

WEARABLE DEVICES WITH DEEP LEARNING TO DIAGNOSE COVID-19**R. Arunprasath**Dhanalakshmi Srinivasan College of Engineering, Coimbatore, Tamil Nadu, INDIA
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Abstract--- Recent advances in wearable devices has improved the health monitoring system of COVID 19 patients. The severity of virus during pandemic has affected the health care sector drastically. Monitoring of patients is supported by IoT interfaced wearable devices. The proposed work is focused on remote monitoring of patient health care parameters, interfacing with IoT devices and medical image analysis using deep learning. The sensor data and patient information is recorded in cloud server and the health care parameters are analyzed using deep learning approach. For COVID 19 patient the real time data from oximeter, pulse sensor and temperature sensor plays a key parameter for analysis. Deep learning technique is applied to analyze medical images and health care parameters measured from patient data base.

Keywords: Healthcare, Internet of Things, Cloud Computing, COVID-19, deep learning, Wearable sensors

I. INTRODUCTION

The end of year 2019 China has identified the respiratory disease related to SARS and on further analysis leads to finding global pandemic called as COVID19 pandemic. The severe acute respiratory syndrome was caused due to coronavirus and it has similarity with SARS. Li et al. defined a suspected COVID-19 condition as pneumonia and the illness is diagnosed under four criteria: severe fever and high temperature, varying white-cell count or low lymphocyte count and no reduction in symptoms after 5 days. Medical research lab analyzed the severity of disease and the conclusion was made to do research on vaccines to cover global crowd from pandemic. The first COVID-19 vaccines were introduced as an emergency use throughout the world and the initial doses where injected to health care workers and also the study on the side effects of was carried out in early starting of month in 2021 to collect data on the side effects of the COVID-19 vaccine among healthcare workers [2]. The study used a validated the question items covering the participant's demographic data, medical data, and COVID-19-related analogous, general, oral, and skin-related side effects. Results: Injection site pain (89.8%), fatigue (62.2%), headache (45.6%), muscle pain (42%), general side effects. Basic side effects to prevalent among the above 40-year-old group, and their duration was mainly one day (45.1%) or three days (34%) following the vaccine. The important mandate symptoms of COVID-19 are dry cough, fever, muscle ache, fatigue, and shortness of breath.

Along with these, other less-observed symptoms are include diarrhea, headache, and hemoptysis [2]. The individual can be infected with the COVID-19 virus. The virus deeply affects lungs functionality with the impact increasing by up to 14 days. Among the symptoms, research has found that body temperature and dry cough are vital diagnosis parameters of COVID-19[2].

The invention of Smart Healthcare Systems, as well as major advances in medicine and public healthcare, has increased the Quality of Life (QoL) in developing countries. The demand for low cost health care devices supports the patients and elderly people with non-communicable diseases. Recording of sensor data keeps track of all COVID-based medical parameters and post-operative data of people with chronic diseases like diabetes and heart disease on a continuous basis. The proposed AI-based Deep learning health tracking system that uses the Internet of Things to access the patient's medical parameters in both local and remote locations. A cloud server records data from the patient's temperature sensor and pulse sensor; the data is analyzed using Convolution neural network algorithm to identify irregular conditions to share the patient condition.

II.METHODOLOGY

The remote health-care monitoring system consists of sensors, actuators, advanced Communication technology, AI&ML-based prediction system. The patient has to stay in home itself. These wearable's will monitor a person's physiological signs in real time, assess any health problems, and any potential anomalies in order to provide feedback to doctors. Healthcare is an essential part of life and new technology are growing recently and becoming a part of our life; people are relying more on technology with each passing day. People wear a number of wearable devices, from fitness trackers to smart glasses, smart rings, smart shoes, smart contact lenses, etc[5]. In past 10 years there is a unpredictable growth in smart wearable's. The techniques used for COVID-19 symptoms such as temperature, oxygen saturation level or breathing rate already exist. These wearable's can be updated with cloud-based infrastructure to meet the needs of remote assessment of COVID-19 patients. The wearable sensor module analyzes the following health care parameters from COVID-19 patients.

1. Fever is the most common symptom, making temperature sensors a critical component of a wearable sensing system .In 90% or more of cases, fever is the main clinical representation of COVID-19[5].

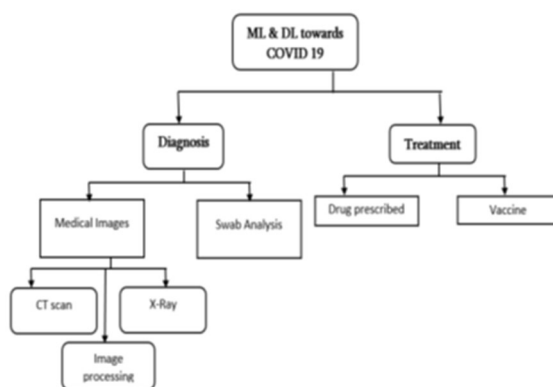


Figure 2 Monitoring system

2. Wearable device with Pulse oximeter sensors play a very important role, as they obtain the photo plethysmogram (PPG) and find the oxygen saturation level based on the light absorption of oxygenated and deoxygenated hemoglobin. The human body transports oxygen by hemoglobin through the circulatory system. A lack of oxygen, i.e., SpO2, can cause brain damage, heart failure,

or sudden death if it reduces to less than 95% [5]. Pulse oximeter Sensor Characteristic is Greater Than 90 Normal less Than 90 abnormal

3. Respiratory rate: Anomalies in the respiratory rate of a patient and detect the illness. Together with SpO₂, HR, and body temperature, RR is one of the clinical features for evaluating the severity of a respiratory disease. A patient with severe respiratory distress has an RR greater than 30 breaths/min [5] which can develop into acute respiratory distress syndrome (ARDS)

4. Cough and lung sound monitoring: Dry cough is one of the symptoms of COVID-19. People affected with virus may spread the disease when they cough and monitoring of dry cough or not also helps in its prevention.

5. Blood pressure monitoring: Blood pressure (BP) is one of the most important vital signs that reveals cardiovascular and cerebro-vascular functions. The BP level of patient is the main risk parameter for cardiovascular morbidity and mortality. The vulnerable population, i.e., those with underlying conditions, has a higher risk of severe complications from COVID-19 [5].

6. ECG Sensor: The ECG sensor device fit to the patient to read the electrical activity the heart over a period of time. The sensor outputs are converted to digital signal. The information collected is carried out using a microcontroller and is transmitted through IoT module.

7. Pulse oximeter Sensor is a non-invasive device used to measure the oxygen-carrying capacity of hemoglobin, instead of measuring directly from a blood sample. It is very helpful for continuous measurement of the oxygen saturation of blood [5].

III. PROPOSED MODELS

Deep learning (DL) in Artificial intelligence approaches accurate screening of the spread of the virus from mild to severe infections, and is used in supervising the disease continuously. Smart watches to collect data from patients and use a heuristic model for its detection. In pandemic situation, AI is implemented in medical research to identifying who has the most risk, diagnosing patients, developing drugs faster, finding existing drugs that can help lower the spread of the disease; understanding viruses, better mapping where viruses come from, and predicting the next pandemic. At the start of the pandemic smart watches made headlines regarding the following and tracking of COVID-19 symptoms. Initially the viral infection, there is a possibility that the person who takes the sample from the patient may also become infected. The testing can take a few hours, and the person can transmit the virus to a group of people during this time. To avoid these problems, medical staff remotely monitors the patients BP, ECG, pulse rate, HR, and fever using wearable devices with AI technology. Deep learning is an important tool in fighting the current pandemic.

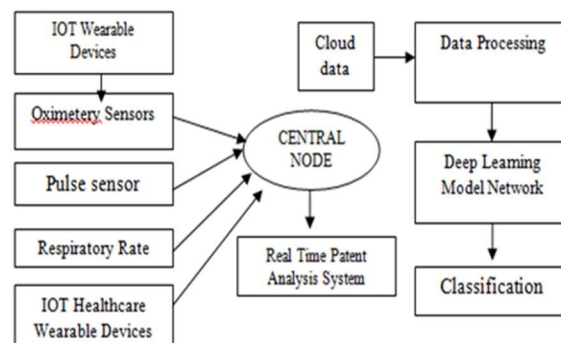


Figure 3 Central Node Systems

Wearable Devices has a key component of a healthcare system found on Internet of Things and as such the development of accurate sensors like Pulse sensors ,Pulse oximetry sensor, Respiratory rate sensors can be used to collect personalized data and stored for analysis the early detection of person health care conditions and save one's own life.

Preprocessing removes the redundancy present in captured images and data without affecting the details that play a role in the overall process. Segmentation is used for medical analysis in healthcare sector. It is used in diagnosing the images, for deep learning, to find out the accurate data for helping doctors to take faster decision in the right treatment. This might be color information we can use for texture segmentation and that was developed through a spatial gray level dependence matrix.

Feature Extraction in machine learning, pattern recognition and in data processing, feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant. The mathematical operation of convolution is performed between the input image and a filter of a particular size. Convolutional Neural Network to improve the classification performance. The AWS Deep Learning AMIs support all the popular deep learning frameworks which allowing you to define models and then train them at scale. Built for Amazon Linux and Ubuntu, the AMIs come pre-configured with Tensor Flow, PyTorch, Apache Net, Chainer, Microsoft Cognitive Toolkit, Gluon, Horovod, and Keras. Classification Image classification is the process of categorizing and labelling groups of pixels or vectors within an image based on a specific rule.

IV.RESULTS AND DISCUSSION

The system uses wearable sensors for collecting patient health data is show in Figure-2 and the gathered information is transmitted via API and Internet connection. The health information was further investigated using an optimized Convolutional neural network (CNN).The user dataset data helps train the model to analyze and classify real-time patient health information. The dataset 4800 scholarly articles to gather patient health information. The global community listed the COVID-19 patient health condition, which was used to learn the neural network. From the collected data, 30% the information was used for training, and 70% was used as a testing dataset. The system’s excellence is evaluated using various performance metrics defined in the following equations and the sensor measurements.

(Mean square error)

$$MSE = \frac{\sum (\text{Correctly predicted} - \text{wrongly predicted})}{\text{Total no of samples}}$$

Total no of samples

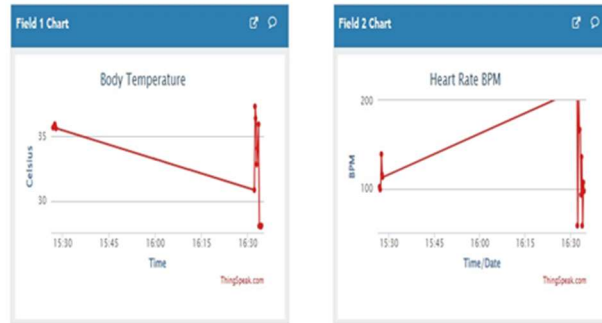


Figure 4 Heart rate monitoring range

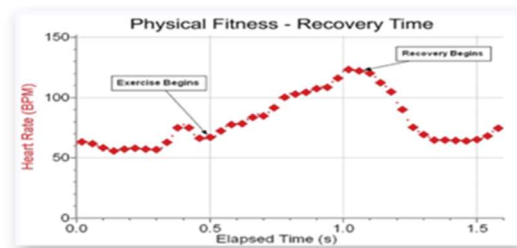


Figure 4 Physical Fitness monitoring

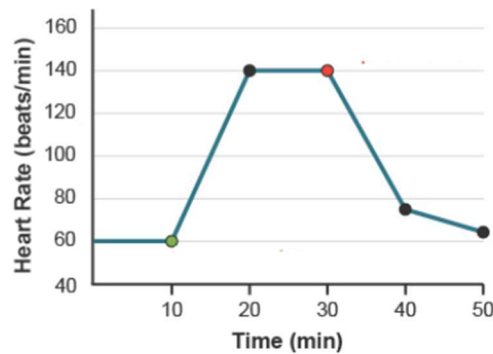


Figure 5 Heart Rate flow

V.CONCLUSION AND FEATURE WORK

A wearable device prototype model is designed to monitor the Covid-19 health symptoms of potentially infected patients (PIP) during the quarantine period from remote locations. The proposed IoT-based system has been structured in such a way that it can help to recover from the tremendous loss occurring because of the COVID-19 pandemic. The system is successful at achieving the goals which were set primarily. As maintaining physical distance plays a crucial part in combating the virus, the proposed approach enables the healthcare professionals to provide their service to the patients by monitoring them remotely. The system can establish a low-cost health monitoring system with significant efficiency. Additionally, the feature that generates real-time data enables the authorizes and healthcare professionals to get notified in time to respond to a critical situation quickly. The Deep learning-based proposed system also opens an opportunity to understand the patient's health better and provide proper treatment by getting information on the severity of Virus. Thus, patients with other diseases can be treated accordingly without the possibility of being

mistreated. The embedded multiple sensors for the system were developed as a prototype and can be improved even more by adding other sensors. The embedded multiple sensors implemented physically for the system.

The most significant drawback of using the cloud is that it introduces security risks, and as such have presented several work focused on improving security in the cloud. It was found that access control policies and encryption can significantly enhance security, but that no known standard is suitable for immediate application into a wearable, IoT-based healthcare system. Deep learning and the development of a secure yet lightweight encryption scheme for cloud storage were the two areas that provide the most opportunity for researchers seeking to make significant improvements in the field of IoT-based healthcare.

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