iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** X **Month of publication:** October 2017

DOI: http://doi.org/10.22214/ijraset.2017.10059

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, October 2017- Available at www.ijraset.com

Stepping Stones Of Nanorobotics

Aditya Vaishampayan[1], Deepali H. Shah[2], Tejas V Shah[3]
[1, 2, 3] *Instrumentation and Control Engineering, Gujarat Technological University*

Abstract: ***The modern trend of nanorobotics is conceptually envisaged in this paper. The use of Nanorobots as nanomedicine for diagnosing and treating medical injuries as well as performing microsurgeries has been developed by recent research. Nanorobots developing from their nascent stages require further development in areas regarding their structural and working methods as well as their medical applications. The way in which Nanorobots can be employed into and effused from the host's body is also a remarkable research area of development. The remedy for chronic diseases and ailments treatment has eminent development by research techniques and reduced costs due to mass manufacturing of Nanorobots.***
Keywords**:** ***Nanomedicine, Nanobot, Nanotechnology, Nanomaterial, Nanorobot, Nanorobotics***

I. INTRODUCTION

The idea of nanorobotics comes from research in nanotechnology which was inspired from the talk of Richard Feynman in 1959. The ideas proposed in this area remain highly theoretical because there are higher level of science and technological challenges involved in fabricating such devices. Nanorobots, Nanomachines, and other Nano systems are objects with overall dimensions at or below the micrometer range and are made of assemblies of Nano scale components with individual dimensions ranging approximately between 1 to 100 nm. Nanorobotics is gradually becoming important in fields such as engineering, microelectronics and health care. The application of nanorobotics in the field of health care has prominent development in recent times. There are many treatments today that are very expensive, span over long time durations and involve considerable health risk with little certainty of patient being cured. The recent research in nanorobotics has extended its benefits to curing patients through quicker, safer and much cheaper treatments with increased efficiency.

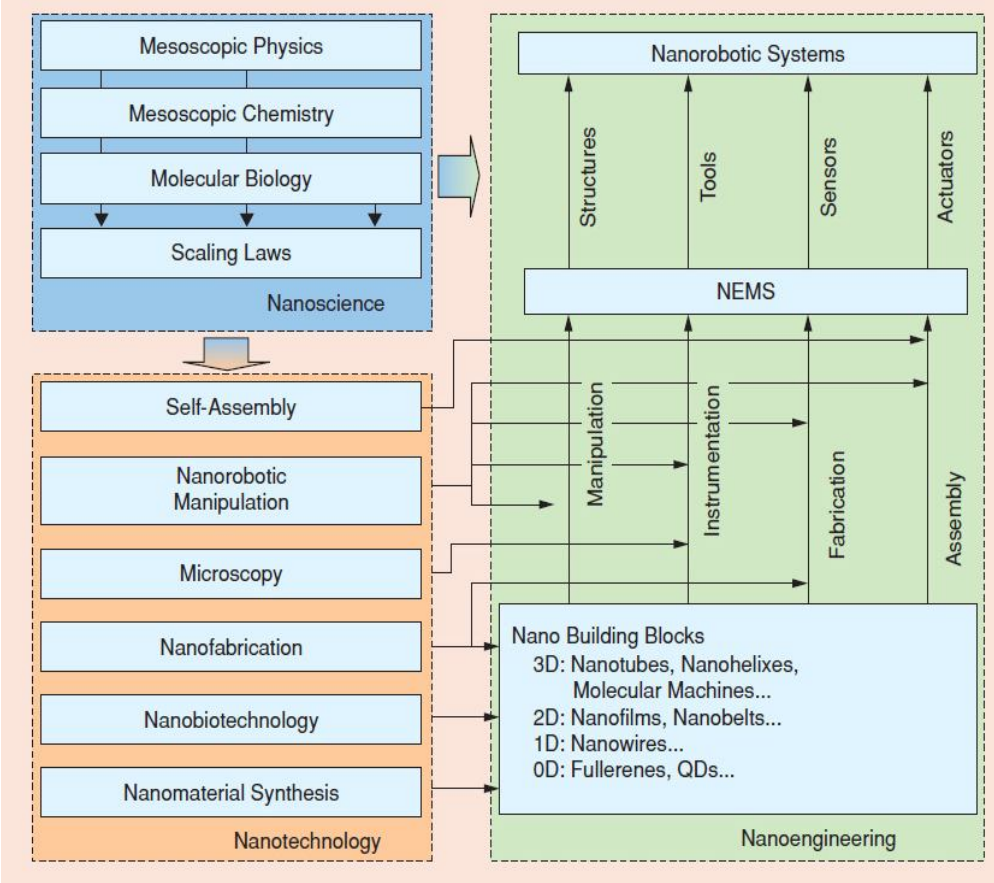


Fig.1 Roadmap of nanorobotics

II. STRUCTURE OF NANOROBOTS

Though being extremely small Nanorobots are capable of performing tasks like actuating, sensing, signalling, information processing and much more. These devices include miniature power driven mechanical parts that are required to retract, dispense drugs or do a needful action at the specific targeted site in the body to cure disease. The surface of Nanorobots is made up of chemically passive diamonds. By exhaustive experimental work, the surface of Nanorobots has been materialized which has high surface energy and hydrophobicity of the chemically passive diamond surface, lesser leukocyte activity occurs resulting in less fibrinogen adsorption on the nanorobot and is thus prevented from attack by the hosts immune system. The complete structure of nanorobot is comprised of medicine cavity, peripherals, power supply, propulsion systems and communication system.

A. Medicine cavity

It is a cavity inside a nanorobot which is capable of holding small doses of medicine (payloads) which can be released at site of infection and injury or any place where it is specifically required in the body. In traditional chemotherapy, we have to rely on circulatory system of the body for the delivery of medicine at the specific target in the body whereas with the help of nanorobots, we can release the drugs directly on cancerous tissue and nearby tissues are saved from getting affected by the drug.

B. Peripherals:

Nanorobots possessing tools such as electrodes, chisels, cutters etc. are being proposed to assist in microsurgery applications.

1) *Knives, cutter:* Parts such as knives, chisel, and cutter are used to remove plaque by helping the nanorobot to grab, break down and crush material into small pieces which then pass out from human body via excretory channels.
2) *Electrodes:*Nanorobots can generate electric current with the help of electrodes which is used to kill the malignant cells by heating them.
3) *Lasers:*Lasers installed in Nanorobots can burn the harmful materials such as cancerous cells, blood clots, plaques etc. Lasers vaporize the affected cells and thus prevent damage the surrounding tissue.

C. Power Supply

The Nanorobots need power to perform their assigned tasks as well as for communication with the controller and also for propulsion through the host's body to reach the targeted destination. Due to extremely small size of nanorobot, the power needed is extremely low in the range of 10 to 100 Pico watts to even micro-watts. Potential means of generating power for the nanorobot are:

1) Power can be derived from counter-current motion or fluid flow i.e. blood flow due to circulatory system.
2) A nanorobot can derive its power from the temperature difference of the reservoir and the host's body temperature.
3) Nanorobots can metabolize glucose and oxygen for energy. Glucose and oxygen can be obtained easily within the body and nanorobots can use ATP (adenosine triphosphate) for power requirement of itself.
4) Acoustic power can be supplied externally as it is probably most appropriate in clinical setting. Ultrasound waves are sent to the Nanorobots to provide power.

D. Propulsion systems

This is quite an important design consideration for the Nanorobots. Early prototypes can be simple "ball like" robots without self-propulsion mechanisms. They may simply be injected into the reservoir with normal injection water and are allowed to navigate their paths through the reservoir following the natural path created by the injection water or the oil flowing naturally to the producers. However, the advanced designs can be incorporated with flagella like structures or can be guided by sound waves.

E. Communication system

It is very essential to know the actions done by Nanorobots inside the body. Acoustic messaging is one of the simplest way to send broadcast messages to the nanorobot. It can be done using an ultrasound probe that sends encoded messages between 1 to 10 MHz This makes communication with the nanorobot easy and harmless. Moreover, ultrasound equipment's can be easily made available in a clinical facility.

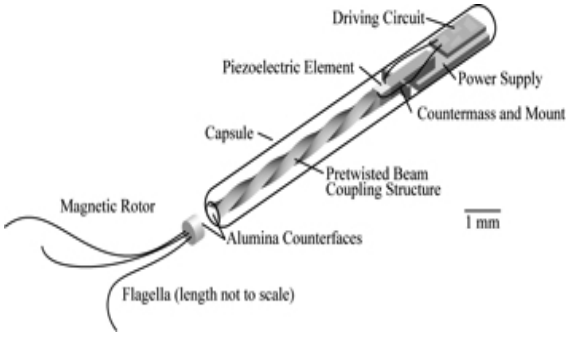


Fig.2 Components of a nanorobot

III. IMPLEMENATION IN MEDICINAL FIELD

A. Cancer Treatment

Tumours lack in lymphatic drainage systems. This property allows the small size Nanorobots to accumulate at tumour sites and not get attacked by the immune system of the cell. Nanorobots have the ability to overcome problems such as drug resistance, lack of selectivity and solubility which makes them real ideal soldiers for target specific actions. In photodynamic therapy, a particle is placed inside the body and light is illuminated from outside. The particle reaches the affected cells via the circulatory system. Illumination from outside activates the chemical dyes inside the particle leading to the destruction of most organic molecules that are present in the vicinity of the particle and thus leaving no toxic reactive molecules.

B. Visualization

As Nanorobots are smaller than cells, they can be used as contrast agents. The ultrasound and MRI images with a better contrast can be obtained with such agents. The small size of Nanorobots enhances them with properties that can be very useful particularly in imaging. Exceptionally excellent image of tumour sites is obtained with recent techniques using MRI and quantum dots together. Some coated Nanorobots have ability to glow. When they are injected to the tumour sites, their luminance allows the surgeon to locate and accurately remove the tumour. On other side, the quantum dots are usually made of quite toxic elements. It is difficult to track a small group of cells throughout the body, so scientists dye the cells which light up when illuminated by light of certain wavelength. Frequency of light absorbed depends on the colour of the dye. Hence, there was a need to increase the number of light sources in order to make it equal to the number of cells. Luminescent tags are quantum dots attached to proteins that penetrate through cell membranes. Thus, sizes are selected such that the frequency of light used to make a group of quantum dots fluoresce is always an even multiple of the frequency which is required to make another group.

C. Detection of proteins

Understanding the properties of proteins is very essential as they determine the cells machinery and structure. Gold nanoparticles are widely used in the field of chemistry to identify protein-protein interaction.

D. Sensing

The magnetic Nanorobots bind to a suitable antibody allowing researchers to label specific structures, molecules or microorganisms. Detection of genetic sequence in a sample can be done using gold nanoparticles tagged with short segments of DNA. Sensor test chips contain thousands of nanowires that help in the detection of proteins and other biomarkers which are left behind by cancer cells that may help to enable the detection and diagnosis of cancer in the early stages.

E. Tissue Engineering

Nanorobots could be used in tissue engineering to reproduce or repair damaged tissue. Successful research in tissue engineering may help replace conventional treatments like artificial implants or organ transplants. Nanoparticles such as carbon nanotubes, graphene, molybdenum disulphide and tungsten disulphide are being integrated into Nanorobots as reinforcing agents. Potentially, these Nano-composites may be used as a best replacement, light weight, mechanically strong composite for bone implants.

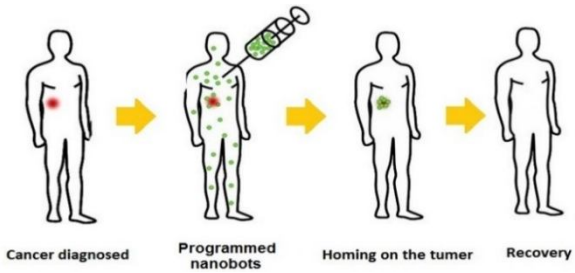


Fig.3Tumour treatment using Nanorobots

IV. RETRIEVAL OF NANOROBOTS FROM THE BODY

Once a therapeutic function is completed, excretion of these Nanorobots from the body becomes mandatory. Some nanodevices can effuse themselves from the body via the usual human excretory channels whereas others need to be effused by medical personnel. Nanorobots contain on board ballast tanks which play a crucial role for effusing the Nanorobots from blood. Blood to be cleared is passed from the patient to a specialized centrifugation apparatus where transmitters command Nanorobots to establish neutral buoyancy. Since no other blood component can maintain exact neutral buoyancy, hence those other blood components precipitate outward during gentle centrifugation and get added back to filtered plasma on the other side of the apparatus. Thus, there are multiple ways through which Nanorobots can be effused from the host's body.


Fig.4 Nanorobot injecting drug into a cell

V. ADVANTAGES & DISADVANTAGES

A. *Advantages*

1) Chronic medical diseases such as cancer can easily be cured with the help of nanorobotics.
2) Nanorobots work on a particular site in the body and have reduced negative effects of drugs and surgical procedures. This prevents the surrounding healthy cells from getting affected.
3) Batch processing will reduce the costs though the initial development cost is high.

B. *Disadvantages*

1) Designing a nanorobot is very difficult due to its extreme small in size.
2) Initial design and development cost is exorbitant.
3) Nanorobotics is in nascent stage and it lacks proper knowledge about effect of nanoparticles on biochemical pathways.
4) Nanorobots need to be very accurate, otherwise harmful effects may occur.
5) The society's ethical use of Nano medicine beyond safety concern, poses a serious question to researchers.

VI. FUTURE PERSPECTIVE AND CONCLUSION

The possibility to exploit the structure of biomolecules for novel functional materials, biosensors and therapeutic applications has created the burgeoning field of Nano-biotechnology. The development of nanorobotics was a result of a highly collaborative effort and amalgamation of several advanced technologies such as Nano-bioelectronics, electromagnetics as well as proteomics which will be the basis to advance medical nanorobotics. Future envisaged for Nanorobots is antibody Nanorobots which may act as antibodies in patients having weak immune systems. Such Nanorobots will continuously patrol the patient's blood stream looking out for harmful pathogens and eliminating them before they can cause any harm to the patient. Nanorobots will provide safeguard to mankind by equipping doctors and surgeons to fight against diseases ranging from common bacterial and viral infections to life threatening chronic ailments.

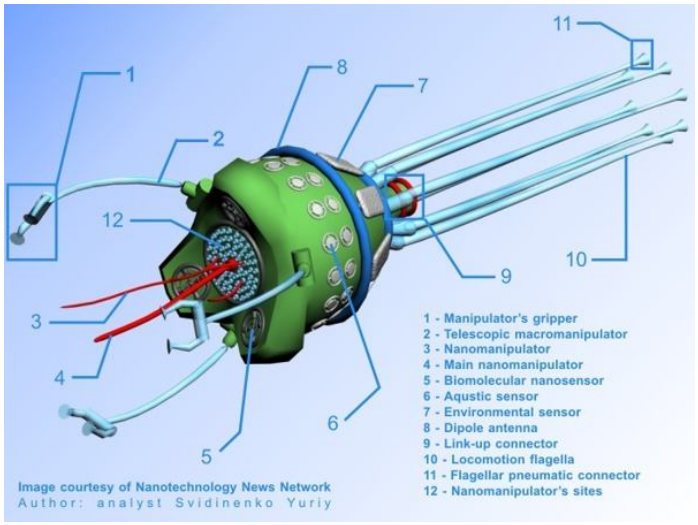


Fig.5 Future Nanorobots

VII. ACKNOWLEDGMENT

I want to thank Prof. Deepali H Shah and Prof. (Dr.) Tejas V Shah for mentoring me and guiding me throughout the paper. I also thank my family and friends to support me and motivate me while writing this paper. I thank all the other authors who have made significant contributions to the field of nanorobotics.

REFERENCES

[1] Guneet Singh Mehta, DevendraNagal, Dr.S.S. Mehta, Swati Sharma(2012), Nanobots and their application in Biomedical Engineering, Proc. of the Intl. Conf. on Advances in Electronics, Electrical and Computer Science Engineering,[Online].pp. 215-219, Availible: http://seekdl.org/nm.php?id=332

[2] Robert A. Freitas Jr., Computational Tasks In Medical Nanorobotics, Nanoscale and Bio-Inspired Computing. [Online], (2), pp. 1–25, Available: http://www.nanomedicine.com/Papers/NMRevMar05.pdf

[3] NandkishorKshirsagar, SwapnilPatil, RajeshwarKshirsagar, Anita Wagh, Anil Bade, (2014) Review on application of nanorobots in health care, World journal of pharmacy and pharmaceutical sciences, [Online], 3(5), pp. 472-480. Available: https://www.google.co.in/search?q=)+Review+on+application+of+nanorobots+in+health+care&rlz=1C1YQLS_enIN750IN750&oq=)+Review+on+application+of+nanorobots+in+health+care&aqs=chrome..69i57.315j0j4&sourceid=chrome&ie=UTF-8#

[4] Kailash Chandra Mishra (2012), A Review On Supply Of Power To Nanorobots Used In Nanomedicine, International Journal of Advances in Engineering & Technology, [Online],4(2), pp. 564-571,Availible:http://www.e-ijaet.org/media/63I10-IJAET1009228-A-REVIEW-ON-SUPPLY.pdf

[5] SonalMazumder and Saket Bhargava,(2014), Nanorobots: Current State And Future Perspectives, International Journal of Development Research, [Online], 4(6), pp. 1234-1239,Available: http://www.journalijdr.com/sites/default/files/issue-pdf/1759.pdf

[6] [Online], Available: http://lfs-tpe-nanorobots.e-monsite.com/medias/images/plan-bsr-2-1.jpg

[7] Somanna M B (2015),Nanobots: The Future Of Medical Treatments, International Journal Of Scientific & Technology Research, [Online], 4(6), pp. 276-278, Available: http://www.ijstr.org/final-print/dec2015/Nanobots-The-Future-Of-Medical-Treatments.pdf

[8] [Online], Available: https://ninithi.files.wordpress.com/2015/08/cancer-treatment.jpg

[9] [Online], Available: https://usercontent2.hubstatic.com/12977509.jpg

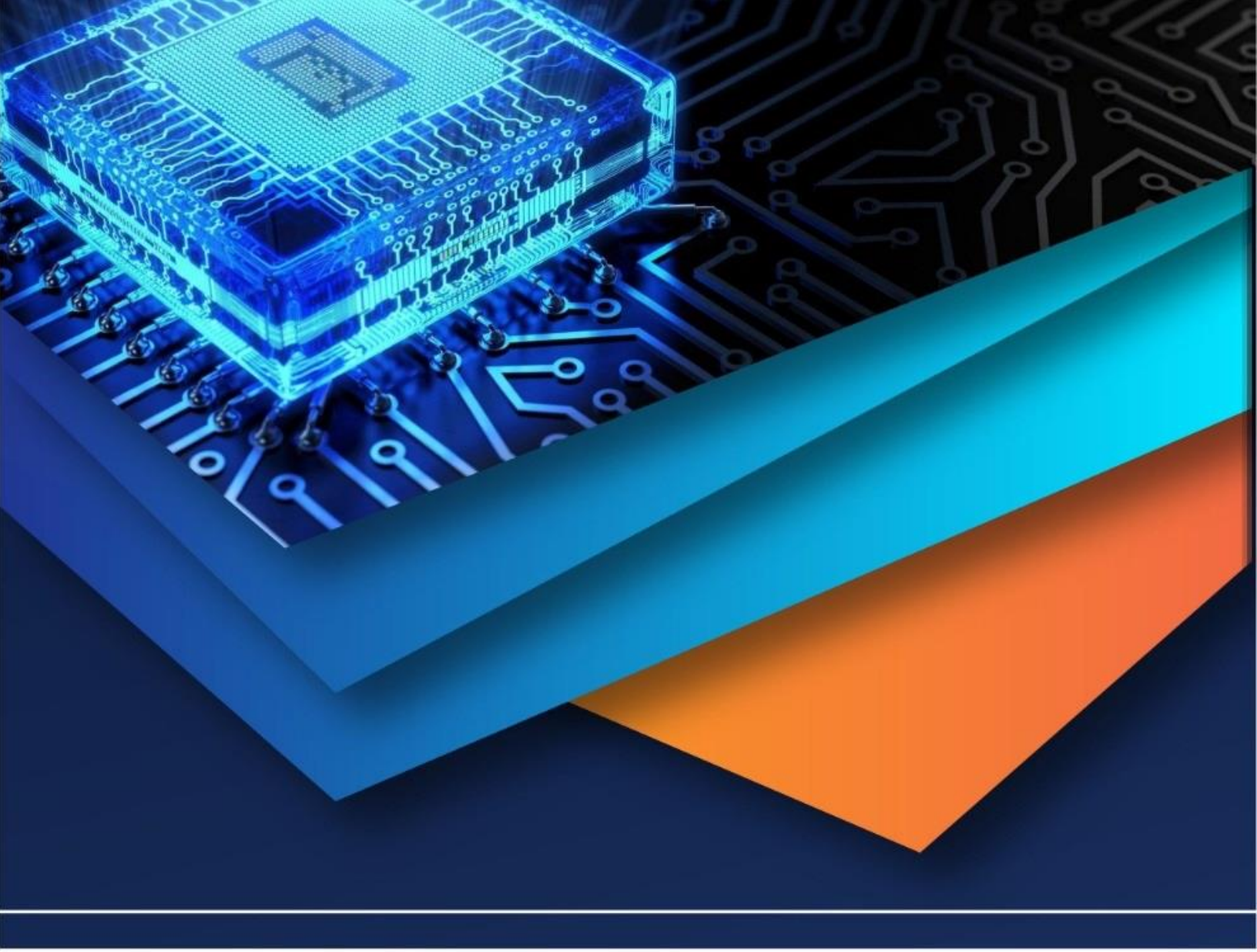
[10] E .Anitha(2012), Nanorobots, GRA - Global Research Analysis, [Online].1(5), pp. 45-48,Availible: https://www.worldwidejournals.com/global-journal-for-research-analysis-GJRA/

[11] [Online], Available: http://www.biotechnologynotes.com/nano-biotechnology/nano-medicine-meaning-advantages-and-disadvantages/809

[12] Robert A. Freitas, Jr.,(2005), Current Status of Nanomedicine and Medical Nanorobotics, Journal of Computational and Theoretical Nanoscience[Online], pp. 392-428, Available: http://www.nanomedicine.com/Papers/NMRevMar05.pdf

[13] [Online] Available: http://www.nanotech-now.com/images/Art_Gallery/YS-MCR-details-large.jpg

[14] [Online] Available: http://newnanobots.blogspot.in/p/nano-robot-working.html



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY