AI CONVERGED WITH NANOTECHNOLOGY & ITS APPLICATIONS ON DETECTING THE VIRUSES PRIOR TO HUMAN DISRUPTION

T S Lavanya, Dr. Y. L. Malathi Latha

1 UG Student, 2 Head of the Department, Department of Computer Science, Swami Vivekananda Institute of Technology, Secunderabad, Telangana, India.

Abstract—SARS COVID 19 has hit the world where we witnessed and are witnessing not only the drastic fall in the economy but also its vulnerable affect on changing the livelihood of each individual. Till date the virus has infected over 118 million people worldwide and caused over 2.6 million deaths.[1]

Being a part of throughgoing world where everything is revolving around technology, where in our points of interest’s Artificial Intelligence, Nanotechnology plays a vital role in various areas of research in treating diagnosing, testing the covid 19 virus. Reviewing all those scenarios in this paper we get to a framework where we with the help of the “technology-biology merge” (AI with Nanotechnology) we would be able to detect the viruses, bacteria which are airborne, waterborne before it affects our people in our country.

KEYWORDS– Artificial Intelligence, Principal component Analysis, Artificial Neural Networks, NLP- Natural Language Processing, DL models, Position specific scoring matrices, Sensors, Nanotechnology, nanoparticle, Nanoscience.

INTRODUCTION

SARS COVID -19 - severe acute respiratory syndrome coronavirus 2 has registered its 1st case in DECEMBER 2019, Wuhan, China. This sars- cov 2 that is positively stranded RNA beta coronavirus belongs to the largest group of viruses – NIDOVIRALES order, Cornidovirinae suborder and Coronaviridae family says Dr Ramya Dwivedi under Nano Medical life sciences research[1].

Artificial intelligence plays a vital role in the era of advancements. The human reasoning can be induced and complex problems can be solved. For example, AI sensors sense the object without any physical contact.

Artificial Neural Networks - ANN’s are computing systems inspired by the biological neural networks that constitute animal brains. Such systems learn or progressively improve performance to-do tasks by considering examples, generally without task specific programming.

Why ANN’S?
We are utmost interested in using Ann’s because of the following reasons,
1. Neural networks learn from examples.
Before Neural Networks the conventional computation was used where in the algorithm’s each step that is the solution’s blueprint must be known to the programmer so as to seek the solution and to feed the machine with the input.

But the ANN’S, as they learn from the examples it attains the capability of predicting the outcome of unknown test cases efficiently.

Nanotechnology which refers to building things or objects which are at atom or molecules scale or even less than that which is termed “nanoparticle”. It used to study the particle which is 1 billionth of meter! For example, materials such as their color, strength, reactivity, can differ substantially between the nano scale and macro. Carbon ‘nanotubes are 100 times stronger than steel but 6 times lighter. Well known physicist Dr Richard Feynman is the father of Nanotechnology.

Its efficiently used in treating cancers by rapid and sensitive detection of molecules that are cancer related and generate agents that are used for therapy.

Why Nanotechnology is powerful?
• It comprises of Engineering –Science—Technology.
   The justification is as follows given by the European Commission of Public health

Nanotechnology is the term given to those areas of science and engineering where phenomena that take place at dimensions in the nanometre scale are utilized in the design, characterization, production and application of materials, structures, devices and systems.
In diagnostics Nanotechnology would help in detecting the spots of changes in the body parts. In future it definitely be the case that the nanorobots would report the changes in our body parts in which they will be programmed to detect the change and report back to our smart gadgets.

The delivery of antibodies is swiftly happening exactly at the part of the body where they should be released and work, such is the power of Nanotechnology.

Artificial Intelligence with Nanotechnology is the powerful technological merge with the biology. According to Sacha Gomez and Pablo Varona from the Grupo de Neurocomputation Biological at the Universidad Autonomy de Madrid, these are the following reasons for bringing in the AI to be converging with Nanotechnology: [11]

1. Nanotechnology suffers from the physical limitations where in macroscopic world is different from physics.
2. Numerical simulations, analytical approximations have been challenging tasks in nanotechnology This is where AI plays a key role.

LITERATURE SURVEY

APPLICATION OF ARTIFICIAL INTELLIGENCE TO FIGHT AGAINST COVID-19:

According to Jianguo Chen et al[3]. Artificial Intelligence in battling covid – 19 has been used in mainly four aspects:

1. Vaccine development:
   AI algorithms have been used to develop covid – 19 vaccines for epitome predictions and these algorithms’ data set consists of netMHC whose abbreviation is major histocompatibility complex which is a local vertebrate DNA that contains polymorphic genes, that consists of cell surface protein for adaptive immune system.

Reverse vaccinology system has also been converged for predicting and evaluating the potential vaccines for covid.

Position specific scoring matrices are also used predict epitope and immune interactions, thereby predicting the production of adaptive immunity in the target host.

Outbreak prediction:
To predict the outbreak of covid 19 the datasets would definitely be important, the two AI companies blue dot [10] collected heterogeneous data from sources like real time climate, news reports, animal infections etc on a very large scale, Meta biota [8] collected data from various social sources such as biology, socioeconomic, political and environmental data. After collection of large datasets which underwent the various Machine learning and NLP- Natural Language Processing techniques and predicted the outbreak of transmission by detecting, marking and displaying the risk frequency of the virus.

CNNMODEL – CNN is a type of neural network model which allows us to extract higher representations for the image content. Unlike the classical image recognition where you define the image features yourself, CNN takes the image's raw pixel data, trains the model, then extracts the features automatically for better classification. [7]

LSTM MODEL – Long short-term memory (LSTM) is an artificial recurrent neural network (RNN) architecture used in the field of deep learning. ... Relative insensitivity to gap length is an advantage of LSTM over RNNs, hidden Markov models and other sequence learning methods in numerous applications.: Wikipedia

GRU MODEL – GRU (Gated Recurrent Unit) aims to solve the vanishing gradient problem which comes with a standard recurrent neural network. GRU can also be considered as a variation on the LSTM because both are designed similarly and, in some cases, produce equally excellent results. [7]
RF MODEL – Random Forest, like its name implies, consists of a large number of individual decision trees that operate as an ensemble. Each individual tree in the random forest spits out a class prediction and the class with the most votes become our model’s prediction [7].

1. Transmission Prediction:
Meta biota [8] on collecting the large social and non-social datasets NLP has played a major role in predicting the outbreak and spread.

Along with this DL models are used where the inputs were the features, number of covid cases reported on each day, on completion of a week, the following days prediction was been made.

2. Social Distancing:
Infrared cameras powered with AI to sense and detect the high temperatures in the crowd, video tracking technologies have also come into existence that monitor the data of each individual passing by will be monitored within a fraction of second and detect the covid patient in public places. This is only possible when the entire data of each individual who is tested positive works as a separate dataset.

Various AI based applications like Arogya sethu have also been made to detect the hotspots and look through the covid cases in each locality.

By the above survey we can say that the datasets play a major role in the application of any algorithm in the artificial intelligence.

In the similar way we can have the infrared cameras powered with sensors having the datasets of the memory or the DNA of the similar unusual viruses so as to detect the outbreak in the vicinity of the sensors placed as soon as the air is affected.

However, monitoring such a minute particle is a challenge with this approach.


Nanotechnology is the study and application of materials whose dimensions are <100nm.

Irrespective of the surface may it be large small or acute the multifunctionality, surface adaptability and enhanced solubility helped in many diagnostics such as cancer treatment.

In battling covid 19 Nanotechnology is been used in the major scenario that is -

a. Prevention –
Self-sterilizing personal protective equipment is the main point of interest where in the personal protective equipment must be made in such a way that the virus particles with different morphological sizes that is from 20 nm to 900nm [9] must be identified by the nanotechnology and those unusual viruses must be destroyed by the nanorobots which would be intended to act upon certain inputs.

b. Detection of sars cov 2 – According to the survey conducted by Priya Singh et al [4] COVID – 19 patients have been exhibited, exhibiting a wide range of symptoms that are similar to other respiratory diseases so as to detect the covid 19the thin line have to be differentiated to serve this purpose and to prevent the spread of infection nucleic acid-based tests which were costly and time consuming. The motto was to develop a rapid cum cost effective tests that detects the presence or the absence of the virus in the human body or in the air. To achieve this nanotechnology enhanced the detection techniques which are RT-PCR and immunofluorescence by virtue of nanoparticles.
For detecting the low magnitude signals nanomaterials are employed as labels for enhancing those signals. Nano labelling is done by attaching metals like silver or gold nanoparticles on the targeted bio recognizing probes results in significant outcomes.

Nanoparticles have excellent multiplexing capabilities for which they were suitable for the state of art technologies for virus detection.

i) Nanotechnology in nucleic acid tests
A detection method which is similar to the method for detecting the hepatitis has been developed where in the Silica coated magnetic nanoparticles acted more rapid than Dyna beads commercialized kits. The reason being is that nanoparticles of Fe3O4 / SiO2 had the large surface areas that can isolate DNA samples with low virus concentrations, time effective. RNA dependent RNA polymerase genes from SARS-CoV and SARS – CoV 2 is in the developmental stage.

ii) Nanotechnology in protein-based tests
Development of the graphene-based transistor biosensing devices(sensors) coated with the specific antibodies against sars CoV 2 spike protein and this can detect the spike protein with concentrations of 1 fg/ml in phosphate – buffered saline and 100 fg/ml in clinical transport medium. This is a highly sensitive rapid detection method for detecting the virus which is in the developmental stage.

iii) Nanotechnology in treatment of Covid-19 –
Remdesivir authorized by the US FDA has been the emergency drug to be given to the covid 19 patients. Covid 19 effects the respiratory system at its very worse, cytokine [9] is most important field that modulates the adverse effects. Example – leukemia inhibitory factor. The nanoparticles of the leukemia inhibitory factor increase the tolerance in respiratory acute distress syndrome. Referencing this cytokine, a resistance system has been developed in order to treat the sars cov 2. Noting the vital thought of Zhang et al which is that in the process of treating the covid any drug could disrupt the binding to the spike protein ACE2 which has the potential to inhibit the virus, so the novel peptide-based drug has been taken into consideration which has the disadvantage of degrading the enzymes and reducing their efficacy.

According to the research by the North-western University’s Simpson Querrey Institute collaborated with the authors peptide drug chemical composition, carrier allows for the development of nanostructures would help in reducing the degrading of the enzymes and stabilizing the efficacy.

Also, with the ZnO nanoparticles modulation of host immune response is done which lead to the secretion of the cytokines.

Based on the surface area, particle size electric charge nanoparticles the Nanotechnology played a vital role in generating the absolute time and quantity of delivery of antibodies to treat the virus.

i) Nanotechnology in immunomodulation
Immune system modulation is the most important in immunomodulation. The main factor for designing the biocompatible nanomedicines is the understanding of immune responses towards nanomaterials. Carbon- and carbon-based nanomaterials such as graphene and nano diamonds are sensed by the immune cells and their interaction with immune cells elicits immune simulating or suppressing response.

According to Orecchioni et al the effects of GO and GO functionalized with amino groups (GONH2), they polarized Tcells and activated monocytes toward a T helper – 1 mediated the immune system response with low toxicity.

AI POWERED WITH NANOTECHNOLOGY IN RAPID COVID TESTS: [2]
In a study published in ACS Sensor scientists at OSAKA UNIVERSITY have a new system where the silicon nanopores is sensitive enough to detect the single virus particle when coupled with machine learning algorithm such powerful tool is this AI converging with Nanotechnology.
Silicon nitride which is 50nm thick suspend on a silicon wafer has tiny 300nm diameter nanopores, a voltage difference applied to the either side of the wafer makes the ions travel in electrophoresis, this motion is monitored by the current generated and when viral particle enters a nanopore it blocks some of the ions from passing through leading a transient dip in current.

The dip reflects the physical properties such as volume, surface, charge, shape which would be beneficiary in detecting the kind of virus. The author Tomoji Kawai et al[5] explains that this new method is cost effective which does not require the costly reagents.

When only Artificial Intelligence is used the challenging part was to deal with the most minute particles that is the nanoparticles may it be the DNA of the similar harmful viruses powered with cytokine.

When only nanotechnology is applied for detecting the virus it is utmost important that the information of kinds of input is stored so as to refer whenever a new example will be fed as the input.

So, the convergence of Artificial intelligence with Nanotechnology is important.

NANOTECHNOLOGY IN WATER TREATMENT:[6] Nano adsorption:
Adsorption is capability of all solid substances to attract their surfaces molecules of gases or solutions with which they are in close contacts. Solids that are used to absorb gases or dissolved substances are called adsorbents, and the adsorbed molecules are called as adsorbate.

Nano absorbents: 
Carbon based nano adsorbents i.e., carbon nanotubes (CNT’s) Metal based nano adsorbents  
Polymeric Non-absorbent Zeolites

CARBON NANOTUBES: 
CNT’s are the allotropes of carbon with cylindrical nanostructure.

These have to be stabilized in aqueous suspension in order to avoid aggregation that reduces the active surface.

POLYMERIC NANO ADSORBENTS:
Polymeric nano adsorbents such as dendrimers are utilizible for removing organics and heavy metals. Organic compounds can be adsorbed by interior hydrophobic shells, whereas heavy metals can be tailored exterior branches.

ZEOLITES:
Zeolites in combination with silver atoms have been known since the early 1980’s.

Zeolite has very porous structure in which nanoparticles such a silver ion can be embedded. When used for sanitary purposes, the silver attacks microbes and inhibits their growth.

NANO FILTRATION:
Membrane filtration plays an important role in removing various types of contamination and enables high level of water purification.

Nano filtration produces water that meets highly stringent requirements in terms of water reuse. Since this process is highly efficient in removal of organic and inorganic substances bacteria and viruses the need for subsequent disinfection of water is minimal.

Membrane separation processes are rapidly advancing applications for water and waste water treatment.

NANOENGIEERED MEMBRANE FILTRATION:
1. Nanofiltration membranes 
2. Nanocomposite membranes 
3. Self-assembling membranes 

Our interest is in-AQUAPROPIN BASED MEMBRANES:

Aquaporin’s are pore-forming proteins and ubiquitous in living cells.
Under certain conditions, they form highly
selective water channels that are able to reject
most ionic molecules.
This kind of membrane can withstand pressure
up to 10 bar and allow a water flux greater
for example required for brackish water destination.

PROPOSED METHODOLOGY

1. The graphene-based transistors biosensing
must be used to detect the affected air whose main
concentration would be the kind of virus’s DNA or
memory which will be fed in the processor of the
sensor.

2. Moreover, there must be a reference which
should be updated for every minute so that the
sensor learns from the kind of input its being
through.

3. Every detected particle’s property or the
memory or DNA must be monitored by the
graphene-based transistor biosensing and must go
through the system which will be further formulated
in such way that we can confirm the affect in the air.
We would definitely face the uncertainties at the
very beginning which would definitely be solved by
the field of cytokines.

4. However, data collection and monitoring is
definitely a challenge with this approach.

Artificially intelligent infrared cameras powered with
the nanotechnology sensors most specifically
graphene-based transistor biosensing, passed
through the silver/ gold nanoparticles which helps in
rapid detection. This DNA or memory coupled with
ANN will help the Ai cum nanotechnology sensors in
identifying the new examples effortlessly.

Additionally, a system which is similar to the
weather reporting framework would help us in the
constant monitoring of each minute’s particles
moving across the sensors in particular vicinities.
FOR WATER BORN VIRUSES

A sensor with the memory of the usual
components of water. Which means training the
artificial intelligence machine to be familiar with
the usual components around. Or feed the memory
of the specific bacteria so as to be more particular
on our detection process.

Similar to the detecting the air borne viruses we store
the properties of the nanoparticle of the
components of the water

Other way is to use AQUAPROPIN BASED
MEMBRANES and place the sensor in such a way
that the outcome of the membrane filtration can
be fed as the input to the sensor so it measures
the level of similarity to the input that we have given to our sensor.

CONCLUSION

Artificial intelligence converged with Nanotechnology is highly powerful tool which help us battle this pandemic up to major extent. For this convergence to detect the virus before it affects the humans in large scale, referencing from the existing methodologies from the surveys done by the well-established authors gave us deep insight about the solutions. An infrared AI camera which will be based on the artificial neural network algorithm and the principle component analysis powered with the nanoparticle’s which will detect and react upon the unusual viruses specifically referring from the protein based covid tests using nanotechnology could detect the virus particle. Passing through the sensors, it immediately gives us a warning. As this is a tedious task we would need a system such as a weather reporting system so as to monitor, gather, enhance the huge datasets for being better for each day.

We initially will face challenges as it is not an easy task here Artificial neural network’s learning capability will better the sensors each time and definitely attain the capability of predicting the virus weather if its SARS cov 2 or the other viruses wherein the thin line is given by the cytokine field.

All these aspects would help the system learn from the mistakes and adapt to the change effectively.

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Karnataka, IndiadSchool of Chemical and Biomolecular Engineering, The University of Sydney, Sydney, NSW, 2006, Australia


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11. G. M. Sacha and P. Varona
Grupo de Neurocomputation Biological. Escuela Politécnica Superior, Universidad Autónoma de Madrid, Canto Blanco, Madrid, Spain E-28049