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A REVIEW ON NANOROBOTICS: A MIRACULOUS NANOMEDICINE AND EMERGING TOOL IN NANOERA

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ABSTRACT

The recent advancement in the field of nanotechnology is the delivery of nanomedicine. The study of nanotechnology of creating machines or robots (nanorobots) by theoretical engineering near about nanometer (10^{-9} meters) is "Nanorobotics". The names 'nanorobots', 'nanoids', 'nanites /nanomites' 'Industrial robots', 'humanoid', 'surgical robots' have been used to describe these hypothetical devices. In this article focused on concept, design, advantages, disadvantages, application and future aspects on nanomedicine delivering agent nanorobots in different fields. The development of design of nanorobots has been done by using various approaches such as: Biochip, Nubots, Positional Nanoassembly, Usage of Bacteria etc. These are implemented by using several components such as sensors, actuators, control, power, communication and by interfacing cross-special scales between organic inorganic systems. Due to specific site operation mechanism leads no any harmful activities and no side effects and non-immunogenic. The initial cost of design development is high but accurate delivery of medicine to target site is the boon to mankind. These nano devices are used for the purpose of maintaining and protecting the human body against pathogens in different areas (food, industry, agriculture, farming, space technology etc.). Recently in nano era used for the treatment of cancer (In Obese Prostate Cancer, colon cancer, Kidney cancer etc.), cerebral Aneurysm, removal of kidney stones, Gene therapy, Nanodentistry, Neurosurgery, Diagnosis and Testing, Diamond nanotechnology for skin treatments, implementation of Anti–HIV etc. Various new developed nanotechnology based nanorobotic projects has been planned and proposed for future aspects in different fields of bio-medicines.

KEY WORDS

Nanotechnology, Nanorobotics, Nanorobots, Nanomedicine, Robotics.

INTRODUCTION

A nanorobot is a type of active structure capable of actuation, sensing, manipulation, propulsion, signaling, information processing, intelligence, and swarm behavior at the nanoscale (10^{-9}m) [1]. Robotics is the use of technology to design and manufacture (intelligent) machines, built for specific purposes, and programmed to perform specific tasks. The possibility of nanorobots was first proposed by Richard Feyman in his talk "There's Plenty of Room at the Bottom" in 1959. Generally, nanotechnology deals with size ranging from 1 to 100 nanometers. Nanorobots are nanodevices that are used for the purpose of maintaining and protecting the human body against pathogens. These are theoretical microscopic devices measured on the scale of nanometer. They would work at the atomic, molecular and cellular level to perform in both the medical and industrial fields. These are very sensitive to the acoustic signal and can be programmed using the sound waves to perform the specified tasks. These nanorobots identify the particular harmful cells and try to quarantine it. These are implemented by using

several components such as sensors, actuators, control, power, communication and by interfacing cross-special scales between organic inorganic systems. The application of robotics is rapidly increasing in our day-to-day life for several functions such as industrial applications-moving or lifting heavy products, transporting within a limited area by following specific path, processing, welding, home appliances, autonomous robots, military robots for reducing human involvement and danger, collaborative robots for interacting with human such that for performing several tasks, educational robots, mobile robots and humanoids. In the longer term, perhaps 10–20 years from today, the earliest molecular machine systems and nanorobots may join the medical armamentarium, finally giving physicians the most potent tools imaginable to conquer human disease, ill-health, and aging [2].

CLASSIFICATION OF ROBOTS

Robots are categorized depending upon the circuits of the Robots and the variety of application it can perform. The robots are classified into three types:

1. **Simple level robots-** These are automatic machines which do not contain complex circuit. They are developed just to extend human potential. For Example- Washing Machine.
2. **Middle level Robots**– These robots are programmed but can never be reprogrammed. These robots contain sensor-based circuit & can perform multiple tasks. For Example- Fully Automatic Washing Machine.
3. **Complex level Robots-** These robots are programmed and can be reprogrammed as well. They contain complex model-based circuit. For Example- Laptop or Computer.

Types of robots

Various types of functioning robots are used in different fields of medical and non-medical discipline. Some of them are as follows:

1. **Industrial robots-** These are an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes. The field of industrial robotics may be more practically defined as the study, design and use of robot systems for manufacturing. Typical applications of industrial robots include welding, painting, ironing, assembly, pick and place, palletizing, product inspection, and testing, all accomplished with high endurance, speed, and precision. The most commonly used robot configurations for industrial automation include articulated robots, SCARA robots and gantry robots. In the context of general robotics, most types of industrial robots would fall into the category of robot arms.
2. **Humanoid robots-** These are a robot with its overall appearance based on that of the human body. In general, humanoid robots have a torso with a head, two arms and two legs, although some forms of humanoid robots may model only part of the body, for example, from the waist up. Some humanoid robots may also have a 'face' with 'eyes' and 'mouth'. Androids are humanoid robots built to resemble a male human, and Gynoids are humanoid robots built to resemble a human female.
3. **Surgical robots-** These are used in performing surgery. Three major advances aided by surgical robots have been remote surgery, minimally invasive surgery, and unmanned surgery. Major potential advantages of robotic surgery are precision and miniaturization magnification. Some surgical robots are autonomous, and they are not always under the control of a surgeon. They are only sometimes used as tools to extend the surgical skills of a trained surgeon.
4. **Swimming robots-** These are micro or nano robots that can swim when injected into the body via vascular and digestive system by using blood sugar as fuel. They are used to perform medical task the main aim of these robots is to avoid major surgery and enhance diagnosis of disease. The capabilities of nanorobots include therapeutic and diagnostic functions such as ultra-sounding, biopsy, and laser and produce heat by retractable arm.
5. **Domestic or household robots** – Robots which are used at home. This sort of robots consists of numerous different gears for example- robotic pool cleaners, robotic sweepers, robotic vacuum cleaners, robotic sewer cleaners and other robots that can perform different household tasks. Also, a number of scrutiny and tele-presence robots can also be considered as domestic robots if brought into play in that sort of environment.

6. **Service robots** – Robots that cannot be classed into any other types by practice. These could be various data collecting robots, robots prepared to exhibit technologies, robots employed for research, etc.
7. **Military robots** – Robots brought into play in military & armed forces. This sort of robots consists of bomb discarding robots, various shipping robots, exploration drones. Often robots at the start produced for military and armed forces purposes can be employed in law enforcement, exploration and salvage and other associated fields.
8. **Entertainment robots** – These types of robots are employed for entertainment. This is an extremely wide-ranging category. It begins with model robots such as robosapien or the running photo frames and concludes with real heavy weights like articulated robot arms employed as movement simulators.
9. **Space robots** – This type of robots would consist of the robots employed on Canadarm that was brought into play in space Shuttles, the International Space Station, together with Mars explorers and other robots employed in space exploration and other activities.
10. **Hobby and competition robots** – Robots that is created by students. Sumo-bots, Line followers, robots prepared merely for learning, fun and robots prepared for contests.
11. **Magnetic resonance imaging (MRI) based nanorobots -** The robotic platform uses MRI for feeding back information to a controller responsible for the real-time control and navigation along pre-planned paths in the blood vessels of untethered magnetic carriers, nanorobots, and/or magnetotactic bacteria (MTB) loaded with sensory or therapeutic agents acting like a wireless robotic arm, manipulator, or other extensions necessary to perform specific remote tasks. Unlike known magnetic targeting methods, the present platform allows us to reach locations deep in the human body while enhancing targeting efficacy using real-time navigational or trajectory control [3].
12. **Nanorobots with sensors-** This is an innovative approach for the development of nanorobots with sensors for medicine. The nanorobots operate in a virtual environment comparing random, thermal and chemical control techniques. The nanorobot architecture model has nanobioelectronics as the basis for manufacturing integrated system devices with embedded nanobiosensors and actuators, which facilitates its application for medical target identification and drug delivery [4].
13. **Respirocytes-** These are designed as artificial mechanical red blood cells which are blood borne spherical 1 µm diameter sized. The outer shell is made of diamondoid 1000 atm pressure vessel with reversible molecule-selective pumps [5,6]. They carry oxygen and carbon dioxide molecules throughout the body.
14. **Microbivores-** These are the nanorobot which functions as artificial white blood cell and also known as nanorobotic phagocytes. The microbivore is a spheroid device made up of diamond and sapphire which measures 3.4 µm in diameter along its major axis and 2.0 µm diameter along minor axis and consists of 610 billion precisely arranged structural atoms. It traps in the pathogens present in the blood stream and break down to smaller molecules. The main function of microbivore is to absorb and digest the pathogens in the blood stream by the process of phagocytosis. These consist of 4 fundamental components: An array of reversible binding sites, An array of telescoping grapples, A morcellation chamber and Digestion chamber [7].
15. **Clottocytes-** The theoretically designed clottocyte describes artificial mechanical platelet or clottocyte that would complete hemostasis in approximately 1 sec. It is spherical nanorobot powered by serum-oxyglucose approximately 2 µm in diameter containing a fiber mesh that is compactly folded onboard. The response time of clottocyte is 100-1000 times faster than the natural hemostatic system. The fiber mesh would be biodegradable and upon release, a soluble film coating of the mesh would dissolve in contact with the plasma to expose sticky mesh [8].

WORKING OF NANOROBOTS

Carbon is the principal element comprising the bulk of a medical nanorobot (probably in the form of diamond or diamondoid nanocomposites). Many other light elements such as hydrogen, sulfur, oxygen, nitrogen, fluorine, silicon, etc. will be used for special purposes in nanoscale gears and other components. When an implantation of a tiny robot into our blood stream, robot detects the cause of the fever, travels to the appropriate system and provides a dose of medication directly to the infected area. It working mechanism in different ways to target sites as follows:

1) The attached bacteria by rotating their flagella push the microscope to forward by using different chemicals the on/off motions of microrobots are controlled. These chemicals bind to the flagellar motor restrict their movement. Mainly used chemicals are EDTA and copper ions are used to stop their motion. EDTA (ethylene diamine tetra acetic acid) used to restart their motion.
2) By attachment of nanorobots to blood cells to target sites.
3) The swimming robots contain robotic body, poly styrene microspheres, which are also called as micro beads that bond to specific sites.
4) By bacteria propulsion method of micro bacteria delivery, the bacteria was propelled by rotating their flagella with high speed then the bacteria adhere to the micro beads. This attachment takes place in 2 steps-
    a) Reversible: In reversible attachment the bacteria adhere to the micro bead with vander wall forces, acid-base interactions and electrostatic forces. These are weaker bonds hence this attachment is reversible.
    b) Irreversible: Irreversibly attached to them by forming strong bonds.
5) By Speed controlling techniques.

PHARMACEUTICAL APPROACHES

The development of nanorobots is done by using various approaches such as: Biochip, Nubots, Positional Nano assembly, Usage of Bacteria etc.

1) Biochip- 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.

2) Nubots- Nubot is an acronym for "nucleic acid robots." These are manmade robotics devices at the Nanoscale. Representative nubots includes numerous Deoxy Nucleic Acid walkers reported by Ned Seeman's group at NYU, Niles Pierce's group at Caltech, John Reif's group at Duke University, Chengde Mao's group at Purdue, and Andrew Turberfield's group at the University of Oxford.

3) Positional Nanoassembly- In the year 2000, Robert Frietas and Ralph Merkle found nanofactory collaboration which is an ongoing effort consisting of ten organizations with 23 researchers from four countries. This collaboration aims at developing positionally controlled mechanosynthesis and diamondoid nanofactory which is capable of constructing a diamondoid medical nanorobot.

4) Usage of Bacteria- This approach makes use of biological microorganisms, such as *Escherichia coli* bacteria. So this model uses a flagellum for propulsion purpose. The use of electromagnetic fields is to control the motion of biological integrated device and its limited applications. Through directional and magnetic field intensities, the displacement speeds, directions, and behaviors of swarms of these bacterial actuators can be controlled from an external computer [9].

Pharmaceutical Advantages

- Rapid elimination of disease.
- The microscopic size of nanomachines translates into high operational speed.
- Faster and more precise diagnosis.
- Non-degradation of treatment agents.
- Remains durable in operation for years, decades or centuries.

Pharmaceutical Disadvantages

- Possible food chain interruption.
- Lack of knowledge.
- Nano implements could adjust human DNA structure.
- Environmental hazards.

CONCEPT AND DESIGNING OF NANOTECHNOLOGY

1. **Development of a new approach using genetic algorithms, neural networks, and nanorobotics concepts**- It is applied to the problem of control design for nanoassembly automation and its application in medicine. It is a practical approach to validate the proposed design and simulated a virtual environment focused on control automation for nanorobotics teams that exhibit collective behavior. This collective behavior is a suitable way to perform a large range of tasks and positional assembly manipulation in a complex three-dimensional workspace. The application of such theoretical and practical analyses of control modeling techniques are suitable for the investigation of nanorobotics system design in nanomedicine [10].
2. **Nanorobot Hardware Architecture concept-** It is designed for nanorobots application in epidemic control, which should enable real time *in vivo* prognosis of biohazard infection. The recent developments in the field of nanoelectronics, with transducers progressively shrinking down to smaller sizes through nanotechnology and carbon nanotubes, are expected to result in innovative biomedical instrumentation possibilities, with new therapies and efficient diagnosis methodologies for medical defense [11].
3. **Medical nanorobots with nanobiosensors concept-** The research and development of nanorobots with embedded nanobiosensors and actuators is considered a new possibility to provide new medical devices for doctors [12]. As integrated control mechanisms at microscopic environments differ from conventional control techniques, approaches using event-based feed forward control are sought to effectively advance new medical technologies [13,14].
4. **Task based nanorobot model prototyping concept-** This is designed with detection of protein alpha-NAGA higher concentrations in blood stream simulation. It incorporates the physical morphology of the biological environment along with physiological fluid flow patterns and this is allied with the nanorobot systems for orientation, drive mechanisms, sensing and control. The real time 3D simulation is used to achieve high-fidelity on control modelling and equipment prototyping. Hence, the NCD (Nanorobot Control Design) software was implemented and is used for nanorobot sensing and actuation. The computational model is applied as a practical tool for control and manufacturing design analyses. Real time 3D design and simulation are important for the fast development of nanotechnology, helping also in the research and development of medical nanorobots [15,16]. Such tools have significantly supported the semiconductor industry to achieve faster VLSI implementation [17]. It has similarly direct impact on nanomanufacturing and also nanoelectronics progress [18]. Simulation can anticipate performance, help in new device prototyping and manufacturing, nanomechatronics control design and hardware implementation [19, 20].
5. **An innovative nanorobot architecture concept based on nanobioelectronics for diabetes-** It is a computational concept with the application of medical nanorobotics for diabetes by using clinical data. Integrated simulation can provide interactive tools for addressing nanorobot choices on sensing, hardware design specification, manufacturing analysis and methodology for control investigation. In the proposed 3D prototyping, a physician can help the patient to avoid hyperglycemia by means of a handheld device, like a cell phone enclosed with cloth that is used as a smart portable device to communicate with nanorobots. Therefore, this architecture provides a suitable choice to establish a practical medical nanorobotics platform for in vivo health monitoring [21].

APPLICATIONS

In this nano era robots and nanorobots are used in various fields. Some of them are described as below-

I. Pharmaceutical application

II. Non-Pharmaceutical application

I. Pharmaceutical application: It includes-

1. **Nanorobotics in Surgery:** 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. This programmed surgical nanorobot performs various functions like searching for pathogens, and then

diagnosis and correction of lesions by nano-manipulation synchronized by an on-board computer while conserving and contacting with the supervisory surgeon through coded ultrasound signals. Nowadays, the earlier forms of cellular nano-surgery are being explored. For example, a micropipette rapidly vibrating at a frequency of 100 Hz micropipette comparatively less than 1-micron tip diameter is used to cut dendrites from single neurons. This process is not ought to damage the cell capability.

2. Diagnosis and Testing: Medical nanorobots are used for the purpose of diagnosis, testing and monitoring of microorganisms, tissues and cells in the blood stream. These nanorobots are capable of noting down the record, and report some vital signs such as temperature, pressure and immune system's parameters of different parts of the human body continuously.

3. Nanorobotics in Gene Therapy: Nanorobots are also applicable in treating genetic diseases, by relating the molecular structures of DNA and proteins in the cell. The modifications and irregularities in the DNA and protein sequences are then corrected (edited). The chromosomal replacement therapy is very efficient compared to the cell repair. An assembled repair vessel is inbuilt in the human body to perform the maintenance of genetics by floating inside the nucleus of a cell. Supercoil of DNA when enlarged within its lower pair of robotic arms, the nanomachine pulls the strand which is unwounded for analysis; meanwhile the upper arms detach the proteins from the chain. The information which is stored in the large nanocomputer's database is placed outside the nucleus and compared with the molecular structures of both DNA and proteins that are connected through communication link to cell repair ship. Abnormalities found in the structures are corrected, and the proteins reattached to the Deoxy Nucleic Acid chain once again reforms into their original form. (Fig. 1)

Fig. 1 Nanorobotics in Gene Therapy

4. Nanorobots in Cancer Detection and Treatment: The current stages of medical technologies and therapy tools are used for the successful treatment of cancer. It is based on the improvement of efficient drug delivery to decrease the side-effects from the chemotherapy. Nanorobots with embedded chemical biosensors are used for detecting the tumor cells in early stages of cancer development inside a patient's body. Nanosensors are also utilized to find the intensity of E-cadherin signals. (Fig. 2)

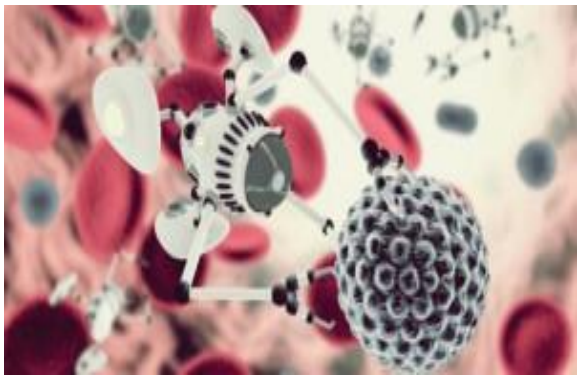

Fig. 2 Nanorobots in Cancer Detection and Treatment

5. Nanodentistry: It is one of the topmost applications as nanorobots help in different processes involved in dentistry. These nanorobots are helpful in desensitizing tooth, oral anesthesia, straightening of irregular set of teeth and improvement of the teeth durability, major tooth repairs and improvement of appearance of teeth, etc. (Fig. 3) Treatment possibilities might include the application of nanotechnology to local anesthesia, dentition denaturalization, the permanent cure for hypersensitivity, complete orthodontic realignment in a single visit, covalently bonded diamondized enamel, and continuous oral health maintenance using mechanical dentifrobots. Dental nanorobots could be constructed to destroy caries-causing bacteria or to repair tooth blemishes where decay has set in, by using a computer to direct these tiny workers in their tasks. Dental nanorobots might be programmed to use specific motility mechanisms to crawl or swim through human tissue with navigational precision, to acquire energy, to sense and manipulate their surroundings, to achieve safe cytopenetration, and to use any of a multitude of techniques to monitor, interrupt, or alter nerve-impulse traffic in individual nerve cells in real time [22].

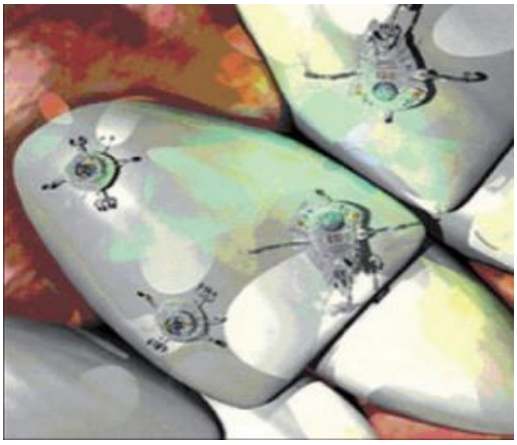

Fig. 3 Nanodentistry

6. Nanorobots in monitoring and controlling the glucose level: These can also be used as ancillary devices for processing different chemical reactions in the affected organs and useful for monitoring and controlling the glucose levels by emit a signal on specified lunch time and to measure the glucose levels in desired intervals of time in diabetic patients.

7. In treatment of Arterosclerosis: These are used to treat Arterosclerosis by breaking the plaques in the arteries releasing chemicals at the site of injury. Nanorobots could conceivably treat the condition by cutting away the plaque and it would then enter the bloodstream.

8. Nanorobots in neurosurgery- The topic of spinal cord injury and nerve damage is an important area of concern within neurosurgery as a field, and as a significant life-altering event for affected patients. It includes promoting the regeneration of axons via growth factors [23] and enriched scaffolds [24]. Advancements in technology have led to the development of devices on the nanoscale which allows manipulation of individual axons. A nanoknife with a 40-nanometer diameter has been developed and found to be effective for axon surgery [25]. The use of dielectrophoresis, which involves the use of electrical fields to manipulate polarizable objects in space, has been found to be effective in achieving controlled movement of axons within a surgical field [26]. Following controlled transection of axons and maneuvering them into position using dielectrophoresis, fusion between the two ends can be induced via electrofusion [27], polyethylene glycol [28], or laser-induced cell fusion [29], amongst other methods. Nanodevices are enabling a new dimension of precision and control with the reconnection of nerves. Circulating nanorobot has been developed for the monitoring of intracranial aneurysm development and progression [30].

9. In microbiology- The field of microbiology has been successfully used as a springboard for the initial development of robotic functions in nanobiotechnology. Although microrobots and nanorobots can be constructed and have function [31], their use within the vascular system is limited by challenges with transportation and propulsion. An effective strategy for enabling propulsion of

microrobots and nanorobots is coupling them to magnetotactic bacteria such as Magnetococcus, Magnetospirillum magnetotacticum or Magnetospirillum magneticum [32, 33]. The largest componenet of these nanorobots integrated into magnetotactic bacteria would be the bacterial cell component. The smallest known species of magnetotactic bacteria is the marine magnetotactic spirillum, which is 0.5 µm (500 nanometers), just above the upper limit of the NNI's definition of the nanoscale. However, the marine magnetotactic spirillum's usefulness is limited by their speed, and magnetotactic cocci are more useful for intravascular function. The magnetotactic bacteria can be guided in the desired direction using the application of magnetic fields [34]. The components of the magnetotactic bacteria that are responsive to the magnetic field are called magnetosomes. Magnetosomes are prokaryotic pseudo-organelles with about 15-20 magnetite crystals, each about 50 nm in diameter, contained within an invagination of the prokaryotic cell membrane [35].

10. In heamatology- There is a rich base of research and potential applications for nanomedicine and nanorobotic applications in the field of hematology. From uses ranging to emergency transfusions of non-blood oxygen carrying compounds to restoring primary hemostasis, there is a wide array of applications under study for nanorobotics in hematology [36]. One of these devices currently under design is a nanorobot dubbed a respirocyte. This robot is equipped to have three functions as it travels through the bloodstream. First, collecting oxygen as it passes through the respiratory system for distribution throughout the bloodstream. Second, collecting carbon dioxide from tissues for release into the lungs. And finally, metabolizing circulating glucose to power its own functions. The total size of the robot would be about one micron, or 1,000 nanometers. However, the contained components would be constructed on the nanoscale. These include an onboard computer of 58 nm diameter, and oxygen and carbon dioxide loading rotors with a maximum 14 nm diameter in any one dimension. The respirocyte is designed to carry 236 times more oxygen per unit of volume compared to red blood cells [37]. Development and use of this technology could provide an effective and lower risk alternative to blood transfusions. Circulationg “clottocyte” nanorobot with haemostatic functions [38] and phagocytic “microbivores” with customizable antigen binding sites for targeting of pathogens have been developed [39].

11. In regular measurement of BGLs: The nanorobot can be programmed to activate sensors and measure regularly the BGLs early in the morning, before the expected breakfast time.

12. In kidney stones treatments: Breaking up of painful kidney stones using a small laser by nanorobots.

13. It is used in Targeted-delivery of pharmaceutical agents to specific cellular and intracellular destinations within the human body.

14. Helpful in Breaking up blood clots and parasite removal.

15. Can be a very helpful and hopeful for the radiation therapy and chemotherapy.

II. Non-Pharmaceutical application: It includes in-

1. **Outer Space** – Robotic arms that are under the control of a human being are employed to unload the docking cove of outer-space shuttles to launch satellites or to build a space station.
2. **The Intelligent Home** – Robotic systems can nowadays scrutinize home safety, ecological circumstances and energy consumption. Door & windows can be unlocked mechanically and electrical device such as lights and A/C can be pre-programmed to turn on. This helps residents to enjoy appliances irrespective of their mobility.
3. **Exploration** – Robots can enter the environments that are injurious to human beings. An illustration is observing the atmosphere within a volcano or investigating our deep marine life. NASA has utilized robotic probe for environmental study, ever since the early 60’s.
4. **Military Robots** – Flying robot drones are brought into play for close watch in present time’s modern armed force. In the future robotic airplane and automobiles could be employed to transmit petroleum, bullets, bombs, etc or clear minefields.
5. **Farms** – Programmed robots are used by harvesters to cut and collect crops. Robotic milk farms are existing permitting workers to nourish and milk their cattle distantly.
6. **The Car Industry** – Robotic arms are used; these arms are able to execute numerous tasks in the car manufacturing & assembling procedure. They carry out jobs such as sorting, cutting, welding, lifting, painting and bending. Similar functions but on a minor scale are now being intended for the

food industry to execute tasks like- the trimming, cutting and processing of different types of meats like- chicken, beef, fish, lamb, etc.

7. **Hospitals** – The development of a robotic suit is under construction that will allow nurses to raise patients without injuring their backbones. Scientists in Japan have crafted a power facilitated suit which will provide nurses the additional power that they need to lift patients.
8. **Disaster Areas** – Observation robots built-in with superior sensing and imaging gears. This robot can work in dangerous environments like urban site spoiled by earthquakes by inspecting floors, walls, and roofs for structural reality.
9. **Entertainment** – Interactive robots that shows behaviors and education capability. One such robot is owned by SONY which moves around freely, responds to all your commands, carries your luggage and even responds to your oral instructions.

ROBOTIC PROJECTS

The robotic vehicles are special type of machines designed to move on the ground, in the air, under water and in space autonomously without a human on board. These robotic vehicles are controlled and operated by various sensors-based control systems. The robotic vehicles are specially designed to use in conditions where human beings are unable to enter such as fire accidents, very high or very low temperatures, etc. some of them are as follows designed by engineers.

1. **Infrared Controlled Robotic Vehicle:** The project is designed to control a robotic vehicle using a standard TV remote. IR sensor is interfaced to the control unit on the robot for sensing the IR signals transmitted by the remote. This data is conveyed to the control unit which moves the robot as desired. An 8051 series microcontroller is used in this project as control device. Transmitting end uses a TV remote through which IR commands are transmitted. At the receiver end, these commands are used for controlling the robot in all directions such as forward, backward and left or right etc. At the receiving end the movement is achieved by two motors that are interfaced to the microcontroller.
2. **Radio Frequency (RFID) Controlled Robotic Vehicle with Laser Beam Arrangement:** The RFID tag is a microchip with an antenna in a compact package. The Tag can be attached to the object to be tracked through Radio frequency. The Tag's antenna picks up the signals from the RFID reader and then returns the signal usually with some additional data like unique serial number. The RFID tags are too small so that it can be incorporated in any objects. Some Tags require battery while most of them do not need battery power and read at short distances using the electromagnetic induction. The Tag contains stored data which can be send to several meters through the radio waves. The flow diagramme is as follows- (Fig. 4)

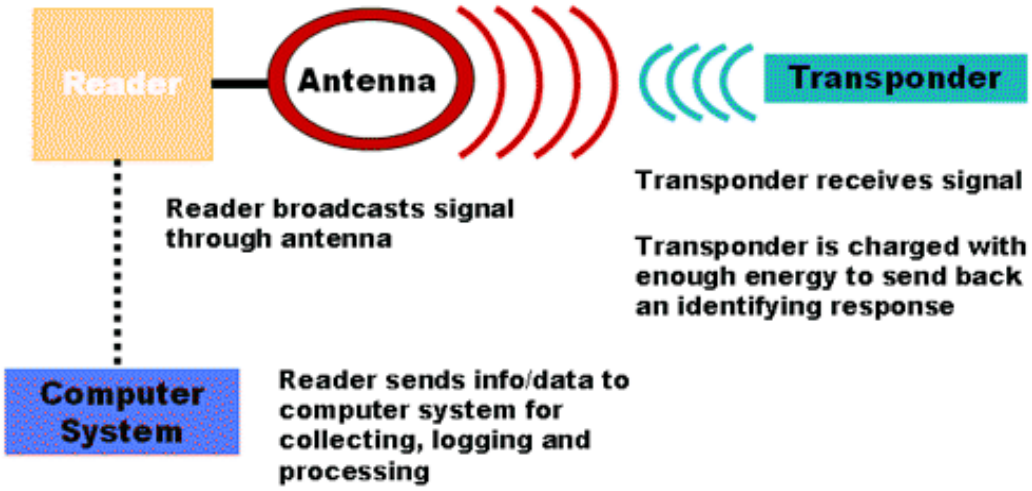

Fig. 4 The RFID

3. **8051 Microcontroller Based Line Following Robotic Vehicle:** A line follower robot is a robot which follows a certain path controlled by a feedback mechanism. The line fallowing robot is

one of the self-operating robots. That detects and fallows a line drawn on the area. The line is indicated by white line on a block surface or block line on a white surface. This system must be sense by the line. This application is depending upon the sensors. Here we are using two sensors for path detection purpose. That is proximity sensor and IR sensor. The proximity sensor used for path detection and IR sensor used for obstacle detection. These sensors mounted at front end of the robot. The microcontroller is an intelligent device the whole circuit is controlled by the microcontroller. These are utilized in different field by various applications as follows-

i) Industrial Applications: These robots can be used as automated equipment carriers in industries replacing traditional conveyer belts.

ii) Automobile applications: These robots can also be used as automatic cars running on roads with embedded magnets.

iii) Domestic applications: These can also be used at homes for domestic purposes like floor cleaning etc.

iv) Guidance applications: These can be used in public places like shopping malls, museums etc to provide path guidance.

4. **Controlling and Movement of Pick and Place Robotic Arm by Using Android Wirelessly**: A pick and place robot is the one which is used to pick up an object and place it in the desired location. It can be a cylindrical robot providing movement in horizontal, vertical and rotational axes, a spherical robot providing two rotational and one linear movement, an articulate robot or a scara robot (fixed robots with 3 vertical axes rotary arms). They are faster and can get the work done in seconds compared to their human counterparts. They are flexible, accurate and have the appropriate design and increase the safety of the working environment and actually never get tired. (Fig. 5)

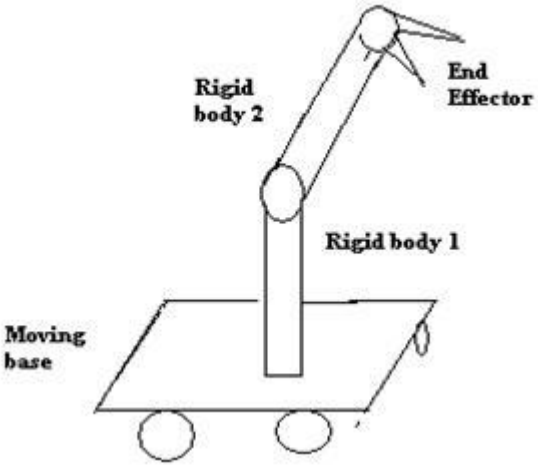

Fig. 5 A Simple Pick N Place Robot

5. **Voice Controlled Robotic Vehicle by Long Distance Speech Recognition:** The basic principle of voice recognition involves the fact that speech or words spoken by any human being cause vibrations in air, known as sound waves. These continuous or analog waves are digitized and processed and then decoded to appropriate words and then appropriate sentences. Its Speech Recognition System component (Fig. 6) are described below as-

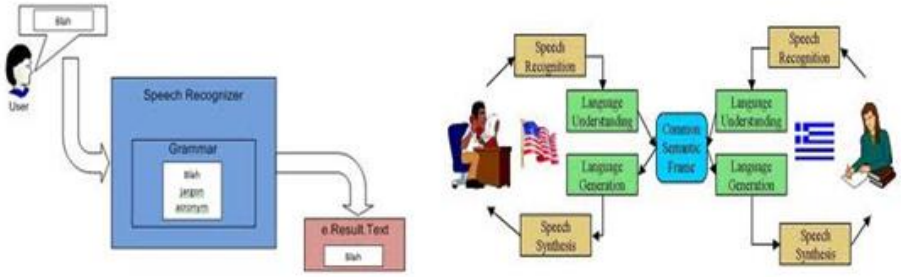

Fig. 6 Components of a Speech Recognition System

a) A speech capturing Device: It consists of a microphone, which converts the sound wave signals to electrical signals and an Analog to Digital Converter which samples and digitizes the analog signals to obtain the discrete data that the computer can understand.

b) A Digital Signal Module or a Processor: It performs processing on the raw speech signal like frequency domain conversion, restoring only the required information etc.

c) Preprocessed signal storage: The preprocessed speech is stored in the memory to carry out further task of speech recognition.

d) Reference Speech patterns: The computer or the system consists of predefined speech patterns or templates already stored in the memory, to be used as the reference for matching.

e) Pattern matching algorithm: The unknown speech signal is compared with the reference speech pattern to determine the actual words or the pattern of words.

6. Metal Detector Robotic Vehicle: (the robotic vehicle with LASER gun): Principle behind the LASER revolves around three things; those are absorption, spontaneous emission and stimulated emission. An adequate amount of energy from the photon is interacts with the atom, causing the atom to jump from lower energy state to higher energy state. This atom is fall back to the lower energy state by emitting a photon called as spontaneous emission. In stimulated emission is the release of energy from the atom by artificial means. So the photon interacts with the excited atom, has the same energy and polarization as the incident photon. Such robot is used basically in military operations and also by traffic police to detect the speed of moving vehicles.

7. Pick N Place with Soft Catching Gripper: The project is designed to develop a pick n place robotic vehicle with a soft catching gripper. For example, it can safely handle a bomb very carefully to avoid explosion while catching. The robotic vehicle is RF controlled for remote operation.

8. Fire Fighting Robotic Vehicle using 8051 Microcontroller: The 8051 Microcontroller was designed in 1980's by Intel. These are utilized in-

- **Energy Management:** Competent measuring device systems aid in calculating energy consumption in domestic and industrialized applications. These meter systems are prepared competent by integrating microcontrollers.
- **Touch screens:** A high degree of microcontroller suppliers integrate touch sensing abilities in their designs. Transportable devices such as media players, gaming devices & cell phones are some illustrations of micro-controller integrated with touch sensing screens.
- **Automobiles:** The microcontroller 8051 discovers broad recognition in supplying automobile solutions. They are extensively utilized in hybrid motor vehicles to control engine variations. In addition, works such as cruise power and anti-brake mechanism has created it more capable with the amalgamation of micro-controllers.
- **Medical Devices:** Handy medicinal gadgets such as glucose & blood pressure monitors bring into play micro-controllers, to put on view the measurements, as a result, offering higher dependability in giving correct medical results.

9.Radio Frequency Controlled Robot with Night Vision Wireless Camera for Spying in War Field: The spying robot as its name suggests in the one used for the purpose of spying on enemy territories. Its applications can be:

1. At the time of war where it can be used to collect information from the enemy terrain and monitor that information at a far secure area, and safely devise a plan for the counter attack.

2. Tracking locations of terrorist organizations and then plan attack at suitable time.
3. Making a surveillance of any disaster affected area where human beings can't go.

1. **Fire Fighting Robot Remotely Operated with Android Applications:** Robots can be used in place of conventional fire brigade vehicles (where the whole operation is carried out manually) for remotely extinguishing the fire. These robots can be fully automatic or can be controlled remotely. Here such a robot is developed which consists of a water tank and a pipe connected to the tank such that water is supplied from the tank to the pipe which is thrown out from the pipe through a nozzle as per operation by the user. The whole operation of the robot and its movement is done by control signals from a GUI application on the Android based smart phone.

10. **Dual Tone Multi Frequency based Mobile Phone Controlled Robot:** DTMF or Dual Tone Multi Frequency is used for telecommunication signaling over analog telephone lines in voice frequency band between telephone handsets, other communication devices and the switching center.

11. **Digital Compass and Global Positioning System Based Self Navigation System:** GPS or Global Positioning System is a satellite navigation system that furnishes location and time information in all climate conditions to the user. GPS is used for navigation in planes, ships, cars and trucks also. The system gives critical abilities to military and civilian users around the globe. GPS provides continuous real time, 3-dimensional positioning, navigation and timing worldwide. The GPS system consists of three segments: The space segment (the GPS satellites), the control system (operated by the U.S. military) and the user segment (which includes both military and civilian users and their GPS equipment).

12. **Line Following Robotic Vehicle with Walking and Climbing Mechanism:** The components required for designing of it are to be estimated based on robot application. Gather all the electrical and electronic components such as resistors, capacitors, IR transmitters, DC motors, transistors, robot body and photo diodes with appropriate ratings along with other parts such as cardboard, bolts, nuts, aluminum strips, etc., as per requirement. All the required components for designing robotics projects (project kits) can be easily purchased online. Simple steps to design a line follower robot with walking and climbing mechanism are shown below.

Step1: Gathering required Components (Electrical and Electronic Components)
Step 2: Analyzing the Circuit for Line Follower Robot
Step3: Assembling and Soldering Components
Step 4: Working of Line Follower Robot
Step5: Line Follower Robotic Vehicle with Walking and Climbing Mechanism.

14. War Field Spying Robot with Night Vision Wireless Camera by Android Application: The project is designed to develop a robotic vehicle using android application for remote operation attached with wireless camera for monitoring purpose. The robot along with camera can wirelessly transmit real time video with night vision capabilities. A wireless camera is mounted on the robot body for spying purpose even in complete darkness by using infrared lighting. This is kind of robot can be helpful for spying purpose in war fields. An 8051 series of microcontroller is used for the desired operation. At the transmitting end using android application device, commands are sent to the receiver to control the movement of the robot either to move forward, backward and left or right etc. At the receiving end two motors are interfaced to the microcontroller where they are used for the movement of the vehicle. Remote operation is achieved by any smart-phone/Tablet etc., with Android OS, upon a GUI (Graphical User Interface) based touch screen operation. The android application device transmitter acts as a remote control that has the advantage of adequate range, while the receiver end Bluetooth device fed to the microcontroller drives DC motors via motor driver IC for necessary work [https://www.edgefxkits.com, https://www.elprocus.com].

FUTURE ASPECT

Few new DTMF Projects and electronic projects ideas have been planned and proposed based on robotics. Some of them are- DTMF Based Load Control System, Cell Phone Based DTMF Controlled Garage Door

Opening System, Display of Dialed Telephone Numbers on Seven Segment Displays, Automatic Dialing to Any Telephone Using I2C Protocol on Detecting Burglary, Cell Phone Controlled Robotic Vehicle etc.

CONCLUSIONS

Robotics is an area of interest to human beings for more than one hundred years. From these types of inventions, it will be useful for man to cure many diseases then lead a fantastic long life. We can use the technology for more accuracy in any field. Nanorobots are going to revolutionize in medical industries in future. But in these technologies, there is possible danger also. Thus, it is needful to invent these kinds of special featured nanorobots in the safe kind which will be in nonhazardous to the living kind. Robotics is a broad field and everyday there is a pioneering invention in the field. Robots were invented by the humans just for fun but by now they are used for assisting humans in various sectors. Human beings are better suitable for multifaceted, imaginative, adaptive jobs, and robots are good for dreary, recurring tasks, permitting human beings to do the harder thinking jobs, whereas a robot is employed for substituting humans for various recurring tasks or entertainment to make living more expedient. This is not the end of Robotic world there will be many more applications of Robotics in future.

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