IJARCCE

ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 7.39 ⨳ Vol. 11, Issue 2, February 2022

DOI: 10.17148/IJARCCE.2022.11211

DESIGN AND CONSTRUCTION OF A COVID-19 DOOR ENTRANCE CHECKING SYSTEM

Nnebe S. U[1], Ebilite U.N[2], Nwankwo V.I[3]

Department of Electronic and Computer Engineering Nnamdi Azikiwe University, Awka[1, 2]

Federal Polytechnic, Oko, Anambra State, Nigeria[3]

Abstract: Covid-19 is a deadly pandemic that is currently ravaging the whole world. The World Health Organization (WHO) has recommended the wearing of face masks to contain the spread of the virus. Enforcing the wearing of face masts most times requires that the security personnel will be in close proximity with the people required to have their face masks on. This requirement makes the security personnel vulnerable. There is the need to have an automated checking system in order check conformity. This will ensure complete isolation. In this work, an automated Covid-19 Entrance Door Checking System that checks if individuals wear face mask or not before securing access to the door is designed and implemented. This system was implemented using an electromagnetic solenoid lock to perform the locking mechanism and a Raspberry pi as the controller was coded in python language using Geany as the IDE after which it was executed in the raspberry pi. The controller was interfaced with a camera module and a Temperature module for providing the user input interface on which the face is detected. The system features a liquid crystal display (LCD) Monitor for indicating system status as well as the reason for denial of access. The system operates by scanning the user's face, checks if he is putting on nose mast, upon successful verification, the electronic lock unlocks and the user will be allowed to access the door. If the user on the other hand does not wear nose mast, the electronic lock will not be unlocked and the LCD will indicate reason.

Keywords: Raspberry pi, Face masks, temperature detection, camera module.

I. INTRODUCTION

A new strain which has not previously been identified in humans is novel coronavirus (nCoV). Coronaviruses (CoV) are a wide group of viruses which cause illness that range from colds to deadly infections like Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) (WHO EMRO, 2020). The first infected patient of coronavirus was found in December 2019. From that period, COVID-19 has become a pandemic all over the world (Lau H.,et al., 2020). People all over the world are facing challenging situations due to this pandemic. Every day a large number of people are being infected and some die of the virus. At the time of writing this paper, almost 16,207,130 infected cases have been confirmed where 648,513 are dead (Worldometer, 2020). This number is increasing day by day. Fever, dry cough, tiredness, diarrhea, loss of taste, and smell are the major symptoms of coronavirus as stated by the World Health Organization (WHO) (Li L., et al., 2020). Many precautionary measures have been taken to fight against coronavirus such as hand washing, maintaining a safe distance, wearing of nose mask, refraining from touching eyes, nose, and mouth. However, wearing of nose mask is the simplest one among them. COVID-19 is a disease that spread from human to human and can be contained ensuring regular use of nose mask. Very sadly, people are not properly obeying these rules; thus the virus tends to spread faster than before. Proper enforcement is required for optimal result. Detecting non-compliance was done by security personnel with its inherent risk. There is therefore the need for automated nose mask compliance detection system in order to effectively reduce the spread of coronavirus.

Face mask detection is a technique to find out whether someone is wearing a mask or not. It is similar to detecting any object from a scene. Many systems have been introduced for object detection. Deep learning techniques are highly used in medical applications (Islam M.Z., Islam M. M., and Asraf A., 2020), (Muhammad L. J. et. al., 2020). Recently, deep learning architectures (Liu L. et al., 2018) have shown a remarkable role in object detection. These architectures can be incorporated in detecting the mask on a face.

This paper aims at designing a system to find out whether a person is using a mask or not and informing the relevant authority in a smart city network. In this system CCTV cameras are used to capture real-time video footage of different public places in the city. From that video footage, facial images are extracted and these images are used to identify those that are wearing masks and those that are not. Convolutional Neural Network (CNN) learning algorithm is used for

DOI: 10.17148/IJARCCE.2022.11211

feature extraction from the images then these features are learned by multiple hidden layers. Whenever the architecture identifies people without face mask this information is transferred through the city network to the relevant authority to take necessary actions. The developed system deals with data collected from different locations transferred to it via the smart city network. This paper feature the design and implementation of a system that can ensure proper enforcement of the law on people who are not following basic health guidelines, in this case, use of face mask in this pandemic situation.

2.0 REVIEW OF RELATED WORKS

In the meantime, many systems have been developed for COVID-19 in smart city networks. BlueDot and HealthMap services have been introduced in (Halegoua G, 2020). BlueDot method was first used to mark the cluster of unusual pneumonia in Wuhan which finally detected the disease as a pandemic. It also predicted that the virus would spread from Wuhan to Bangkok, Taipei, Singapore, Tokyo and Hong Kong. HealthMap service, based on San Francisco, spotted the patients with a cough which is the initial sign of COVID-19, using Artificial Intelligence (AI) and big data.

A study on using facemask to restrict the growth of COVID-19 is introduced in (Garcia L.P., 2020). The study indicated that the masks that are adequately fit will effectively interrupt the spread of droplets expelled when coughing or sneezing. Masks that are not perfectly fitted are also capable of retaining airborne particles and viruses. (Allam Z. and Jones D.S., 2020) proposed a framework on smart city networks focusing on how data sharing should be performed during the outbreak of COVID-19. The proposed system discussed the prospects of Urban Health Data regarding the safety issues of the economy and national security. In the system, the data is collected from various points of the city using sensors, trackers, and from laboratories.

A face mask detecting model named RetinaFaceMask combining with a cross-class object removal algorithm is proposed by (Jiang M., Fan X., and Yan H., 2020). The developed model includes one stage detector consisting of feature pyramid network that results in slightly higher precision and recall than the baseline result. For reducing the shortage of datasets, they have applied transfer learning, a well-known deep learning technique. (Gupta M., Abdelsalam M., and Mittal S., 2020) proposed a model to enforce the social distance using smart city and Intelligent Transportation System (ITS) during COVID-19 pandemic.

Their model proposed deploying sensors in different places of the city to monitor the real-time movement of objects and offered a data-sharing platform. A noticeable contribution of a smart city in controlling the spread of coronavirus in South Korea is explained by (Sonn J.W. and Lee J.K., 2020). A time-space cartographer speeded up the contact tracking in the city including patient movement, purchase history, cell phone usages, and cell phone location. Real-time monitoring has been carried out on CCTV cameras in the hallways of residential buildings.

A remarkable pandemic control model without lockdown in a smart city has been outlined by (Sonn J.W, Kang M., and Choi Y., 2020). The patients have been interviewed and their past movement has been monitored. They have claimed that some patients tried to conceal about their past mobility but real-time tracking system found the exact information.

In this paper, a Covid-19 Entrance Door Checking System that can identify people who are do not use of face mask in this pandemic situation, has been designed and implemented. The data collected will help the enforcing authority to deal with non-compliance and thus deter further deviant and consequently reduce the spread of the virus.

3.0 SYSTEM DESIGNS

The methodology adopted for the design of this work involves the integration and interfacing of the various sub units of the work together. The block diagram of the project is shown in Figure 1.

The system is made of the following subsystems: central processing unit, display unit, alarm unit, temperature sensor, regulated power supply unit and camera.

The central processing unit is the control subsystem which is actually a microcontroller. The microcontroller used is the Raspberry Pi. The Raspberry Pi is a low-cost computer that runs Linux and has a set of GPIO (general purpose input/output) ports for controlling electronic components and experimenting with the Internet of Things (IoT). The control subsystem is interfaced with the other subsystems to form a full functional product.

DOI: 10.17148/IJARCCE.2022.11211

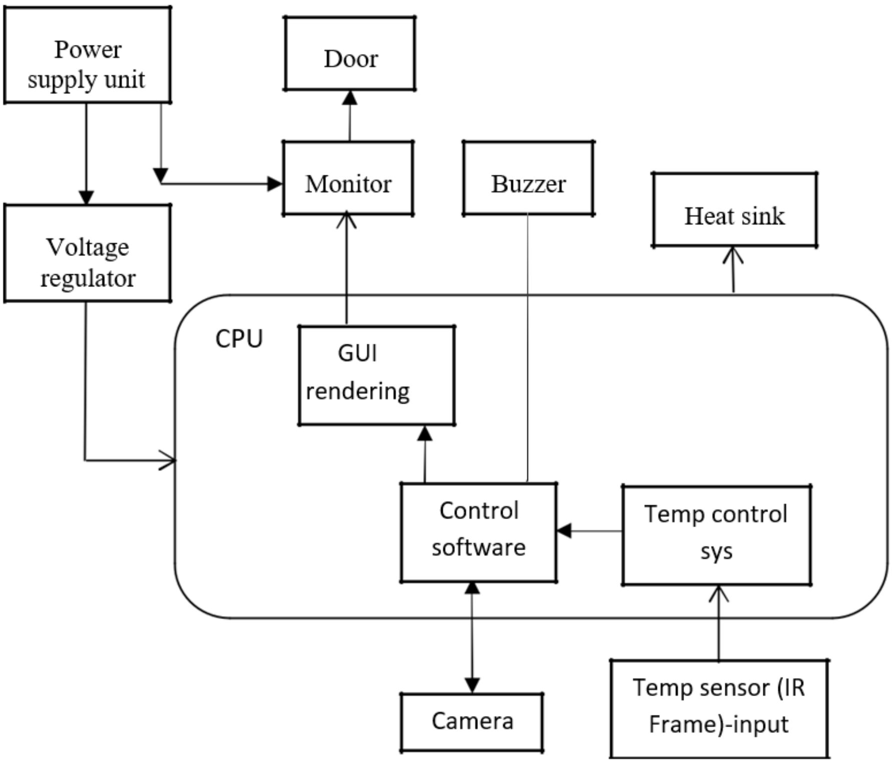

Fig.1 : Block Diagram of A covid-19 Door Entrance Checking System

The display Subsystem is a 24inches Visual Display Unit (VDU). The video output of the Raspberry Pi is fed into the VDU. The specifications of the VDU used for display are as follows; size is 24 inches, resolution is 1080x1080 pixels, Frequency is 60Hz, aspect ratio is 16:9 and clock rate of 100MHz. An electronic door locking system is used in the project such that when the Raspberry Pi sends a signal to the relay, it either locks or unlocks the door depending on the information sent. The camera used in the project is the Raspberry Pi Camera Module v2 which is a custom made add-on board for the Raspberry Pi with an 8 megapixel Sony IMX219 image sensor and a fixed focus lens.

The temperature sensor used in the project is MLX90614. The MLX90614 is a Contactless Infrared (IR) Digital Temperature Sensor that measures the temperature of a specific object between -70° C to 382.2°C. The sensor measures the temperature of the object using infrared rays without any physical contact and communicates with the microcontroller via the I2C protocol.

This is made feasible by the Stefan-Boltzmann Law, which states that all objects and living beings emit infrared energy, the intensity of which is precisely proportional to the temperature of the item or living thing. As a result, the MLX90614 sensor measures an object's temperature by measuring the amount of IR energy it emits. MLX90614 Temperature Sensor Specifications are: operating voltage: 3.6V to 5V (available in 3V and 5V version), supply current: 1.5mA, object temperature range: -70° C to 382.2°C, ambient temperature range: -40° C to 125°C, accuracy: 0.02°C, field of view: 80° and distance between object and sensor: 2cm-5cm (approx.). The temperature sensor is powered using 5V via pin 1 of the chip. Pin no 2 serve as the ground, pin no 3 as the SDA-Serial Data pin and pin no 4 as the SCL- Serial Clock. The alarm system used is the buzzer.

The essence is to alert the security people when the person is not wearing face masks or when the temperature of the individual is high and the person refuses to leave the door.

The entire system is powered by means of a dual regulated power supply circuit. The power supply was well smoothened using capacitors and regulated using voltage regulator ICs LM7812 and LM7805 to avoid fluctuations. A channel relay board controls the Electronic Lock system's switching. It includes all essential components and connections, such as a base current limiting resistor, a flywheel diode, LED indications, and a header for connecting to other devices. To turn on the relay, an LM358 comparator is utilized as the mains sensor to automatically turn it on and off.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 7.39 ⋇ Vol. 11, Issue 2, February 2022

DOI: 10.17148/IJARCCE.2022.11211

4.0 SYSTEM IMPLEMENTATION AND RESULT

4.1 Hardware Design

The system was implemented at subsystem levels, then integrating the various subsystems together to form one functional system. Each subsystem was tested separately before advancing to the next stage. This method was adopted for ease of faults troubleshooting at unit level than at entire system level. The following units were implemented separately:

A. The input Units (Camera Module)

- The ribbon wire or Flex wire was connected to the Raspberry Pi on one end (terminal) while the other end was also connected to the camera end.
- The Raspberry Pi was connected to a Power supply and booted on for installation of relevant operating systems.
- The camera module was mounted at an angle for quality vision.

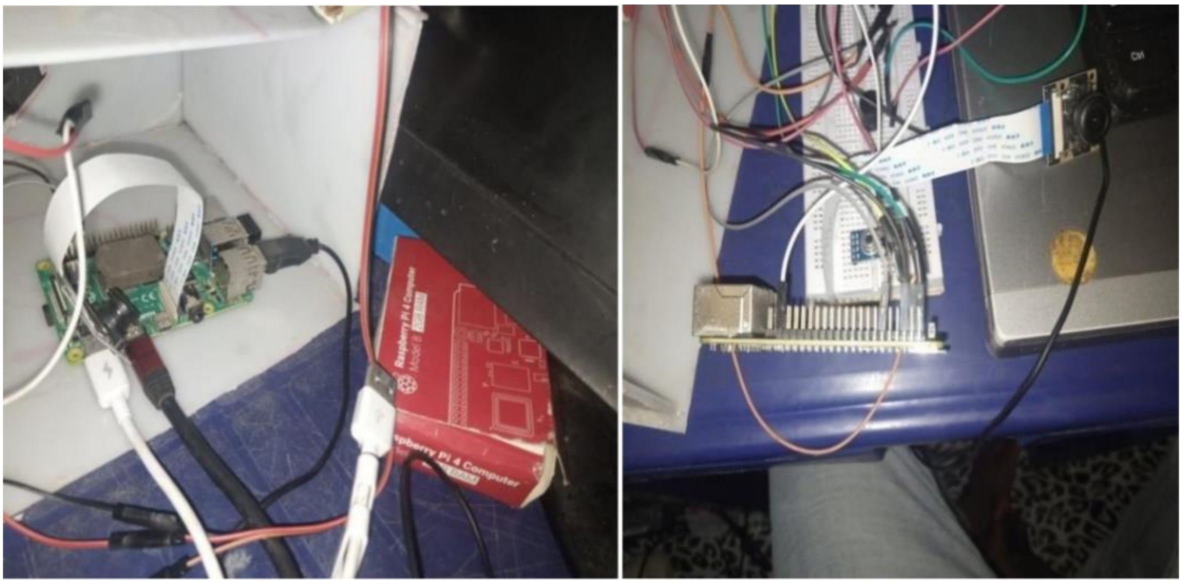

Figure 2: Raspberry Pi and Camera Module

B. The Display Unit (LCD Monitor Display)

- The Raspberry Pi microcontroller was interfaced with VDU via HDMI cable. Both device possess HDMI ports; thus output from the processor can be displayed on a large screen.

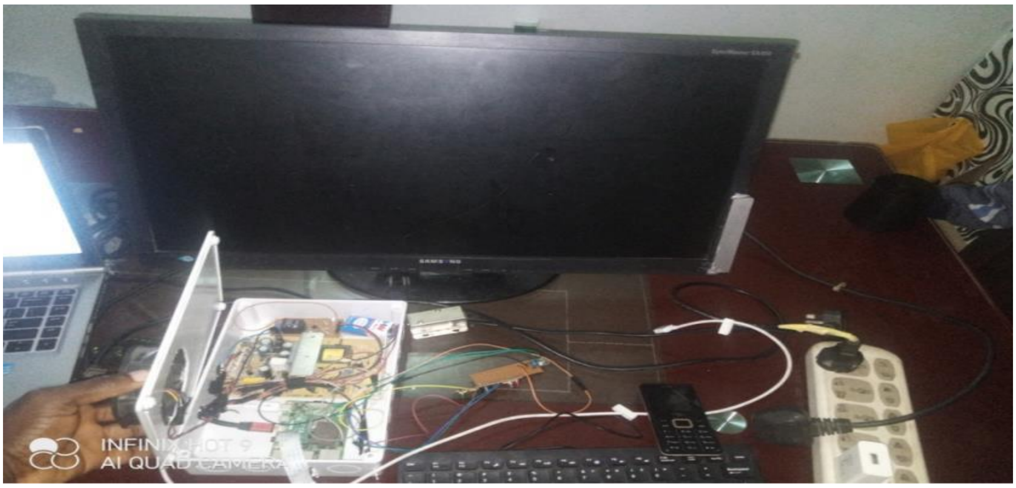

Figure 3: Raspberry pi interfacing with Monitor

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 7.39 ⋇ Vol. 11, Issue 2, February 2022

DOI: 10.17148/IJARCCE.2022.11211

C. The output Unit (Electromechanical lock and buzzer)

- The two terminals of the electromagnetic lock were interfaced to the Relay module which was connected to the Raspberry Pi pin and to any other desired pin for output.
- The buzzer was driven by the same relay which was interfaced with the solenoid lock with a 10k resistor to the raspberry pi board.

Figure 4 Output Unit: Solenoid Lock and buzzer.

4.2 Software Design

The software design consists of software codes/ programs to run the system. The software was developed using python language. It was developed with built in Raspberry pi IDE (geany). Software codes were written for the following interfaces:

- LCD display software code
- Nose Mask Verification software code
- Solenoid lock and Buzzer Software code

4.3 System Testing

In this stage the individual units have been integrated to form the complete system. The program was written inside the Raspberry pi and connected to the camera module, electric lock and temperature sensor for Interfacing. The system is connected to AC power supply and monitored to ensure the required performance. One function of the control device that lets the lock open in order to gain access to the door is Nose Mask Detection process.

This process involves the following steps:

1. Place Your face in front of the camera and temperature sensor
2. While standing in front of the camera stay still for the camera to scan you to determine if you are putting on mask or not
3. If "no mask" is detected the door entrance would remain locked and the monitor will display "Put on your mask". If "mask is on" it would display "mask on".
4. After the camera verification, the temperature is checked. If the temperature is "normal" the door would open but if the temperature is "high" the buzzer would come on and the door will remain locked.

DOI: 10.17148/IJARCCE.2022.11211

FLOW CHART DESIGN

Figure 5 is the flow chart of the Covid-19 Door Entrance Checking System. It chronicles the procedural operation of the system.

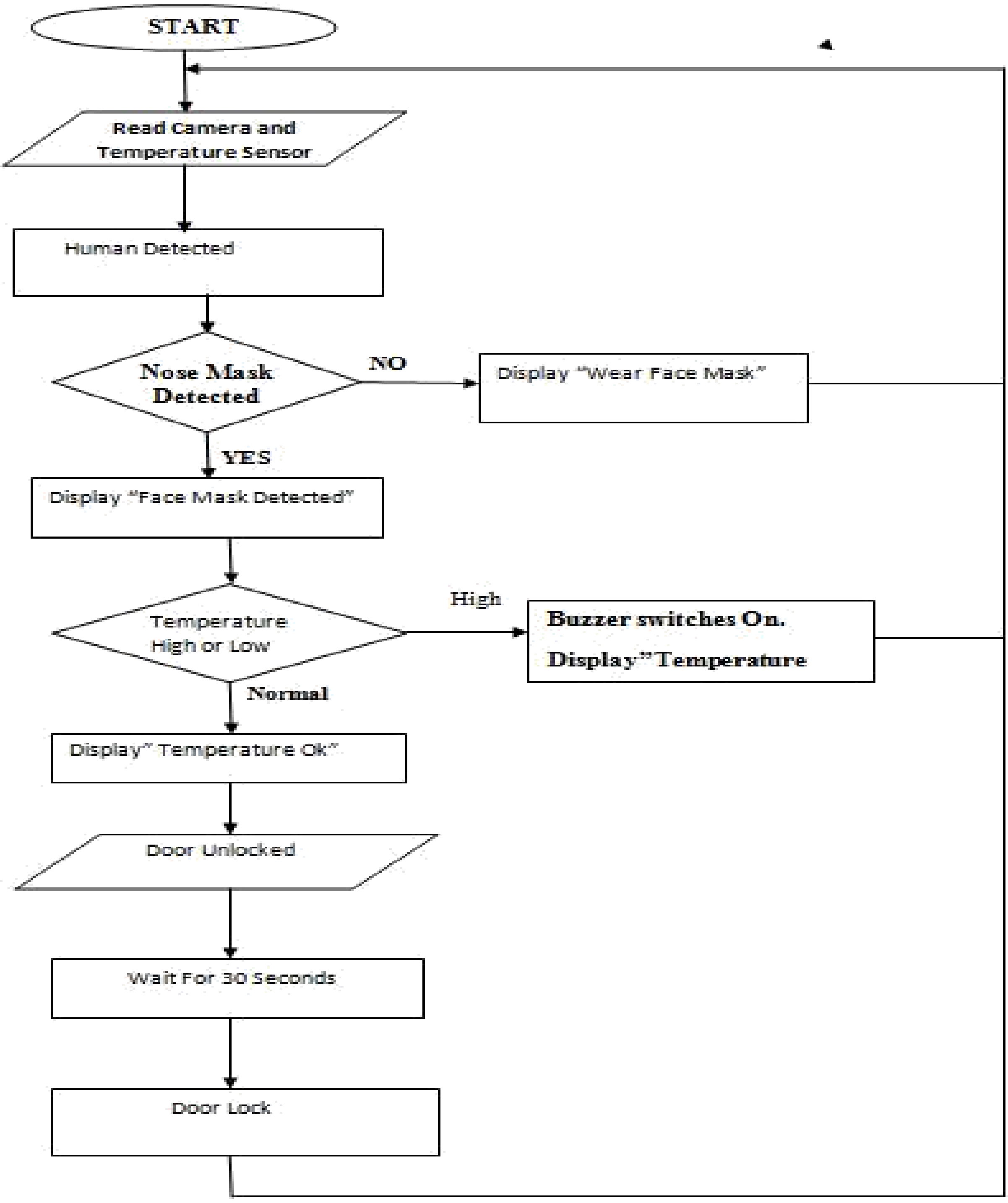

Figure 5: Flow chart design for Covid-19 Door Entrance Checking System.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 7.39 ⋇ Vol. 11, Issue 2, February 2022

DOI: 10.17148/IJARCCE.2022.11211

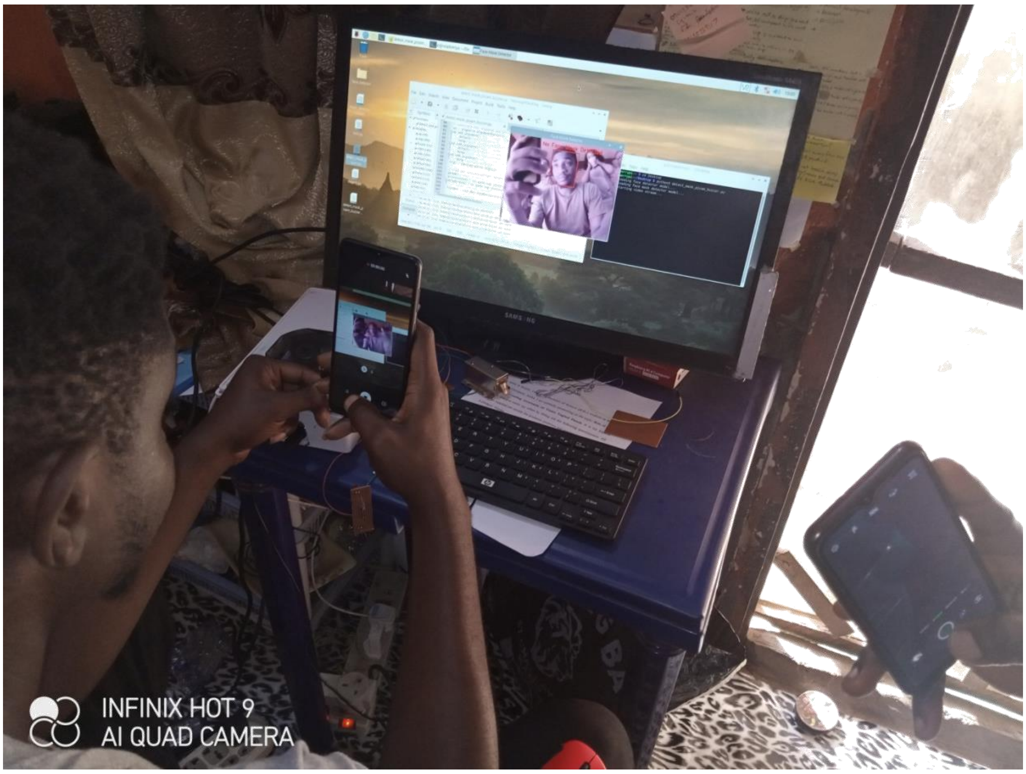

Figure 6: Front View During the Training of the Recognition system

Figure: Finished work

4.4 System Evaluation

The system is programmed in such a way that when Nose mask is detected and the temperature is normal, access is granted and the door opens but if there is no face mask and the Temperature is high the Alarm system is set on, the LED comes on and access is denied. In both cases the user is prompted accordingly through the LCD Display. The system was evaluated and result shown in table 1.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 7.39 ⁜ Vol. 11, Issue 2, February 2022

DOI: 10.17148/IJARCCE.2022.11211

Table 1: Evaluation of the system

Test Cases	Observation	Result
When the system is powered ON	LCD displays "Waiting for Nose Mask Detection" and the green Led comes on	The door remains locked
When the Nose Mask is detected	LCD displays Mask on, wait for temperature check	The door remains Locked
When the Nose mask is detected and Temperature normal	LCD displays Mask on, Temperature Normal and access granted	The door lock opens
When the Nose mask is detected and Temperature High	LCD siplays Mask on, Temperature High	The door remains locked
When the Nose Mask is detected	LCD displays no mask, Access denied	The Door remains locked

5.0 CONCLUSION

The Covid-19 Door Entrance Checking System is a well-engineered system that is very efficient and easy to use; it meets the security needs for the curbing of the spread of covid-19. It provides more security and prevention than the traditional way of regulating the spread of the virus. If the system is mass produced and deployed around the cities, it will go a long way reducing the spread of coronavirus. As the most commonly known and widely used biometric security system, the growing need of face detection will inevitably revolutionize the security aspects of our daily life in the nearest future.

REFERENCES

1. Allam Z. and Jones D.S., (2020), On the Coronavirus (COVID-19) Outbreak and the Smart City Network: Universal Data Sharing Standards Coupled with Artificial Intelligence (AI) to Benefit Urban Health Monitoring and Management, Healthcare, vol. 8, no. 1, p. 46.
2. Calavia L., Baladrón C., Aguiar J.M., Carro B., and SánchezEsguevillas A., (2012) A Semantic Autonomous Video Surveillance System for Dense Camera Networks in Smart Cities, Sensors, vol. 12, no. 8, pp. 10407–10429.
3. Garcia L.P., (2020), Uso de máscara facial para limitar a transmissão da COVID-19, Epidemiol. e Serv. saude Rev. do Sist. Unico Saude do Bras., vol. 29, no. 2, p. e2020023.
4. Gupta M., Abdelsalam M., and Mittal S. (2020), Enabling and Enforcing Social Distancing Measures using Smart City and ITS Infrastructures: A COVID-19 Use Case, [Online]. Available at: https://arxiv.org/abs/2004.09246.
5. Halegoua G., (2020), Smart City Technologies Smart Cities, doi: 10.7551/mitpress/11426.003.0005.
6. Islam M.Z., Islam M. M., and Asraf A., (2020) A Combined Deep CNNLSTM Network for the Detection of Novel Coronavirus (COVID-19) Using X-ray Images, Informatics in Medicine Unlocked, vol. 20, pp. 100412, Aug. 2020.
7. Jiang M., Fan X., and Yan H. (2020), RetinaMask: A Face Mask detector [Online]. Available at: http://arxiv.org/abs/2005.03950.
8. Lau H. et al., (2020) Internationally lost COVID-19 cases, J. Microbiol. Immunol. Infect., vol. 53, no. 3, pp. 454–458.
9. Li L. et al., (2020) COVID-19 patients' clinical characteristics, discharge rate, and fatality rate of meta-analysis, J. Med. Virol., vol. 92, no. 6, pp. 577–583.
10. Liu L. et al., (2018) Deep Learning for Generic Object Detection: A Survey, Int. J. Comput. Vis., vol. 128, no. 2, pp. 261–318.
11. Muhammad L. J., Islam M. M., Usman S. S., and Ayon S.I., (2020) Predictive Data Mining Models for Novel Coronavirus (COVID-19) Infected Patients' Recovery, SN Comput. Sci., vol. 1, no. 4, p. 206.
12. Sonn J.W., Kang M., and Choi Y. (2020), Smart city technologies for pandemic control without lockdown, Int. J. Urban Sci., vol. 24, no. 2, pp. 149–151. Sonn J. W. and Lee J.K. (2020), The smart city as time-space cartographer in COVID-19 control: the South Korean strategy and democratic control of surveillance technology, Eurasian Geogr. Econ., pp. 1– 11.
13. WHO EMRO (2020) About COVID-19 Health topics [Online] Available at http://www.emro.who.int/health-topics/coronavirus/about-covid-19.html
14. Worldometer (2020), Coronavirus Cases [Online] Available at https://www.worldometers.info/coronavirus.