DESIGN AND DEVELOPMENT OF IOT BASED REMOTE COVID-19 PATIENT MONITORING SYSTEM USING MACHINE LEARNING AND EDGE COMPUTING TECHNIQUE

Project Reference No.: 45S_MTech_058

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Introduction:

The Covid-19 and its mutant strains have changed the way of life for everyone including the healthcare workers as well as elderly persons of our society. The monitoring of infected individuals, for mild, moderate, and severe infections, is equally important and becomes difficult as the number of patients increases. The rapid spread of the virus in India has led to an exponential increase in the number of patients and thus the difficulty in monitoring patients in hospitals and remote areas also has increased exponentially. In traditional healthcare systems even remote monitoring facilities are available but lack health sensors, accuracy, and quality. This paper proposed to provide IoT based real-time patient monitoring system using machine learning which allows doctors, nurses, and hospitals in charge of personal or caretakers to monitor patient health condition status through handheld devices linked with a mobile edge such as mobile or tablet remotely on a regular basis which can witness in low-risk chances of illness and emergencies.

The appropriate wearable health sensors attached to the patient will transmit data to the global server via ESP32 micro-controller, this sensor data is processed for analysis and storing the real-time health parameter of the patient in global cloud ThingSpeak using write Key. With the help of Read-Key, the real-time data is read in form of a CSV file. Then real-time health parameter CSV file is loaded in ML Text Editor with help of python Numpy for making insight decisions by modeling through a machine learning ensemble algorithm. The output classifies the type of symptom condition whether it is a normal, mild, moderate, or severe symptom, and recommends respective precautions accordingly. This output data can be accessed by anybody anywhere through their hand-held devices such as mobile phones and tablets remotely using the Twilio application also the current status of a patient's health condition is shown in Telegram chat.

Objectives:

The present work proposes the following objectives to solve this problem.

1. To design wearable device with sensors for collecting real-time health data of COVID-19 patient.
2. To perform feature extraction on the real-time data, to predict the health status of the patient and provide recommendations using machine learning ensemble technique.
3. c) To access machine learning outcomes and integrate with mobile edge technology to provide the information to the end-user (doctor/caretaker)

Methodology:

The methodology proposed in this project is divided into the following set of steps as shown in Fig. 1. The first step in the proposed method is to collect the real-time health data of COVID-19 patients from the wearable device. This device includes the LM35 Temperature sensor, ECG sensor, Heartbeat sensor, and SPO2 sensor to measure the temperature, heartbeat, respiratory rate, oxygen level, and blood pressure of the patient. The collected real-time health data is processed by the microcontroller ESP32 and sent to the ThingSpeak cloud for readings and further analysis with help of API. In the second step, using the read key, the real-time data is read and saved in a CSV file. Next, pre-processing and feature extraction is done on a CSV file. Then, the secondary datasets are loaded to train the model and extracted CSV file is passed as input to the trained machine learning model. This model then predicts the health condition of the patient and recommends the respective treatment. The third step is to access the resultant output of the model and integrate it with a mobile edge using TWILIO software. This integration helps to send the health status of the patient to the end-user (doctor/caretaker).
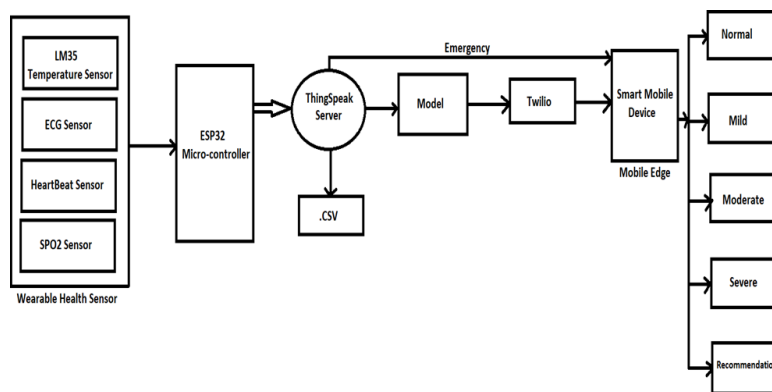

Fig. 1 Remote Patient Monitoring System

Result and Conclusion:
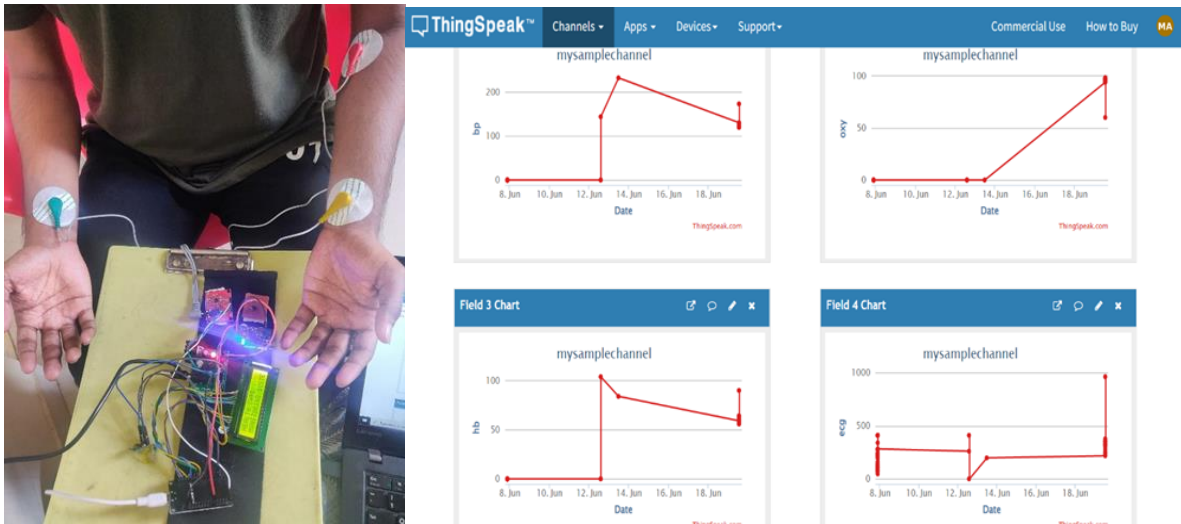
Result of objective 1:

Fig 2: Real-time Experiment and Real-time sensor data in ThingSpeak cloud
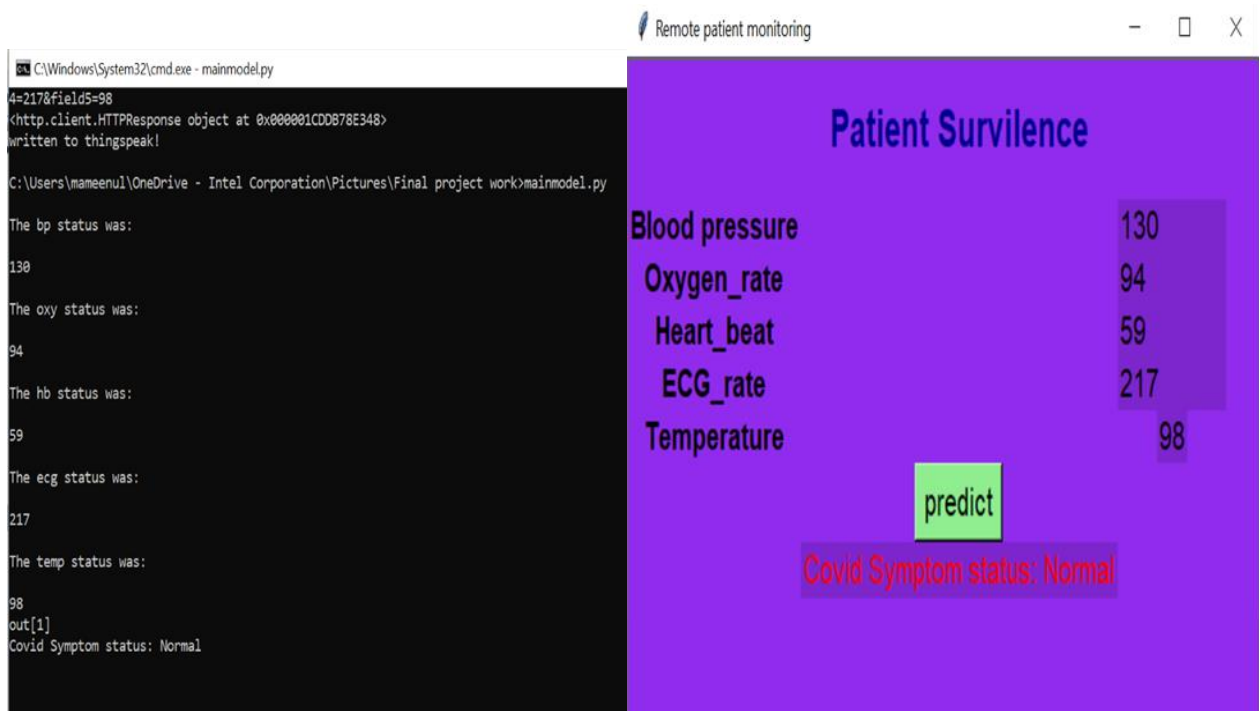
Result of Objective 2:

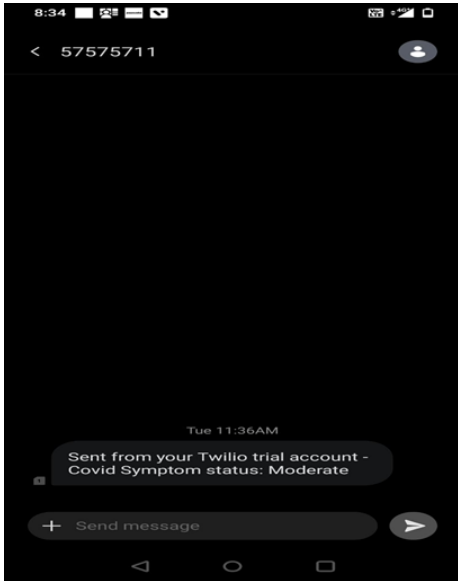Fig 8: ML Model output prediction   Fig 9: GUI of the ML model

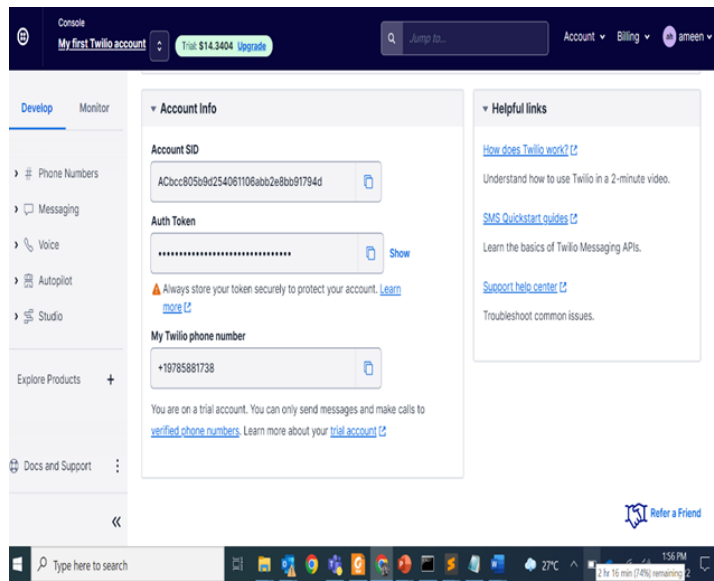Result of Objective 3:

Fig 10: Real-time Message from Twilio app   Fig 11: Twilio Account Setup and API

Conclusion:

1. Numerous patients lose their lives due to negligence of in-charge personnel such as caretakers, doctors, or nurses in hospitals or remote areas.
2. In a traditional healthcare system, there are no proper monitoring facilities not only in hospitals but also in remote places. To maintain the standard and quality of the health care provided at the most favorable level, there is a need to reduce the burden on healthcare systems.
3. Our proposed system described in this paper allows users such as caretakers, doctors, or nurses, as well as hospital in-charge personnel to monitor the patient in ICU's, CCU's, remote places, as well as in homes in real-time, which can improve the efficiency and service quality.
4. There is a huge opportunity to modify this system as a wearable device, that allows us to monitor older people and people staying in remote areas remotely from any place.

Scope for future work:

1. Creating the real-time database in the firebase cloud to store the ore resultant output.
2. Creating a web application to manage patient records