IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

NANOROBOTS SCOPE IN THE MEDICAL FIELD

[1]Shiva Kumar H D, [2]Ramakumar Ishwar Naik, [3]Dr.Hanamantraygouda M B, [4]S B Halesh

[1,2]B.E Student, [3]Assistant Professor, [4]Associate Professor

[1]Department of Mechanical Engineering, Sir M. Visvesvaraya Institute of Technology, Bangalore-562157, India

***Abstract*:** Nanotechnology is the understanding and control of matter at dimensions between 1 and 100 nanometres. Matter at this scale exhibits unique characteristics. Nanotechnology has changed the world of engineering and science to the cores which lead to the enormous development over the past two decades in certain areas such as medical, mechanical and space fields. Due to the novel applications in nanotechnology, new subjects have been evolved for e.g. nanomedicine and nanotoxicology, which gave rise to important technical and economic advancement. They have widely impacted and almost covered the aspects of society such as health, environment, energy etc. In the scope of environment, nanotechnologies can bring up the changes in sensing, remediation, emission reduction, membrane separations, coating, radioactive waste containment, etc. In this review paper, we particularly give an introduction on nanorobots and its future scope across the various subjects. We analyse the future opportunities and challenges of this nanorobots. In most of the future practice, nanorobots can be adapted in medical field to cure major chronic diseases. Therefore, nanorobots are playing a major role in present day and as well keeping potential in the future days.

***Keywords* – Nanorobots, Nanotechnology, Nanomedicine, Nanoscale, Biosensor, Nanodevice, Molecular components.**

1. INTRODUCTION

Nanorobots would be considered as any “smart” object that has ability of signalling, actuation, sensing, information processing, intelligence & manipulation behaviour at nano scale (10^{-9}m). Nanobot, Nanomachine, Nanoids, Nanite or Nanomite are the several different names used to describe nanorobots. Nanorobots are hypothetical device, in other words, nanorobots have not been created yet, its still in research & development stage [1][4].

Nanorobots can be used in Bio-chemical field where the detailed study is necessary at microlevel or nanolevel, an example is a sensor which is having a size of 1.5 nanometres, able to count specific molecules in a sample of chemicals. Nanorobots are primarily advantageous in the field of medical technology [13]. The demand for targeted drug delivery systems is raising as today’s biomedical technologies request new innovative systems to replace difficult & conventional procedures. Biological nanomachines could be used to detect and destroy the cancer cells. Nanorobots can offer a number of advantages over current methods such as [3]:

- Use of nanorobot drug delivery systems with increased bio availability.
- Targeting only infectious cells that have to be treated.
- Fewer mistakes in monitoring & controlling of nanorobots.
- Reach the difficult spots in human anatomy that can’t be operated by surgeon’s hand.
- Drugs are carried by nanorobots and released where the cell has to be treated.
- Better accuracy.

2. HISTORY PERSPECTIVE

According to Richard Feynman, the idea of introducing the nanorobots for medical applications was suggested by Albert Hibbs. Hibbs recommended that certain repair machines might one day be reduced in size to the point that it would be possible to "swallow the surgeon". The idea was further followed into Feynman's essay "There's Plenty of Room at the Bottom" in the year 1959. A detailed theoretical discussion about nanorobots has been presented by Robert Freitas in the medical context of nanomedicine [9].

3. CONSTRUCTION OF NANOROBOTS

Although nanorobots are hypothetical devices, yet its research and design is not new. Scientists are researching to create nanorobot prototypes by using foremost molecular design software to make over nano-structures that can store and deliver various molecular drugs. So far, researchers have created few designs of nanorobot as shown in Fig.1. During the process of designing of nanorobots, some factors & properties has to be considered to ensure proper operation of nanorobot as listed below:

- Size and shape.
- Sensors.
- Means of mobility/propulsion.
- Power generation & Data storage.
- Telemetry and transmission.
- Control and navigation.

Followed by Paul Rothemund, scientist from Caltech University in the U.S, created major impact in nanorobot history by designing a method known as 'DNA origami', in 2006 [1]. Due to which scientists have been able to evaluate & recreate the DNA material into particular shapes and even program the 3D DNA structures to carry out very basic robotic operations, such as fusing to other cells and operating within other DNA material. However, the DNA nanorobots created so far have faced some difficulties in movement, activation and targeting of drug release.

Fig.1: Different Designs of Nanorobot

4. APPLICATIONS

4.1 Nanomedicine

Nanorobots are widely used in medical field. In the future, medical nanotechnology is anticipated to utilize nanorobots to perform treatment at cellular level by injecting into patient's body. Some of the nanorobot's operation includes early diagnosis and targeted drug delivery for cancer biomedical instrumentation, surgery, monitoring of diabetes, and health care. The movement of robot through the arteries and veins is shown in Fig.2, here the robot uses a pair of tail appendages to swim inside the body. The Nanorobots supposed to use in medical technology should be non-replicating, because replication would lead to increase in device complexity, reduce reliability, and disrupt with the medical mission. Although manufacturing of nanorobots is hypothetical, it is supposed to believe that nanoscale machines would possess some special characteristics like, solidly integrating into a large-scale machine that can be used to build macroscopic products [1][5][6].

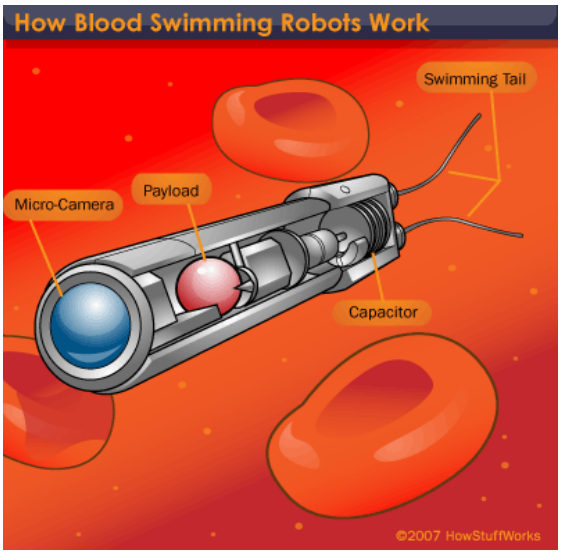

Fig.2: The Nanorobot Swimming Inside The Body.

4.2. In Detection and Treatment of Cancer

Cancer can be diagnosed and successfully treated at present condition because of medical field's immense advancement in diagnosing equipment that is used during therapies. However, survival of cancer patient depends on how earlier it was diagnosed and treated, which means that cancer should be detected at its primary stages i.e., before the metastasis has begun. For the efficient treatment of patients, proper drug delivery system has to be designed in order to reduce the side effects of chemotherapy. Considering the ability of the nanorobots to sail as bloodborne devices, they are widely useful in targeting the cancer cells in chemotherapy. For the spotting of tumour cells development in human body, the biosensor-nanorobots can be implemented at the early stages of cancer [1][5][6].

4.3. In Dentistry

Due to the advancement in nanotechnology, it is leading to the emergence of a new field called Nanodentistry. Nanorobot positions oral painkillers in-order to reduce the sensitivity in tooth. Therefore modifying the tissue and re-aligning the irregular set of teeth to enhance the tooth longevity. Further, nanorobots are used to do preventive, reviving, curative procedures by implementing tissue engineering procedures for major tooth repair [1][2][10][12].

4.4. In Repairing of Genes

Biosensor-Nanorobots can easily treat genetic diseases by comparing the molecular structures of both protein & DNA found in the cell with reference structures and respective information will be stored in the database of a nanocomputer. Any irregularities can be modified and corrected at that instant by reattaching the proteins to the DNA chain, which re-coils into its original form. Sailing inside the human cell, an automated repair device of diameter 50nm performs certain maintenance (as shown in Fig.3) in genetic structure by curing well beyond the reach of present-day physicians. By the use of nanorobot's arms, DNA is held and the nanorobot gently takes off the unwound strand through an opening in its front for analysis. Arms, meanwhile, releases regulatory proteins from the chain and collect them in a storage port. By this way, gene therapy will be done with the help of nanorobots, therefore holding potential in the future [1][8][11].

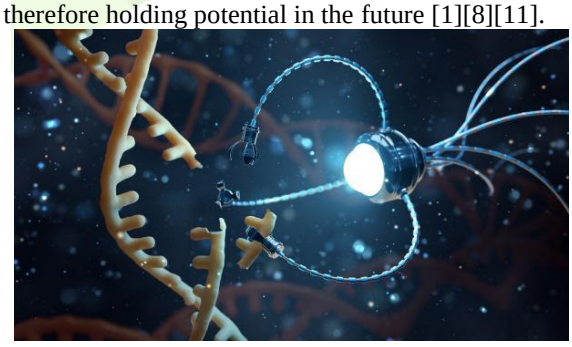

Fig.3: The Application of Nanorobotics in the Bio-Medical Industry.

5. ADVANTAGES OF NANOROBOTS

Many conventional techniques have been developed to diagnose body ailments as well as to repair them. Long time ago many surgeries are done by the great ancient Indian surgeon Sushruta (nearly 600 BC), whose methods have been adopted by present day surgeons and the same methods are improvised by using current technology. But all the molecular level surgeries can't be done using conventional tools. As the day passes there are many discoveries done on human anatomy to know more about it. Nanorobots hold more potential and have advantages over conventional medical techniques. So nanotechnology is employed to treat some of the acute and chronic diseases easily, beyond the reach. Some of the current day medical practices hold drawbacks such as:

1. Incisions causes harm to tissue layers, which take time to heal.
2. Anaesthesia can be used to suppress the pain to a great extent, yet it is only for a short span of time.
3. Delicate surgeries such as eye surgery still do not have 100% success rate.
4. In any of the conventional techniques, the patient's life is totally in the hands of the operator/ surgeon/ Physician. It is risky, as one mistake could lead to disaster.
5. Actual surgery consumes more time to find a cause of disease/molecular damage and to treat it.

Robot aided surgery is already in successful use, as we can see from the Da Vinci surgical robot. Scientists and researchers however are working on a more stable, undeviating and bio-compatible approach. Instead of curing from the outside, they work to defend the body from the inside. That is where the medical nanorobot comes in.

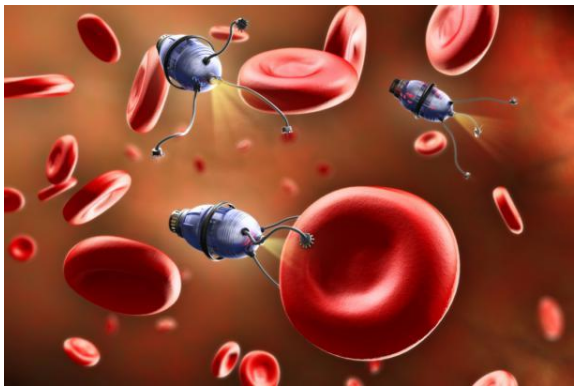

Fig.4: Nanorobots wade through blood to deliver drugs.

The major advantages of this technology are:

1. Minimal or no tissue trauma as they will be guided to particular target.
2. Comparatively less recovery time and ensures less post-treatment care required.
3. Continuous monitoring and diagnosis from the inside, as it stores and process previous data, identify patterns and hence, help to predict onset of an ailment.
4. Instantaneous and spontaneous response to a sudden change.
5. Nanorobots are pre-programmed, they can be guided externally.
6. Deliver payloads such as drugs (as shown in Fig.4), or healthy cells to the specific site.
7. Disassemble and get excreted after completion of task, if required.

6. DISADVANTAGES OF NANOROBOTS

- It is expensive to design the nanorobots, as it involves lot of complex designs [1].
- Still it is hypothetical; therefore more research work has to be done so that the bots are able to overcome the body's immune response [7].
- Our immune system can be challenged if we depend a lot on nanotechnology.
- Nanorobots, if misused by terrorists, could even be used as bio-weapons and may become a threat to the society and may lead to bio-war.
- It is possible, that there will be some negative effects on the environment as new toxins and contaminants may be created by nanotechnology. Hence, care has to be taken to overcome this drawback.

7. CONCLUSION

Nanorobots holds such a vast scope that, the above mentioned ideas do become reality any time sooner or later, such that every branch of medicine ought to benefit. Nanorobot hold both advantages and disadvantages characteristics, but it depends upon the field that it is being used. Nanorobots applied to medication hold an abundance of guarantee from annihilating infection to turning around the maturing procedure (wrinkles, age-related conditions are altogether treatable at the molecular level). This incorporate greater bioavailability, directed treatment, less human interface, arrive at remote regions in human life systems, enormous interfacial region for mass exchange, unmistakable method, less side effects and greater speed of drug action with better precision. Nanorobots are also candidates for industrial applications. They will furnish joined activity – drugs marketed with diagnostics, imaging agents acting as drugs, surgery with instant diagnostic feedback. Therefore Nanorobot becomes a major element in future medical field to ease the human interaction in molecular level surgeries.

REFERENCES

[1]. Preeti Khulbe, "Nanorobots: A Review". *IJPSR*, 2014; **Vol. 5(6)**: 2164-2173. E-ISSN: 0975-8232; P-ISSN: 2320-5148 International Journal of Pharmaceutical Sciences and Research.

[2]. M.Mehta**,** K.Subramani**, "**Nanodiagnostics in Microbiology and Dentistry**".** Emerging Nanotechnologies in DentistryProcesses, Materials and Applications**,** Micro and Nano Technologies**,** 2012, Pages 365-390**.**

[3]. Sharma KR. "Nanostructuring of Nanorobots for use in Nanomedicine", *International Journal of Engineering & Technology*. 2012;2(2):116-134.29. Available: http://ietjournals.org/archive/2012/feb_vol_2_no _2/6686111325866989.pdf.

[4]. Arun Raj R, Vijayalekshmi N G and Akhila S, "Nanorobots – Medicine of the Future". *International Journal of Comprehensive Pharmacy*, 2012, ISSN 0976-8157.

[5]. Zyga, Lisa, "Virtual 3D nanorobots could lead to real cancer-fighting technology". (December 5, 2007). *physorg.com*.

[6]. Yarin, A. L, "Nanofibers, nanofluidics, nanoparticles and nanobots for drug and protein delivery systems". *ScientiaPharmaceutica Central European Symposium on Pharmaceutical Technology*. (2010). 78 (3): 542. doi:10.3797/scipharm.cespt.8.L02

[7]. Patel, G. M.; Patel, G. C.; Patel, R. B.; Patel, J. K.; Patel, M. (2006). "Nanorobot: A versatile tool in nanomedicine". *Journal of Drug Targeting*. 14 (2): 63–67. doi:10.1080/10611860600612862. PMID 16608733.

[8]. Jin, S.; Ye, K. (2007). "Nanoparticle-Mediated Drug Delivery and Gene Therapy".Biotechnology Progress. 23 (1): 32–41. doi:10.1021/bp060348j. PMID 17269667.

[9]. Richard P. Feynman (December 1959). "There's Plenty of Room at the Bottom". Archived from the original on 2010-02-11.Retrieved 2016-04-14.

[10]. Neetha J Shetty, P. Swathi, K. David, "Nanorobots: Future in Dentistry". *The Saudi Dental Journal*, 2012.

[11]. Seeman. N. C. (2005). "From genes to machines: DNA nanomechanical devices". Trends in Biochemical Sciences. 30 (3): 119–125. doi:10.1016/j.tibs.2005.01.007. PMC 3471994.PMID 15752983.

[12]. Santosh Kumar Verma, Rashi Chauhan, "Nanorobotics in dentistry – A review". *Indian Journal of Dentistry*, **Volume 5**, Supplement, August 2014, Pages 62-70.

[13]. https://en.wikipedia.org/wiki/Nanorobotics

[14]. Sujayita Mazumder , Gopa Roy Biswas and Sutapa Biswas Majee, "Applications of Nanorobots in Medical Techniques". *International Journal of Pharmaceutical Sciences and Research* · July 2020

[15]. Aruntapan Dash, Preetam Chandan Mohapatra, "Nano Robotics – A Review". *National Conference on Modern Trends in Engineering Solutions* (NCMTES-2013), Conference Paper, December 2013