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IoT Based COVID Preventive System for Work Environment

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Abstract - **The much recent global pandemic, COVID-19 has brought drastic changes to the livelihood of people from all avenues of life across the nation. As normalcy is being slowly restored, it is also essentially crucial that the health and wellness of members are ensured. Instead of the manual biometric system, facial recognition can be deployed to mark the presence of the members. Besides, a non-contact infrared sensor can be utilized to check for the body temperature of the individuals. If the body temperature exceeds the threshold value, an intimation will be sent to the higher authorities concerning the wellness of the individual, otherwise, their presence to the organization/institution will be noted. Furthermore, using a QR scanner, the health history of each person as per the Arogya Setu app will be taken into accord. The attendance checking feature has been clubbed with health verification so that every employee will mandatorily report before the system since presence for work is important to everyone. The data generated by the static portal setup is recorded by the device daily which will then be uploaded into a database and stored on the Cloud. The system can be further advanced by including a Bluetooth module for proximity.**

Keywords—COVID-19,IoT, Arogya Setu,face detection

I. INTRODUCTION

A coronavirus is a group of viruses which aims at impacting and infecting the respiratory system of individuals. This group of coronaviruses includes SARS and the other commonly known cold and influenza viruses. [1] However, the global pandemic caused by the well-known COVID-19 has coined a name 2019- nCoV on January 2020 by the World Health Organisation (WHO). It is expected to have its roots from the initial cases that emerged in Wuhan, capital of Hubei Province of China. [2] Multiple nurses and medical workers of the PICC crew are immersed completely into the task of taking care of the infected patients and working around the clock to restore them to their normal health conditions on a global scale. In the United States, out of the first 300 patients admitted to multiple hospitals across the city, it is noted that 60.7% of them are men. 91.3% of them required ventilator support to facilitate the breathing process. The challenge to the process of effective detection and testing is that a sizeable proportion of the population remains asymptomatic to the infection and does not display any visible symptoms of contracting the virus which makes the process of tracking its roots an arduous process.[3] However, normalcy has to be restored even though the COVID situation has left several students, teachers, and working personnel homebound. [4] IoT (Internet of Things) allows for the interconnectivity of multiple devices across several regions to ensure connectivity. [5] It can be effectively deployed in the current COVID scenario to tackle the challenges that occur in restoring normalcy while ensuring that safety and security are not compromised at any cost in organizations and institutions [6, 7]. They invent and boom in the use of mobile phones and smart appliances in the health and welfare sector has paved way for the data about each individual to be assessed and evaluated on a mass scale. By the current COVID-19 scenario, IoT offers multiple applications such as the smart ventilators and masks or the provisions made for the allowance of self-isolation at home while being monitored by the medical facilities. Several modern necessities like secured data storage systems, cloud and edge computing, intelligent data management, sensors for smart health devices [8]. What started as a country level scare in China with several speculations raised about its origin has now manifested into a global pandemic with a multitude of research carried out to determine a cure [9]. As a global pandemic, COVID-19 has been inflicting major casualties and losses to the human population across the world from all walks of life. Approximately, 31.9 million people have been affected by the SARS-CoV-2 virus with close to 977K deaths reported under the radar. The table is topped by countries namely the US, India, Brazil, and Russia accounting for the maximum number of infected individuals. In India alone, 5.73 million people were and are affected by COVID of which close to 91K people have succumbed to the virus. Maharashtra, Andhra Pradesh, Tamil Nadu have whooping numbers of COVID-

infected people. While several measures are being taken at the State and Central level to combat the situation, it has become the need of the hour, at least for the working population to step out of the comfort of their homes to sustain their living and as well as to resolve the economical imbalance. With these reasons on the front, the proposed model will certainly help to ensure the safety and health wellness of all the employees when administered in their organizations.

II. RELATED WORKS

It was declared by the World Health Organisation (WHO) on 30th January 2020that COVID-19 is the sixth health emergency of an international scale that was given the name "global pandemic" shortly after. [10,11] Even more difficult was the fact that a sizeable group of the COVID infected population was asymptomatic who were capable of serving as potential carriers of the virus, as a result, mass testing had to be reinforced. [12] Intel's computer vision library OpenCV, inducted in 1999, allows for multiple functionalities like face detection and recognition to be done simplifying the computer vision. 90-95% accuracy is achieved in detecting the face, while face recognition is the process of comparing the face against a database of faces. [13] It involves gathering of Haar features which are computed by taking the difference of the summed-up pixel intensities in adjacent rectangular regions at a particular location in a detection window. This process can be hastened by making use of Integral images. [14] Thermal imaging can be deployed to gauge the temperature of individuals. The heat of a human body is proportional to the amount of radiation that it emits. Capturing the radiation that is emitted and displaying it in the form of an electronic image is the essence of thermal imaging. When the amount of radiation emitted exceeds a pre-set threshold value, the poor health condition of the person will be recorded. [15] With the data that is obtained from the thermal image, the medical conditions and extensive diagnosis can be made on the state of the individual. [16]

Based on the results obtained from the above two analyses, the table is updated with the results of the registration and recognition phases. [17] This finds strong implementation in both institutions and organizations removing the need and time invested into manual attendance verification. [18] The Wi-Fi module can be utilized to send messages regarding the status report generated to the designated higher authorities [19,20]. Particularly, the ESP8266 has been dominating the world of IoT projects. This module can be programmed by using the Raspberry Pi3+. [19] It is operated based on TCP/IP technology that can be connected using the WR841N router possessing a PCB antenna. [21,22]

III. PROPOSED IDEA

The setup to mark the attendance while checking the health condition of an individual will be propped up in a fixed location. When the individual checks into the organization /institution every day, it will be mandatory for him/her to report before the machine. Only after the welfare of the individual is ascertained, the presence of the individual will be noted. In instances if the individual is unwell, the notification will be automatically sent to the designated higher authorities. Overall system workflow is shown in Fig. 1.

The unique aspect of the proposed model lies in the fact that it integrates multiple distinct entities of health wellness and structuring them into a unified model. Aarogya Setu app has a large database of the users' health status because its usage has been stressed and emphasized a lot from the Government's end. Hence, incorporating this application will ensure that accurate and reliable results on the health records of every individual can be obtained. Pairing the health wellness system with the attendance procedures works well in ensuring that every person who reports to the organization makes their way to the portal since attendance is of utmost importance to the working individuals. Thus, implementing the system this way will ensure that maximum corporation can be obtained from the employees.

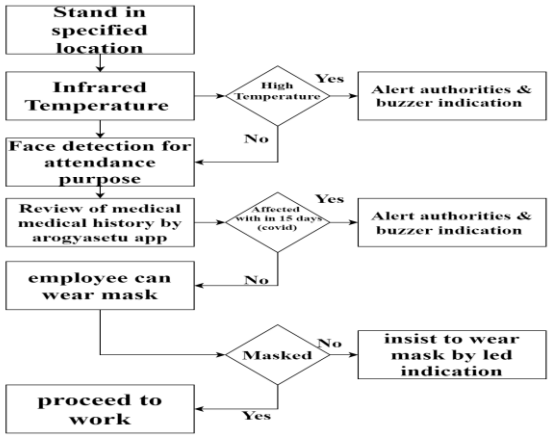


Fig. 1. Overall System workflow

A. *Thermal Detection*

The underlying basis of thermal detection is around infrared radiation. Each human being captures infrared radiation. The radiation that is emitted by an individual is proportional to body temperature. This radiation is captured by the thermal imaging scanner and displayed as an image. It is noted that the temperature near the eyes and the forehead tend to be comparatively higher when a person is running a fever. Based on the thermal images produced, the presence or absence of fever can be gauged.

B. *Face Detection*

For the face to be detected, Haar features are considered by taking the adjacent rectangular regions and summing up the pixel intensities in each region and calculating the differences between them. By deploying Adaboost training, the process of selection and training of the features can be sped.

C. IR Sensing

The GY-906 non-contact infrared sensor has been deployed in this project to carry out the process of temperature detection. From the image captured by the camera, the GY-906 singles

out the best spot on the forehead to carry out temperature measurement. If the temperature is in the normal range, the system proceeds to the next stage. Otherwise, incompletion of the process is indicated with a buzzer sound, and intimation is given out to the higher authorities.

D. *Mask Detection*

Once the identity of a person has been confirmed by facial detection and recognition modules, it is imperative to ensure that the individual is masked. This can be attained by initially training the model with a dataset that is categorized by the presence and absence of masks. By utilizing this model, when an individual stands before it, similar to face detection, mask detection can also be successfully carried out. If the mask is detected, the individual can proceed. Otherwise, an indication will be given in the form of an LED light alerting the individual to put on the mask.

E. Aarogya Setu App Analysis

Aarogya Setu application plays a vital role in checking for the medical history of an individual who turns up for work. This application provides an option for a QR code to be generated. On scanning the generated QR code, the welfare of the individual over a stipulated period of time can be assessed and analyzed. Details such as the name registered mobile number and health status of the individual pops on the screen upon scanning of QR code. If a notification arises that the individual is COVID positive or has been down with COVID for the past 15 days, the information is immediately conveyed to the higher authorities and buzzer notification is given.

F. Storage in Database

Once, the recognition of the individual and the good health is verified, the presence of the respective individual is noted. And also all the details which have been analyzed are stored in the database.

IV. SYSTEM DESIGN

The system is an integration of multiple health verification and attendance management procedures. It performs processing on all the input data that has been obtained and generates out the desired response in the form of buzzer notification and blinking of LED lights.

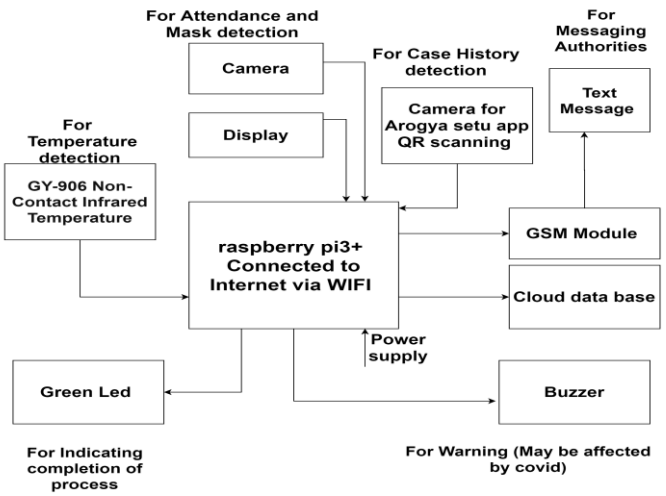


Fig. 2. System Architecture

The Raspberry Pi3+ which is connected to the Internet via Wi-Fi forms the center of the entire system. The images captured by the camera and the display produced to serve as the inputs for the mask detection and attendance enlisting phase. These are fed into the Raspberry Pi3+ system which receives power supply.

To check whether an individual's body temperature is below the marked threshold level, GY-906 non-contact infrared sensor is utilized in this case. This temperature sensor facilitates in determining the best spots on the forehead from the image captured of the individual by the camera to measure his body temperature. This is also fed into the Raspberry Pi3+ as an added input. To determine the health status of an individual from his previous medical history, the application which has been made mandatory Aarogya Setu is brought into use here. Each individual is expected to generate a QR code from the Aarogya Setu application on his/ her mobile device. This QR code then gets scanned by the camera on the static portal setup and given as input. With all these inputs that are obtained, the processing is done to ensure if the individual is healthy or not. If an individual clears all stages of detection and is deemed fit and healthy, then the system displays a green light allowing the person to proceed and marking their attendance as well. If the individual fails in any of the stages raising speculations that he/she might be unhealthy, then the information is directly sent over to the higher authorities. This is done with the help of a GSM module which facilitates sending out a texting message to the designated authorities. All these details are constantly updated and stored in the database or on the server. When a disruption occurs in any of the stages, a buzzer is sounded as a warning to highlight to the user to follow the steps or as a warning that the detection phase has not been completed successfully. System Architecture is shown in Fig. 2.

A. Module 1 Thermal Detection

Post-COVID scenario arises with the situation that many have to step out of their houses while at the same time ensuring that their health and security is assured. As an important measure, it is becoming mandatory to detect the temperature of

individuals who report to institutions/organizations since fever is said to be one of the leading symptoms of a likely COVID infection among symptomatic people. GY-906 infrared non-contact temperature sensor is used to measure the temperature of people on the static portal setup. Once mask detection has been performed by assessment of facial landmarks on the captured image, temperature measurement is done by the GY-906 temperature sensor that is fixated in the static portal setup. For temperature detection, the individual will have to temporarily remove his mask for the system to perform detection of facial landmarks. The process of facial landmark detection is done to find the best point on the forehead to measure the temperature. The static system then aligns the chosen position on the forehead with the GY-906 temperature sensor using the PID control system, from where the temperature is noted. If the temperature is normal, the data gets stored on the database or updated in the cloud, flashing a green light indicating approval. If the temperature noted exceeds the threshold level, then a buzzer sound is emitted and intimation is sent out to the higher authorities. The output display is shown in Fig. 3.

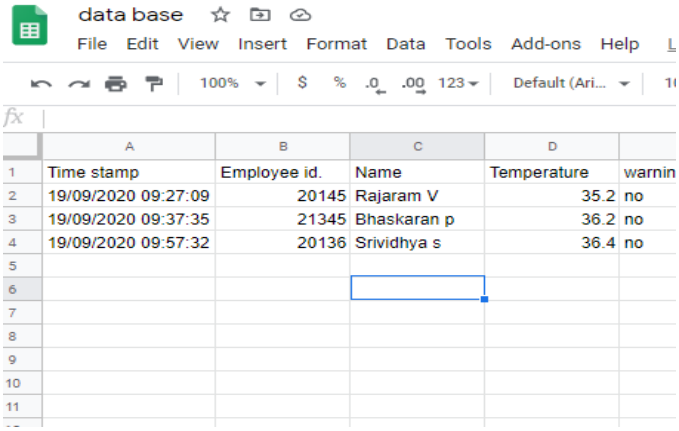
Fig. 3. Temperature detection

B. Module-2 Face detection for Attendance purpose

In current conventional attendance systems, a lot of time has been invested and lost in it which can be minimized. This system can also help to efficiently replace the laborious manual process of marking the attendance of an individual in either an organization or institution. The camera takes the image of the person who reports before the static terminal. The camera is connected to the RPI4 module. The Raspberry Pi 4 which is to be deployed in this system offers far greater processing speed compared to its predecessors. The perks of using RPI4 lies in the fact that it is embedded with 802.11n wireless LAN and Bluetooth 4.1. The WIFI feature on the raspberry pi can be enabled by using the command-line raspberry pi config tool. The image of the individual can be effectively taken in any direction. Once the image has been captured, face detection and recognition phases are undergone. The camera is linked to the Real-Time Clock (RTC) which accurately notes the reporting time of the specific person. Along with the recognized individual's identity, the clocking time is fed as input to the raspberry module. The Wi-Fi feature on the raspberry pi performs the role of transferring the data that has been received by the camera and the timing that has been clocked by the RTC to be transferred to the cloud or any other form of databaseutilized. The outputted data which has been stored on the cloud or the server can be retrieved to use for further processing or future references. The Output is shown in Fig. 4 and Fig. 5

Fig. 4. Face Detection

Face detection can be performed effectively using OpenCV, which has a built-in face detector that is capable of detecting 90%-95% of the faces accurately. Haar-like features are initially generated to be used in object recognition. The presence or absence of Haar-like features can be determined by integrating all the features into an Integral Image. This allows the detector to compute the features quickly. This process can be enhanced by using an Adaboost learning algorithm. Finally, the portions which are not needed can be removed and joining the classifiers in a cascade.


data base

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	A	B	C	D	
1	Time stamp	Employee id.	Name	Temperature	warnin
2	19/09/2020 09:27:09	20145	Rajaram V	35.2	no
3	19/09/2020 09:37:35	21345	Bhaskaran p	36.2	no
4	19/09/2020 09:57:32	20136	Srividhya s	36.4	no
5					
6					
7					
8					
9					
10					
11					

Fig. 5. Employee database update

C. Module-3 Aarogya Setu App Analysis

In the wake of the current COVID-19 pandemic, it is incumbent for every individual to install the Aarogya Setu application on their mobile device. This application provides instant information about the health and welfare of the person, which draws light to the fact on why it is being extensively deployed in multiple organizations and institutions. With the click of a button, a user can generate a QR code from the Aarogya Setu app installed on his/her mobile phone. The

camera in the static portal setup will scan the QR code generated from the mobile phone to verify and validate the health status of the individual. The details which are displayed upon scanning include the name, mobile number as well as the medical status. The medical status is displayed with varying colors to highlight the details. These medical status messages fall into one of preset 5 categories which quickens the process of detecting the health status of the person. This method of verifying the well-being of the individual can be considered as highly accurate since at the backdrop, JSON web tokens are utilized for ensuring the safe transmission of information with the aid of digital signatures provided with a public/private key pair. Furthermore, the application is also very apt to be able to detect if fake QR codes are generated to fool the system. The details accessed from scanning the QR code will then be fed as input to the Raspberry pi3+ which is connected to the Internet via Wi-Fi. Workflow and output are shown in Fig. 6 and Fig. 7 respectively.

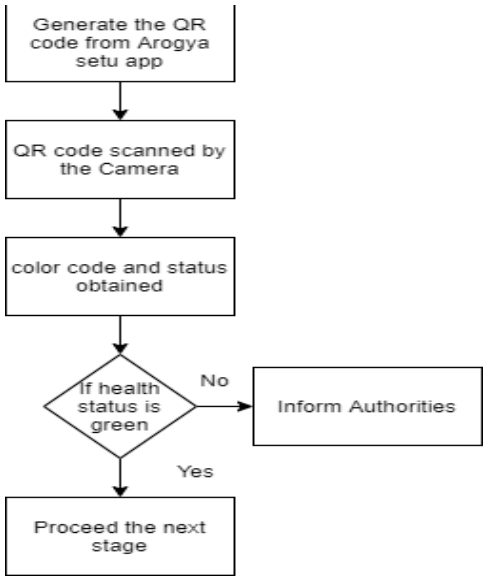

Fig. 6. Workflow for Arogya Setu

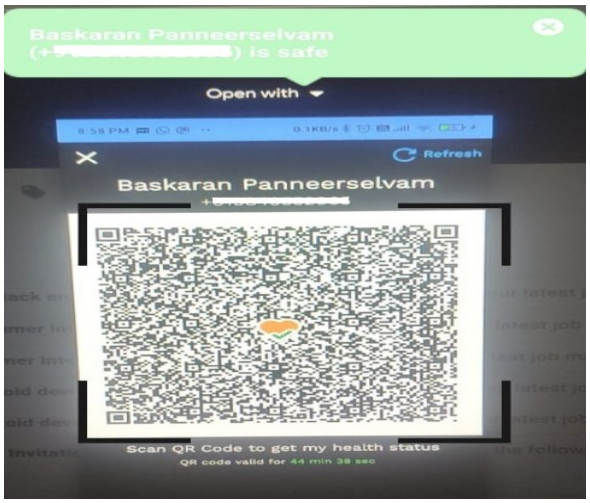

Fig. 7. COVID history notification

D. Module-4 Mask Wearing Confirmation

Mask Detection phase can be broadly classified into two portions; the training and the application of the face mask detection. In the training portion, the face mask dataset is first loaded into the model. A face mask dataset can be artificially created by taking a standard set of images without the mask and determining the Region of Interest (ROI) which is the face region and thereafter assessing the facial landmarks to fix the location of the face mask. Facial landmarks are specific attributes that allow the system to identify notable facial structures such as the location of the eyes, nose, ears, mouth, jawline, etc. This can be performed using a customer computer vision Python script. Once the face mask dataset has been successfully loaded, the face mask classifier is trained using Keras/ Tensorflow packages. Then, the face mask classifier is serialized to the disk. As part of the application of the face mask detector, the face mask classifier is loaded from disk. The faces in the image captured are detected and the Region of Interest (ROI) is singled out to determine the facial region. At this stage, the face mask classifier that was previously trained is applied to determine the presence or absence of a mask. The prediction is printed on the screen indicating with a green boundary box around the Region of Interest if the mask is worn and with a red boundary box if otherwise. The Output is shown in Fig. 8.

Fig. 8. Mask on Detection

V. REAL-TIME SETUP

This real-time experimental setup shown in Fig. 9 illustrates a prototypical view of how the system will function. Python 3 is used for coding purposes. The image captured by the webcam of the setup will be up on the display and fed as input to the raspberry pi as well. This real-time experimental setup shown in Fig. 9 illustrates a prototypical view of how the system will function. Python 3 is used for coding purposes. The image captured by the webcam of the setup will be up on the display and fed as input to the raspberry pi as well. The GY-906 non-contact IR sensor will determine the ideal points on the forehead from the image on the display to measure the body temperature.

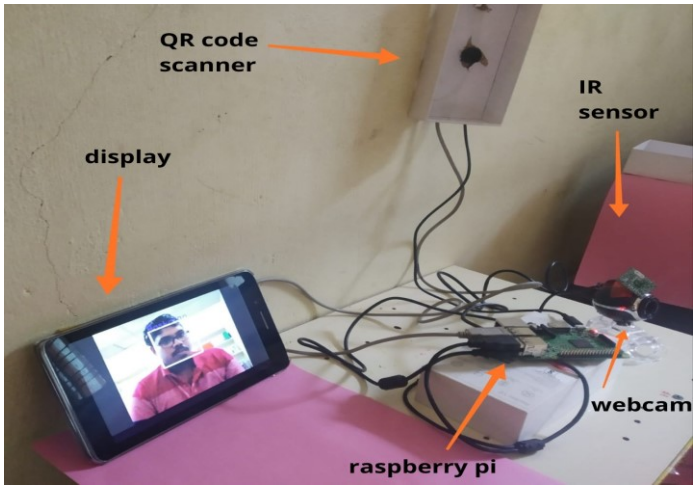

Fig. 9. Real-time experimental view

The QR code sensor will scan the QR code that is generated from the Aarogya Setu application on the individual's mobile phone. All these inputs will be fed into the system and processing will be done to deem if the individual is fit and healthy.

VI. CONCLUSION AND FUTURE SCOPE

The proposed work setup constantly checks for the temperature of the individual and when it crosses the threshold mark, the poor health of the individual will be brought to the notice of higher authorities. the packet setup consists of a sensor to check for the presence of an individual and to ensure that the packet setup is always placed in the proximity of the individual. the thermal imaging sensor measures the temperature of the individual constantly at regular intervals of time. this packet setup can be additionally deployed as a preventive measure if individuals resort to alternative temporary measures to foil the static portal setup. if the temperature is not within an appropriate range, an intimation is sent out to the higher authorities regarding the poor health status of the individual. this packet setup will further increase the process of checking for the efficiency of the system at constantly ensuring the health and safety of its employees or members. in future work, the portable setup which checks that an individual is healthy and alright will be designed such that it can be fitted in the pocket.

References

[1] Mohammed, M. N., Halim Syamsudin, S. Al-Zubaidi, Ramli R. AKS, and E. Yusuf. "Novel COVID-19 detection and diagnosis system using IOT based smart helmet." International Journal of Psychosocial Rehabilitation 24, no. 7 2020.

[2] Arrichiello, Antonio, Salvatore Alessio Angileri, Anna Maria Ierardi, Letizia Di Meglio, and Gianpaolo Carrafiello. "Bedside vascular access procedures for COVID-19 patients." The journal of vascular access 2020.

[3] Chand, S., Kapoor, S., Orsi, D., Fazzari, M.J., Tanner, T.G., Umeh, G.C., Islam, M. and Dicpinigaitis, P.V. COVID-19-Associated Critical Illness—Report of the First 300 Patients Admitted to Intensive Care Units at a New York City Medical Center. Journal of intensive care medicine, 35(10), pp.963-970 2020.

[4] Ashraf, Muhammad Usman, Abdul Hannan, Sehrish Munawar Cheema, Zahra Ali, and Abdulraheem Alofi. "Detection and Tracking Contagion using IoT-Edge Technologies: Confronting COVID-19 Pandemic." In 2020 International Conference on Electrical, Communication, and Computer Engineering (ICECCE), pp. 1-6. IEEE, 2020.

[5] Combe, Laurie G. "Converging Pandemics Impact on Students, Schools, and Communities: COVID-19 and Racism." NASN School Nurse 35, no. 5 : 246-249 2020.

[6] Singh, Ravi Pratap, Mohd Javaid, Abid Haleem, and Rajiv Suman. "Internet of things (IoT) applications to fight against COVID-19 pandemic." Diabetes & Metabolic Syndrome: Clinical Research & Reviews 2020.

[7] Kumar, Krishna, Narendra Kumar, and Rachna Shah. "Role of IoT to avoid spreading of COVID-19." International Journal of Intelligent Networks 1 2020:

[8] Baskaran P., Baskaran K., Rajaram V. (2021) Design of E-Water Application to Maintain the Flow of Water from Common Faucets by Enabling GSM. Artificial Intelligence Techniques for Advanced Computing Applications. Lecture Notes in Networks and Systems, vol 130.

[9] Chamola, Vinay, Vikas Hassija, Vatsal Gupta, and Mohsen Guizani. "A Comprehensive Review of the COVID-19 Pandemic and the Role of IoT, Drones, AI, Blockchain, and 5G in Managing its Impact." IEEE Access 8 90225-90265 2020.

[10] Bai, Li, Dawei Yang, Xun Wang, Lin Tong, Xiaodan Zhu, Nanshan Zhong, Chunxue Bai et al. "Chinese experts' consensus on the Internet of Things-aided diagnosis and treatment of coronavirus disease 2019 (COVID-19)." Clinical eHealth 3 7-15 2020

[11] Lai, Chih-Cheng, Tzu-Ping Shih, Wen-Chien Ko, Hung-Jen Tang, and Po-Ren Hsueh. "Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and corona virus disease-2019 (COVID-19): the epidemic and the challenges." International journal of antimicrobial agents : 105924. 2020

[12] Lai, Chih-Cheng, Yen Hung Liu, Cheng-Yi Wang, Ya-Hui Wang, Shun-Chung Hsueh, Muh-Yen Yen, Wen-Chien Ko, and Po-Ren Hsueh. "Asymptomatic carrier state, acute respiratory disease, and pneumonia due to severe acute respiratory syndrome coronavirus 2 (SARSCoV-2): facts and myths." Journal of Microbiology, Immunology and Infection 2020.

[13] Emami, Shervin, and Valentin Petrut Suciu. "Facial recognition using OpenCV." Journal of Mobile, Embedded and Distributed Systems 4, no. 1 : 38-43. 2012

[14] Nagpal, Gagandeep Singh, Gagandeep Singh, Jappreet Singh, and Nishant Yadav. "Facial detection and recognition using OPENCV on Raspberry Pi Zero." In 2018 International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), pp. 945-950. IEEE, 2018.

[15] Negied, N. K.. Human biometrics: Moving towards thermal imaging. International Journal of Recent Technology and Engineering (IJRTE), ISSN, 2277-3878 2014.

[16] Shaikh, Shazia, Nazneen Akhter, and Ramesh Manza. Current Trends in the Application of Thermal Imaging in Medical Condition Analysis. International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume-8 Issue-8, June 2019.

[17] Madhu, B. S., & Kanagotagi, K. IoT based Automatic Attendance Management System. In 2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC) (pp. 83-86). IEEE. 2017

[18] Devikar, P., Krishnamoorthy, A., Bhanage, A., & Chauhan, M. S. IoT based biometric attendance system. Mumbai University: India. No Sensor Nilai OPC Alarm, 1. 2016

[19] Srivastava, P., Bajaj, M., & Rana, A. S. Overview of ESP8266 Wi-Fi module based smart irrigation system using IOT. In 2018 Fourth International Conference on Advances in Electrical, Electronics,

Information, Communication and Bio-Informatics (AEEICB) (pp. 1-5). IEEE. 2018

[20] Anish, C. Amala, A. Amala Merlin, G. Jelin Jeba Malar, and J. Jeseeba. "WIRELESS NOTICE BOARD USING ARDUINO AND IOT TECHNOLOGY. International Journal of Recent Trends in Engineering & Research (IJRTER) Conference on Recent Trends in Electrical and Electronics Engineering (RTEEE '19) 2019.

[21] Chandy, Abraham. "A review on iot based medical imaging technology for healthcare applications." Journal of Innovative Image Processing (JIIP) 1, no. 01 51-60 2019.

[22] Smys, S., and Jennifer S. Raj. "Internet of things and big data analytics for health care with cloud computing." Journal of Information Technology 1, no. 01 9-18 2019