Manufacturing and applications of Nanorobotics -Review

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Abstract: ***Nanorobots would constitute any* "smart" *structure capable of* actuation, sensing, signaling, information processing, intelligence, manipulation and swarm behavior *at nano scale (10-9m) Nanorobotics is one of the newest offshoots of Nanotechnologies. Nanorobots are simply devices that are very small in size in the region of 10.9 nanometers and are functionally capable of carrying out task that are humanly impossible. Manufacturing nanomachines assembled from molecular components is a very challenging task. Nanotechnology is showing great effective results in human treatment by using nanorobotics application in medicine, health care, space and mechanics***

KEY WORDS:- Nanorobots , nanomachines, human , mechanics and space

INTRODUCTION:-

Nanorobots would constitute any ***"smart"*** structure capable of *actuation, sensing, signaling, information processing, intelligence, manipulation and swarm behavior* at nano scale (10-9m). The word "nanobot" (also "nanite", "nanogene", or "nanoant") is often used to indicate this fictional context and is an informal or even pejorative term to refer to the engineering concept of nanorobots.

One vision of a nanoassembler or nanorobot is a device with robotic arms, motors, sensors and computer to control the behaviour, all at the scale of nanometres. In 1992, the book called "Nanosystem" by Drexlergives an analysis of the feasibility of machine components for such nanorobots . However, even to build a molecular motor, researchers have to consider laws of thermodynamics when motors are actually in operation . Just building a miniature version of an ordinary motor is not adequate. Recently, a controversy arose surrounding Feynman's vision of nanorobots. In 2003, an open debate through letters between K. E. Drexler and R. E. Smalley (who was awarded a Nobel Prize for the discovery of fullerenes) was presented to public. Smalley was not convinced that such molecular assemblers envisioned by Drexler are physically possible, while Drexler insists on his previous findings. Certainly, the study of similarly-sized biological machines – organic cells – suggests there may be more effective alternatives to Drexler's nanorobots. Even if nanorobots can be realised, they will not be available in the near future .

The word nanorobot is the correct technical term in the nonfictional context of serious engineering studies. Some proponents of nanorobotics, in reaction to the grey goo scare scenarios that they earlier helped to propagate, hold the view that nanorobots capable of replication outside of a restricted factory environment do not form a necessary part of a purported productive nanotechnology, and that the process of self-replication, if it were ever to be developed, could be made inherently safe . They further assert that free-foraging replicators are in fact absent from their current plans for developing and using molecular manufacturing.

Nanorobotics is one of the newest offshoots of Nanotechnologies. Nanorobots are simply devices that are very small in size in the region of 10.9 nanometers and are functionally capable of carrying out task that are humanly impossible. The construction of nanorobots is a complex engineering process still in its infancy. But as newer technologies are being tried, the day is not far off when they will be introduced in every field of industry, notably the medical industry. Currently major researches are going all over the world and the day is not far off when everything becomes in real world application.

MANUFACTURING :-

Manufacturing nanomachines assembled from molecular components is a very challenging task. Because of the level of difficulty, many engineers and scientists continue working cooperatively across multidisciplinary approaches to achieve breakthroughs in this new area of development. Thus, it is quite understandable the importance of the following distinct techniques currently applied towards manufacturing nanorobots:

Biochip

The joint use of nanoelectronics, photolithography, and new biomaterials provides a possible approach to manufacturing nanorobots for common medical uses, such as surgical instrumentation, diagnosis, and drug delivery.(Fisher, B. (2008); Cavalcanti, A et al., 2008; Hill, C.,et al ., 2008). This method for manufacturing on nanotechnology scale is in use in the electronics industry since 2008 (Cale T. S et al.,2008) So, practical nanorobots should be integrated as nanoelectronics devices, which will allow tele-operation and advanced capabilities for medical instrumentation (*Couvreur, P.; Vauthier, C. (2006):, Elder, J. B.et al 2008).*

Nubots

A *nucleic acid robot* (nubot) is an organic molecular machine at the nanoscale. DNA structure can provide means to assemble 2D and 3D nanomechanical devices. DNA based machines can be activated using small molecules, proteins and other molecules of DNA. Biological circuit gates based on DNA materials have been engineered as molecular machines to allow in-vitro drug delivery for targeted health problems. Such material based systems would work most closely to smart biomaterial drug system delivery, while not allowing precise in vivo teleoperation of such engineered prototypes.

Surface-bound systems

Several reports have demonstrated the attachment of synthetic molecular motors to surfaces.These primitive nanomachines have been shown to undergo machine-like motions when confined to the surface of a macroscopic material. The surface anchored motors could potentially be used to move and position nanoscale materials on a surface in the manner of a conveyor belt.

Positional nanoassembly

Nanofactory Collaboration, founded by Robert Freitas and Ralph Merkle in 2000 and involving 23 researchers from 10 organizations and 4 countries, focuses on developing a practical research agenda specifically aimed at developing positionally-controlled diamond mechanosynthesis and a diamonded nanofactory that would have the capability of building diamondoid medical nanorobots.

Biohybrids

This approach uses a biodegradable material attached to magnetic particles that allow them to be guided around the body.

Bacteria-based

This approach proposes the use of biological microorganisms, like the bacterium *Escherichia coli*[52] and *Salmonella typhimurium*. Thus the model uses a flagellum for propulsion purposes. Electromagnetic fields normally control the motion of this kind of biological integrated device.Chemists at the University of Nebraska have created a humidity gauge by fusing a bacterium to a silicone computer chip.

Virus-based

Retroviruses can be retrained to attach to cells and replace DNA. They go through a process called reverse transcription to deliver genetic packaging in a vector. Usually, these devices are Pol – Gag genes of the virus for the Capsid and Delivery system. This process is called retroviral gene therapy, having the ability to re-engineer cellular DNA by usage of viral vectors.This approach has appeared in the form of retroviral, adenoviral, and lentiviral gene delivery systems. These gene therapy vectors have been used in cats to send genes into the genetically modified organism (GMO), causing it to display the trait.

3D printing

3D printing is the process by which a three-dimensional structure is built through the various processes of additive manufacturing. Nanoscale 3D printing involves many of the same process, incorporated at a much smaller scale. To print a structure in the 5-400 µm scale, the precision of the 3D printing machine is improved greatly. A two-steps process of 3D printing, using a 3D printing and laser etched plates method was incorporated as an improvement technique. To be more precise at a nanoscale, the 3D printing process uses a laser etching machine, which etches into each plate the details needed for the segment of nanorobot. The plate is then transferred to the 3D printer, which fills the etched regions with the desired nanoparticle. The 3D printing process is repeated until the nanorobot is built from the bottom up. This 3D printing process has many benefits. First, it increases the overall accuracy of the printing process. Second, it has the potential to create functional segments of a nanorobot. The 3D printer uses a liquid resin, which is hardened at precisely the correct spots by a focused laser beam. The focal point of the laser beam is guided through the resin by movable mirrors and leaves behind a hardened line of solid polymer, just a few hundred nanometers wide. This fine resolution enables the creation of intricately structured sculptures as tiny as a grain of sand. This process takes place by using photoactive resins, which are hardened by the laser at an extremely small scale to create the structure. This process is quick by nanoscale 3D printing standards. Ultra-small features can be made with the 3D micro-fabrication technique used in multiphoton photopolymerisation. This approach uses a focused laser to trace the desired 3D object into a block of gel. Due to the nonlinear nature of photo excitation, the gel is cured to a solid only in the places where the laser was focused while the remaining gel is then washed away. Feature sizes of under 100 nm are easily produced, as well as complex structures with moving and interlocked parts.

Applications of Nanorobotics:-

Nanorobotic in medicine -

Nanotechnology is showing great effective results in human treatment by using nanorobotics application in medicine**.** Their promise of fast recovery and precise treatment at the same time cost effective solution have great potential to take the medicine industry by storm. Due to their nanoscale features, it can be easily injected to human body to target the exact place from where the disease is spreading. Its core action removes the disease spreading bacteria or infectious cells, without effecting other parts of the body.In case of sugar deficiency or energy loss, energy supplements like glucose can be induced in the body with the help of nanorobots.

Nanorobots in health care-

Nanorobotics has bright future in the field of health care, its huge success in treating critical diseases has made it an useful invention. Nanorobots, being too small to be seen with naked eyes in injected in to human bodies for treating various critical diseases. It also serves purpose like monitoring health issues, and diagnosing any potential harm to the body thus leaving a scope for early treatment. Nanorobots in cancer treatment has gained much positive feedbacks, as compared to the traditional methods of chemotherapy , while damaging the cancer cells, nanorobots works without effecting other parts of the body , thus no signs of side effects are observed. Other noteworthy application of nanorobots are drug delivery to target areas, monitoring diabetes, assisting during surgeries, etc.

Nanorobotic application in space -

Space scientist are usingnano electromechanical systems, or NEMS to use nanorobots in space which could sail through the surface of other planets and collect various data, study the environment and gather useful information of the surface. Small size makes it less vulnerable and together they can form an antenna and sail back to the space Centre or earth directly. Use of solar cells, in the space rockets could be another revolutionary idea. It will help to save a huge amount of fuel used in rocket top travel to space. The solar sails will use sun light to obtain power and serve as fuel. Thus nanorobotic application in spacewill stand out to be a very cost saving mechanism.

Nanorobotic applications in mechanics -

The application of nano machines may be of great use in future. Especially in industries it may serve great potential as because of their small size they may replace huge machines and save space crunches, also areas where a human engineer may not reach, a nanorobot can easily move in to do the necessary changes.

To conclude we must say that applications of nanorobots have a bright future holding up. Its application may be used in different sectors to gain more productivity and save more time also help medical science to find out cure of life threatening illness like cancer.

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