IoT Based Non-Contact Portable Thermal Scanner for COVID Patient Screening

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***Abstract*—Coronavirus disease (COVID-19) is a contagious disease which is caused by a cluster of RNA viruses. Humans are affected by upper respiratory tract infections that can range from mild to deadly state. It is the most challenging work to identify the person in the early stage, who are infected in COVID-19. As a result, it can minimize the secondary transmission also. Here we propose an IoT based non-contact thermal scanner for COVID patient screening. The prototype system can measure temperature in non-contact condition, then the data are store in the cloud database. In utilization for societal development, we developed a mobile App to assist the medical professionals in pre-screening and serve the patients who are infected by this contagious virus. By using this mobile App, we also create public awareness. So it can prevent the community from the spread as early as possible and outbreak the pandemic state.**

Keywords—Internet of Thing (IoT), Thermal Scanner, Mobile app, COVID-19

I. INTRODUCTION

IoT or Internet of Things is influencing our lifestyle in every way. IoT is everywhere, from Television, which can be controlled by smartphones to cars with GPS systems. IoT is a huge network of internet supporting gadgets, gadgets share data with the help of embedded sensors. A common platform is provided by IoT for storing data from different sensors. In healthcare, IoT plays a vital role. IoT provides the facility of remote monitoring so that patients don't need to visit doctors. Consulting, video conferencing, paperwork, monitoring can be done by a doctor remotely by IoT. This saves a lot of time, helping doctors to cure patients very fast.

Coronaviruses are a part of the subfamily "Ortho corona virinae", in the family Corona viridae. Coronaviruses were first discovered in the animal bodies. Human coronaviruses were discovered several years later. Severe Acute Respiratory Syndrome Coronavirus 2 or SARS-COV-2 was previously known as the 2019 novel coronavirus (2019-nCOV). The virus was first discovered in Wuhan, China and so, sometimes called the Wuhan Virus. On 20 January 2020, it was confirmed that the virus is transmitting from human to human. Fever, dry cough, and tiredness are the most common symptoms of infected patients.

The 3D picture of the coronavirus is shown in Fig. 1. The virus is transmitted mainly via respiratory droplets from coughs and sneezes with a range of 6ft. When a physically fit person encounters an infected person (within a range of 1-2 meters), the fit person gets infected. One of the symptoms of the COVID-19 is high fever [1].

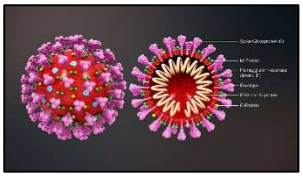

Fig. 1. 3D coronavirus structure

During the thermal scanning of patients, some persons are getting infected as the scanning device comes in contact with the infected person. These numbers of patients can be

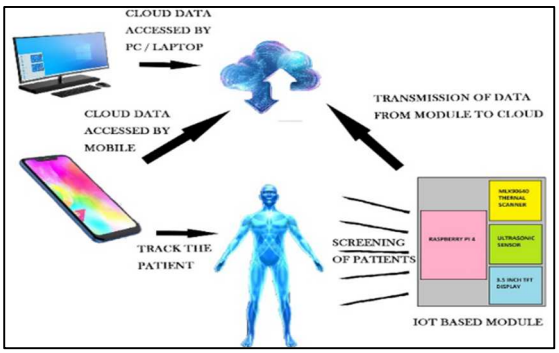

Fig. 2. IoT based non-contact thermal scanner

minimized if a contact-less portable screening system is designed, so that people with abnormal body temperature can be identified and maintained a safe distance from them as a precautionary measure. Motivated from these issues, IoT based non-contact thermal scanner for COVID patient screening is proposed in this paper. The Fig. 2 shows the structure of the proposed system

Raspberry Pi 4 interacts with a non-contact MLX90640 thermal camera sensor for the screening of people. The data from the module is stored in the cloud database. This data can be accessed by handheld devices (mobile, laptop). GPS can track the position of patients. The health department can track the areas visited by the patient by GPS present in the mobile application. An alert text message will be generated and sent to a registered mobile number via GSM module.

The main objectives of our proposed project are summarized below:

1. Non-Contact screening for COVID-19 patients.

2. Instant transmission of data to the cloud database for future use.

3. Easy access to stored data from anywhere at any time by the assigned persons only.

4. Ultrasonic sensors can be used to maintain a safe distance from an infected patient.

5. Sending an alert message to a registered mobile number about a nearby infected person.

6. GPS tracking to the affected patients.

II. Literature Review

Yosuke Nakayama et al. [2] and Guanghao Sun et al. [3] proposed a screening system at airport quarantine stations. Utilizing that idea, we are proposing an IoT based thermal screening system that will be portable and will be available at a low cost. The thermal scanner can be carried anywhere very easily.

The papers of different authors helped to develop a clear idea about the working of different sensors and what to choose for our project.

A Divya Priya et al. [4] and Ashwini Gutte et al. [5] proposed the use of Raspberry Pi for health monitoring. In our project, the Raspberry Pi 4 is used along with an MLX90640 temperature sensor camera for detecting the body temperature. The latest model of Raspberry Pi series is Raspberry Pi 4 and it is faster and better than other Raspberry models. It comes with 4GB of RAM for better performance. It supports USB 3.0 to store data faster and supports faster network connections.

Dongxu He et al. [6] proposed the use of MLX90640 chip for measuring electrical equipment temperature. MLX90640 thermal sensor camera along with Raspberry Pi 4 are used in our project for detecting the body temperature. It is used as a cost-effective thermal sensor camera. This sensor can work easily when it is kept in an environment whose temperature ranges -40°C to 85°C. It can measure the object temperature ranging between -40°C and 300°C.

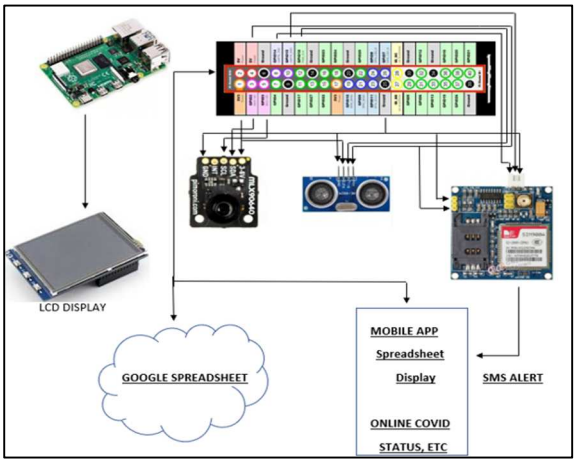

Fig. 3. Connection of the proposed model

Maria Islam et al. [7] and Preetika Rani [8] proposed the idea of developing an android application for health monitoring. In our project, an android application has been developed that can be used to see the temperature readings from MLX90640. A location tracking feature is present within the application for tracking the areas visited by an infected patient. The patient can also chat from home with his/her doctor remotely via this application.

Jaroslaw Majchrzak et al. [9] and Navya Amin Singh et al. [10] proposed the idea of the ultrasonic sensor for distance measurement. In our project, the ultrasonic sensor is used for maintaining a safe distance from the person whose body temperature will be abnormal. Ultrasonic Sensor works by emitting high-frequency sound waves that humans cannot hear. Then that sound waves reflect back to the sensor and in this way, the distance is calculated based on the returning time.

Vivek Pardeshi et al. [11] and S. Dixit et al. [12] proposed the use of GSM in health monitoring. GSM Sim900A module is used in our model for sending an alert message to a registered number.

Additionally, TFT display is used to provide the output of MLX90640 respectively in our proposed model. The output will be a thermal image of the person along with the body temperature of that person. 3.5-inch TFT LCD is a touch-screen display. It supports either single-finger or stylus pressure or five-finger, multi-gesture touch screen. It has a 320 x 240 RGB resolution. NewVision NV3035C single-chip digital driver chipset is employed during this display.

III. Proposed Model

The main function of our model is to determine the body temperature of a person and to maintain a safe distance from the person. GSM module is used to generate an alert

message to a registered mobile number. The data i.e., the temperature is stored in the cloud for future use. GPS is also used for tracking the affected patient.

The connection of the device is shown in the Fig. 3.

A. The connection between Raspberry Pi 4 and MLX90640

The PIN 1 (3V3), PIN 25 (GND), PIN 3 (GPIO 02), PIN 5 (GPIO 03) of Raspberry Pi 4 are connected with the input pin (VIN), GND pin, SCL pin, SDA pin of MLX90640 respectively.

B. The connection between Raspberry Pi 4 and Ultrasonic Sensor

The PIN 4 (5V), PIN 25 (GND), PIN 1 (3V3), PIN 12 (GPIO 18) of Raspberry Pi 4 are connected with the VCC pin, GND pin, ECHO pin, TRIGGER pin of an ultrasonic sensor respectively.

C. The connection between Raspberry Pi 4 and GSM SIM 900A

The PIN 9 (TX), PIN 8 (RX), ground pins 6 \& 7 (GND), PIN 3 (5V) of the GSM module are connected to the PIN 10 (RX), PIN 8 (TX), PIN 25 (GND), PIN 4 (5V) of Raspberry Pi 4 respectively.

D. The Connection of Raspberry Pi 4 and 3.5-inch TFT Display

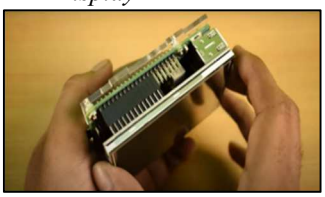

Fig. 4. Connection of TFT and Raspberry Pi 4

The TFT Display connection is given: PIN 1, 17 connect with 3.3V, PIN 2, 4 connect as 5V, PIN 3, 5, 7, 8, 10, 12, 13, 15, 16 connect with NC (No Connection), 6, 9, 14, 20, 25 as Ground (GND), PIN 11 connect TP_IRQ (Active low interrupt pin), 18 also connect with LCD_RS (Register select pin), 19 connect with LCD_SI (SPI data input), 21 connect TP_SO (SPI data output), 22 connect RST, 23 connect LCD_SCK, 24 connect LCD_CS , and 26 connect TP_CS. It contains many pins but the connection is very much easy. Just connect the display with Raspberry Pi 4 as the way showing in Fig. 4 or the connection between Raspberry Pi 4 and the TFT display can be done with jumper wires also. After that, some coding is needed. For this, connect the keyboard display and mouse and pc monitor or laptop with Raspberry Pi. During this time, the TFT display should be connected to a power supply using the USB cable. A terminal will be displayed on the pc or laptop screen. Then the coding is to be done on the terminal and the TFT display will be started. For the whole setup to work properly, the internet is compulsory.

IV. WORKING PRINCIPLE

Here, we have proposed an IoT based non-contact screening device that will identify the body temperature. Here, MLX90640 non-contact IR thermal sensor camera will be utilized along with Raspberry Pi 4 to identify the body temperature of a person. A TFT display is installed with the Raspberry Pi 4. Whenever a person is present in front of the sensor camera, the thermal picture of his/her body along with the body temperature will be displayed on the TFT screen. If a person is detected with temperature which is not normal, an alert text message will be sent with the help of GSM SIM900A to a registered mobile number. An ultrasonic sensor is also installed with this device. If that person with abnormal temperature is present within a range of 1 meter, then an alert message will generate on the TFT display. The data (temperature readings) will be stored in the Google-spreadsheet cloud database for future use. This spreadsheet can also be accessed by PC/handheld devices anytime anywhere.

We have proposed two different mobile apps. One app is for patients and one for doctors. A person registers him/her-self in the app. By using the screening, if that person is found infected, then the person's whole journey can be tracked by the doctors' app so that the areas visited by that infected person can be tracked for safety. Also, the via patient's app, a person can take an appointment in corona specialized hospitals personally. Doctors can create a Patient's report via the doctor's app and patients can see their reports via their patient's app from their home anytime. The chat feature is present in both patient's app and doctor's app so that conversation can be done anytime between patient and doctor.

As a security feature for both tracking and chat, a "friend request" feature is given so that a specific doctor can interact with the patient and also track his journey. Otherwise, it will be impossible to chat or track the patient without his/her acceptance.

Apart from these features, some useful and awareness information about COVID, so that a person can keep himself updated and try to stay safe from the infection.

A. Mobile Application Features

Two separate Android mobile applications have been prepared. One for patients and another one for doctors.

B. Patient's App

1) Whenever the app starts, it opens with a splash screen. After that, it goes to the login screen (only for the first time). Fig 5 shows the SPLASH SCREEN of the PATIENT'S APP.

2) The patient needs to register some details in the app before using the full features of this app. The registration will be done whenever the user uses the app for the first time. The user needs to enter *his/her name, email id, phone number, age, and his/her present health*

condition. After that, the user will be directly redirected to the main part. The app is created in such a way that if someone uninstalls and then again installs the app, then no registration will be required, a login feature is present so that the same user can enter the app with his *old email-id and password*, without a second-time registration. Whenever the user closes the app and again opens the app, the user will be directed to the main part of the app without a repeated login. In such a way, a user-friendly login system is tried to be created. Fig. 6 shows the REGISTRATION SCREEN and LOGIN SCREEN.

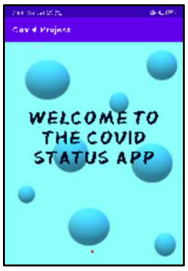

Fig. 5. Splash Screen

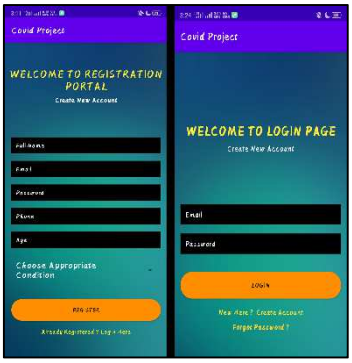

Fig. 6. Registration & Login Page

3) When registration is complete, then the user will be redirected to the main activity. Here the user is introduced with 9 main options. Some of these options also contain sub-options which is discussed later. Additionally, the logout option is also present if a user wants to get out of an account and will be redirected to the Login Screen. Fig. 7 shows the MAIN PAGE of the app.

4) The first option named "DOCTOR'S APPOINTMENT" contains an appointment page so that the user can get an appointment in the "COVID special hospitals" directly with this app. The Patient should enter *self-name, self -address, self- mobile number, doctor of a specific hospital, and in which hospital, he/she wants the appointment*.

Fig. 7. Main Page

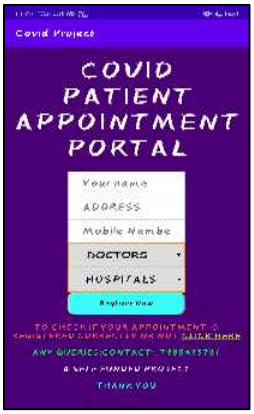

Fig. 8. Appointment Page

Only after entering all details, registration will be done. In the doctor's option, separate doctors for male and female patients are present from different hospitals, and for final verification, the user needs to choose the hospital once again. The user will not be able to change the details after registration. The details will be stored in the Google spreadsheet. Fig. 8 shows APPOINTMENT PAGE and Fig. 9 shows the details entered by the patient which is stored on google spreadsheet.

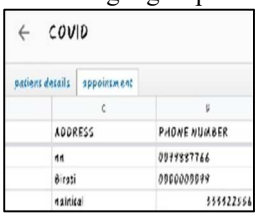

Fig. 9. Stored Details

Fig. 10. Patient's details

5) The next option is "CHECK YOUR STATUS" where the patient can check his or her health condition that the doctor suggests. These details will be filled by the DOCTOR'S APP, discussed later. Fig. 10 shows the PATIENT DETAILS.

Fig. 11. Near-by Hospitals

Fig. 12. Guidance Page

6) Another option is "FIND HOSPITALS NEAR YOU". This option contains a live map that will show which hospitals are present near you're your present location. This will help the user to visit the nearest hospital without facing the harassment of searching for hospitals. Users can also search for a hospital in the SEARCH box. Fig. 11 shows a MAP WITH NEAREST HOSPITALS.

Fig. 13. Status of the World

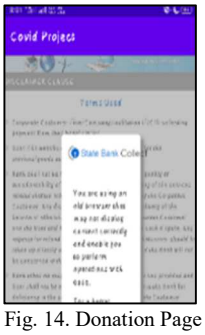

Fig. 14. Donation Page

7) Another option is "GUIDANCE". This option contains seven other guidance options: *Infection and protection control, Guidance for school / workspace/ institution, Points of entry or mass gathering, control*

animals to human's transmission, 12 guides to help them work from home, General public advice, ICMR guidelines. Each of these sub-options is connected to different websites of WHO (World Health Organization) and ICMR website that suggest the best possible instructions to protect yourself and others from COVID infection. Fig. 12 shows the GUIDANCE PAGE with the seven said options.

Fig. 15. Social Media Page


Fig. 16. Requests Page

8) Another option is "STATUS OF THE WORLD" that contains sub options *Status of the world* and *Status of Indian states* which are connected to the websites that show the current condition of the world and Indian states. Fig. 13 shows the STATUS OF THE WORLD PAGE with the two said options.

9) A "DONATION LINK" is connected to the PM CARE FUND from where the user can donate if he/she wish to. Fig. 14 shows the DONATION PAGE.

10) A "SOCIAL MEDIA" option is present here which links to WHO, *MOHFW India, MOH Twitter*. Fig. 15 shows the SOCIAL MEDIA page with the three said options.

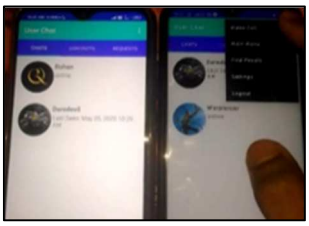
Fig. 17. Both apps with chat feature

Fig. 18. Splash Screen

11) The next option is "TRACKED BY DOC FOR SAFETY". Doctors need to track their Patient's journey for safety. By this option, the user will be redirected to an ACTIVITY where the user can accept the friend request from the DOCTOR'S APP of his doctor so that his doctor can track his journey. Fig. 16 shows the TRACKED BY DOC FOR SAFETY PAGE from where patient can accept request from doctor.

12) The last option is "CHAT WITH DOCTOR". Using this feature, the user can chat directly with his/her doctor remotely. This will help a user to contact doctor, any time anywhere. Fig. 17 shows the chat feature in two separate APPS (patient's app and doctor's app) in two separate phones.

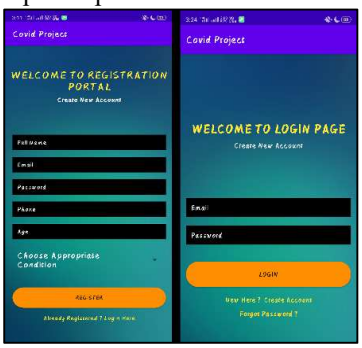

Fig. 19. Registration & Login Page

Fig. 20. Main Page

C. Doctor's app

1) Whenever the app starts, it opens with a splash screen. After that, the registration page opens (first time only). Fig. 18 shows the SPLASH SCREEN.

2) Same as that of PATIENT'S APP, the doctor must register for the first time (one time only). After that, the app directly goes to the main activity. If the app is uninstalled and installed again, then the doctor can directly login with the old account. Fig. 19 shows the REGISTRATION and LOGIN PAGE respectively.

Fig. 21. Patient's details

3) The main activity contains three options, *Patient details, Track effected patient* and *Chat with doctor*. Fig. 20 shows the MAIN PAGE of the doctor's app.

Fig. 22. Patient's Details Portal


Fig. 23. Patient's Position

4) In the PATIENT DETAILS option, there is a page where doctor will fill up the Patient's report. The details will be stored in the Google spreadsheet. Fig. 21 shows the details entered by the doctor and Fig. 22 shows the PATIENT DETAILS PORTAL page. Entered details can be accessed by the PATIENT'S APP.

5) In the TRACK EFFECTED PATIENT option, the doctor can track his patient's journey. The doctor will have to send a friend request from this app to the PATIENT'S APP and when the patient accepts the doctor can track the patient. It opens a map that will show the places visited by the patient. Fig. 23 shows locations travelled by a patient's app user.

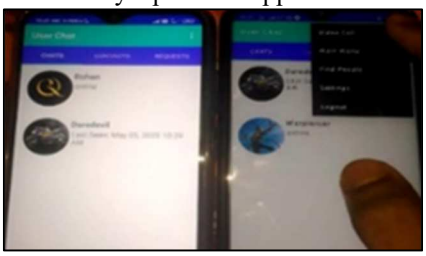

Fig. 24. Both apps with chat feature

6) The last option is "CHAT WITH PATIENT". Using this feature, doctor can chat with his/her patient remotely. This will help the doctor to get in touch with the patient, anytime-anywhere, and help him to recover. Fig. 24 shows the chat feature in two separate apps (doctor's app and patient's app) in two separate phones.

V. CONCLUSION

The outbreak of Coronavirus proved disastrous for human beings. Till now, it is uncontrollable and is spreading like wildfire. Body temperature is an important factor in this case. Here, an IoT based model is proposed that will be used to identify the body temperature of a person. If the abnormal temperature is detected in an early stage, then proper safety measures could be applied. The system is cost-effective, portable. The tracking feature is also available so that the areas visited by the infected person can be checked. Thus, this prototype system is portable, simple, and cost-effective which can be placed anywhere for the well-being of people. The most important aspect of this research work is that the non-contact based thermal scanner is utilized which may be preferred in the pandemic situation.

VI. FUTURE WORK

The prototype module can be improved to obtain better results in a quicker method. Through the non-contact based thermal screening, only temperature detection is possible here. But in the future, this type of cloud computing module could be used to diagnosis the diseases by continuously monitoring the patients remotely.

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