Detection of COVID-19 Using Screen Printed Electrode based Biosensor

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Abstract – Corona virus (COVID-19) is an infectious disease, now this COVID-19 pandemic got spread all over the world which causes illness in the respiratory system in humans, it can spread widely in a short time. In this paper the concept of wireless sensor network (WSN) for Internet of things (IoT) is allocated to the healthcare and detection system for COVID-19 is used to design the biomedical sensors with microcontrollers which are used to collect the data, biosensor based low-cost sensitive portable devices for COVID-19 testing kit which is based on Screen printed electrode sensor (SPEs), this is the complete model of health professionals are observe patients information at the ThingSpeak with help of Wi-Fi, Bluetooth module, professionals workload is minimizing to reducing the possibility of the infected COVID-19 condition. the performance of this work is the data is monitored by the patient's status, the output of these sensors is communicated via wireless sensing node and acquiring for same data has to be send to the remote wireless monitor for the observed patients status via IoT, If in case of any emergency patients can also control the conditions. The stage of infection disease patients can also monitor system data is to inform the medical professionals at the time being finished. Hence the optimistic results show that the biomedical sensors and SPEs are in beneficial process for identification of COVID-19 so it can be situating the results on ThingSpeak and Bluetooth module, The clinical centers to help conditions behind its conformation with additional biomedical sensors.

Keywords – COVID-19, Internet of Things, Wireless Sensor Network, Point of Care, Screen Printed Electrode Biosensor, ThingSpeak.

I. INTRODUCTION

Internet of Things is performed on new opportunities analyzer to gather and transmission details to the servers in order to work those system and make a fast decision [1]. IoT applications can assist in many fields including in limited industries, health services etc [3]. at present situation the most usage of IoT in health care system can be conclude as remote monitoring of the patient's health conditions in real time [4] IoT networks could be utilized to maintain conditions as in March 2020, COVID-19 disease strike the world, short of putting extremely necessary on individuals and associations. The [5] Corona virus is a respiratory infection which means that its spread has passed the whole world and the greater number of infected patients is expand quickly, many efforts have been done to identify potential COVID-19 patients' symptoms by tracing patient's condition which led to patient isolation and therefore contributes to slow down the spread of the virus. It has been more infectious contrasted with SARS in 2003[2].

The prescribed authority methodology is to be control of virus spread is to detect physical distance until vaccines are available. Contagious diseases would have a low risk of increases when better monitoring, medical care, transmits is executed. In [6] IoT gadgets for medical care is contain of different sensors interfacing with microcontroller which perform a real time data of the clients [7],This equipment will help to capture the real-time data and other necessary information from sensors are associated to an hardware set up could be used to identify the COVID-19 infected patient dependent on measurements of body temperature, blood pressure. The [8] Additionally, the availability of patients condition details will also make it easier for doctors and nurse to control the action, but also help patients implement actions separately if needed. So, it is necessary to process and

present good patient condition data together with sensors measurement results in Things Speak, The Thing Speak is that works very well in collecting the large amount of data with help of WI-FI module and collected the patient's data displaying in graphs.

This work aims to advance a system that can display the results of patient's health the conditions and SPEs kit to find the biosensor antibody detection with help of saliva test trip and display the values with help of Bluetooth module and by using that data we can monitor the patients in real time using the Thingspeak live monitoring system for the needs of COVID-19 patient treatment. Pandemic like Coronavirus disease appear that there is a critical need for varying our traditional healthcare monitoring system, at present patients need to visit a doctors or clinic to check-up their health. In [9] real time early detection and monitoring framework is developed for COVID-19 used for most common symptoms of screening process [10]. This document proposes a COVID-19 patient monitoring system that will be collect real time symptom data from wearable sensors technology. To rapidly recognize possible corona virus cases from real-time data. The monitoring system can be present in implementation of IoT communications that will monitor infected patients, while we can find the patients conditions, as well as the detection of patients from the virus. These systems can also give to understanding the nature of viruses and infected people by collect, analyze and archiving relevant data.

II. WORK IN THIS AREA

WSN is a great role in healthcare as well as health monitoring system for the important's of the patients and medical staff. In [11] this design a few transferable medical devices are linked to a server application that allows doctors and medical personnel to remotely perform real-time monitoring with this application, doctors and medical personnel can make a diagnosis not only from the patient's condition from onetime but from all the time the medical devices are used. In the study of [12] using this data, it checks the patients' health conditions is normal or abnormal condition, According to the patients' health conditions are directly to a medical Center through internet, doctor will give medical advices to the patients and analysis to obtained results are provide to the proposed system, it is clear and accurate monitoring, It can be used in medical kit.[13] the further technology should be better the condition of solution in wireless communication, dependability, interface, interpretability, dependably of sensor nodes [14] this two system are like web based ,rural health care service during WSN, The web based health care accomplishment can be occurrence by the interdependence between gateway and remote control by GPRS communication expand the analysis of the healthcare system.

IoT is a virtual role to track the patient health treatment [15] health factors related to wearable sensors are used to monitor the physical parameters heart rate, body temperature of patients, it used to WSN is combined with IoT to always monitor the patient condition, the sensor data is also received to the medical staff with help of wireless module such as zigbee and internet cloud computing. The [16] proposed system and implementation is using ThingSpeak. [17] The track of the patient is health wirelessly over internet, the physiological parameters are updated with in 1 minute on the web page it has a default action, to decreases the workload at doctors and give a capable medical service, IoT has a find the best solution for patient's monitoring at reduced cost, reduced tradeoff between the patient outcome and disease management. The health monitoring system has become a human need today. In [18] an electronic health registration system that was cheap, lightweight, energy efficient and has a centralized system had been developed. With this portable form, patients can keep records of health parameters during the trip. Meanwhile, centralized data storage is used with the Internet of Things, IoT system is mainly performed to COVID-19, the patients' conditions and alert the crisis for COVID-19, after being tested positive. The [19] main aim is to design and decrease the death rate in mankind, the framework utilizes different devices alert by controller to gather data from sensor, the internet permit data is to be transfer from the patient. The patient is in isolation stage the data will be gathered from patients to the cloud, the data monitored by the doctor, the [4] system is to be dedicated and controlling in mankind and care by using lives in emergencies and if alert. The smart monitoring alert system is important for observing the COVID-19 patients, it can be alert in case of abnormal condition of the patients.

To control impact situations like 2020, the collected data will be uploaded to this framework, develop to propose the needs of the COVID-19 patients The sensors will be send data to the cloud and the doctors will send the data of alert patients in time, and nurses are monitoring the patient's condition. The [20] IoT framework is mainly performed to the COVID-19, the proposed framework is helping the system to monitor and update the health condition of patients among network of associate sensors designed to test for COVID-19, The study of point of care testing is a analytic part in precaution, observation and critical care of the diseases improvement. It describes about advances in testing gadgets for identify COVID-19 and also earlier obtain biosensors are detecting the virus, it considers for proteins, complete viruses. The biosensor describes the classification of detection of SARS-COV2 biomarkers such as antibodies, nucleic, antigens, metabolic results data will be collected on the evolution of point of care gadget for SARS-Cov2 detection to provide this data for future analysis [21]. Currently a portable diagnostic device for COVID-19, The accuracy & sensitivity of these solutions depend on the IoT protocol for the time progression of SARS-Cov2 viral infection.

III. PROPOSED METHODOLOGY

The proposed system is consisting of two methods rapid PoC tests that can detect COVID-19 infections, i) Design and implementation of wireless sensor developed for Internet of Things with point of care for healthcare of patients suffering from COVID-19, by using the two input sensors like temperature sensors, heartbeat sensor make it is continues monitoring the patients without taking any person we are connecting to following Wi-Fi, LCD display. ii) The Screening of COVID-19, with help of point care test measurement by using the screen-printed Electrode sensor probe, use of performing a diagnostic test to the patients and provide quick results and effective treatment of progressing, the saliva diagnostics that allows a suitable and cost efficient of point of care test aims for quick observation and also to improve the possibility of survival of patients with disease the reactions that they monitor as biosensor Screen printed sensing probe.

In **Fig 1** The proposed the consists of an ATmega328 microcontroller. Temperature sensor, heartbeat sensors, are interfaced as inputs and Wi-Fi module, LCD modules are interfaced as outputs for microcontroller. Each user owns one sensor, which can get the data from user and then Wi-Fi module transmitter transmits data received from the controller and display the values of the LCD display module and also biosensor module is identifies the antibodies by using sensing probe, The modules section receive the information from transmitter and the received information is displayed on PC or Mobile phone, The data displayed on LCD also.This helps to reduce the monitoring of a patient using a man power. Totally the combination of embedded components will fulfill the requirement at the receiver section. ESP2866 Wi-Fi module is access to Wi-Fi or internet and its best implement in the IoT platform and it is combined with TCP/IP protocol It can also communicate with any microcontroller. It will be communicating with controller and send to the information on Thing-speak. The ESP8266 is connected with the help network is arranged in the platform, Internet of Things (IoT) Processing is done by using ThingSpeak , which is an open source cloud service with proper security. And it is arranged for each user with\ the SSID and a password. The user API key is also performed with help of ArduinoIDE, the sensors data send the monitored data always to the IoT using the Arduino. The Arduino controller is transferred the live monitoring data is send to the ThingSpeak. The API key allows for easy visualization of collected data through different forms, these are performed with graphical method based on the monitored data.

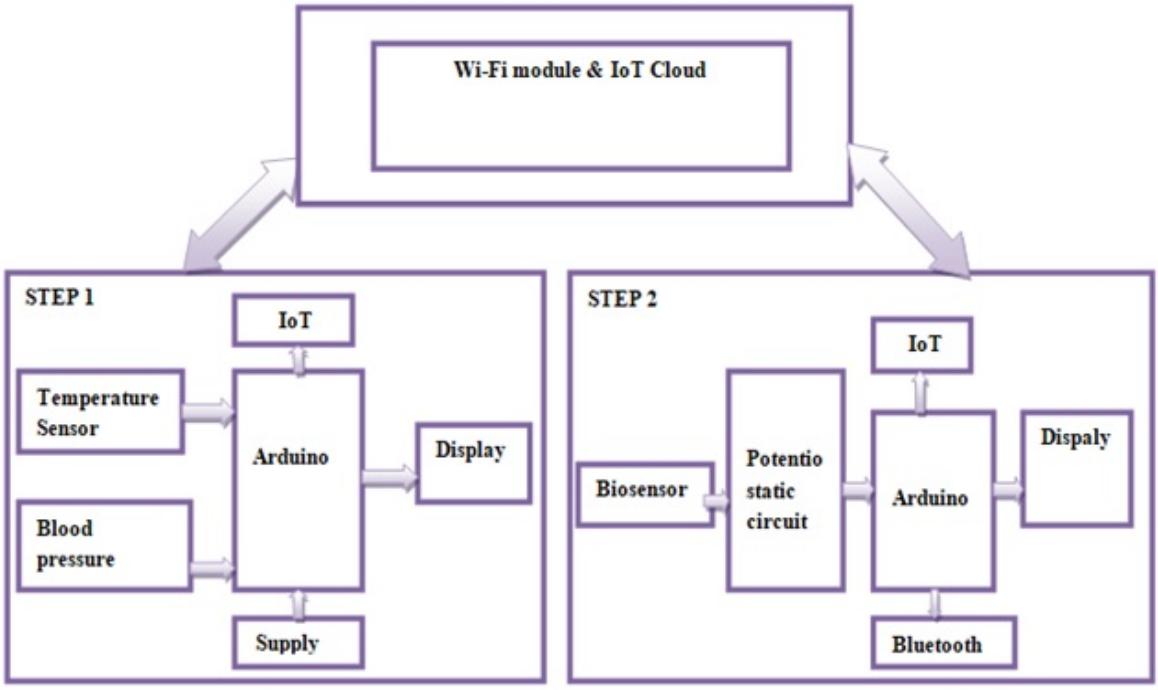

Fig 1. Proposed Sensor Architecture

Block diagram Description

Sensor module: The module of the sensor comprises various sensors like Temperature, Blood pressure sensor.

LM35 Temperature sensor:

This sensor takes place very important role in the healthcare monitoring system for COVID-19 based on the temperature of the patient condition because it is depending on each patient as different temperature condition and temperature condition is normal

and abnormal. The patient's temperature measurement is 93 F to 98 F degrees. The temperature is 93 F degree then patient is normal condition. The temperature is more than 98.6 degrees Fahrenheit is equivalent to or 36.5 degrees Celsius. Body temperature higher than 37.8 C (100 degrees F) is considered as fever so patient's condition is abnormal.

Blood pressure sensor:
The Blood pressure sensor measures the patient's heart rate status, when a finger is placed, it can detect and activates the beat LED light with each together with each heartbeat. it is depending on the heart rate condition normal or abnormal, the patient's condition normal then the heart beat rate is 80 to 120 Bpm, abnormal is 120 Bpm and above.

Screen printed electrode biosensor:
The core part of the initial hardware prototype of the system is Screen Printed electrode sensor along with the major constituents such as Screen Printed Sensing Probe, IoT Module, Arduino UNO Board and an LCD Display is used, By using a screen printed Biosensor which consists of 3 electrodes namely Reference Electrode, Working Electrode and Counter Electrode we can detect the properties of the samples and the low voltage outputs of the sample can be generated using potentiostatic circuit which consists of LMP7721 and LM358 along with resistors and capacitors. The potentiostatic maintains constant voltage between the reference electrode and counter electrode. The output is given to the Arduino Board interfaced to an LCD as well as a IoT Module (wireless communication) through which the sensitivity (low voltage) values of the different samples can be seen.

Controller module:
It is considered as the most important part of this prototype. The Arduino UNO microcontroller is based on the ATmega328. The proposed work Arduino is utilized as controller. Arduino is mostly used now a days because it is low cost and used as a system of pc board. We can connect sensors together at time when required. Compared to other boards the Arduino is more competitive, and it has memory to store, an integrated Wi-Fi module is given. Arduino usually uses Arduino as its software for it Arduino is used as coding language .in the proposed work is used for sending the instructions to cloud through the information which passes from the sensor to Arduino. The Arduino displays the values on an a Thingspeak when the data is collected from sensors physically. its helps in control as well as monitoring the parameter to maintain the health condition, it continuously addresses the server side and shows the information collected on monitor as well as on an Thingspeak and LCD display.

LCD monitor:
16x2 LCD consists of two parallel plates involving the space is fill up with liquid crystals, Once the voltage is applied, the back-plate transfer charge to the front plate which is display the text on the screen. This LCD is used in this project to display information from a sensor value. The patient condition data from the sensors are obtained and send to the controller. The program code in software Arduino IDE in the controller helps to display the obtained values in the LCD monitor.

WI-FI module:
The Wi-Fi module ESP8266 is a standalone Soc with an integrated TCP/IP conventions heap that allows each microchip to accept the Wi-Fi web. This may allow the microcontroller to connect with Wi-Fi and the supply voltage of the module is 3.3v, In order to communicate with WiFi module, the microcontroller needs to use a set of Arduino AT commands and using UART at the specified baud rate. The data is process from Arduino controller is sent to the cloud through module, The ESP8266 uses the TCP/IP protocols is helps in uploading of data, the module can be performed in both modes.

Bluetooth module:
HC-05 module is Bluetooth serial port protocol module, which means it communicates Arduino through serial communication, the supply voltage is DC 5V and it is communication is through serial communication which is performed to interface with PC.

ThingSpeak:
ThingSpeak is an IoT platform whose API key is to store and retrieve information from devices utilize the protocols on the network. ThingSpeak permit the information of sensor table applications, social platform of things with status updates, The details which are sent to the cloud servers from the WI-FI ESP8266 Module can be viewed in both public and private modes monitor systems of patients data and control system over the network is used the Channels and web pages are assigned by ThingSpeak. its Collects data from the sensors. User wants to create an Account on ThingSpeak.com, after click on get Started, now we need to add fields and names after that to get Channels with a unique API key is available for each user. The user has to login to use the cloud service using SSID and Password.

IV. MODEL IMPLEMENTATION AND RESULTS

The model characterized as hardware and software, first hardware considering assembled with the sensors and one processor then, the software comes into action here we are utilizing Arduino IDE, and this implementation model is utilized two Arduino, sensors are for detection and receiving the data into cloud. The medical sensors are measured from the data respectively. The data from the sensors transferred to the microcontroller, this data is further transferred to the ESP8266 Wi-Fi module to the cloud through internet. The web is used as ThingSpeak, it enables to gather and keep sensor information to the cloud, and respectively sensor condition is view of a graphical format representing x,y coordinates. and display patients decline health condition on the graph and cloud.

Flow chart of the proposed work

The flow chart is representing the workflow of design prototype, we can see that the overall flow of the procedure in patients' conditions. As show in **Fig 2**. the flow from start to sensors deals with recognition of different sensors values which are associated with the person like temperature and heartbeat, the sensor values gives to microcontroller to perform specific operation, the values of sensors are transmitted to the pc using WI-FI module, and also are displayed in LCD and WI-FI module works with AT commands and connected to the network connection , send the sensors data through a module to monitoring parameters to cloud and plots the values and display the values on ThingSpeak.

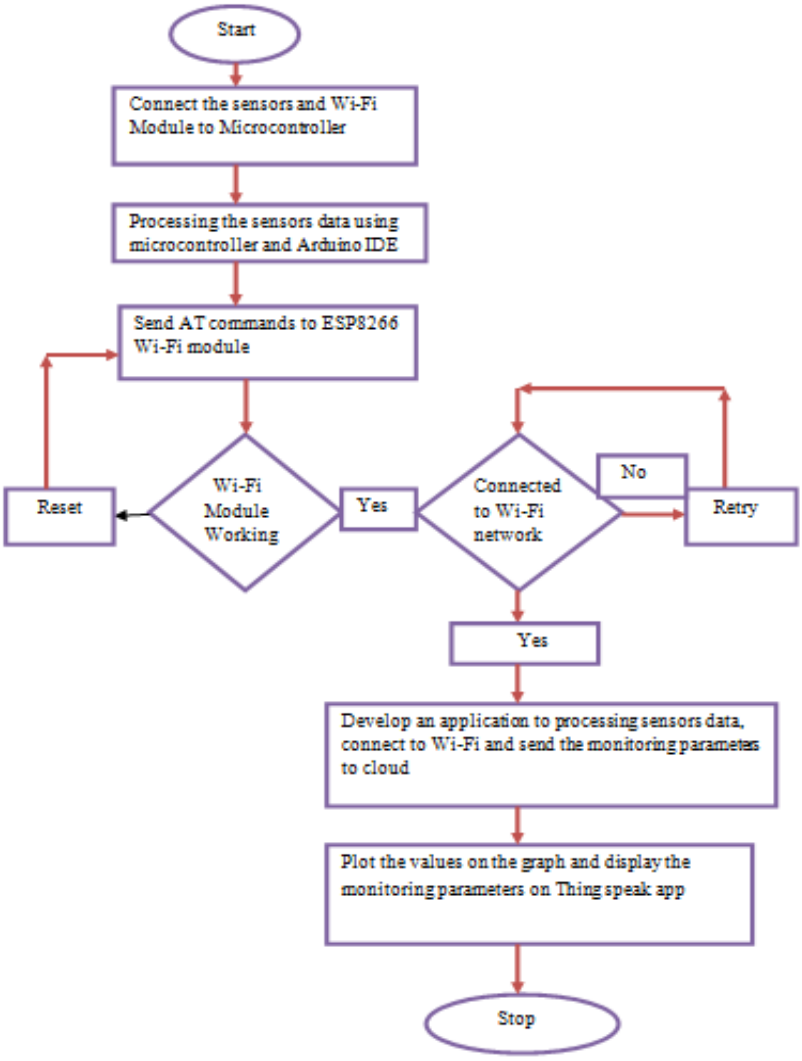

Fig 2. Proposed Workflow Diagram

The implementation and results "Detection of COVID-19 using screen printed electrode-based biosensor "system shown in **Fig 3.** below. This system used to monitor and check the patients' conditions of health using Arduino and ThingSpeak successful results of the system are shown in the below figures and explain briefly.

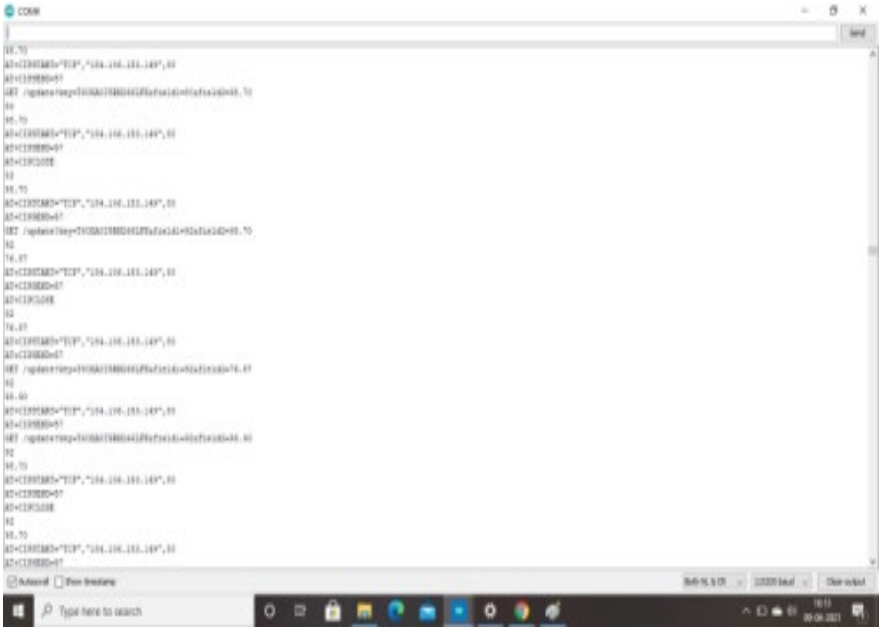

Fig 3. Sensors Result and Wi-Fi status on Serial monitor

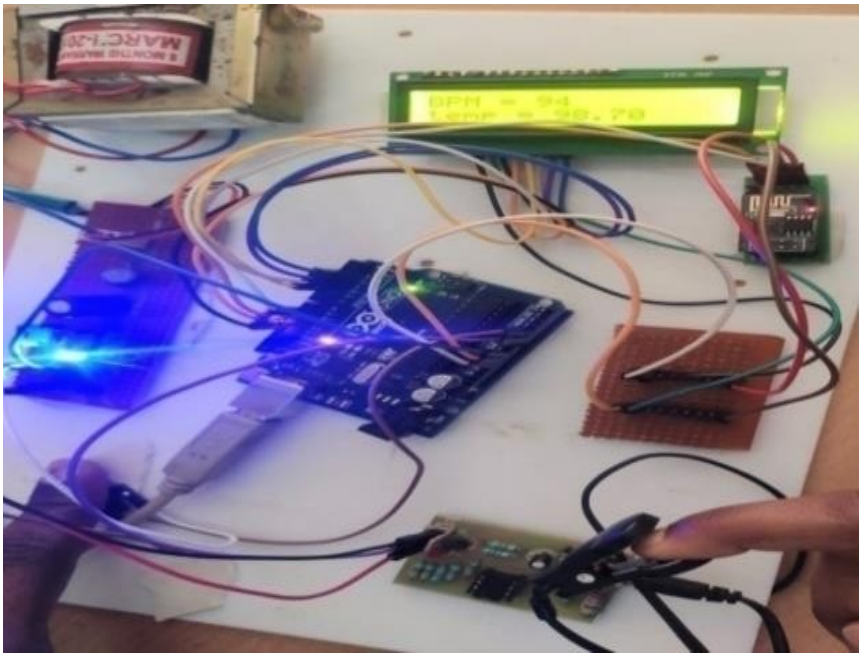

Fig 4. The Patients' Health Monitoring System Based on Sensors

The above equipment arrangement as shown in **Fig 4** and some of the steps are there to implementation process. Create an account on Things speak platform. Connect the sensors to LCD display and Wi-Fi module. Associate Arduino board to system per USB cable. After that associate with the select board and com ports in Arduino IDE. Programming for health monitoring

and alert system in IDE, compile and upload the platform in board, the compilation is successful done after the displaying the Wi-Fi status on the sensor results on serial monitor as shown in below figure.

The Sensors data is obtain through controlling it with microcontroller, Data additionally execute by different sensors are measured with physiologic biomarkers such as Blood pressure, temperature sensor, these are associated with the network in between information collection, generally Doctors mobile phone or PC and LCD display the states of the patient. WI-FI module is associated to pin of the microcontroller the process flows according to the specified conditions in the Program and gives the respective values as output Displayed on LCD **Fig 5.**

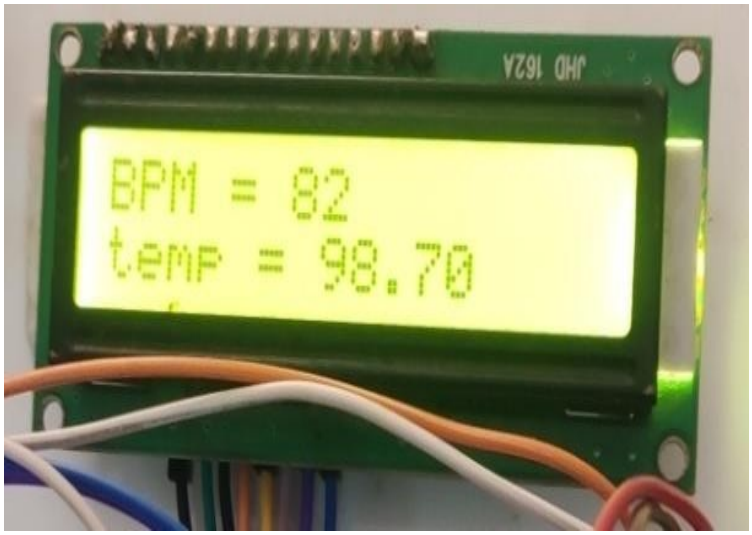

Fig 5. LCD Display the Sensors Value

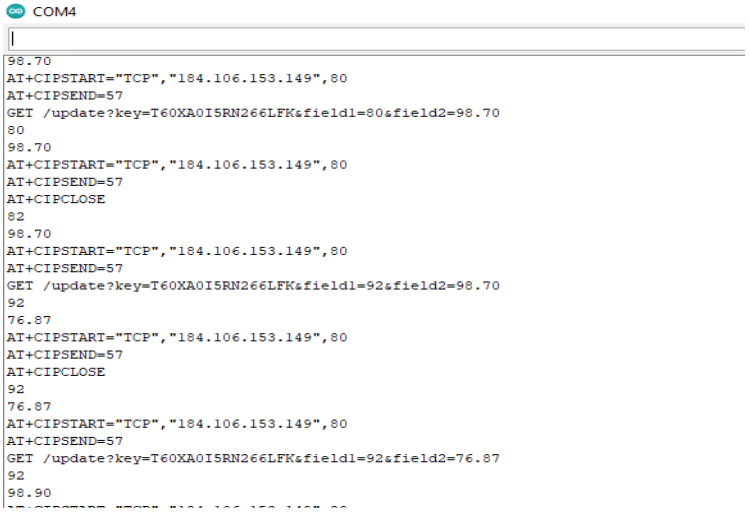

Fig 6. Sensor Values on Serial Monitor

The patient's conditions information is collected simultaneously upload to the cloud servers Fig 6. The data can be shown graphically with respect to time. The data uploaded can be retrieve at any time using the data export facility. This shows the data in a table format with different values monitored using sensors with respect to time. The doctor can view the results immediately and prescribe the patient with proper prescription. In this project, health monitoring of a person is done using the values obtained from the sensors.

The temperature sensor senses the value based on the Thermistor. The values are plotted based on the temperature measured with respect to time and date. Fig 7shows a normal condition in which the value is around 30oC to 100oC. If the values is lower or higher than the normal values the graph shows in **Fig 7** a variation.

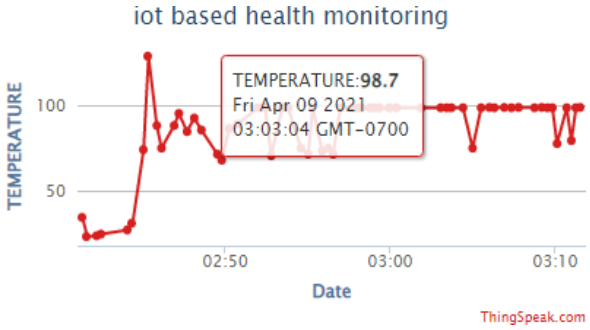

Fig 7. Temperature Live Monitoring Using ThingSpeak

The pulse rate sensors measure the values based on the pressure of the blood flow. The normal range is about 60 BPM to 110 BPM. The difference in the beats per minute creates a change in the pulse rate.

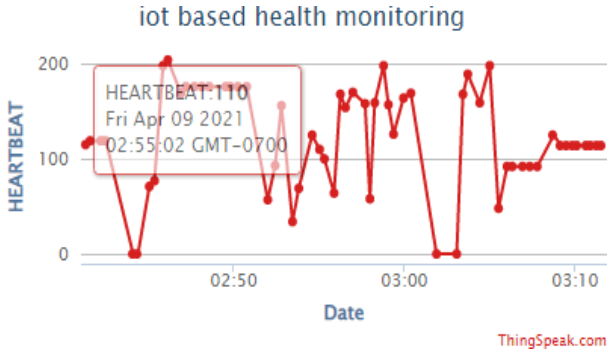

Fig 8. Heartbeat Live Monitoring Using Things Speak

From these values the doctor can take necessary steps and prescribe proper treatment. As shown in **Fig 8**, These values also help the doctor to understand the present condition and status of the patients.

The biosensor is implemented which are utilized to detect bimolecular is called biomarkers. The biomarkers in patients' samples and in this way give an symptom to a specific disease condition, in **Fig 9**, Biomarkers in patients sample can be used to design a testing method for diagnosis infection of antibodies and antigens explicit to viral.

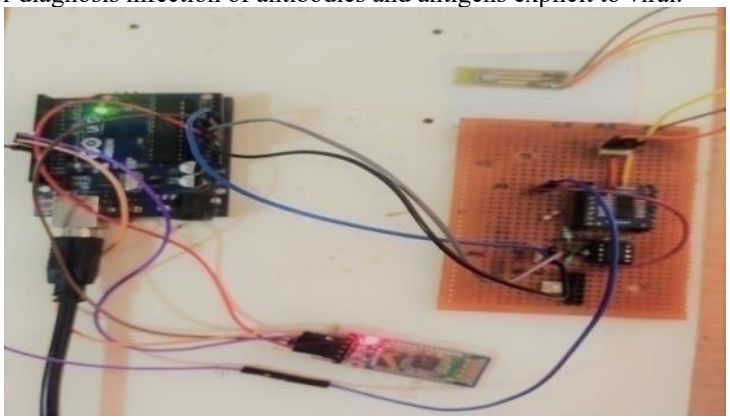

Fig 9. Detection of COVID-19 based Screen Printed Electrode Sensor Kit

If the condition of the biomarker values is like symptoms of the COVID-19 condition, then we need to use low- cost sensitive portable devices for covid-19 testing kit which is based on screen printed electrode sensor (SPEs) and its find antibody germs of the patient's body by using the SPEs kit. The patients' conditions of the temperature and heart beat sensors values are normal condition then no need to check the SPEs kit and if in case of the patients abnormal temperature and heartbeat then we need to take patients saliva samples check the biosensor based SPEs kit and its identify the COVID-19 detection in patients body as shown in **Fig 10**.

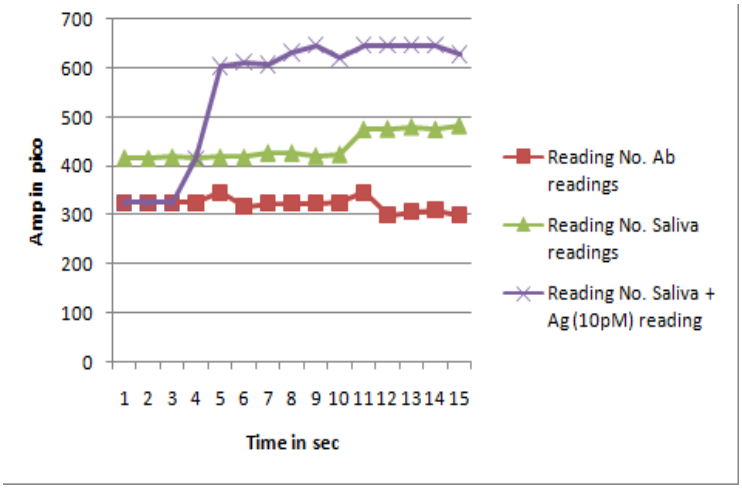

Fig 10. Different Samples Values of Saliva

The samples data transmitted through Arduino IDE and send the data for receiver of Bluetooth module (HC-05). The HC-05 module is displaying the average saliva sample values in Fig.11, with help of Bluetooth terminal on pc or mobile phone.

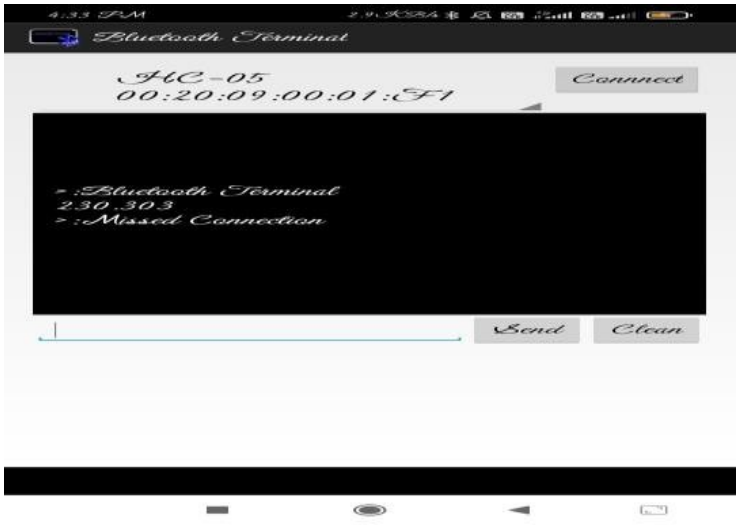

Fig 11. Display the Saliva Sample Value

V. CONCLUSION

From this study it can be concluded that a Detection of COVID-19 using screen printed electrode-based biosensor, this framework is designed to monitor patient's physiologic parameters such as blood pressure and temperature level sensor. The system is capable to obtain data from sensors and transmit the data together with the ThingSpeak to a server is be monitored by medical staffs. The proposed system integrates a wireless sensor with a PC act as an IoT gateway where the sensors can

collect user's physiological parameter and the Android application connects to the internet to send the data to the server after adding patients data. this system built using open source ThingSpeaks to be monitored that can display live data of the patients conditions the sensor data is available in hospital and the connection between the sensor device and IoT uses WI-FI module standard communication protocol. Makes it easier for patients to report their condition without having to go out from patients place so that health care providers can immediately provide services according to the patient's condition.

The future work of this study will cover more detailed work of the system, such as development of alert system and recommendation system based on the collected data and to use more features in ThingSpeak to provide more capabilities. Performance analysis will also be performed more thoroughly to find the limitation of the system by using multiple devices and more patients. Therefore, this technology will be more helpful to support quality supervision with real-time information.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author(s) declare(s) that they have no conflicts of interest

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