnology in communication systems will be discussed in section 4.

2. NANOTECHNOLGY

Nanotechnology was first developed in 1965, it consists of the processing of, separation, consolidation, and deformation of materials by one atom or by one molecule. It's fabrication of devices in a scale ranging from 1 to 100 nanometers [4]. Nanoscale science can be divided into three broad areas, nanostructures, nanofabrication and Nano characterization with typical applications in Nano electronics, life sciences and energy. There are several applications of nanotechnology nowadays as illustrated in Figure 1, but with respect to electrical and electronics fields, a feasible applications of nanotechnology are; Communications, Bio-engineering, Medical Electronics and Robotics [4].

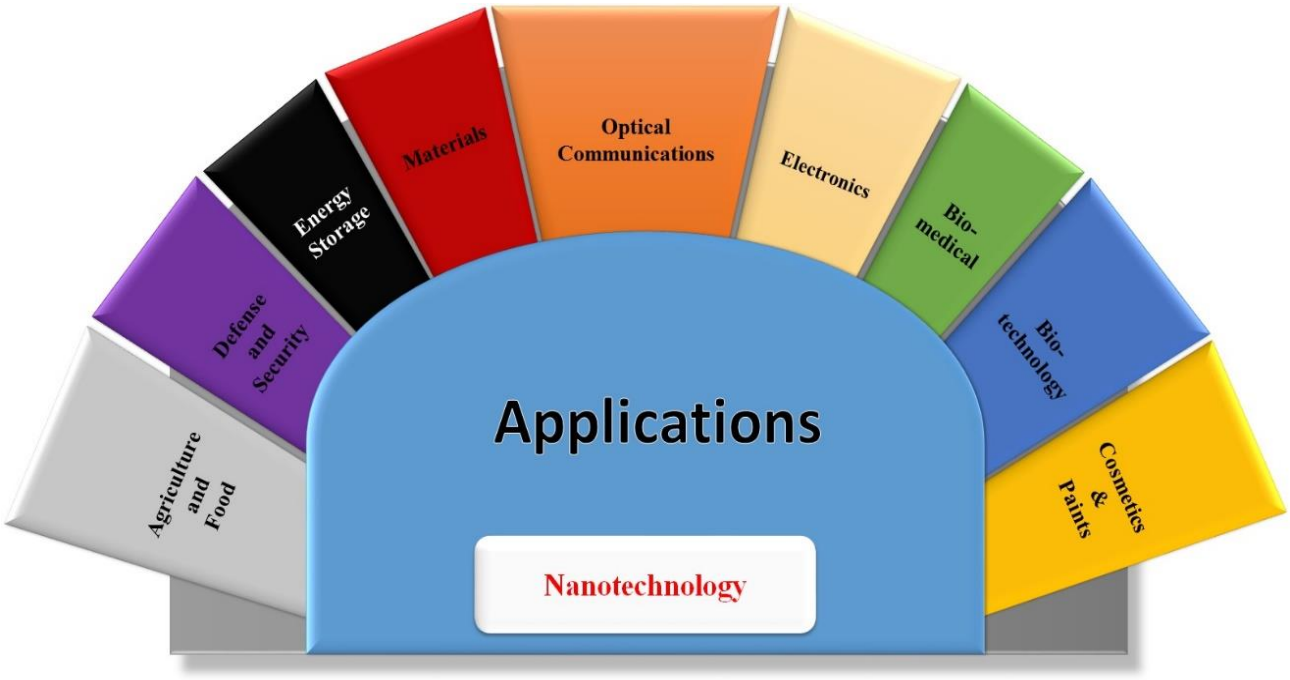

Figure 1. Nanotechnology Applications [4]

Nanotechnology will enable manufacturers to produce computer chips and sensors that are considerably smaller, faster, more energy efficient, and cheaper to manufacture than their present-day counterparts .Micromechanical sensors also became an elementary part of automotive technologies in mid-1990, roughly ten years later more miniaturized micromechanical sensors are enabling novel features for consumer electronics and mobile devices. Within the next ten years the development of truly embedded sensors based on nanostructures will become a part of our everyday intelligent environments [5]. Nanorobotics is the emerging technology field of creating machines or robots whose components are at or close to the microscopic scale of a nanometer (9-10 meters). Nanorobotics refers to the nanotechnology engineering discipline of designing and building Nano robots, with devices ranging in size from 0.1-10 micrometers and constructed of nanoscale or molecular components [6].

In communication systems, a mobile devices with highly level of computation and communication when interacting with other human environments such as home, office, public place are require an intelligent way to sensing, computing, and communication technologies specially when these devices became and embedded systems [7]. Core requirements for this kind of mobile devices intelligence are that the devices must be autonomous and robust, can be deployed easily, and survive without explicit management or care, and the mobility of these devices also implies limited size and restrictions on the power consumption [8]. Other requirements for intelligent mobile systems are; Intelligent interfacing and interacting with other devices and environments, sensing, context, awareness, and increased data rates which require more memory and computing power. All these requirements lead to a situation which cannot be resolved with current technologies. However, nanotechnology could provide

solutions for sensing, actuation, radio, embedding intelligence into the environment, power efficient computing and memory [9].

3. NANOTECHNOLOGY APPLICATONS

Nanotechnology plays an important role in field of telecommunication engineering, and make 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.

3. 1. 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 makes the nanotechnology the hugest from previous traditional technologies [10].

Wireless technology industries have promised at the implementation of the intelligent operations that allows to ensure 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 [10]. The Nano devices may be loaded to achieve some capabilities like self-powering, sensible to the environment or smart interaction with other systems [11]. In Cellular phones the enhanced in the carbon nanotube will be added soon which comes below the nanotechnology [11]. In five generation of mobile systems, cells are referred as Nano devices as they are equipped up with nanotechnology. One of the relevant visions of the wireless industries is to achieve a means of Nano intelligent technologies to be prepared to serve the person in a smart manner. This requires that the network devices and mobile together with the intelligence means are all mind to be embedded in human environments such as home, workplace, or public places and will create a new platform that allow to sensing, and computing, in Nano communication systems [12].

3. 2. Internet of Things (IoT) Technology

Internet of Things (IoT) is the arrangement of physical articles or things introduced with equipment, programming, sensors and network system to enable it to achieve more essential regard and organization by exchanging data with the executive and other related objects [13]. Nano Intelligent Things, could be the accompanying possible thing that could hit within the near future [14]. Nano bio chips can be prepared for pass the data or information among themselves or to the machines or to the general population and are self-learning by illustration affirmation, upgrading themselves by each time they play out the mission [15,16].

The nanotechnology with the internet of thing will provides a Nano size of things able to communication together with the ability to interact with human or machines in a good and efficient manner. Furthermore Nano Intelligent things will provides a smart ways to dynamic linking for all Nano things likely contact with the Internet or with a other Nano systems and applications such as linking the devices of medical nanoparticles with the Internet or

nanoparticles devices that can slide into contact with the human body to provide several other applications provides a vital contact with humans [17]. Besides many smart applications such as the production of nanoscale machines capable of connecting to the Internet be controlled from the distance.

3. 3. Body area network

Body area network devices now can be coordinated into dress or body. Much work has been finished by many research groups on improvement of intelligent Nano materials and combination of microelectronics into garments or implanted in the human body [18]. Therapeutic devices such as pacemakers, prosthesis, and stents are now becomes really used in medical. One case is a sensors focused at congestive heart failure patients, these sensors may planted inside body and communicate to each other by the way of interbody Nano communication as in Figure 2 [19].

The embedded sensors in a size like a grain of rice can be utilized to measure many medical metrics inside the body such as measuring the flow rate of blood in the arteries within the human body, a complex surgical, internal survey of vital parts of the body and likewise be utilized for medication treatments for nerve or tissue incitement [20].

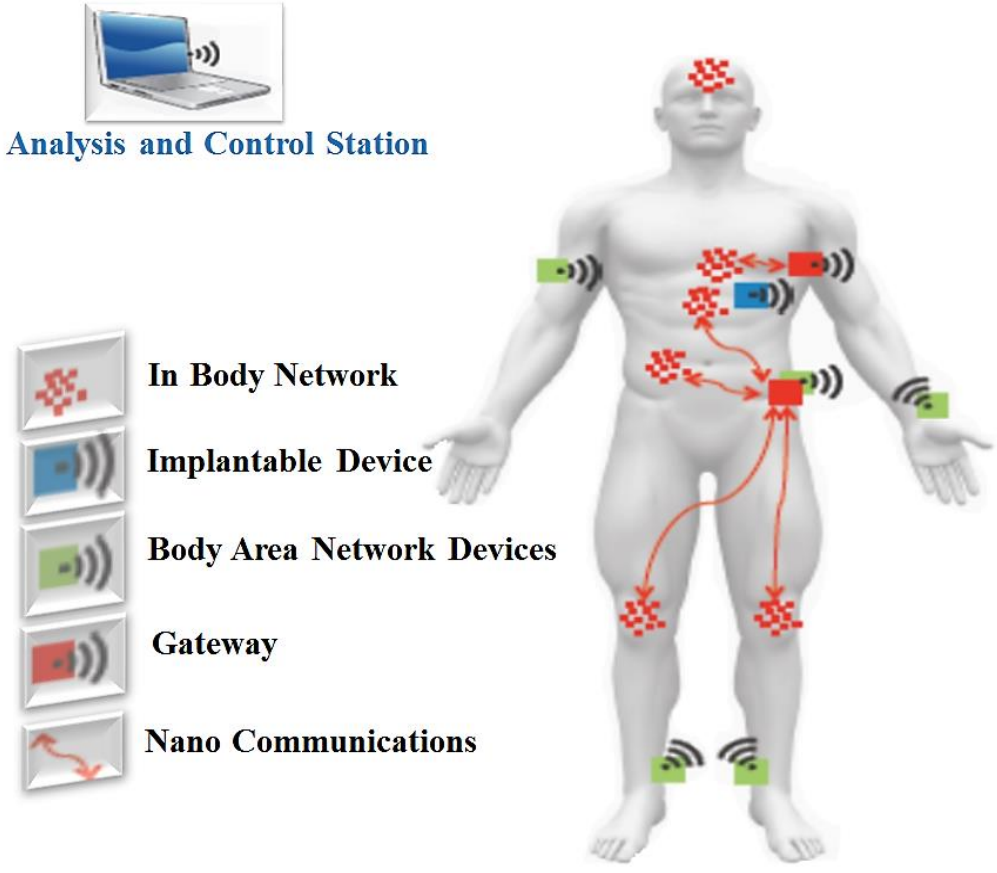

Figure 2. Nano sensors for interbody communications [19]

The advancement of smaller scale inserts opens up the likelihood of Intra Body Networks (IBNs), where BAN segments are scaled down and disappear inside the body [20]. Sensors and actuators, can be acknowledged by embedded devices conveying remotely through tissue [21]. Much further into the future it can anticipate BANs and IBNs which make use of various bio nanotechnologies. Biotechnology known as any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use. Bio nanotechnology can be characterized as a branch of nanotechnology in view of utilizing the natural structures, for example, proteins, DNA, and so forth as building pieces of nanoscale devices for instance Nano engines [22].

3. 4. Mobile and wireless devices

Portable devices for calculation and sensing are becomes a key dreams of remote business to have surrounding knowledge which they are constantly accessible and prepared to serve the client [23]. These devices can attached to human situations like home, office, open spots in conjunction with cell phones [23]. One of the key requirements for implanting devices into physical objects of the world requires that devices able to adjust to their surroundings and turn into a part of the system of devices encompassing them. Such example for that like organic frameworks which develop and adjust to nature independently [24].

Nanotechnology can help in the advancement of new types of insightful Nano devices and Nano sensors that can able to communicate with these organic frameworks. Nanotechnology would provide possibilities which may be as complicated as helping to advancing conditions in the nature of our environment, or as basic as knowing whether the organic product is healthy or damaged [25].

Other example of using nanotechnology in wireless devices like remote sensors which are an especially huge region of research in the improvement of military nanotechnologies. Sensors are viewed as critical for insight gathering with respect to neighborhood conditions, the development of foe troops or hardware, to survey constant harm or undermine the viability of a foe's assault. Nano sensors in observation applications could likewise assume a key part in enhancing the precision of weapons conveyance and boosting the lethality of assaults, for instance by giving data to change control levels. Nano wireless devices could be scattered over a combat for catching an information on temperature, weight, vibration, increasing speed, light, magnetics, or acoustics and impart this data constantly [26].

3. 5. Nano communication and networks

Nano machine is described as mechanical devices that relies 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 [27].

Communication based on electromagnetic waves is the most basic strategy to interconnect microelectronic devices and these waves can propagate with low loss along wires or wirelessly. To establish a bidirectional wireless Nano communication, a radio frequency systems should to be coordinated in the Nano machine which required a development in Nano scale antennas for very high frequencies [28]. The communication between the Nano scale machines is defined by which is knows as Molecular communication represent the transmission and reception of information encoded in molecules. Molecular communication

can be used to interconnect multiple Nano machines, resulting in Nano networks which are using the message is encoded using molecules [29]. the coding techniques can be considered to represent the information in Nano networks called molecular encoding, uses internal parameters of the molecules to encode the information such as the chemical structure, relative positioning of molecular elements or polarization [30]. The receiver must be able to detect these specific molecules to decode the information. This technique is similar to the use of encrypted packets in communication networks, in which only the intended receiver is capable to read the information. As shown in Figure 3 below molecular encoding is used in phenomenal communication, where only members of the transmitter specie can decode the transmitted message [31]. Text, voice and video are usually transmitted over traditional communication networks. By contrast, in Nano networks, since the message is a molecule, the transmitted information is more related to phenomena, chemical states and processes.

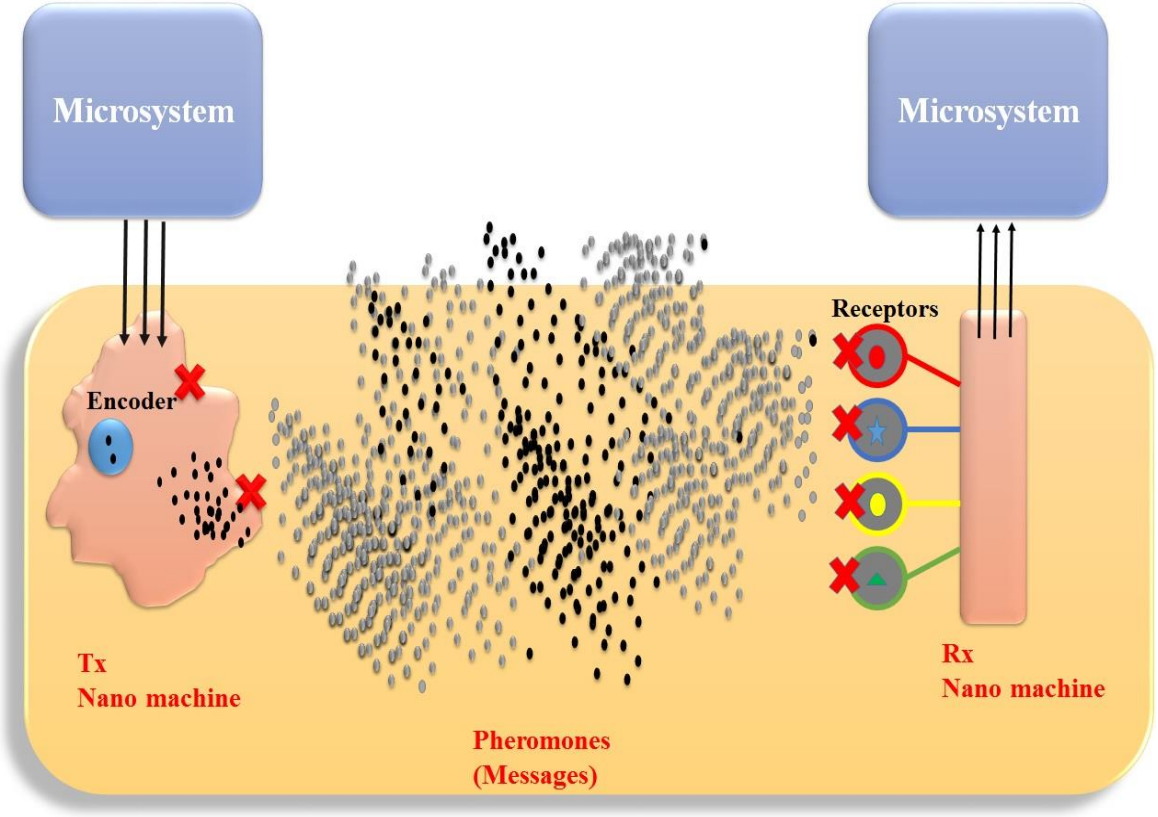

Figure 3. Molecular communication based on pheromones encoding [30].

The communication between Nano machines take place as in the traditional communication that means the systems have to transmit a message over a carrier to the receiver and the information carried should be encoded in transmitter side and decoded in receiver . but the message In molecular communication is a molecule, This molecular message will present a predefined external structure that will allow an easy recognition at the receiver it will be inactive means that molecular messages will not be prone to react to other

molecules in the medium in addition that molecular messages should easily be eliminated without any side effect they are decoded at the receiver Nano machine [32].

The carriers are particular molecules which are able to transport chemo signals or molecular structures containing the information. The use of molecules as information carriers in molecular communication was observed in biological systems [33]. The carrier used may be a molecular motors or calcium ions. Molecular motors for example like kinesin, dynein and myosin, are proteins that can generate movements using chemical energy which used to transport a data molecule packet from the transmitter to the receiver [34]. Figure 4 shows a molecular motor as a protein that transforms chemical energy into mechanical work at a molecular scale [35].

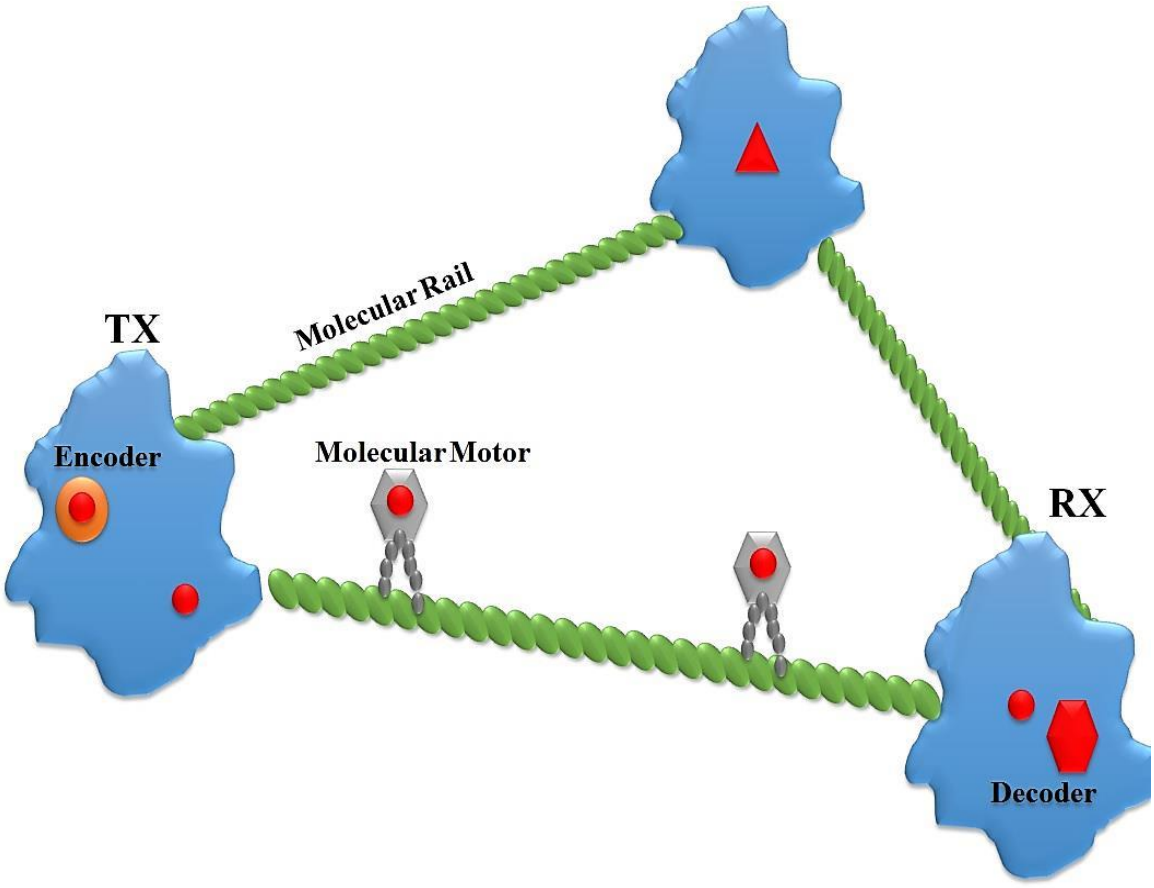

Figure 4. Molecular motors for molecular communication [30]

The molecular motors has the ability to move molecules and the molecular motors travel or move along molecular rails called microtubules [35]. The calcium ions carrier is used by transmitter to modulate the concentration of ions in amplitude and frequency to encode the information [36]. In molecular communication, the medium can be wet or dry, for example in-body or environmental monitoring Nano networks, and the propagation is even more dependent on the medium conditions.

3. 6. Quantum computing

By replacing current computers by more progressed and quick preparing quantum computers innovation, the most exceptional innovation that will be in charge of adding new features and means of processing and computing in an intelligent way [37]. In quantum computers, the binary rates in conventional computers are repeated by quantum bitsor qubits, which can be in a state of 0, 1 and superposition simultaneously. As the quantum computer can hold multiple states simultaneously, it is assumed that it has the potential to perform a millions of computation at the same time [38]. This would make the computer much faster than ever before. The development of quantum computer is still under research.

3. 7. Information storing and processing

For information processing and transmission, the development in electronic, optical and optoelectronic components are expected to producing a fast and precise process communication devices. The Photonic crystals will be potentially used for designing purely optical circuits as a basis for future information processing based on light only. Nanotechnology concept in nanoscale storage device that build on CMOS technology by using quantum dabs and carbon nanotubes will achieves a great expectations for storing the large amount of data [39].

New technologies such versatile 3D Nano computer chip that firmly interconnects memory, with the impact of minimizing information bottlenecks will promise a fast and precise data processing. With further work, the progress could be the way to an exceptionally significant steps in execution, proficiency, and the capacity to rapidly handle a very large amount of data known as big data over ordinary chips. in addition, a 3D integration memory and emerging nanotechnologies like CNT transistors are promising steps for building the next generation of ultra-high efficiency and high performance electronic systems that can operate on massive amounts of data [40].

3. 8. Nano sensors and nano devices

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 needs 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 [41]. 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 [42].

Nano sensors are any biological, chemical, or surgical sensory points used to convey information about nanoparticles to the macroscopic world. Nano devices are used mainly in various medicinal purposes as gateways to building other Nano products, such as computer chips that work at the nanoscale and Nano robots. In human body area communications,

Nano sensors deliver real-time information about the antibodies to antigens, cell receptors to their glands, and DNA and RNA to nucleic acid with a complimentary sequence [43].

The transducing mechanism may be Optical, Mass or Electrochemical. In optical mechanism many phenomena's can be used to detect various chemical metrics such phenomena's like Luminescence to detect the concentration of H_2O hydrogen peroxide (H_2O_2) by using luminescent optical sensors, Absorption, Polarization, and Fluorescence. And by mass mechanism the communication take place due to Acoustic wave, Microbalance, and Resonant [44].

In the near future Nano sensors will provides many new applications such as enabling personalized images for viruses and pathogens, or to fabricate a screen geomatics DNA for large set of Single nucleotide polymorphisms (SNPs). Other future applications that can be developed will promise a spectacular interaction between physics, materials, computing and communication by integrate the nano scale sensors, nano processors. Optical communication, and Nano microelectromechanical systems all together to design a new generation of nano satellites that able to act as a bio explorer with high sensitivity or monitoring harsh environments [45].

4. FUTURE POSSIBILITIES

Nanotechnology opens the best way to deal with many fields, for example, Telecommunications, Bio Engineering, Medical Electronics and Robotics. These are the four fundamental locale that there is potential to offer business openings later on [46]. In communicate and information exchange the use of the nanotechnology will be recognized new estimates of unbelievable ways to offer smart transmission media. Due to revolutionized in telecommunications, other aspects can be achieved such a revolution in computing, and networking industries. The emerging innovation technologies may be in Nanomaterials with novel optical, electrical, and magnetic properties, faster and smaller non-silicon-based chipsets, memory, and processors, new science computers based on Quantum Computing, Advanced microscopy and manufacturing systems [47].

A future prediction of nanotechnology in telecommunication engineering's such in building a Nano headphones interact as the cell phone by allowing listening amplification and location focused microphones to interface with voice activated technology [48] [49]. Other technology like use chips in jacket, shirt, blouse, or pants that can be downloaded with ID, allowing fast access to secure items. OLED innovation, which remains for natural light-emanating diode, is enhancing the screens of advanced mobile phones and different media communications innovation [50]. OLED screens are adaptable and paper thin, and can be put on any surface for utilize. By 2020, each surface of homes can possibly get to be distinctly computational. Messaging by speculation is considered one of great expectations relied upon fast and magnificent communications and provides much better voice communication strategy than mobile VoIP, through eye tracking technology innovation and a sensor mounted headset, may will have the capacity to transform contemplations into messages [51]. Nanotechnology can adding more of communication techniques that cannot be predicted currently and may outweigh ratio imagination because this technology in the first phase of research, particularly in the field of telecommunications engineering research.

5. CONCLUSIONS

Nowadays the use of wireless communication is rapidly increasing and quickly expanding. The fundamental drivers for the utilization of nanotechnology in wireless devices and systems are superior, bring down power utilization and minimized size of communication components. Nanotechnology is set to significantly influence communication systems provoking to less requesting meeting of related advancements, enormous capacity information, minimized limit devices, and higher execution registering. Nanotechnology for Telecommunications covers ask about and developmental issues and what's more future course of nanotechnology as they apply to broadcast communications.

Molecular communication is integration of biology to interact with biological systems, nanotechnology to enable nanoscale and microscale interactions, and computer science to integrate into larger scale information and communication processing systems. Molecular Communication is another facet of communication engineering that tries to replicate natural communication protocols and apply them for various interesting applications. It has significant potential and is at a critical stage, where some practical applications of molecular communication are required, which will only be possible with the cooperative effort of the scientists from all different fields of science especially in telecommunication engineering. Nano networking is a novel idea which will extend the features of Nano machines by connecting them together in one Nano core network, and may accessed to internet to promising a new means of future Nano network by make the concept and deploying the internet of things more smarter. This paper has presented a review the use of nanotechnology in more sophisticated and widely used communications engineering techniques in present and expected to be used in a more intelligent in the near future, where it was introduced the concept of nanotechnology as one of the techniques that are used in the development of several areas in the telecommunications engineering.

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