FACE MASK DETECTION USING ARTIFICIAL INTELLIGENCE TO OPERATE AUTOMATIC DOOR

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Abstract— After the new Coronavirus disease (COVID-19) case spread rapidly in Wuhan-China in December 2019, the World Health Organization (WHO) confirmed that this is a dangerous virus that can be spread from one human to another through droplets and airborne particles. The COVID-19 pandemic is one of the most pressing issues of recent times. Despite an ever-increasing pool of scientific evidence pointing to the effectiveness of the simple act of wearing face masks in greatly reducing the number of cases. Therefore, we have come up with a project that we are building is face mask detection using AI. The system is designed to detect the faces and to determine whether the person is wearing a face mask or not.

Keywords— Facemask, Artificial Intelligence, Arduino, COVID-19.

I. INTRODUCTION

The method of wearing masks could be beneficial, in reducing COVID-19 transmission in low-income countries where the supply of vaccines is limited. Countries such as Bangladesh, people are not used to wearing masks, thus it becomes difficult for them to make a habit. On the other hand, even if measures are taken such as staff monitoring the people entering, there are higher chances of spreading Covid in this situation as social distancing is not being maintained and if the mask is not worn. So, in order to create a safer environment for all of us, something must be done to encourage the habit of wearing masks among the general public.

Our main motive is not to punish people by denying them service for not wearing a mask. Instead, it is there to nudge them in the right direction and help them get into the habit of wearing masks. Too often hear of employees being harassed by angry customers when requesting them to wear masks - having an automated system can help prevent that. An automatic system can eliminate the human involvement in overseeing the mask wearing process. With enough of these systems active in public places, the "inconvenience" might be more effective at making people wear masks than simple passive "Wear Masks" signs. Therefore, we have come up with a system for crowded places such as malls, using artificial intelligence, and using an android phone which will contain the face detection app, the system will be able detect whether a person is wearing a mask or not. If a person is not wearing a mask, then entry to such places will be denied, and a message will be displayed with the help of an LCD screen, the user will be able to see why he is not being granted access and if they are granted access then signal will be sent to the automatic door to open. These parts will be managed by the microcontroller which in our project will be the Arduino-Nano.

The reason for choosing Android phones over dedicated controllers such as a Raspberry Pi is as follows: every year, an astounding number of devices are sent to landfills due to being considered outdated. Our project requires only a very basic device with a working camera. Thus, we can draw from this plentiful source and give these devices a new lease on life - a cost effective and eco-friendly solution.

II. HARDWARE COMPONENTS

Arduino Nano: Arduino Nano is one type of microcontroller board, and it is designed by Arduino.cc. It can be built with a microcontroller like Atmega328. This microcontroller is also used in Arduino UNO. It is a small size board and also flexible with a wide variety of applications. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. It has 8 analog I/O Pins and 22 digital input/output pins

Figure 1: Arduino Nano

IR SENSOR: An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. There are two types of infrared sensors: active and passive. Active infrared sensors both emit and detect infrared radiation. Active IR sensors act as **proximity sensors**, and they are commonly used in obstacle detection systems. For our project, we will be using the active IR sensor [1].

Figure 2: IR sensor

LED: They are semiconductor devices that emit visible or infrared light when current follows through them. In our project, for demo purposes we will be using this replacement of an automated door.

Figure 3: LEDs

LCD: It is an electronic device that is used to display data and messages. There are different types of displays available in the market with different combinations such as 8×2, 8×1, 16×1, and 10×2. However, we will be using LCD 16×2 and as the name suggests, it includes 16 Columns & 2 Rows. The LCD 16×2 is broadly used in devices, DIY circuits, electronic projects due to less cost, programmable friendly & simple to access [2].

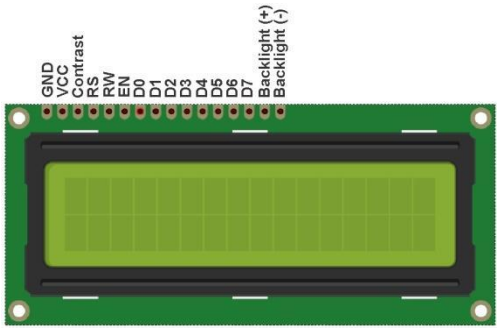

Figure 4: LCD display (16x2)

III.MOBILE APPLICATION

The mobile application is used for capturing the images of any person entering the building and detects whether the person is wearing a mask or not. This is achieved by connecting our mobile app with our AI model.

A. Creating App using android studio

The mobile app was built on android studio. It is a free platform which is used to develop mobile applications specifically for android phones. The software can be installed in any operating system.

Figure 5: Android Studio software

B. Front End

Our design for the frontend consists of mainly 3 buttons and an image receiver which views the image captured by the app.

The “Cam->Rear” button which gives the user a choice to switch between the front or rear camera.

The “Activate Arduino” button allows the user to connect the App with the Arduino. The phone will be connected with the Arduino using the USB cable.

The last button , “Detect” is an optional button in case the app fails to trigger automatically thus the user can manually capture an image of a person to check whether they are wear a mask or not.

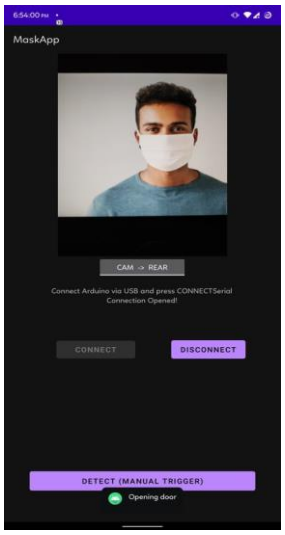

Figure 6: Frontend of the mobile app

C. *Back End*

Here we have interfaced our AI model with the App which was done in the android studio platform.

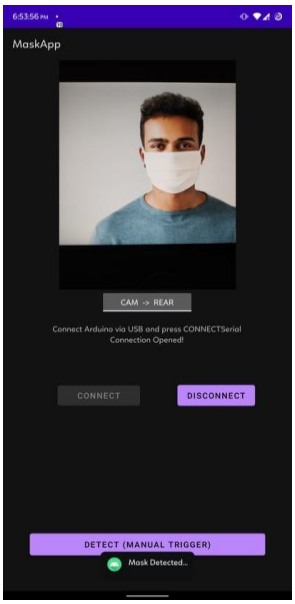

Figure 7: Output of the mobile App

D. *AI Model*

For creating the AI model we used Google's Teachable Machine, which is a user-friendly web application used to train various types of AI. All the user has to do is give it data for the different classes the AI has to recognize, tweak training settings if desired, and click "Train". The model will be trained and ready to test in only a few minutes, on Google's powerful cloud computing hardware.

In our case we used two sets of images - one of masked individuals and the other without. The masked dataset uses photos of individuals that have been edited to include a simulated white face mask on them (dataset courtesy of GitHub user @prajnasb). In spite of this, we have observed good performance in detecting a myriad of face masks in a variety of conditions.

The trained model was exported in the Tensor Flow-Lite format for its lightweight computing hardware requirements and ease of integration with our android app.

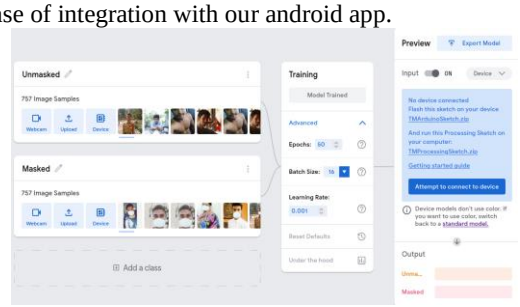

Figure 8: Teachable Machine UI

Figure 9 is the accuracy graph of our AI model. The highest accuracy that can be achieved is 1 so as we can see our AI model's accuracy is very high with the given dataset. We can assume that its prediction will be accurate most of the time.

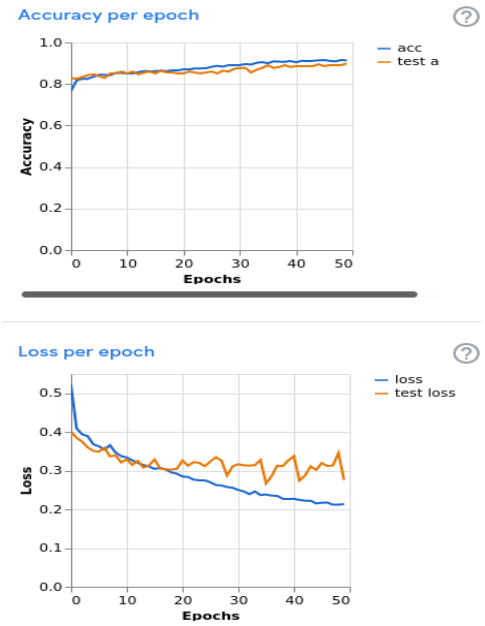

Figure 9: Training statistics from Teachable

Figure 10 is an overview of accuracy for each dataset type. Two datasets were fed into our model, Masked and unmasked. Both of the classes show a high accuracy rate for 114 samples taken from the dataset.

Accuracy per class

CLASS	ACCURACY	# SAMPLES
Unmasked	0.82	114
Masked	0.97	114

Figure 10: Accuracy Result for each dataset

III. PROPOSED SYSTEM METHODOLOGY

The Arduino Nano will be connected with an IR sensor which will detect any person entering the place. The Arduino will also be connected with the automated door. If the IR sensor detects any person then it sends a low signal to the Arduino and the Arduino in return triggers the mobile app using the USB cable.

The mobile app gets activated and captures the image of the incoming person. Using the AI model it checks whether that person is wearing a mask or not. If it is detected that the person is not wearing a mask, then the app sends a signal to the Arduino and the Arduino turns on the red LED and displays a message for that person to see that entry is not granted. The LCD will display a message to take a mask from a mask dispenser set up beside the doorway. In other cases if a person is wearing a mask then the Arduino receives the signal from the app and signals the automated door to open along with the Green LED to turn on.

However, for this process the system can detect each person at a time and the app will also capture each image of a single person.

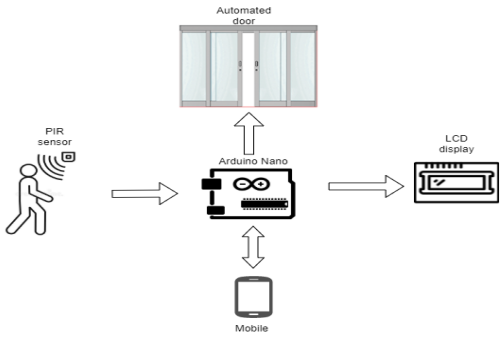

Figure 11: Block Diagram of the proposed system

A. FLOWCHART DIAGRAM

In the system analysis, the first part is the hardware phase in which the AI model gets trained and the app is being created. In addition, the AI model is connected with the app and it is tested for different real time images. In the hardware phase, the app is connected with the Arduino by the USB and based on the software result the door is opened and closed.

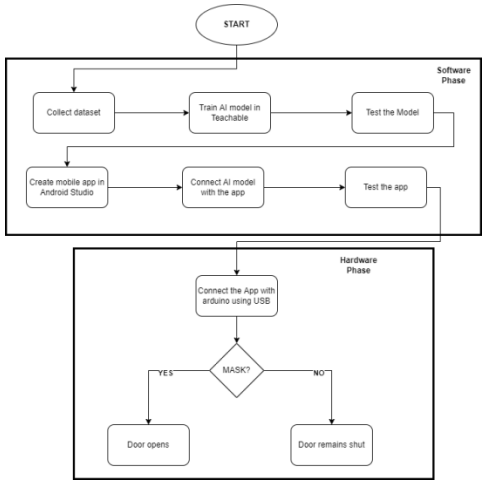

Figure 12: Flowchart of proposed system

B. SCHEMATIC CIRCUIT VIEW

In the schematics, all the hardware components were connected with each other just like in the Figure-13. The PIR motion sensor is connected with the Arduino Nano microcontroller along with LCD display (16x2) and LEDs. With the help of the dedicated 5V pins of the Arduino-Nano microcontroller board, we can provide 5V to all the sensors and modules.

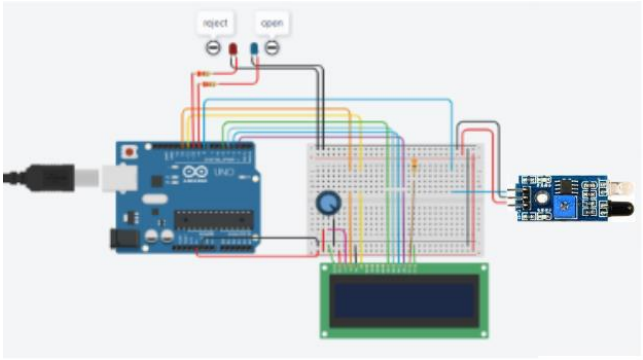

Figure 13: Schematic circuit diagram

After creating the circuit design, it was tested for accuracy in an online simulation, Tinker cad.

Tinker cad is a free-of-charge, online 3D modeling program that runs in a web browser and is used by millions of people.

IV. RESULT ANALYSIS AND DISCUSSION

We have built up prototype using the Figure-13 as a sample and all the connections were made accordingly. However, due to time constraints we were not able to implement an automatic door therefore, LEDs have been used in replacement of the automatic door. Figure-14 is the prototype that was built upon the schematic circuit.

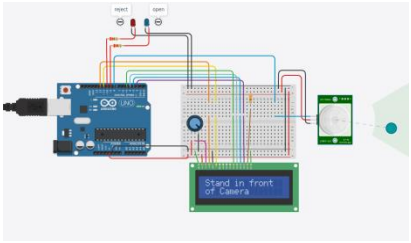

Figure 14: Proposed system Prototype

After building the prototype, it was later tested using real time images as shown below for the following two scenarios.

A. When a person is not wearing a mask

As we can see, after the IR sensor is triggered the AI detects that the person is not wearing a mask thus Arduino signals the red LED to turn on and the servo remains as it is. Below is the output of the system in the Figure-15.

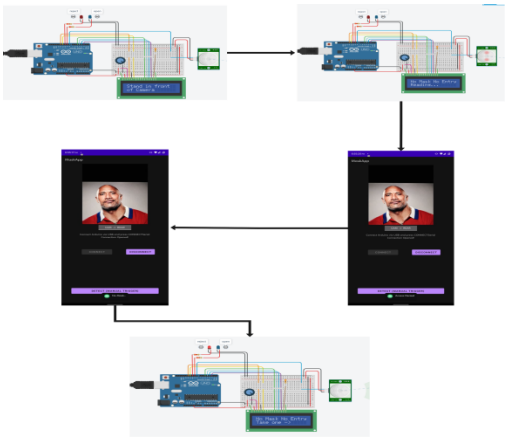

Figure 25: Output flow diagram of the system

B. When the person is wearing a mask.

Similarly, after the IR sensor gets triggered by the presence of a person, the AI detects that person is wearing the mask therefore, Arduino signals the servo to open along with it the green LED is turned on just as shown in the Figure-16.

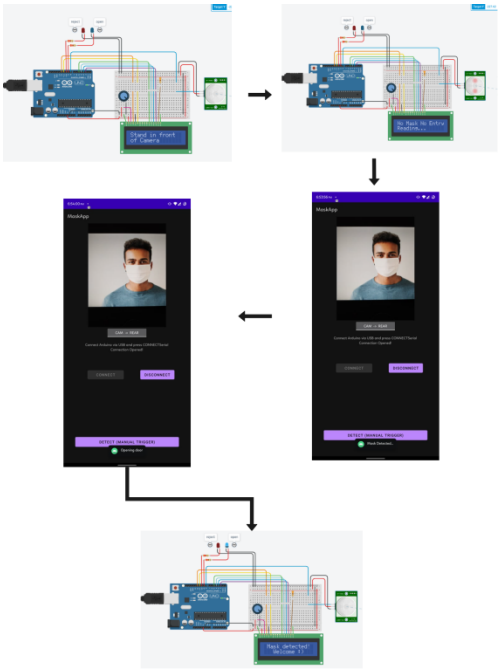

Figure 36: Output flow diagram for the system

V. DRAWBACKS

The AI model we trained for this prototype is fairly rudimentary. A small dataset was used in training to save time, so the resulting AI can only handle a limited number of situations (face angle, illumination, mask types etc.).

Since we are aiming to reuse and recycle old android devices, these devices must be responsibly sourced so that we do not contribute to the e-waste problem - only devices that cannot be used for regular every day, or economically repaired to restore general functionality, should be used to create our system. Finding such devices may prove to be a challenge as phones that are too old may not be able to handle running the system day.

VI. FUTURE SCOPE

When deploying in the real world, more thorough training of the AI model will be required to ensure robust performance in the varied conditions it will encounter such as dim lighting, face coverings such as veils, people facing away or moving their face quickly etc.

VII. CONCLUSION

The aim of our project is to ensure a safe environment for all by promoting and enforcing the use of face masks in public spaces. With enough of these systems in service in malls, train stations, clinics and other crowded public utilities, we can help create the habit of mask-wearing among the masses by reminding them in a more active manner than with mere passive suggestion.

VIII. REFERENCES

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