Baridefendo- An Autonomous Safety Ensuring System

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***Abstract*— — Coronavirus is an infectious and deadly disease. The best way to safeguard yourself is by staying at home. But moving out to shops to get daily groceries and some places becomes unavoidable. Wearing a mask, checking temperature, and sanitizing are done manually at most shops and in some personal places. Hence the proposed model allows an entry only after the temperature and mask inspection. Once the condition is satisfied, the person is sanitized and the barricade gets opened. If the person is without the mask, he/she can drop a coin and get a mask. Finally, to maintain social distance, the maximum count of people who can enter the place will be fixed, and if the maximum count is attained, the gateway remains closed. All these processes occur autonomously. This system helps in preventing the spread of disease when the person is out.**

Keywords—COVID-19, Computer Vision, Arduino, Raspberry Pi, Safety measures

I. Introduction

The world is massively struck due to Coronavirus. People are pushed to such a situation due to poor and careless safety measures; the number of fatalities has increased drastically. Crowded streets, markets, malls, and many more public places have become the hotspot for spreading this virus. Hence there is a need to control this pandemic by introducing a safety-ensuring system. Intel Research initiative launched the OpenCV project in 1999. It was an advance to a series of projects including real-time ray tracing, 3D displays walls, and also mask detection, in which CPU-intensive applications were also part.

Initially, the thermometer was invented in 1592, using a simple air system in the glass bulb. Later, to connect the associated electronics or signal processors the biosensor reader device was introduced. These help to display the results in a way that helps the user to interrupt easily. They are further developed into small sensors (TMP36), which are way more user-friendly and can be used extensively.

The number of fatalities due to this deadly disease was recorded as 3,771,674 and 174,968,088 were affected (As of June 2021) worldwide. These numbers are increasing day by day. As said before, crowded areas have become the most vulnerable to the spread. Because people are not using their masks and getting sanitized properly. Also, social distancing is neglected in many places and overcrowding happens most of the time. Hence to reduce the risk of being vulnerable to this deadly disease and to ensure safe entry into public areas, Baridefendo is introduced to address the mentioned problems.

II. Litreature Survey

The spread of the disease has to be done by breaking the chain of the covid 19 viruses. "Stay home, stay safe" is the most frequent word used, as in [1], it is said that the inclined affected rate of coronavirus has urged people to search for a safe lifestyle to live. Many have accepted the new normal. [2] Prevention and protection plans aimed to reduce the effect of covid-19 by implementing various methods to prevent the transmission of the virus in the workplace and the environment. The mentioned use of masks can reduce the spread of the virus to a greater extent. Adding to it the waste generated has to be disposed of safely so that our environment will not be affected. Notably, necessary measures have to be taken so that one can stay safe, by [3] washing hands and social distancing have prevented the spread of the disease more prominently. The report claimed that in a group of 341 individuals, only 61 percent of them are aware of social distancing and frequent hand washing. Many are not following the rules laid by the government. Hence necessary steps have to be taken to safeguard the people.

IoT-based safety monitoring systems have become quite common due to their reliability and low-cost nature. Subsystems that determine the temperature without any contact rely on an infrared sensor or thermal camera using Arduino Uno as the microcontroller, while computer vision techniques are used for mask detection and social distancing checks. These checks are performed by leveraging on camera-equipped Raspberry Pi [4]. The data for planning, monitoring on a real time basis and auditing is obtained from the server. Here the standard operating procedure (SOP) compliance system alerts the people entering and the managers in case of any violence. such as counts the number of people entering and leaving a particular place, crossing the limit, if social distancing is not maintained, or if the temperature is more than expected [5].

COVID-19 continues to spread and now has affected more than 200 countries across the globe. Wearing masks has become a day-to-day practice which has been introduced to the people moving out for their work. The people are asked to wear a face mask wherever they go and whenever

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they interact with other people. [6] According to a recent report, even the most effective commercial facial recognition algorithms have been tested and are found that the error rates range between 5% to 50% as in [7] in matching the photos of a person digitally with and without a mask [8]. And detecting fake masking like covering with hands etc. becomes a difficult task.

The hand is one of the main media which spreads the virus to a great extent. Therefore, washing the hand regularly decreases the spread of this disease as in [9]. Hence to ensure safe and conservative sanitization, an automatic hand sanitizer was introduced. It was integrated with a mechanism such that sanitizing liquid comes out without pressing any nozzle using an ultrasonic sensor as in [10]. This module can control the spread of the virus to a great extent. Improper wearing of a mask is ineffective. Thus, a model based on face-mask wearing conditions is established using image super resolution and classification networks (SRCNet). The proposed algorithm contains four main steps: Image pre-processing, facial detection and cropping, image super-resolution, and facemask-wearing condition identification [14].

III. PROPOSED SYSTEM

As the famous saying goes, "Prevention is better than cause". The spread of the vibrant virus has to be prevented before it affects a large number of people. As mentioned in section I, Our Baridefendo is designed in a way that automates the detection process. All these steps were manually processed earlier. So, human errors were quite common, and even the person who is responsible for this process can get affected by contact with the public. But our proposed system ensures that the spread of disease in public is restricted to a greater extent. Our Baridefendo consists of four modules. The four modules are the population density module, temperature detection module, mask detection, and hand sanitizer module. The modules are explained in detail in further sub-sections. Figure 1 depicts the 3D designing of the system. The picture shows the entrance and exit of the place, where people are standing in a queue to get access to entry. The work flow of the system with all the four modules and its conditions is depicted in figure 2.

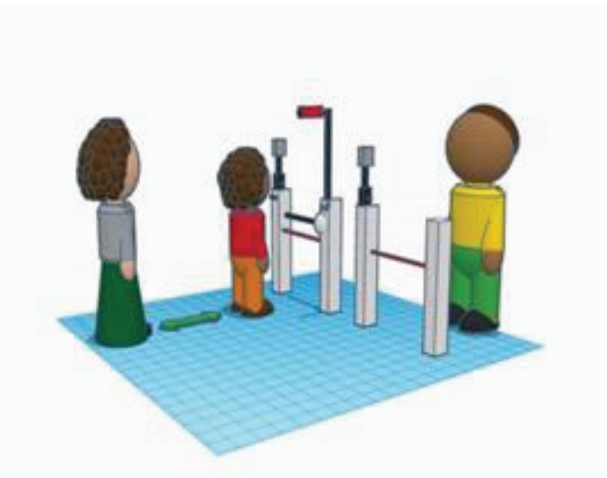

Fig. 1. 3D Diagram of the System

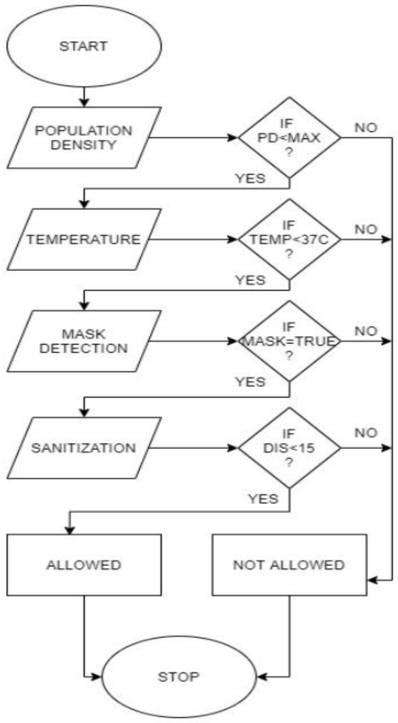

Fig. 1. Workflow of the System

IV. LITREATURE SURVEY

A. *Population Density Module*

This module determines the count of people inside a particular place. Here laser light and a light dependent resistor (LDR) is used in combo to determine the movement of people who are entering in and moving out. Intensity of light is inversely proportional to the resistance of the light-dependent resistor. Hence the circuit starts to conduct when the light is low. Our model consists of two sets of laser light and a light-dependent resistor (LDR). One set is placed at the entry gate and another set is placed at the exit gate. As the people pass by, the light on the LDR interferes. Hence when the output of LDR kept at the entry gate is low the count is increased. Similarly, when the output of LDR kept at the exit gate is low the count is decreased. The maximum count of people who can stay is customizable. Once the threshold is reached, the motor is not turned ON which denotes the gate will remain closed.

B. *Temperature Detection Module*

As the second step, the flow comes to the temperature detection module. The circuit diagram using TMP36 sensor and servo motor for temperature checking and sanitizer module is shown in figure 3. Temperature detection plays a crucial role in the system as temperature checking becomes the major factor to know whether the person has abnormalities or not. In our proposed system, the TMP36 sensor is used to detect the temperature of the person. If a person places his/her hand near the sensor, the sensor will automatically measure the temperature of the person. The threshold temperature has been fixed as 97.9 F since it's the normal body temperature of a human. If the sensor detects a temperature which exceeds the threshold temperature, then the flow will be interrupted and the person won't be allowed inside. Since the person was found with abnormalities, the system won't check for further conditions i.e., mask detection and sanitisation. So, the barricade remains closed.

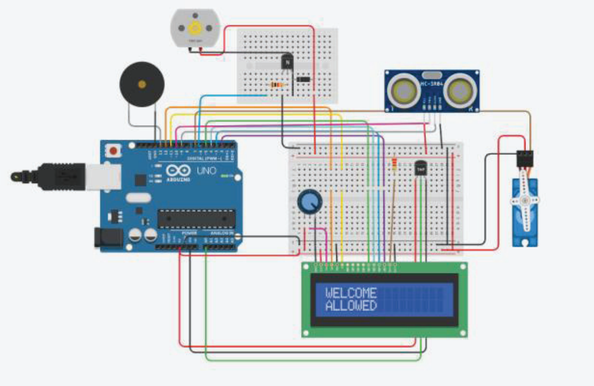

Fig. 3. Circuit design for temperature detection and sanitizer module

C. Face Mask Detection Module

The face mask recognition system is developed with a Machine learning algorithm through the MobileNetV2 - image classification method. This is a method based on CNN (Convolutional Neural Networks) developed by Google which provides a very efficient mobile-oriented model that can be used as a base for many visual recognition tasks with improved performance and enhancement to be more efficient. These steps are used to construct the model.

1) Collecting the Data: The development of the Face Mask Detection model begins with collecting the data. The collected dataset contains the images which contain nine mask variants that include differences in shape, colour and nose coverage. Then the collected dataset is labelled into two groups; with and without a mask.

2) Pre-processing: This process involves four steps to be done. They are Resizing image size, Converting the image to an array, Pre-processing input using MobileNetV2, and Encoding on labels.

3) Splitting the data: In this process, the data is split into two batches, “Training Data” (75 %), and “Testing Data” (25 %). Each batch consists of images with-mask and without-mask.

4) Building the model: This process involves six steps. They are Constructing the training image generator for augmentation, the Base model with MobileNetV2, Summing-up the model parameters, Compiling the model, Training the model, and saving the model for the future projection process.

5) Evaluating the model: Making predictions on the testing set and running the model with 20 iterations followed by assessment of the loss and accuracy.

6) Implementing the model: To change the default, adjust the template as follows.

7) For papers with less than six authors: The face detection algorithm works based on the video uploaded. The face is detected first after that re-processing will be carried out including resizing the image, converting it to the array, pre-processing input using MobileNetV2.

Then the classifier predicts input data from the saved model. Besides, the video frame will also be labelled, whether the person is wearing a mask or not, along with the predicted percentage. Our model predicts the with mask (1), without mask (2), Fake masking (like covering face with hands (3), wearing mask below the nose (4), etc.) as shown in figure 4.

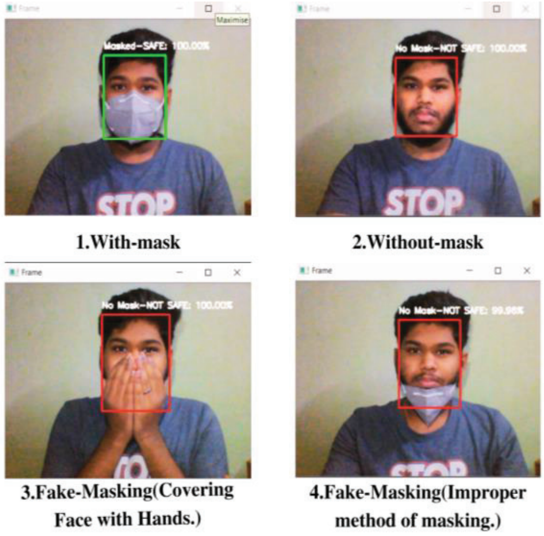

Fig.4. Sample outputs obtained from the Classifier

D. Hand Sanitizer Module

The ultrasonic sensor is used to detect the hand. The transmitter and the receiver of the ultrasonic sensor are connected to the Arduino and the servo motor respectively. The expected result is that if the distance between the hand and the ultrasonic sensor is less than 10cm, the servo motor gets turned on and if the distance between the hand and ultrasonic sensor is more than 10cm, the servo motor remains off. This circuit is externally connected to the servo motor which controls the opening of the barricade. So, when a person satisfies the above conditions (population density, Temperature check, face mask check) he/she gets automatically sanitized and finally, the barricade gets opened. But this sanitization circuit gets enabled only after the temperature check. If the person’s temperature exceeds 97.9F, that person will not be sanitized and the barricade remains closed.

V. RESULTS AND DISCUSSION

The proposed system consists of four modules. The proposed system consists of four modules, namely; population density module, temperature detection module, sanitizer module which are processed using Arduino UNO with Arduino IDE software. The list of hardware components used in the Arduino has been mentioned in table 1 along with the pins allotted. Mask detection module is processed using Keras, Tensorflow, MobileNet, and OpenCV with the help of Raspberry Pi V2 camera.

TABLE I. LIST OF COMPONENTS USED IN ARDUINO

Components Used	Pins
LDR	D0, D1, GND
TMP36	A0, GND, 5V
Ultrasonic Sensor	D9, D10, 5V, GND
DC Motor	5V, GND
Servo Motor	D7, GND, 5V
LCD Display 16X2	D12, D11, D5, D4, D3, D2, GND, 5V

People count is displayed on the LCD. Once the count reaches the threshold number, the motor will not turn on. We can prevent overcrowding by limiting the number of entries. Thus, the spread of the coronavirus can be controlled to an extent. Figure 5 depicts the graphical representation of people count tracked in a place where the maximum count was restricted to 50.

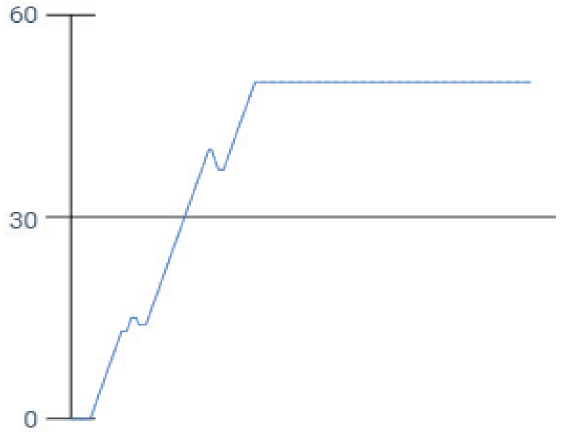

Fig. 5. Count of the people (threshold count = 50)

In the case where the maximum number of people is not attained, the temperature is checked. If the temperature is less than 97 F, the flow moves to the next condition. Else, the person is prohibited from entry.

Figure 6 represents the graphical representation of temperature check where the y- axis represents the temperature in Fahrenheit and x- axis represents the time.

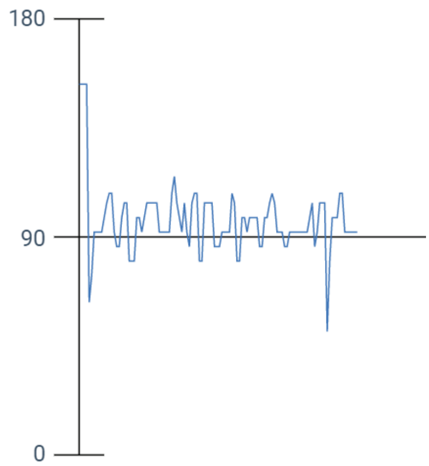

Fig. 6. Temperature check for different values

The face mask detector didn't use any modified masked and unmasked images dataset. The model is accurate, and since the MobileNetV2 architecture is used, it's also computationally efficient and thus making it easier to deploy the model to embedded systems (Raspberry Pi, Nano Pi, etc). The accuracy and training of the system is depicted in the figure 7.

The result for 20 iterations in evaluating the loss and accuracy when training the model is shown in Table2.

EPOCH	LOSS	ACCURACY	VAL_LOSS	VAL_ACCURACY
1/20	0.4092	0.8426	0.1551	0.9765
2/20	0.1478	0.9611	0.0962	0.9791
3/20	0.1086	0.9693	0.0632	0.9856
4/20	0.0784	0.9795	0.0532	0.9883
5/20	0.0636	0.9818	0.0460	0.9896
6/20	0.0550	0.9828	0.0405	0.9869
7/20	0.0564	0.9838	0.0392	0.9883
8/20	0.0520	0.9858	0.0387	0.9909
9/20	0.0471	0.9855	0.0349	0.9935
10/20	0.0440	0.9875	0.0328	0.9922
11/20	0.0411	0.9898	0.0322	0.9935
12/20	0.0444	0.9871	0.0312	0.9961
13/20	0.0361	0.9888	0.0295	0.9948
14/20	0.0310	0.9924	0.0287	0.9961
15/20	0.0281	0.9924	0.0287	0.9948
16/20	0.0289	0.9908	0.0289	0.9948
17/20	0.0305	0.9898	0.0295	0.9948
18/20	0.0275	0.9911	0.0253	0.9961
19/20	0.0333	0.9901	0.0288	0.9948
20/20	0.0257	0.9921	0.0360	0.9896

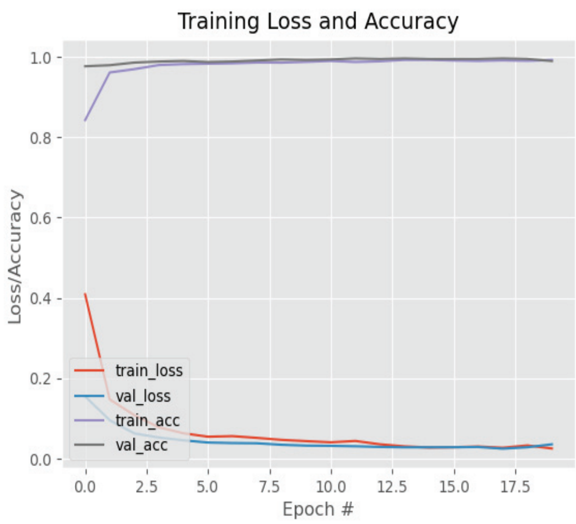

Fig.7. It is seen that Accuracy is increasing from the start and loss is decreasing. Accuracy is pretty good in our model (Accuracy > loss)

VI. CONCLUSION

In conclusion, a safety system with an open CV camera, temperature sensor, Ultrasonic sensor, and LDR were successfully developed. Moreover, the remote feature of the additional mask vending machine supports the system, and also the people who have forgotten their masks can benefit from this. The system is efficient enough to carry out the monitoring procedures for different categories of people since it is trained with a wide data set. The proposed solution generates accurate results under certain performance limitations. The results rely on both hardware and software, which is a definite and desirable advantage for such systems. Future work plans to conduct demonstrations with various deep learning and computer vision frameworks along with integrated LiDAR for object detection and to maintain the count of the people using Raspberry Pi to achieve a higher framerate.

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