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Temperature actuated non-touch automatic door

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***Abstract* – Amongst the various symptoms developed by humans infected with Coronavirus disease (COVID-19), rise in body temperature is the most preliminary symptom. As the corona virus is highly contagious, it is very important to avoid physical contact with an infected person in order to prevent the spread of this pandemic. Towards achieving this, entry into public places such as airports, railway stations, malls, schools and colleges, offices, etc. is allowed after scanning of body temperature manually through infra-red temperature guns. However, apart from being cumbersome and time consuming, this method of temperature scanning and manually regulating entry is unsafe too. Moreover, there is no record keeping and monitoring of any individual who is diagnosed with fever and can be a suspected COVID-19 virus carrier. As the virus is highly transmittable, it is thus imperative to automate the entry of people based on body temperature measurement. This paper covers designing and developing a system which would measure the body temperature and regulate the entry of people through a mechanized door which would be actuated for opening only if the person seeking entry does not have fever. The system would also have a digital camera for capturing the Aadhar card/ID card details of any fever infected person at the entry point and these details can be transmitted to any designated email ID by a network video recorder, which would also be part of the system.**

Index Terms - Arduino uno, COVID-19, IP camera, IR proximity sensors, IR temperature sensors, Temperature actuated door.

INTRODUCTION

COVID-19 is a highly transmissible disease caused by coronavirus. The second wave of this dangerous pandemic is presently soaring in India. In fact, currently India's outbreak is the largest ever recorded in the world. In order to prevent its rapid spreading and to stay safe, we have to follow various precautions such as washing hands regularly, wearing masks in public, social distancing, and avoiding touching surfaces. We can't have the same old habits of eating, travelling, buying or even doing our routine work. As per the guidelines of "WORLD HEALTH ORGANIZATION" (WHO) for general public, screening should be carried out at all entry points. This can be done by measurement of body temperature, generally by using a manually operated thermal scanner. Persons with a body temperature greater than 98.6°F are denied entry and are advised, to report to the nearest Covid facility for further medical check-up. However, the use of such manual temperature assessment devices may increase the risk of spreading infection. One method to prevent this is through avoiding human intervention by the use of an infrared (IR) temperature detector and an automatic door [1]. The schematic of such a system is shown in Figure I, which works by sensing the person seeking entry using an IR based proximity sensor and measuring the body temperature by an IR based temperature sensor. The Arduino operates the motor depending on the signal received from the IR temperature sensor.

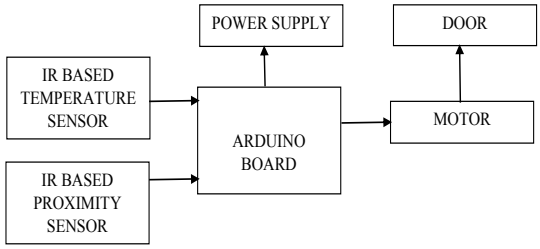

FIGURE I
BLOCK DIAGRAM OF AN AUTOMATED DOOR SYSTEM

However, the above automated door system does not have the provision of counting the number of persons permitted entry and also does not capture and transmit the details of the person who has been denied entry due to high body temperature.

This paper describes a smart entry system which would regulate the entry of persons based on measurement of body temperature and would also keep the count of number of people entering the premises. Further, the system has the technical novelty of being capable of capturing, by a digital camera, the identity details (Aadhar card / ID card) of the suspected patient (having higher body temperature than the set point of 98.6°F) and transmitting the same by generating an email to the designated email IDs. The system would thus help the concerned authorities by providing details of the suspected patient, which would be of immense help in tracking the individual.

RELATED WORK

Automatic door opening systems are commonly used at the entry of public places. Based on the signal received from an IR proximity sensor, the motorized door automatically opens for permitting entry and then closes after a pre-set time

interval. Such systems eliminate the requirement of manual operation of the door [2], [3] & [4].

Counting of persons entering or leaving a premises can be automated by the use of proximity sensors placed after the entry and exit doors/gates. The total number of persons present at the facility at any given time can be displayed on a LED display unit. Also, Bidirectional Visitor Counter (BVC) systems are available for simultaneously counting the persons entering and leaving a premises [5].

Contact as well as non-contact thermometers are used for measurement of body temperature [6]. Mercury thermometer is the most common contact thermometer used for sensing the body temperature by placement in the mouth or armpit. However, contact thermometers have the disadvantage of spreading of infection if not used with proper precaution. On the other hand, non-contact thermometers are preferable for use in Covid situation as these thermometers do not need physical contact of the sensing element with the person's body. Also, non-contact thermometers are simple and quicker to use, and are thus advantageous for body temperature checking in public places.

Amongst the various non-contact thermometers, the infrared thermometers are most suitable for screening of persons at public places, as these thermometers are required to be held 2 to 15 cm away from the person and typically measure the temperature on the hand or forehead [7]. These thermometers use photodetectors for sensing infrared electromagnetic waves of wavelengths less than 14,000 nm emitted from the body [8].

While an infrared temperature thermometer detects the electromagnetic waves emitted from an object, the IR proximity sensor emits infrared electromagnetic waves and detects the target object by sensing changes in reflected electromagnetic signals [9].

Instead of Future Technology Devices International Limited USB to serial driver chip, the Arduino Uno contains the single chip microcontroller Atmega8U2 programmed as a USB to serial converter [10].

The OV7670 is a compact, highly responsive complementary metal oxide semiconductor camera operating at 30 frames per second (fps) in video graphics array [11].

Table I gives the advantageous add-in features of the proposed system versus the existing systems.

TABLE I
Proposed system vs Existing systems

S.No.	Proposed system	Existing systems
1	Software based	Manual based
2	Reduces human contact	Increases human contact
3	Increased safety	Unsafe
4	No scope of error	Prone to human
5	ID details of patient captured	No such feature
6	Transmits ID details by email	No such feature

As can be seen from literature survey and also Table I, the existing systems do not have the provision of counting the number of persons entering into the premises and also do not help in providing information for tracking suspected covid patients. This is a serious disadvantage, which can be overcome by the proposed system.

PROPOSED WORK

- **Basics of the system**
  The system consists of an automatic mechanized door, which will be actuated by a body temperature measuring sensor. Additionally, the door would operate only when the body temperature is below a set point. This would prevent entry of persons suffering from fever. Further, the system would be capable of counting the total number of persons allowed entry based on their body temperature measurement. When the temperature reading exceeds the pre-determined limit, the door would not open and the image of the person's identity card (Aadhar card/driving license etc.) will be stored as well as emailed to the designated email IDs. The proposed system uses the PC memory for storage of the images captured. However, the system is also capable for continuous operation and the data captured can be conveniently handled by a Fog-Based Cloud Network [12].

- **Methodology**
  Sensors, processors and software are the fundamental building blocks of the proposed device. The approach continues with the fundamental inspection of all the components in the device. The block diagram that indicates the interconnection of these blocks is shown in the Figure II. The sensors are interfaced with the Arduino, input from which is sent to the Arduino, which contrasts it with the reference signal and grants/declines permission accordingly.

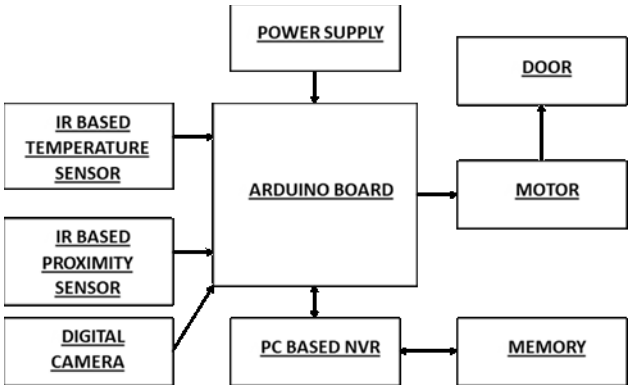

FIGURE II

BLOCK DIAGRAM OF THE PROPOSED SYSTEM

- **Flowchart**

Figure III gives the flowchart of the proposed system.

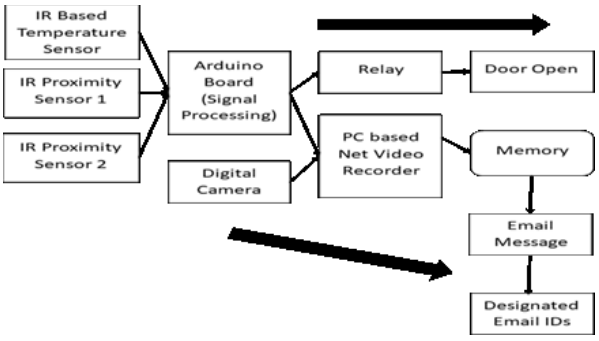

FIGURE III
FLOW CHART OF THE SYSTEM

- **Specifications of major Hardware components**

- MLX90614 Contactless Temperature Sensor Module is shown in the Figure IV.

FIGURE IV
IR TEMPERATURE SENSORS [13]

Accuracy: +/- 0.5°C
Operating voltage: 5V
Supply current: 1.5mA
Temp. range: -40 to 125°C
Field of view: 80°C
Distance from sensor: 5 cm

- HW201 Infrared IR Proximity Sensor Module is shown in the Figure V.

FIGURE V
IR PROXIMITY SENSOR [14]

Operating voltage: 5V
Range: up to 20 cm
Supply current: 20mA

- Arduino Board Uno R3 CH340G is shown in the Figure VI.

FIGURE VI
ARDUINO BOARD [15]

Microcontroller: ATmega328P – 8 bit AVR family
Operating voltage: 5V
Analog input pins: 6
Digital I/O pins: 14
Flash memory: 32 KB
SRAM: 2 KB
EEPROM: 1 KB
Frequency (clock speed): 16 MHz

- OV7670 Camera Module is shown in the Figure VII.

FIGURE VII
CAMERA OV7670 MODULE [16]

Active array size: 640x480
Supply voltage: 3V
Ambient temp (max): 70°C
Lens size: 1/6 inch
Max image transfer rate: 30 fps for VGA
Sensitivity: 1.3 V/(Lux ˙sec)
Pixel size: 3.6µm x 3.6µm

- SG 90 Tower Pro Micro Servo Motor is shown in the Figure VIII.

FIGURE VIII
SG 90 SERVO MOTOR [17]

Operating voltage: 5V
Torque: 2.5 kg/cm
Operating speed: 0.1s/60°
Gear type: Plastic
Rotation: 0-180°
Weight: 9 gm

- **Software tools - Arduino IDE (Integrated Development Environment)**

Arduino IDE is a C/C++ based text editor (Figure IX) which is used for writing and compiling code using a Arduino module. It works with operating systems like MAC, windows, Linux. Arduino Mega, Arduino Uno, Arduino Leonardo, etc.

FIGURE IX
SKETCH AREA OF ARDUINO [18]

- **Assembly - Circuit diagram**

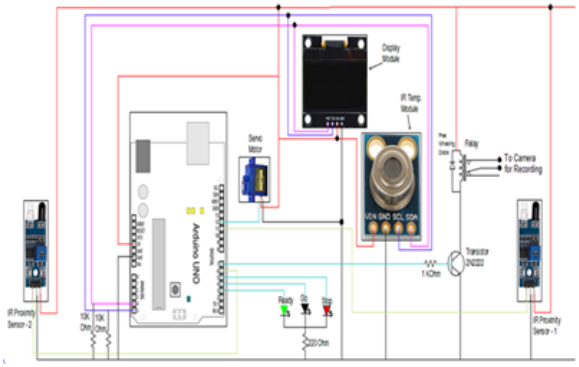

FIGURE X
CONNECTION DIAGRAM OF THE SYSTEM

Set up the components in the fashion as shown in the Figure X. Pre-program the Arduino Board and align the hardware parts to work as desired. The assembly plan and side view of the system are shown in the Figures XI & XII.

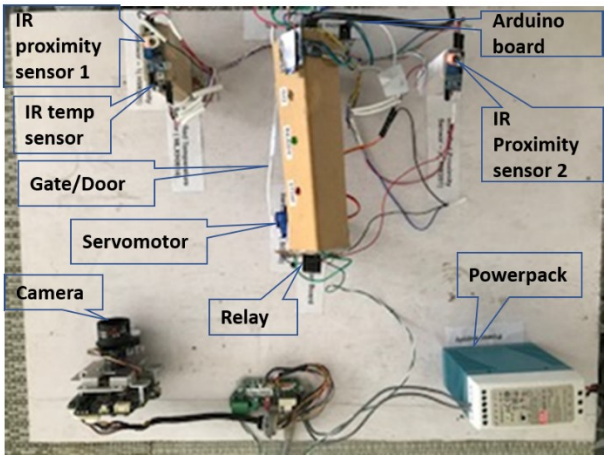

FIGURE XI
ASSEMBLY PLAN OF THE SYSTEM

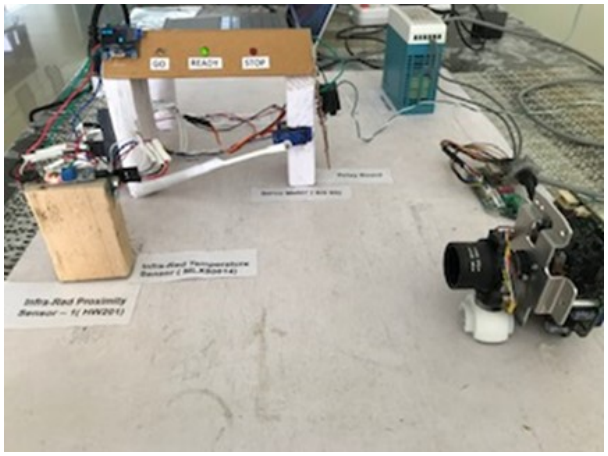

FIGURE XII
ASSEMBLY SIDE VIEW

RESULT ANALYSIS

- **Case 1: Person with normal body temperature**

To start the operation, person stands in front of gate seeking for entry. 'Ready' LED is glowing indicating readiness of the system. Arduino gives ON command (5 V) to READY LED (Pin No.3). IR Proximity Sensor-1 senses the person's presence and its output voltage drops to 0V (Active Low). Command to "READY LED" goes Low (0 V). This is shown in the Figure XIII.

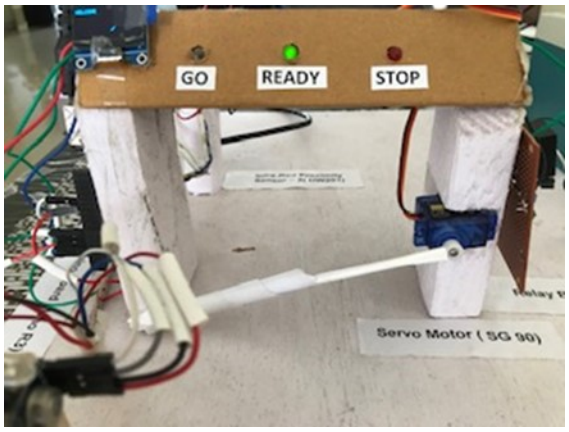

FIGURE XIII
"READY" LED GLOWING INDICATING READINESS OF THE SYSTEM

The IR Temperature sensor sends the temperature data through Serial communication (SCL and SDA) (A4, A5) to Arduino. After getting the (0 V, Low) signal from Proximity Sensor-(Pin No.11), temperature data shall be transmitted to Display module through serial communication (SCL and SDA) (Pin No. A4, A5) as shown in the Figure XIV. The Arduino will start comparing the measured temperature with the pre-set value.

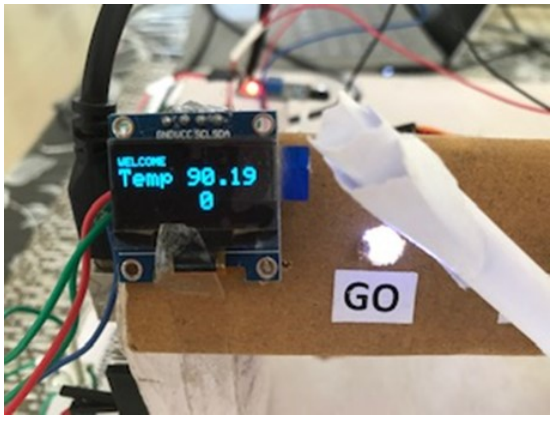

FIGURE XIV
"DISPLAY" LED SHOWING BODY TEMPERATURE < 99.6°F

Arduino will now command the Servo Motor to open the gate through Pulse Width Modulation (PWM) (Pin No.12). Simultaneously it will also give ON command (5 V) (Pin No.4) to "GO" LED as shown in the Figure XV.

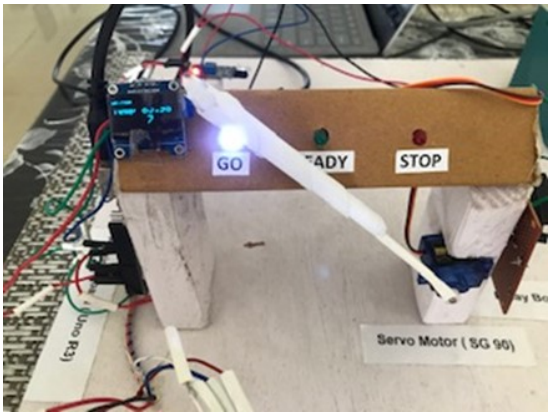

FIGURE XV
"GO" LED GLOWING WITH THE GATE IN OPEN POSITION

As the Gate opens, the person enters. Arduino will command the Servo Motor to close the gate through PWM after a few seconds. Arduino will give ON Command (5 V) to "READY" LED. Proximity Sensor-2 will sense the crossover of the person and shall give a Low signal (0V) to Arduino (Pin No.6).
Arduino will use this signal to increment the count. Arduino will communicate to Display Module through SCL/SDA the current counter data (A4, A5) as shown in the Figure XVI. The system is now ready for next cycle.

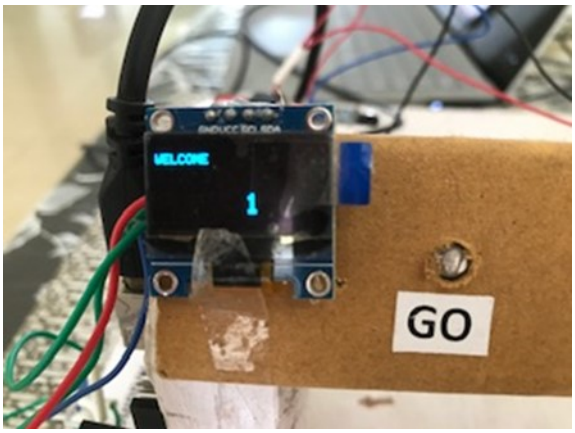

FIGURE XVI
"DISPLAY" LED SHOWING CUMULATIVE COUNT OF PERSONS PERMITTED ENTRY

- **Case 2: Person with abnormal body temperature**

To start the operation, person stands in front of gate seeking for entry. 'Ready' LED is glowing indicating readiness of the system. Arduino gives ON command (5 V) to READY LED (Pin No.3). IR Proximity Sensor-1 senses the person's presence and its output voltage drops to 0V (Active Low). Command to "READY LED" goes Low (0 V). The IR Temperature sensor sends the temperature data through Serial communication (SCL and SDA) (A4, A5) to Arduino. This is shown in the Figure XVII.

FIGURE XVII
HOT WATER CUP BEING USED FOR TESTING OF THE SYSTEM ABOVE A TEMPERATURE OF 99.6OF

After getting the (0 V, Low) signal from Proximity Sensor-(Pin No.11), temperature data shall be transmitted to Display module through serial communication (SCL and SDA) (Pin No. A4, A5) and Arduino will start comparing the measured temperature with the pre-set value.

Arduino will not send any command to the Servo Motor. Hence no opening of Gate. It will give ON command (5 V) (Pin No.5) to "STOP" LED as shown in the Figure XVIII.

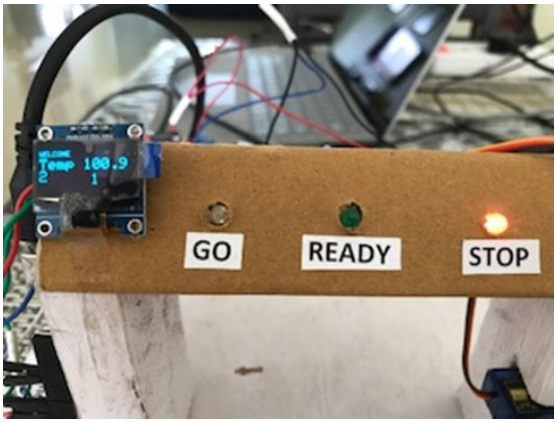

FIGURE XVIII
"STOP" LED GLOWING WITH THE GATE IN CLOSED POSITION

Simultaneously, the Arduino will give a high command (5 V) (Pin No.7) to actuate the relay. The contact of the relay shall now command the Camera to capture image & send Alarm email to the designated email ID as shown in the Figures XIX and XX. The system is now ready for next cycle again.

FIGURE XIX
ALARM INPUT EMAIL RECEIVED FROM THE DIGITAL CAMERA

FIGURE XX
PHOTO OF THE ID CARD RECEIVED ALONG WITH THE ALARM INPUT FROM THE DIGITAL CAMERA

CONCLUSION

Due to the extreme contagiousness of the COVID-19 virus, utmost precaution is needed to be observed towards identifying and isolating suspected patients. Public places such as airports, railway stations, offices, educational institutions, etc., have the highest risk of spreading the virus if proper systems are not in place to identify and segregate suspected carriers of the virus. Presently, screening of persons entering such public places is being carried out manually, which is not desirable as it is not a reliable method. In this project, we have presented a system which will be more secure and effective in identifying persons with high body temperature and their prevention from entering public places by linking the temperature sensor signal to an automatic door actuating system. Further, the system has the valuable advantage of automatically notifying the concerned authorities through a system generated email along with the identity details of the suspected patient. This would help in tracking the patient and thereby, mitigating the risk of further spreading of the virus.

The proposed system can also be integrated with a suitable app for identifying the persons in recent contact with the suspected COVID effected persons, which would help in their tracking & treating and thus prevent the spread of COVID-19 pandemic.

The proposed system has a provision for counting the number of persons entering through the automated door. This can be upgraded by using Bidirectional Visitor Counter (BVC) which can count the visitors entering and leaving a room. When a person enters the room, the count is incremented and when a person leaves the room that count is decremented.

ACKNOWLEDGMENT

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