PART -1

Problem Statement: **TREATMENT OF HIV USING DECOMPOSABLE NANOBOTS**

Concepts Used: 1. Medical Techniques

2. Image Processing
3. Deep Learning
4. Data Analytics
5. IoT (Internet of Things)
6. Organic Matter
7. Nanotechnology

For cells: Host WBC + HIV virus = Infected WBC
Nanorobot + Infected WBC = Restored WBC

For virus: The electrode mounted on the nanorobot could form the battery using the electrolytes in the blood. These protruding electrodes could also kill the damage cells/virus by generating an electric current, and heating the virus up to death

Challenges: 1. Nanobots accumulation leads to **blockage of various pathways** inside the body

Solution: Here, we are using biodegradable Nanobots made up of Spirulina Algae and biocompatible coating. Controlled thickness of iron-magnetic coating provides fine-tuned biodegradation time.

2. **Remote Diagnostic Sensing**: Used Nanobots ability to sense changes in environments associated with the onset of illness makes them a promising probe for remote diagnostic sensing of diseases.

3. **In Vivo Tracking**: Naturally fluorescent biological interior and magnetic iron-oxide exterior allow the use of both fluorescence imaging and more powerful magnetic resonance imaging thus scientists can more easily track and control the nanobots activities inside the body.

4.**Inroduction of Device into the body**: We need to find a way of introducing the nanorobots into the body, and allowing it access to the operations site without causing too much ancillary damage. We have already made the decision to gain access via the circulatory system, which leaves us with a number of considerations. Firstly, the size of the nanorobots should determine the minimum size of the blood vessel that it can traverse. It should not damage the walls of whatever blood vessel the device is in and it should also not block it too much, which would either cause a clot to form, or just slow or stop the blood flow, hampering in precipitating the problem we want to cure in the first place. What this means, of course, is that the smaller the nanomachine the better. However, this must be balanced against the fact that the larger the nanomachine the more versatile and effective it can be. This is especially important in light of the fact that external control problems become much more difficult if we are trying to use multiple machines, even if they don't get in each other's way. Secondly, we can get it into the body without being too destructive in the first place. This requires that we gain access to a large diameter artery that can be traversed easily to gain access to most areas of the body in minimal time. The obvious candidate is the **femoral artery in the leg**. This is in fact the normal access point to the circulatory system for operations that require access to the bloodstream for catheters, dye injections, etc., so it will suit our purposes nicely.

5. Even when HIV treatment has suppressed the level of HIV in blood plasma over a long period of time, HIV can still be found in "viral reservoirs" in blood and lymphoid tissues. If HIV treatment is stopped, HIV will replicate again.

Solution: Directly work over viruses too and kill them, so no replication later.

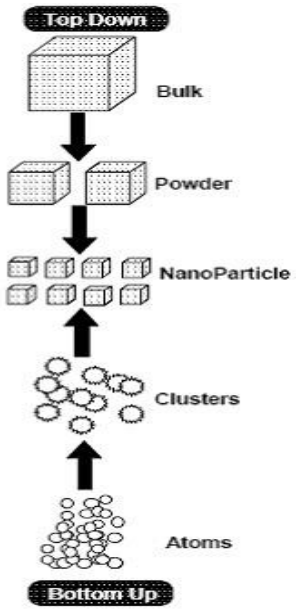
6. Many types of HIV at different stages of life: **Different drugs to target different classes of infected cells in various life cycles of HIV**: Combination of 3-4 antiretroviral drugs is used to treat HIV. As each antiretroviral drug class targets a Cell at different step in the life cycle of HIV, combining drug from at least two different drug classes provide a more effective way to treat & to prevent replication of virus rather than a single drug.

7. **Finding the point of origin and try to burn that** : Using complex calculations through the trajectories & later applying image processing to find the center of origin , we can get closer to origin and rather than destroying

individual cell (In parallel keep on destroying or converting infected cells into normal ones to prevent replication) , work will be done to destroy the virus.

Design

Steps: 1. Develop the biodegradable Nanobot: The mostly followed approach for creation of anti-HIV nanorobots is the bottom-up approach. It involves assembling structures atom-by-atom or molecule-by-molecule which will be useful in manufacturing the devices.



Components:

- Payload – This void section holds a small dose of drug/medicine. The nanorobots could transverse in the blood and release the drug to the site of infection/injury.
- Micro camera – The nanorobot may include a miniature camera. The operator can steer the nanorobot when navigating through the body manually.
- Electrodes – The electrode mounted on the nanorobot could form the battery using the electrolytes in the blood. These protruding electrodes could also kill the damage cells by generating an electric current, and heating the cells up to death.
- Swimming tail – The nanorobot will require a means of propulsion to get into the body as they travel against the flow of blood in the body.

Working: The nanorobots are provided with swarm intelligence for decentralization activity. Swarm intelligence techniques are the algorithms designed for artificial intelligence of the nanorobot in which work is done collaboratively without a centralized control.

- Power System-
  The nanorobots uses the glucose molecules present in the human body as the power source.

- Nano Logic Processor –
  It comprises the main sensing, actuation, data transmission, remote control uploading and coupling power supply subsystem, addressing the basics for operation of medical devices.

- Sensors–
  Nanorobots will have chemical, pressure, temperature sensors, electromagnetic, magnetic, optical sensors, gravity, position/orientation sensors, and molecular recognition sites.

  In addition to that, the nanorobots will also have DNA sensors.

- DNA Sensor –
  The DNA sensor is a cantilever type. In one arm the actual sample is placed and in the second arm the sample from the WBC is placed. Even if the samples differ by a single base, it can be identified Carbon nanotube network field-effect transistors (NTNFETs) that function as selective detectors of DNA immobilization and hybridization.

- RNA converter –
  It converts the RNA of the HIV virus.

- Antenna Interface –
  A system for tracking an object in space comprising a transponder device connected to the object. The transponder device has one or several transponder antennas through which a transponder circuit receives an RF (radio frequency) signal. The transponder device adds a known delay to the RF signal, thereby producing RF response for transmitting through the transponder antenna. This helps to control nanorobot position.

- Actuator – A nanoscale device used to pump fluids, open and close valves. In this model, it is specifically used to provide translational movement for the nanorobot.

2. Enter the Nanobot in the body by technique discussed above.

3. Now, let the intelligent nanobot take its decisions whether to repair the cell and convert it into normal WBC or if its virus just burn it.

Two methods:

In the first method the nanorobots will have biosensor to identify a particular compound. In this case the biosensor will contain a particular antibody. The gp41 and gp120 are two unique HIV envelope protein which is found in the cell membrane of the infected cell. The antigen (gp41 and gp120 protein) and antibody reaction will give the proper signal. In case of infected cell only this reaction will take place as those viral proteins are found in the cell membrane of the infected cell only. Getting the positive signal the nanorobot will inject its nanotube into the nucleus of the infected cell and release the DNase as well as RNase enzyme into the cell. The DNase enzyme is not sequence specific and as a result it will cleave the whole genomic DNA containing the viral genome into single nucleotides. Once the viral genome loses its sequence it loses its viral effect and after the digestion of the whole genomic DNA the cell undergoes normal programmed cell death called apoptosis. Thus, the infected cell of the diseased body can be destroyed to finish off the viral genome in the body.

One another method that can be implemented is that the nanorobots will have two arms that will have two arms. One of the arm will be attached to the infected WBC cell and the other one will be attached to the healthy WBC cell. The DNA sensor will send signals to the CPU present in the nanorobot to match between both the cells and it can be identified by Network field effect transistors (NTNFETs) that can function as selective detector of DNA immobilization and hybridization. If a mismatch is found between the WBC cells, then the CPU send the signal to the RNA converter to activate. Then the RNA converter converts the infected WBC that contains the HIV into DNA that is killing the virus.

4. Obstacle avoidance algorithm is used for movements and control.

5.Now exploit the properties of intelligent nanobots, if cell is highly damaged- according to level of damage, decide the amount of dose that the nanobot need to drop to the cell.

6. These HIV cells mutate and sometimes develop immunity again our medical dose inside the nanobots. Thus, here comes the role of intelligent bots, now we will take the advantage of image processing and analyzation here. We will notice the changes in the cell and accordingly change the doses.

Now, we will apply deep learning and convolutional neural network(CNN) techniques to make our nanobot self- learning and deciding the dose by itself, this is the main part of our training.

Thus it makes use of image processing, deep learning exclusively. If this part is done well, system will get trained and hence the disease will end up from the system and through our generation. Later on, detection and cleaning of virus is done by system once it starts finding the virus and later our system learns and recognizes virus faster. Hence the defined model works over the root cause, the HIV viruses and ends it.

7. For now, if Dose ends, the nanobots will degrade automatically. Looking for some methods to refill the dose in future.

Newness + Feasibility : All the challenges mentioned in the previous models are almost solved in this model and I had even mentioned the solution that are definitely applicable. I am working over this in collaboration with some of my batchmates, looking further for guidance from my faculties in IIT Dhanbad and IISC professor Prof. Ambarish Ghosh. I started working over deep learning in medical image processing as my M.Tech Thesis. Also, approaching Professor Amabrish Ghosh in IISc as intern to work in his project of **Nanobots for drug delivery, removing blockages from particular parts and treating diseases.** Lets hope for a better solution in the future.

REFERENCES

[1] Dr. Ankita Joshi1 , Akash Pardeshi2, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 7, Issue 6 (Sep. - Oct. 2013), PP 84-90

[2] 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.

[3] Mishra, J., A. K., Dash, and R., Kumar, "Nanotechnology Challenges: Nanomedicine: Nanorobots", *Journal of Pharmaceuticals*, 2 (4): 112-119, 2012.

[4] 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.

[5] Khin Haymar Saw Hla, YoungSik Choi and Jong Sou Park," Obstacle Avoidance Algorithm for Collective Movement in Nanorobots" , IJCSNS International Journal of Computer Science and Network Security, VOL.8 No.11, November 2008

[6] Merina, R. M., "Use of nanorobots in heart transplantation", *Emerging Trends in Robotics and Communication Technologies (INTERACT)*, International Conference, IEEE, 265-268, 2010.

[7] Sharma, N. N, and R. K., Mittal, "Nanorobot movement: challenges and biologically inspired solutions" *International journal on smart sensing and intelligent systems*, 1 (1): 88-109, 2008.

[8] Wilner, M.E., Bio-Inspired and Nanoscale Integrated Computing. John Wiley & Sons, Inc., 2009.

[9] Shruthi Harsha 1 , V. Venkateswara Rao, International Journal for Research and Development in Engineering (IJRDE) www.ijrde.com Vol.1: Issue.1, June-July 2012 pp- 38-44

[10] A. Cavalcanti, R. A. Freitas Jr. and L. C. Kretly, "Nanorobotics Control Design: A Practical Approach Tutorial", Proceedings of the ASME Design Engineering Technical Conference, 28th Biennial Mechanisms and Robotics Conference, Salt Lake

City, USA, 2004.
[11] Khin Haymar Saw Hla, YoungSik Choi and Jong Sou Park, Department of Computer Engineering Korea Aerospace
University, Korea, “Obstacle Avoidance Algorithm for Collective Movement in Nanorobots”, IJCSNS International Journal
of Computer Science and Network Security, VOL.8 No.11, November 2008
[12] Daniel P Stites, Abba I. Terr, Tristum G. Parslow, “Basic and clinical immunology”

[13] Bodian D & Howe H A (1941). The rate of progression of virus in nerves
[14] Molecular Biology of the cell by Bruce Alerts
[15] K.Eric drexler , “Nanotechnology summary”
[16] Arthur Guyton , “Textbook of medical physiology”

[17] Recent advancement through various available resources