International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 1 Volume No.7 January - February – 2023
DOI:10.46647/ijetms.2023.v07i01.035 ISSN: 2581-4621

A review/survey paper on Nanobots in Medical Applications for detection of leukemia in human beings

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Abstract
This research examines or surveys the use of nanobots in the medical field. Nanorobotics is the science and technology of developing and fabricating small machines, particularly robotic machines. A nanorobot is any "smart" structure with nanoscale actuation, sensing, signalling, information processing, intelligence, manipulation, and swarm behaviour (10-9m). The phrase "nanorobotics" contrasts with the term "microrobotics" and refers to the branch of nanotechnology engineering that focuses on building and fabricating nanorobots with components that are nanoscale or molecular in nature and range in size from 0.1 to 10 micrometres. One of the early applications of nanomachines in society is in medicine. The biological tools are used to find and get rid of cancer cells. The project presented here was completed as part of the curriculum by a second-year post-graduate student in Bangalore's Dayananda Sagar College of Engineering's electronics and communication engineering department.
Keywords : Nanorobot, Medicine, Intelligence.

1. Brief explanation

In this study, Ze-Wei Guo and the researchers divided samples into three types and proposed two approaches to handle the dataset related to breast cancer [1]. When preprocessing samples, noise is filtered out to produce high-quality images, which are then used as input. When classifying samples, self-regulated ML NN is applied to distinguish between benign, malignant, and normal patients. In order for the experts to acquire important characteristics, they have also used rotating forests to compute and evaluate fitness value and genetic algorithms to increase efficiency [2]. Rotation Forest is then used to detect input samples, and the suggested approach has a 99.48% accuracy rate. Convolutional Neural Network (CNN), a deep learning technique, was also described by the researcher in order to advance breast cancer technology and increase accuracy by 10% to 20% over earlier approaches [3]. After employing rotational operation to expand the dataset, the researchers entered the samples into CNN (two convolution layers, two pooling layers, one fully connected layer). By categorising the progression of cancer cells, they created the hybrid mathematical hierarchical regression model (HMHR), which incorporated linear and nonlinear models to determine the most effective course of treatment for breast cancer [4].

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2. Wavelets Energy

These oscillations have an amplitude that starts at zero, rises, and then falls to zero. It is frequently purposefully created to have particular characteristics that will make them effective for speech, picture, and signal processing, as well as pattern and signal recognition [5]. Here, the wavelet energy's noise reduction function is used to remove the minor fluctuations from the prediction model, and only the overall trend was taken into account. The algorithm and data were then refined to further boost SVM's accuracy in predicting breast cancer [6]. This study uses Wavelets Energy and SVM, a novel intelligent algorithm, to diagnose breast cancer. It increased the precision of intelligent diagnosis in breast cancer by accurately differentiating benign and malignant tumours by using wavelet energy as an activation function to extract aspects of breast cancer [7]. It is ultimately validated through numerical trials. In the diagnosis of breast cancer, WG & SVM is expected to be very successful [8].

3. DNA Nanobots

To reduce side effects, scientists came up with the concept of DNA nanorobots. DNA nanorobots are meant to exclusively target malignant cells while avoiding healthy cells. DNA nanorobots have the potential to effectively treat the illness, even if it is discovered in its later stages. Figure 1 depicts the use of nanobots to recuperate. The scientist created DNA-based nanobots that serve as carriers for medications used to cure cancer [9]. When injected into the body, these bots, which are only 35 nm in diameter and 200 times smaller than a red blood cell, kill only the malignant cells that are infected. The nanorobots' structure was designed by the researchers using an open-source programme called Cadnano, and the bots were constructed using the DNA origami method, which involves creating intricately formed objects out of DNA [10]. By slicing a short section of DNA (the staple strand) and joining it to a longer strand, DNA can be formed into the desired shape. The interaction of the complementary base pairs causes the two strands to join and take the correct shape [11].
These robots resemble two clamshell-like halves of a nano-sized open-ended barrel that can be opened and closed. The DNA double helix-based molecular locks or latches serve as molecular hinges that hold the two halves together [12]. There are 12 locations for attaching payload molecules inside the bots. There are two locations outside where aptamers can be attached (short nucleotide strands with special sequences for recognising molecules on the target cell). The medicine is inserted into the nanobot and molecular anchors hold it in place. When the aptamers identify their intended target, they serve as clasps, and the gadget opens up and releases the payload [13]. The two states of the nanobots' programming are ON and OFF. The two parts open up and transport the medicine to a target cell once they have identified it based on the proteins on its surface (on position). They are tightly closed and skip through healthy cells when they are in the off position. An aptamer encoded logic gate manages the nanobots. It is possible to create autonomous biocomputing structures that can carry out Boolean logic gates from any kind of nanoparticle (NAND, NOT, AND, and OR). Since DNA is a natural substrate for computation, a variety of logic circuits and robots have found use for it [14]. The functionality of logic gating is built into DNA, and logic gating is accomplished by input-induced breakdown of DNA structures. Nanoscale robots with the ability to interact with one another dynamically when placed within the body can be created using DNA origami. These interactions result in logical outputs that, upon spotting the target cell, are used to open or close the nanobot to release the medicine [15].

4. Test Run

For a test run, the researchers created nanobots that could distribute and sort drugs. The robot is made up of three parts: a "leg," a "hand," and a "arm" that transports and administers the medication. The use of the bots in the treatment of cancer is excellent. Recently, scientists developed nanobots that release thrombin, an enzyme that clogs the blood going to the tumour and kills the tumour as a result. This trial has raised hopes that nanobots can be employed as an efficient cancer therapy strategy and are safe enough to use. The key benefits of the bots are their speed and durability. Drugs with regulated releases are more precise, accurate, and have fewer negative effects. Errors made by surgeons are reduced. Its superiority is in computer controlled distribution and faster medication activity. Smart bandages that hasten wound healing can also be created using nanotechnology [16].

5. Convolutional Neural Network (CNN)

These are employed in this paper's author Pooyan Sedigh's classification of skin cancer. The International Skin Imaging Collaboration's primary database, which is used to train the CNN algorithm, contains 97 members (50 benign and 47 malignant) (ISIC). A Generative Adversarial Network (GAN) is created to create fake images of skin cancer in order to make up for the lack of data needed to train the suggested CNN algorithm. Without the obtained synthetic images, the intended trained CNN's classification performance is close to 53%; however, when the obtained synthetic images are included to the primary database, the model's performance rises to 71% [17].

6. GAN Algorithm

According to the images produced by the proposed GAN algorithm, the CNN algorithm's performance in terms of cancer detection improved. Skin cancer is categorised as benign or malignant using CNN. Convolution, pooling, fully connected, and soft max classification layers are the principal layers used to build the CNN. Considering the short database created for this research, CNN uses three convolutional layers. A maximum pooling layer follows each convolutional layer created using the CNN model. In addition, a soft-max layer is connected to the second dense fully connected layer. A Rectified Linear Unit is employed as the activation function in the CNN process (ReLU). After the fully connected layer, a dropout layer is added to further regularise the CNN model and avoid overfitting. S-CNN, a CNN trained using a database of synthetic pictures, fared better than a CNN trained using a preliminary database. Accuracy, sensitivity, specificity, and F1- score are the metrics used to evaluate the performance of the CNN both with and without the synthetic images. By gathering the samples that the classifier has successfully identified as cancer (True positive), the samples that it has correctly identified as benign (True positive) (True Negative). The GAN-derived synthetic databases, which were utilised to create the CNN algorithm, are evaluated both with and without them. The detection of skin cancer based on the CNN algorithm findings was 17% better than when using only the primary database when the CNN was trained with the database consisting of both primary and GAN synthetic pictures [18].

7. PSO (Directed Particle Swarm Optimization) approach

Using nanorobots, the medicine can be delivered to only the tumour cells, sparing the healthy tissues. To make it easier to send Nanorobots to the cancer region, Howida A. Shedeed and Doaa Ezzat devised a novel tweak to the PSO algorithm. The new algorithm is called Directed PSO (DPSO). It can efficiently convey the entire swarm of Nano-robots to the target region after only a few iterations, and it can bring all Nano-robots to the target area in a very short amount of time.

Until one of the Nanorobots reaches the target area, the DPSO algorithm uses the conventional PSO to update Nanorobots' positions. The other Nanorobots will then go in the direction of the one that has already reached the target area. Once the entire swarm has reached the destination, they continue to travel in this direction in small, continuous increments. One Nanorobot can reach the goal and then pulls every other Nanorobot to it. The number of iterations required to deliver all Nanorobots to the tumour location can be significantly reduced in this approach. When utilising PSO, certain Nanorobots occasionally get lost. In this regard, DPSO works better than PSO since it ensures that all Nano-robots may reach the target area.

After positioning the Nanorobots in the deployment area close to the tumour site, the author used C++ to mimic the Nanorobots' movements. Ten times each, the simulation is run using 10, 20, and 30 nanorobots. To imitate PSO, BFOA (Bacterial Foraging Optimization Algorithm), MPSO (Modified PSO Algorithm), and DPSO, the author used four alternative methods. When compared to all other algorithms, DPSO is the fastest at getting Nanorobots to the goal. Additionally, DPSO ensures that the entire swarm of Nano-robots will be able to reach the target region.

8. Conclusions

In this article, we have provided a brief overview of the nanorobots that have been applied to biomedical engineering or the treatment of cancer, the most lethal disease in the world. An existing example of molecular nanotechnology is biological systems. Instead of focusing on the distant future, let's start today by developing some genuine working gadgets that will enable us to directly increase our capabilities rather than relying on the byproducts of other technologies to treat some of the deadliest diseases known to man.

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