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Research Article

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Design and Development of an Artificial Intelligence Chip for Nano-drug Delivery System in Treating Lung Cancer

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Abstract

Cancer has become one of the world's deadly diseases all around the globe. In this manuscript, it has been described with the methodology of generating the cancer signals virtually by designing and formulating a model mathematically and the way of processing the tumor signals deeply through radiotherapy, chemotherapy, bio-immunotherapy, and target therapy by the enhancements of artificial intelligent (AI) algorithms and the strategy of designing and developing AI chip nano-drug delivery technological model for the diagnosis of lung cancer. The main purpose of this manuscript is to modify the rules and regulations which has been adapted in the strait-forward manner in prevailing the guidelines of the treatment regarding the single fitting of doses and drugs into a dignified personalized and precise treatments of cancerwith an enhanced AI technology. It is believed that based on this proposed idea as well as the strategy that has been induced by the state of art techniques taken for this study, it could be prolonged and improvise the life of cancer patients with good health and live without the fear of such dangerous disease. It is also determined on predicting the cancer cells with maximum precision and diagnosis and treatment will be carried out on a timely basis immediately after clear estimation of the disease. In future, based on the AI chip system developed in terms of nano-drug technology, cancers could be treated as chronic disorders and ready diagnosis with treatment will be most common in all medical centers.

Keywords

Lung cancer, Virtual signal processing, Deep reinforcement learning, Artificial intelligent systems, Nano-drug delivery

Introduction

The cancer disease still remains as one of the globe's deadliest diseases with which every year it is it is diagnosed with 19 million absolutely new patients and approximately 10 million deaths all around the world. The worldwide burden of this cancer disease is drastically increasing and leads to many complications in treatment. One global body named the International Agency for Research on Cancer has detected and estimated that by the year2030 there would be approximately 23 million recent cases and 14.5 million deaths. Of the derivatives of cancer such as brain cancer, muscle cancer lung cancer is considered as the disease that is very difficult to treat with therapy and results in mortality that comprises of 24% of cancer infected cases and 6% of deaths resulted all over the world. Hence in the perspectives of researchers, cancer disease is very difficult to

cure permanently or to extend the life of the patient [1]. This is caused primarily due to several reasons that is inclusive of the diagnosis associated to the major lung cancer is happening only at the terminal stage when it gets influenced much depth into the cells of lung and that kind of patient is very lethargic in going to hospital and doing certain general test associated with that. Because, when it is detected in the earlier stage the treatment could be made easier if not, it could be very hazardous [2]. The malignant type of cancer cells occurs very earlier, and its detection is well exposed to the subject. Certain immunological study has been undergone for detecting and treating this sort of lung cancer and with the enhancements in nanotechnology, the medicines in that form could be very sensitive and precise in detecting and analyzing the way how to make the right way of treating this lung cancer. By the adaptation of chip technology and the formulation of nano drugs we could have a high possibility in bringing the solution for treating this deadliest disease very easily [3].

The broad definition of nanotechnology could be made in such a way that the application and fabrication of man-made substances, systems and devices that gets collected within the dimension of one to hundred nanometer in at least single dimension, however this dimensional range is most often not essential related to reveal the cause for which the cancer cells is occurring. The nanoparticle is considered as the broadest term for various sizes and shapes associated with the structures of nano vectors. This has been illustrated in figure 1 and it possess the potential in revolutionizing the path with which the diseases such as cancerous cells and the tumorous cells could be easily attained with its diagnosis and treatment, and it is also based on the current facilities and trends. These potentials are being highly afforded by the nanoparticles because of its maximal surface volume from its area when is visualized with their magnetic, thermal, optical, macro molecule realization along with its electrical characteristics and capability of synthesizing a diversity of sizes and shapes both the chemical and physical composition with which its structural manipulation is made with endogenous and exogenous stimuli. Based on their multidimensional characteristics, nanoparticles possess the potential in overcoming the chemical and the biological barriers within the body of human permitting for diagnostic and therapeutic efficacy and localization with minimal or non-invasiveness and maximal biocompatibility with the motive for improving the subject's lifespan [4]. Moreover, despite being resulted with substantial reports the complete potential of nano-drug particles has to be realized. Its primary happening exists mainly because of its reproducibility, toxicological biopotential, peak scale production and safety precaution challenges that might be assessed inadequately.

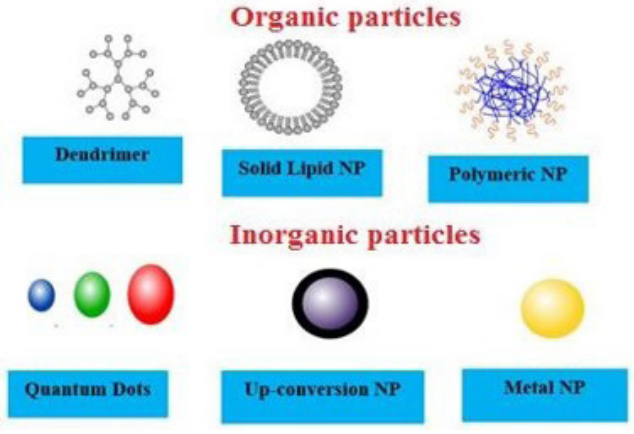

Figure 1: Representation of nanoparticle spectrum used for diagnosing and treatment of lung cancer.

Methodology

Existing method

Lung cancer-segregation and biological facts

Lung cancer is one of the deadliest diseases that has been caused and occurred as a resultant over identifying the existence of neoplastic metamorphosis associated with the lung epithelial cells [5]. For the sake of devising the personalized and comprehensive strategy in the treatment of lung cancer, the clinician or the doctors should not only consider the molecular and the genetic information of the patient, but also essentially to consider the previous medical records and histopathological characteristics. The lung cancer that has been mapped to the malignant respiratory condition has been categorized under SCLC (Small cell lung cancer), MPM (malignant pleural mesothelioma) and NSCLC (Non-small cell lung cancer) [6].

Case history of patient with NSCLC

In equation 2 the patient has been observed and the data has been taken for test as a real time case from China. The name of the patient is Mr. Wang, and his age is 65 years, and he has been identified with the lung cancer belonging to the cluster of non-small cell lung cancer at its third stage along with the existence of Epidermal Growth Factor Receptor (EGFR) mutation. The traditional way of undergoing the treatment of lung cancer is by physical open skin invasive operation, radiotherapy, or chemotherapy [7].

Similar to this subject most the patients have been diagnosed with lung cancer and they belong to this cluster and even the young age group people have been diagnosed with such a deadly disease because of some unusual habits such as smoking, consumption of alcohol, living under polluted (air pollution) environment etc. [8]. This lung cancer has become the emperor of all the lung cancers that have resulted in the highest mortality rate and is very difficult to survive further. The data associated with the growth of tumorous cells has been depicted in table 1.

In this study, for the purpose of analysis we have uti-

Table 1: Data associated with the growth of tumor.

S. No.	Weeks (t)	Diameter (D)
1	0	7.5
2	3	7.8
3	8	8.8
4	15	9.5
5	26	10.4
6	62	15.4
7	65	15.8

lized two various mathematical tumor models for generating the signals as a resultant of tumor growth. One is the model named Logistic version and the other named Gompertz version [9].

Gompertz version

$$U(t) = \frac{dv}{dt} = k_U e^{-\mu t v} \quad (1)$$

In the above equation 1, $U(t)$ is determined as the signal associated with the tumor, and v denotes the volume with which v_0 denotes the volume of the tumor that has been measured initially. k_0 is determined as the thickening rate [10].

Logistic version

$$U(t) = \frac{m'}{m} = p - q \quad (2)$$

Where m' denotes the thickening or the widening rate at t. The parameter p-q determines the difference between the time instant with which the cells of the cancer grow to the cell of the cancer degrades. At each time instant, the measurement ismade in terms of p(t) and $q(t)$, respectively. The time stamp could be measured in terms of daily or weekly basis as it is mentioned in table 1. The data is allowed to be acquired and it is processed in both the version of Logistic and Gompertz. The characteristic of cancer influenced curve is depicted in figure 2. Figure 3 determines the characteristics over the growth of tumor cells across weeks [11].

Through curve fitting strategy and by determining the logistic regression across the prediction of the linear increase in volume of tumor cell existence and the really observed increase in tumor cells, it is evident that the class that has been obtained from prediction has been estimated to be true with which, the enlargement of tumor is happening slowly from thezeroth week to eighth week being the maximal diameter of 8.8 [12, 13]. Later on, between 25 to 60 it could be visualized with exponential and linear widening and finally between 62 to 65 the enlargement shrinks to value from 15.4 and 15.8. Presently, there are two different possible ways for treating the lung tumor via chemotherapy. One strategy is initiating the effects of cytotoxicity whereas the other technique is to target through the track of EGFR for the NSCLC subjects which is determined as target therapy or treatment. The initial line medicine for the subjects of NSCLC with the EGFR strategy are erlotinib, gefitinib, afatinib, or Tagrisso [13]. The mathematical version illustrated for chemotherapeutic procedure for treating lung cancer is as follows in equation 3.

$$\frac{dv}{dt} = -kv^2 + st \quad (3)$$

Where v is determined as the volume or density of tumor, k is associated with the microenvironment of tumor cells, s has been associated with the efficiency of drugs and t determines the dosage of drugs. In this chemotherapy treatment the size of the tumor would become significantly smaller after the implication of anti-tumor medicine and the recovery of normal cells will be evident as there would be increase in resistance of drugs towards tumor cells that has been created by the medicine. In case of tumor cells if it gets enlarged, even if it gets explored with the drug, then the cure is impossible which results in death of the person.

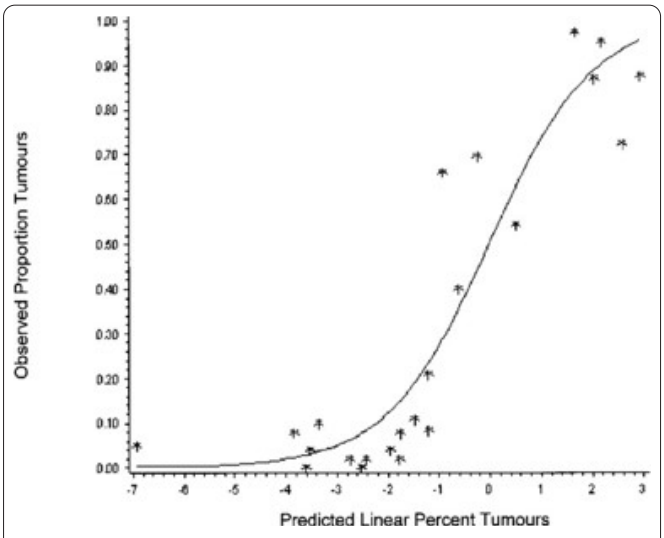

Figure 2: Characteristics over the existence of tumor after prediction.

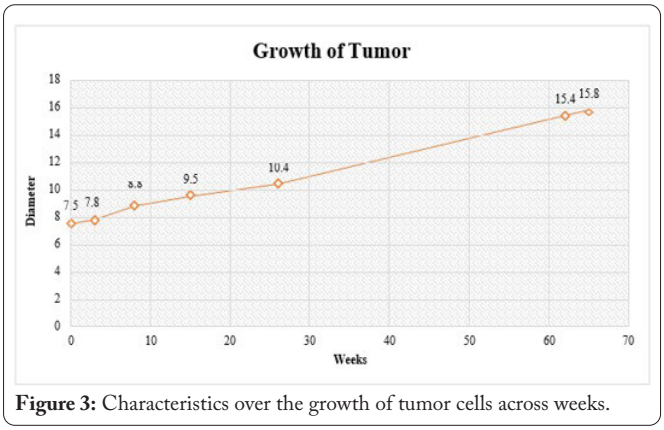

Figure 3: Characteristics over the growth of tumor cells across weeks.

Proposed method

AI algorithms in processing a signal for detecting cancer cells

From the literatures, it has created an impact and the learning that the conventional treatment associated with cancers has been imparted in the way of identification and treatment that would be carried out with the aid of radiotherapy, chemotherapy, and immunotherapy. These are considered to be as an elementary and plain sailing rules developed based on a single dose or a single drug that has to be fit within the cure. Most of the preliminary developed therapies are purely based on previous experiences and the strategies being incorporated by various doctors, clinicians, and instrumental technologists. In this subsequent section, it is adapted with the try for changing the traditional ways of treating such deadlier cancer disease to a specific customized or individualized tumor treatment planning and strategies with the implication of reinforcement, deep learning, and other various AI strategic algorithms. Also especially, it is considered

with the does adapted with anti-drugs, duration of active drugs in immunotherapy such as CTLA 4th version, PD-L 1st version and PD-1st version and accuracy and precision with AI and it is proposed for developing an external diaphragm pacer (EDP) controlled by the gulp in distribution system with the artificial intelligent chip for the detection and treatment of lung tumor.

AI algorithms in treating lung cancer

There are three essential algorithms of artificial intelligence that have been utilized in processing the tumor signals and they are inclusive of reinforcement distributed learning, reinforcement deep learning and normal reinforcement learning.

Results and Discussion

Target and chemotherapy-reinforcement learning

Reinforcement learning is the type of learning the way to interact with the external environment and to initialize suitable actions for enhancing the entire rewards. In figure 4, it is evident that the deep controller is fit and is assisted to deliver thedrug to the patient and also realize the adequate responses from the patient. The deep controller here acts as the agent, or the unit associated with the signal processing unit of deep cancer cells and its respective treatment to make appropriate decision in terms of its response. The algorithm working is as presented in figure 5.

In the mentioned algorithm (Figure 5), the selection over the delivery of drugs has been made after each iteration, then the deep learning system penetrates to the new state of tumor. The determination over the updated tumor state value has produced the reward for delivering the drugs from its previous state. By enabling the working of an entire algorithm that is made similar and mapped with the representation of memory what originally the oncologists have created the learning through various medical experiences in learning is patched by the cumulative collection of rewards for entire state of response and actions. Moreover, the convergence of the algorithm has been made towards the strategy of best treatment ways that has been resulted with the peak value with which the treatment would be functioned.

Deep reinforcement learning

For the purpose of utilizing the historical and the traditional medical experiences, three different types of information such as genomic, clinical (habitual) and electronic information have been accounted. The implication of deep reinforcement learning is for processing the tumor signals and for determining the best policy and norms in the treatment. Initially the Q-network is being converted into the Deep learning Neural Network according to figure 6 which is depicted below. The function associated with the value in the reinforcement learning is $Q(s, a)$ and later it enacts as $Q(s, a, w)$. This algorithm makes the updating associated to the weights of training ω by the reduction of value function. This works as per the following equation 4.

$$L(W_{i+1}) = \frac{1}{2|M_i|}\sum_{n\in Ni}\sum_{t=1}^{T(n)}\left[v_t^{(n)}(W_i) - Q\left(S_t^{(n)}, a_t^{(n)}, W_{i+1}\right)\right]^2 \quad (4)$$

External diaphragm pacing technology induced nano-drug distribution model for lung tumor detection with an integration of AI chip (Figure 7). The drugs that eradicate the lung cancer that penetrates into the tumor cells with higher

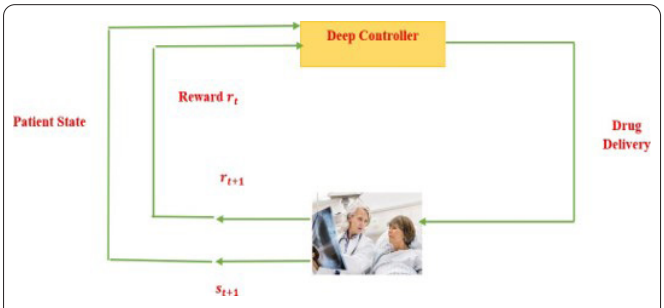

Figure 4: Treatment of cancer using reinforcement learning.

Algorithm 1: Reinforcement learning created on target therapy or bio-immunotherapy.

----Input: Initialize the conditions of learning:
W: Dimension of the tumor.
K: microenvironment associated with the tumor cell.
S: efficiency mapped to the drug.
D: Dosage of drug.
R(s, a)= Assigned or as per the preliminary knowledge of Oncologists.

----Output: Strategy over the optimal tumor treatment: $R^*(a, s)$;
----Make the selection of any one as per the existing policy with the assumption of €-greedy
-While W> Desired Absolute Value do
-Apply the selection over the mapping of D to the size of tumor
-Gather the updated values of W, K & S by utilizing the adaptive model
-Determine the evaluation over the reward wave from the tumor component
-Make the updation of existing state as a resultant of action number R(a, s)
-Reconstruct the value W, K, S
-End While

Figure 5: The working algorithm.

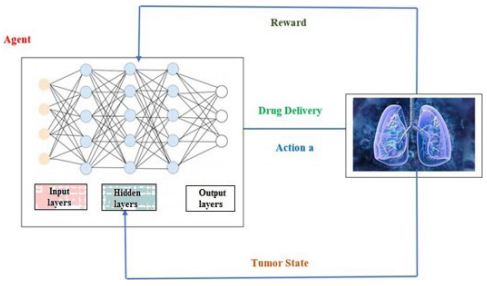

Figure 6: Representation of deep reinforcement learning for bio-immuno therapy.

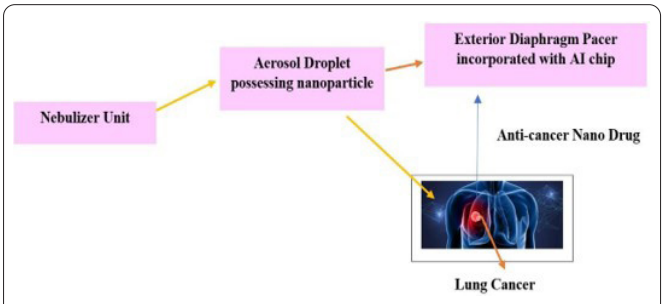

Figure 7: Representation of nano-drug distribution system integrated with AI chip via EDP.

concentration and velocity along with its magnificent positive response are considered as the successive way in treating the NSCLC subjects, but the traditional systematic chemotherapy have proven that the concentration of drug at the pin location of lung tumorous cells must be only between 6 to 11%. The nano crystalline structured and the nebulized drug distribution to NSCLC subjects has been the peak and burnt spot in the tumorous cell research but the equipment's for carrying such missions targeted towards the alveolar region in lung space is still remains inefficient and outdated because of the complexity of the alveolar system and the bad functioning of the lungs. In this proposed study, the presentation over the technique of sniffed in chemotherapy for NSCLC subjects which uses the minimally invasive EDP via the technology for providing the assisted and adaptive nano-drugs in nebulized form that too in a controlled path. The systematic model possesses a binary unit. One is the Driven Right Leg chip induced with EDP unit and the later one is the unit of nebulization. When the activation of EDP is being initiated, the stimulated electrical pulses are being expelled out to the subjects and allows the unit of nebulization to get triggered out for the production of nano-drug to the desired location of lung where the tumor cells are densely detected. The system gathers the response of signals, from the action over the circulation of blood called a pharmacodynamic waveform that pertains how efficient the nano-drug reaches the targeted tumor region. As per the generated and the transmitted signal component, the brilliant agent presents in the IP FPGA core that is driving the Driven Right Leg algorithm results with best decision over treatment for each individual subject.

Conclusion

In this manuscript, various simulated mathematically illustrated model has been formulated for the detection of cancerous signals along with traditional target therapy, chemotherapeutic model, immune or radiotherapy have been realized with the proposed nano-drug distribution system integrated with AI chip via EDP has been realized. The realization has been inferred with different AI algorithms. It also has portraited with the results of how the tumor is getting influenced naturally and how it could be either detected and treated via the clinicians through medical procedures or the detection and treatment could be carried over by the nano drugs by integrating AI chip within the system. Performance realizations could be compared based on complexity, time, and efficiency. It is believed that, as of future a greater number of patients could be explored to such kind of treatments by the drastic enhancements in deep learning techniques, algorithms, digitized computing technologies and most essentially by the nano-drugs. It is important that the disease has to be detected and cured at the earlier stage itself.

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None.

Conflict of Interest

None.

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