CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
http://doi.org/10.5281/zenodo.3549702

Available online at: http://www.iajps.com *Review Article*

"NANOROBOTS: THE NEXT GENERATION MEDICINE''

Pallavi M. Chaudhari*[1], Hitesh L. Shekokare[2]
[1,2]Dr. D. Y. Patil College of Pharmacy Akurdi, Pune
Email: pallavichaudhari26@gmail.com

Abstract:
Nanorobots is the emerging technology field of developing machines whose components are at or near the scale of a nanometer.Nowadays these nano robots play a vital role in the field of Bio MedicineNanomedicine is the process of monitoring diagnosing, treating, and preventing disease and traumatic injury. to detect the target moleculesNanorobots have special sensors, it can be programmed to diagnosis and treat various vital diseasesThe names nanobots, nanoids, nanites or nanomites have also been used to describe this hypothetical devices they are used in medical field for treating arteriosclerosis, cancer treatment, diagnosis and treatment of diabetes, gene therapy are constructed of nanoscale ormolecular components and information listed in review.
Keywords: *Nanorobots, components, Targeted drug delivery, surgery, treatment of Diabetes, cancer therapy, Atherosclerosis, gene therapy, kidney stone etc.*

Corresponding author:
Pallavi M. Chaudhari,
Dr. D. Y. Patil College of Pharmacy Akurdi, Pune
Email: pallavichaudhari26@gmail.com

QR code

Please cite t h i s article in press Pallavi M. Chaudhari et al., ***Nanorobots: The Next Generation Medicine.,*** *Indo Am. J. P. Sci, 2019; 06(11).*

INTRODUCTION:

The recent advances in drug delivery systems basically focuses on site specific drug delivery systems which concerns the administration of drug at the right dose, right time and targeted drug delivery with better safety and efficacy. Nano medicine use nano-sized tool for diagnosis, prevention and treatment of disease. The lattermost goal is to improve the quality of life. The aim of nanomedicine broadly defined as the complete monitoring, Diagnosing and improvement of all human biological systems, working from the molecular level using engineered devices and nanostructures to achive medical benefit. Most predominantly, nanomedicine is the process oftreating traumatic injury, diagnosing and preventing disease andrelieving pain, and of preventing and improving human health, using molecular tools and molecular knowledge of human body[1]

TYPES OF NANOROBOTS:

Microbivore Nanorobot

The body can be protected against both foreign invaders and infectious disease by these nanorobot, but they are designed to be faster at killing bacteria. Within a minutes this type of nanorobort are able to wipe out bacterial infection in a patient, as opposed to the days required for antibiotics to take response Microbivore nanorobots are program so that antibodies bind to the reticular bacteria the robot is seeking. After bacteria connect to an antibody, an arm grabs the bacteria and shift it to the inside of the nanorobot, where it’s destroyed. Bacteria is then librated into the bloodstream as harmless fragments.The microbivore is a spherical device made up of diamond and sapphire which measures 3.4 µm in diameter along its major axis and 2.0 µm diameter Figure 1 [2]

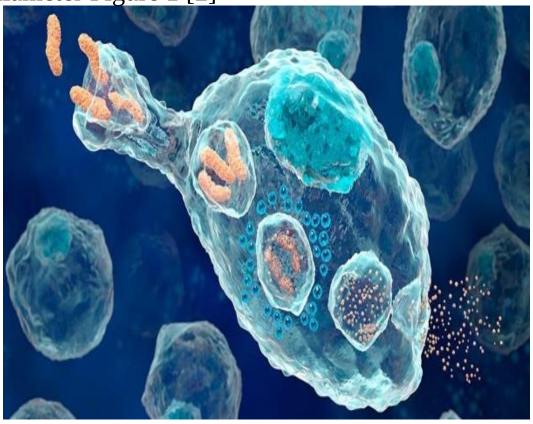

Figure 1. Microbivore Nanorobot

Clottocytes Nanorobot

When there is damage to the endothelium cells of blood vessels by platelets hemostasis is the working of blood clotting. By the collision of exposed collagen from harmed blood vessels to the platelets these type of platelets can be activated. For the natural blood clotting 2-5 minutes can be taken. The efficiency of decreasing the clotting time and reducing the blood loss has been shown by the nanotechnology. In some patients, the blood clots are found to occur infrequently. To treat this abnormality the drugs such as corticosteroids are used. The treatment of corticosteroids has some side effects such as hormonal secretions; blood/platelet could damage lungs and allergic reactions. [3]

The theoretically designed clottocyte describes artificial mechanical platelet or clottocyte that would complete hemostasis in approximately 1 sec[4]

It is round shape nanorobot powered by serum-oxyglucose approximately 2 µm in diameter containing a fiber mesh that is compactly folded onboard. clottocyte is effective 100-1000 times than the natural hemostatic system[5]The fiber mesh would be biologically degradable and upon release, a soluble film coating of the mesh would dissolve in contact with the plasma to expose sticky mesh [6]To control the coordinated mesh release from neighboring clottocytes reliable communication protocols would be required and also to regulate multidevice-activation radius within the local clottocyte population. the change in partial pressure, can be detect as the clottocyte-rich blood enters the injured blood vessel, the onboard sensors of clottocyte rapidly often indicating that it is bleed out of body. Oxygen molecules from the air diffuse through serum at human body temperature if the first clottocyte is 75 µm away from air-serum interface. To the neighbouring clottocytes through acoustic pulse. This detection would be broadcasted rapidly

This allows rapid propagation of a carefully controlled device-enablement cascade. The stickiness in the fiber mesh would be blood group specific to trap blood cells by binding to the antigens present on blood cells (Figure 2). Each mesh would overlap on the neighboring mesh and attract the red blood cells to immediately stop bleeding[7]

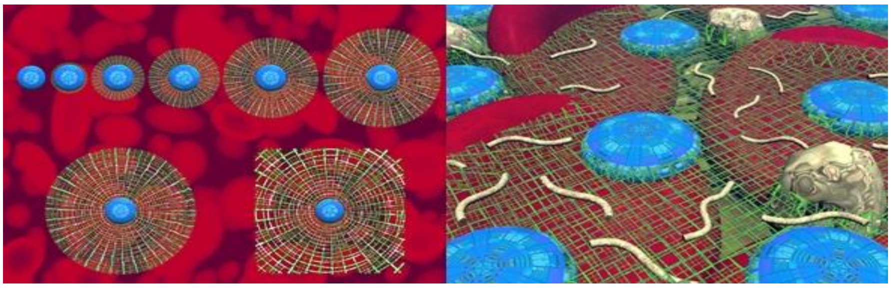

Figure 2. Blood clotting mechanism of clottocytes

The function of clottocytes that is essentially equivalent to that of natural platelets at about 1/10,000th the concentration in the blood stream. 20 clottocytes per cubic millimeter of blood.[8] The major risk associated with the clottocytes is that the additional activity of the mechanical platelets could trigger the disseminated intravascular coagulation resulting in multiple micro thrombi[9]

Respirosite Nanorobot

Respirocytesare the nanorobots designed as artificial mechanical red blood cells which are blood borne spherical 1µm diameter sized (Figure 3). The outer shell is made of diamondoid 1000 atm pressure vessel with reversible molecule-selective pumps [10, 11]Respirocytes carry oxygen and carbon dioxide molecules throughout the body.

The respirocyte is made up of 18 billion atoms which are properly arranged in a diamondoid pressure tanks. Up to 3 billion oxygen and carbon dioxide molecules can be stored in this tank 236 times more oxygen would delivered to the body tissues by respirocytes when compared to natural red blood cells.

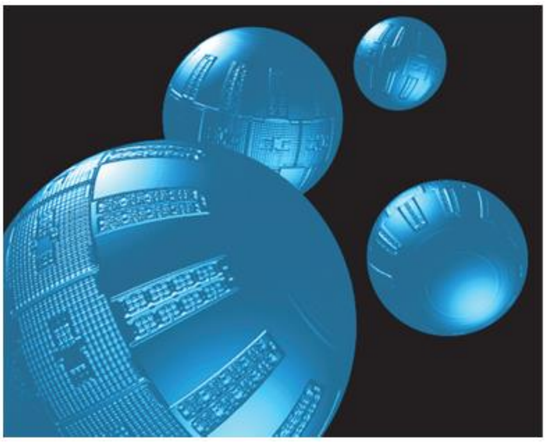

Figure 3. Artificial Red cell

Each respirocyte consists of 3 types of rotors. While travelling through the body rotor releases the stored oxygen. The second type of rotor captures all the carbon dioxide in the blood stream and release at the lungs while the third rotor takes in the glucose from blood stream as fuel source [12, 13] There are 12 identical pumps which are laid around the equator; oxygen rotors on the left, water rotors in the middle and carbon dioxide rotors in the left. On the surface of respirocyte a gas concentration sensors are present.

Through the lung capillaries when the respirocyte passes, Oxygen partial pressure will be high and Carbondixide partial pressure will be low, therefore the on board nano computer commands the sorting rotors to load in oxygen and release the carbon dioxide molecules [14]The water ballast chambers aid in maintaining buoyancy. To scavenge carbon monoxide and other poisonous gases from the body the respirocytes can be programmed. Artificial erythrocyte works as a respirocyte by mimicking the oxygen and carbon dioxide transport functions A 5 cc therapeutic dose of 50% respirocyte saline suspension containing 5 trillion nanorobots would exactly replace the gas carrying capacity of the patient's entire 5.4 litres of blood.

COMPONENTS OF NANOROBOTS

Nanorobots constitutes fuel buffer tank, power supply, sensors, manipulators, motors, onboard computers, pumps, structural support and pressure tank The substructures in a nanorobots include

Chemical sensor

Chemical nanosensors can be planted in the nanorobot to monitor E-cadherin gradients. Thus, nanorobots programmed for such a task can make a detailed screening of the patient whole body. The electromagnetic waves are used to command and detect the current status of nanorobort inside the patient in various medical nanoarchitecture. And the mobile phone is used to collect information about the patients. [15, 16]

Payload

A small dose of drug/medicine holds in this void spaces. The nanorobots can flow through the blood and release the drug to the site of infection/injury.

Micro camera

Micro-camera can be included in nanorobot. When navigating through the body manually the operator can steer the nanorobots [17, 18]

Electrodes
In the blood the electrodes are mounted on the nanorobot to form a battery using electrolytes. The cancer cells can also be killed by these protruding electrodes by generating an electric current, and heating the cells up to death.

Lasers
The harmful material like arterial plaque, blood clots or cancer cells can be burn by these laser.

Ultra sonic signal generators
When the nanorobots are used to target and destroy kidney stones these generators are used.

Swimming tail
As Nanorobot travel against the flow of blood in the body they will require a means of push to get into the body.

ADVANTAGES

- Use of nanorobot drug delivery systems with increased bioavailability.
- Targeted therapy such as only malignant cells treated.
- Reach remote areas in human anatomy not operatable at the surgeon's operating table.
- Non-invasive technique.
- Computer controlled operation with nobs to fine tune the amount, frequency, time of release.
- Better accuracy.
- Drug inactive in areas where therapy not needed minimizing undesired side effects
- Less post treatment care - As it is minimally invasive technique, therefore less post treatment care is required

DISADVANTAGES

- The initial design cost is very high.
- The design of this nanorobot is a very complicated.
- Electrical systems can create stray fields which may activate bioelectric based molecular recognition systems in biology.
- Electrical nanorobots are susceptible to electrical interference from external sources such as electric fields, EMP pulses, and stray fields from other in vivo electrical devices.

APPLICATIONS OF NANOROBOTS

Nanorobotics in Surgery
Through vascular systems and other cavities surgical nanorobots are introduced in the human body. Surgical nanorobots act as semi-autonomous on-site surgeon inside the human body and are programmed or directed by a human surgeon. 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 was performed by this programmed surgical Nanorobot. 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 .To damage the cell capability this process is not powerfull.

Breaking up kidney stones
The pain occurs in the Kidney stones is very intense , for the larger stone it is very difficult to pass.By using ultrasonic frequencies doctors break up large kidney stones, but it's not always effective. Using a small laser nanorobot could break up a kidney stones

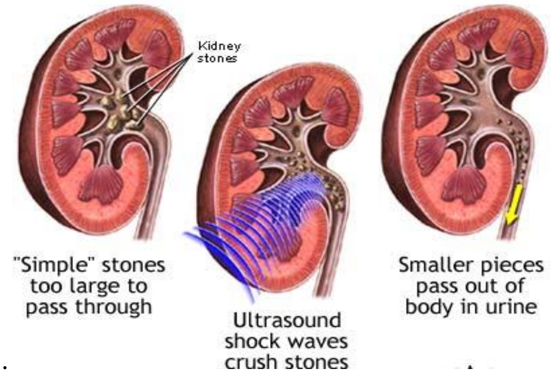

Figure 4. Breaking up kidney stones by laser

Treating arteriosclerosis
Arteriosclerosis is the condition where plaque are formed along the walls of arteries. By cutting away the plaque Nanorobots could conceivably treat the condition, which would then enter the bloodstream.

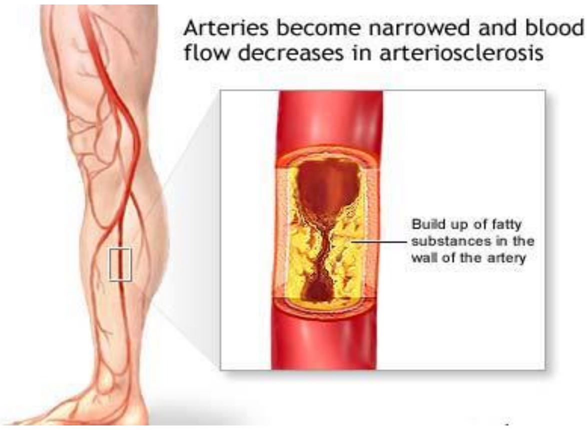

Figure 5 Fatty substances in wall of artery

Breaking up blood clots
The complications can occurs by the blood clot ranging from muscle death to a stroke. Nanorobots circulates in blood stream to break a clot. This robot must be able to remove the blockage without

losing small pieces in the bloodstream is one of the most dangerous application of nanorobort... The robot must also be small size so that it doesn't block the flow of blood itself.

Nanorobots in cancer detection andtreatment

With the current stages of medical technologies and therapy tools cancer can be successfully treated. However, a decisive factor to determine the chances for a patient with cancer to survive is: how earlier it was diagnosed; what means, if possible, a cancer should be detected at least before the metastasis has begun.The development of efficient targeted drug delivery to decrease the side effects from chemotherapy another important aspect to achieve a successful treatment for patients. [21-27]

To navigate as blood borne devices the properties of nanorobots, they can help on such extremely important aspects of cancertherapy. Nanorobots with embedded chemicalbiosensors can be used to perform detection oftumor cells in early stages of development insidethe patient's body. Integrated Nanosensors canbe utilized for such a task in order to find in densityof E-cadherin[28-30]Signals. Therefore a hardwarearchitecture based on nanobioelectronics isdescribed for the application of Nanorobots forcancer therapy. Analyses and conclusions for theproposed model are obtained through real time3D simulation [31-36]

Nanorobots in Gene Therapy

Medical Nano robots can readily treat genetic diseases by comparing the molecular structures of both DNA and proteins found in the cell to known or desired reference structures [37-40] any irregularities can then be corrected, or desired modifications can be made in place. In some cases, other than the repair the chromosomal replacement therapy is more efficient Stretching a supercoil of DNA between its lower pair of robot arms, the Nano machine gently pulls the unwound strand through an opening for further analysis.

Figure 6 Nanorobot repairs DNA chain

Meanwhile, detach regulatory proteins detach from upper arm from the chain and place them in an intake port.The information stored in the database of a larger nano computer positioned outside the nucleus the molecular structures of both DNA and proteins are compared. By a communication link it was connected to the cell repair ship. Irregularities found in either structure are corrected and the proteins reattached to the DNA chain [41-43] which re-coils into its original form. The repair vessel would be smaller than most bacteria and viruses, with a diameter of only 50 nanometers, yet capable of therapies and cures well beyond the reach of present-day physicians.Internal medicine would take on new significance with trillions of these machines coursing through a patient's blood stream. At the molecular level disease would be attacked, and such maladies as cancer, viral infections and arteriosclerosis could be wiped out.

CONCLUSION:

To diagnose and treat various medical conditions like cancer, diabetes, arteriosclerosis, kidney stones etc. the Nano robotics are found to exhibit strong potential. They will provide personalized treatments with improved efficacy and reduced side effects Nanorobots can offer a number of advantages in drug delivery over present methods. These include more bioavailability, targeted therapy, fewer surgeon mistakes; reach remote areas in human anatomy, large interfacial area for mass transfer, non-invasive technique, computer control of delivery, better accuracy, less side effects and greater speed of drug action. Nanotechnology will change health care and human life more profoundly than other developments consequently they will change the shape of the industry, broadening the product development and marketing interactions between Pharma, Biotech, Diagnostic and Healthcare industries.

REFERENCES:

1) Robert A, Freitas Jr. The future of nanofabrication and molecular scale devices in nanomedicine. Studies in Health Technol. Informatics 80: 45-59, 2002
2) Robert A. Freitas Jr., Nanomedicine, Volume I: Basic Capabilities, Landes Bioscience, Georgetown, Tx, 1999.
3) Boonrong, P., and B., Kaewkamnerdpong, "Canonical PSO based Nanorobot Control for Blood Vessel Repair", World Academy of Science, Engineering and Technology, 5: 428-433, 2011.
4) Robert, A. Freitas. Jr. "Microbivores: Artificial Mechanical Phagocytes using Digest and Discharge Protocol", Journal of Evolution and Technology, 14: 1-52, 2005.
5) Wilner, M.E., Bio-Inspired and Nanoscale Integrated Computing. John Wiley & Sons, Inc., 2009.

6) Robert, A. Freitas. Jr. "Microbivores: Artificial Mechanical Phagocytes using Digest and Discharge Protocol", Journal of Evolution and Technology, 14: 1-52, 2005.
7) Wilner, M.E., Bio-Inspired and Nanoscale Integrated Computing. John Wiley & Sons, Inc., 2009.
8) Kannan T. T. M., A. HussainLal, M. Ganesan, and R. Baskaran, "Study and Overview about Molecular Manufacturing System" International Journal of Mechanical Engineering and Robotics Research 2 (1): 193-201, 2013.
9) Wilner, M.E., Bio-Inspired and Nanoscale Integrated Computing. John Wiley & Sons, Respirocytenanorobots, Inc., 2009.
10) Robert, A. Freitas. Jr. "Current Status of Nanomedicine and Medical Nanorobotics", Journal of Computational and Theoretical Nanoscience 2: 1-25, 2005.
11) Robert, A. Freitas. Jr. "Medical Nanorobotics: The Long-Term Goal for Nanomedicine". in Mark J. Schulz, Vesselin N. Shanov, eds., Nanomedicine Design of Particles, Sensors, Motors, Implants, Robots, and Devices, Artech House, Norwood MA, 367-392, 2009.
12) Robert, A. Freitas. Jr. "Exploratory design in medical nanotechnology: A mechanical artificial red cell." Artificial Cells, Blood Substitutes, and Immobilization Biotechnology, 26: 411-430, 1998.
13) Jaiswal, A., H., Thakar, B., Atanukumar, T., Krunali, and D. B., Meshram, "Nanotechnology revolution: respirocytes and its application in life sciences" Innovare journal of life sciences, 1 (1): 8-13, 2013.
14) Mishra, J., A. K., Dash, and R., Kumar, "Nanotechnology Challenges: Nanomedicine: Nanorobots", Journal of Pharmaceuticals, 2 (4): 112-119, 2012.
15) Ahuja SP, Myers JR. A survey on wireless grid computing. J Supercomput ; 37:3-21. 2006.
16) Hanada E, Antoku Y, Tani S, Kimura M, Hasegawa A, Urano S, et al. Electromagnetic interference on medical equipment by low-power mobile telecommunication systems. "Electromagnetic interference on medical equipment by low-power mobile telecommunication systems", IEEE Trans. Electromagn. Compat, 42:470-6. 2000.
17) Kharwade, M., M., Nijhawan, and S., Modani, "Nanorobots: A Future Medical Device in Diagnosis and Treatment", Research Journal of Pharmaceutical, Biological and Chemical Sciences, 4 (2): 1299-1307, 2013.
18) Mishra, J., A. K., Dash, and R., Kumar, "Nanotechnology Challenges: Nanomedicine: Nanorobots", Journal of Pharmaceuticals, 2 (4): 112-119, 2012.
19) McDevitt M.R., Ma D., Lai L.T., Simon J., Borchardt P., Frank R.K., Wu K., Pellegrini V., Curcio M.J., Miederer M., Bander N.H., Scheinberg D.A., "Tumor Therapy with Targeted Atomic Nanogenerators," Science 294, 1537-1540, Nov. 2001.
20) Zhang M., Saharawi C.L., Tao W., Tarn T.J., Xi N., Li G., "Interactive DNA Sequence and Structure Design for DNA Nanoapplications", IEEE Transactions on Nanobioscience, Vol. 3, No. 4, Dec. 2004.
21) Stracke R., Böhm K.J., Burgold J., Schacht H., Unger E., "Physical and Technical Parameters Determining the Functioning of a Kinesin-Based Cell-Free Motor System", Nanotechnology, 11(2):52-56, Jun. 2000.
22) Reppesgaard L., "Nanobiotechnologie: Die Feinmechaniker der Zukunft nutzen Biomaterial ales biomolecular motors", Biomedical Microdevices, 2:179-184, 2000.
23) Whitcomb L.L., "Underwater Robotics: Out of the Research Laboratory and Into the Field", in Proc. IEEE Int'l Conf. on Robotics and Automation, San Francisco, CA, USA,pp. 709-716., apr 2002
24) Cavalcanti A., Hogg T., Shirinzadeh B.,"Nanorobotics System Simulation in 3D Workspaces with Low Reynolds Number", IEEE-RAS MHS Int'l Symposium on Micro-Nanomechatronics and Human Science, Nagoya, Japan, Nov. 2006.
25) Baraff D., "Fast contact force computation for nonpenetrating rigid bodies", in Computer Graphics Proceedings, Annual Conf. Series. ACM SIGGRAPH, 23-34, 1994.
26) Freitas R.A. Jr., "Nanomedicine", Vol. I: Basic Capabilities," Lands Bioscience, 1999, http://www.nanomedicine.com.
27) Geppert L., "The Amazing Vanishing Transistor Act," Cover story, IEEE Spectrum Magazine, pp. 28-33, October 2002.
28) Hagiya M., "From Molecular Computing to Molecular Programming," Proc. 6th DIMACS Workshop on DNA Based Computers, pp. 198-204, Leiden, Netherlands, 2000.
29) Adamson, P.B.; Conti, J.B.; Smith, A.L.; Abraham, W.T.; Aaron, M.F.; Aranda, J.M.; Baker, J.; Bourge, R.C.; Warner Stevenson, L.; Sparks, B. "Reducing events in patients with chronic heart failure (REDUCEhf) study design: continuous hemodynamic monitoring with an implantablendefibrillator. Clin. Cardiol. 30 (11), 567–575. 2007
30) Ohki, T.; Ouriel, K.; Silveira, P.G.; Katzen, B.; White, R.; Criado, F.; Diethrich, E. "Initial results of wireless pressure sensing for endovascular aneurysm repair: the APEX trial—acute pressure measurement to confirm

aneurysm sac exclusion. J. Vasc. Surg. 45 (2), 236–242. 2007

31) Ramcke, T.; Rosner, W.; Risch, L. Circuit configuration having at least one nanoelectronics component and a method for fabricating the component, 2002.
32) Das, S.; Gates, A.J.; Abdu, H.A.; Rose, G.S.; Picconatto, C.A.;Ellenbogen, J.C. "Designs for ultratiny, special-purpose nanoelectronic circuits". IEEE Trans. Circuit's Syst. I-Regul. Pap.54 (11), 2528– 2540. 2002
33) Narayan, R.J.; Kumta, P.N.; Sfeir, C.; Lee, D.-H.; Olton, D.; Choi, D. Nanostructured ceramics in medical devices: applications and prospects. 56 (10), 38–43. 2004
34) Hede, S.; Huilgol, N. "Nano: the new nemesis of cancer. J. Cancer Res. Ther.2 (4), 186–195, 1998.
35) Cavalcanti, A.; Shirinzadeh, B.; Fukuda, T.; Ikeda, S. Hardware architecture for Nano robot application in cerebral aneurysm. IEEE-Nano 2007 Int. Conf.Nanotechnol pp. 237–242, Hong Kong, Aug.2007
36) Goicoechea, J.; Zamarreño, C.R.; Matias, I.R.; Arregui, F.J. "Minimizing the photo bleaching of self-assembled multilayers for sensor applications." Sens. Actuator B-Chem., 126 (1), 41–47, 2007.
37) Leary, S.P.; Liu, C.Y.; Apuzzo, M.L.I. Toward the emergence of Nano neurosurgery: Part III. Nano medicine: targeted Nano therapy, Nano surgery, and progress toward the realization of Nano neurosurgery. Neurosurgery, 58 (6), 1009–1025. 2006
38) Hellman's A., "German Team Creates New Type of Transistor-Like Device," News Analysis, IEEE Spectrum Magazine. 20-21, January 2003.
39) Cavalcanti, L. Rosen, L. C. Kretly, Moshe. Rosenfeld, Shmuel Einav, "Nanorobotics Challenges in Biomedical Applications, Design and Control", IEEE ICECS Int'l Conf. on Electronics, Circuits and Systems,Tel-Aviv, Israel, December 2004.
40) Cavalcanti A., "Assembly Automation with Evolutionary Nano robots and Sensor-Based Control applied to Nano medicine", IEEE Transactions on Nanotechnology, Vol. 2, no. 2, 82-87, June 2003
41) Cavalcanti A. and Freitas R.A. Jr., "Autonomous multi-robot sensor-based cooperation for Nano medicine," Int'l J. "Nonlinear Science Numerical Simulation", Vol. 3, No.4, 743-746, August 2002,