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Automatic Temperature Detection and Sanitization with Authorized Entry using Face Mask Detection

Rukia Rahman

Department of Electronics & Instrumentation Technology, University of Kashmir, Srinagar, India

E-mail: rukiarahman57@gmail.com

Abstract

To contain the chain of Covid-19, taking on the role of Engineering Ambassador of humanity in these dire conditions, this paper develops an electronic equipment referred holistically as "Covid Tunnel" or "Disinfectant Tunnel". The general thesis from which the whole work has evolved is to make use of temperature control and automation by programming to try to pin the potential host of virus in possible hotspots viz., hospitals, administrative complexes, strategic junctions, etc. The first and foremost import of this benevolent project is the application of Automatic Temperature Control. Arduino Nano Temperature Control is employed for checking the temperature of each entrant at the entrance gate. For instance, if a person entering happens to have a body temperature above 38°C, the buzzer goes on indicating a red flag for the entry.

The second and equally important process is filtering based on the face mask. Now, a webcam attached right after, which is program-based on Python, Open CV, Tensor Flow etc. provides the necessary input and the program searches for the face mask. If the entrant is unmasked, a voice in Urdu commands for wearing of the face mask. While a masked person enters, the automated sanitizer pops out for sanitizing as a precautionary measure. The sanitizer itself is automated by a DC motor which in turn is driven by MOSFET integrated circuit. Thusly, this paper tries to kick in with the Electronics and Information Technology and helps arrest the spread of the virus in the community, anticipating a Coronavirus-free world.

Keywords: Automation, arduino nano, convolution neural networks, COVID-19, temperature measurement, face mask detection & auto sanitization

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1. Introduction

To begin with, Covid-19 being the backdrop of this project is a phenomenon only in the context of disruptions it has brought on. Coronavirus is the newest pandemic that strikes human fitness. In early 2020, the overboard transmission of Coronavirus has compelled the medical organization to announce the Coronavirus a planetary epidemic. Greater than 16.6 crores were contaminated by Covid-19 to date in nearly 200 countries.

Pandemics are not new to human history, in actuality; they are as old as the human race itself. However, pandemics occurring have a scale of sorts. The Covid-19 pandemic has been compared with the Spanish pandemic in the early 1900s. The Spanish pandemic was similarly as disastrous as the 2019-emerged pandemic [1].

Covid-19 was reported to have originated in the Wuhan city of the Peoples Republic of China in November 2019, spread reportedly from the Bats for a clear record. Covid-19 as pandemic nomenclature has been derived from pandemical virus which is named Coronavirus while 2019 being the year of emergence – a virus that affects rather throws the respiratory system of humans out of its order. Its impact continues even while writing this miniature Covid-19 overview. Covid-19's overall impact is too great to be told, and humans are still wary of its hoary clutches. That being admitted, there have been millions of deaths worldwide with the United States of America, Italy, Spain & India, feeling the maximum brunt.

The positive cases rise as of date & are numbering in millions as well. However, medical science is now up in arms against the virus as several nations have come up with a vaccine. The human as well as financial losses have dampened the collective spirit of humans. The financial impacts have been equally ill with the labor force & other allied sectors suffering the most.

1.1 Technological Advancement -Pretesting COVID-19

Technocrats as moral & responsible citizens have also had the view of Covid-19 world firsthand, & therefore the thought of innovating with Electronics & Computer Science Engineering to suppress the chain of the virus. There can be no big motivation in the field of Electronics & Computer Science Engineering to improvise & advance the electronic tools, however the Covid-19 provided an all-time bigger opportunity to kick-in with the advancement in the changing overall landscape of the world [2, 3].

2. Materials and Methods

A general idea to try & contain the virus chain by employing some electro-sensors has been proposed. This paper materializes a sort of combination of different electronic and program-based equipment affixed on the entry of doors at potential hotbeds working hand-in-glove with each other which pins the susceptible host of virus. The synopsis is based on placing equipment named "Covid Tunnel" at the possible hotbeds of the Coronavirus. Consequently, is successful in designing & developing the 'Covid Tunnel' which when placed at the entrance of any premise would buzz up to the person having body temperatures above 38°C, & also picks up the unmasked person.

2.1 Step 1: Temperature Measurement using Arduino Nano

2.1.1 Block diagram of Temperature Measurement

Figure 1 is the block diagram which depicts all the allied equipment involved in the system. Firstly, the MLX 90614 temperature sensor reads data from the target body object (Nicholas Wei-Jie Goh, 2021 [4]). Following the temperature reading, the data is routed to Arduino for further system evaluation and finally, the result is displayed on an OLED display. In this block diagram, the object is detected by the ultrasonic sensor, the output of the ultrasonic sensor is applied to MLX90614 which is a non-contact IR temperature sensor designed on SMBus, and the electric output of MLX90614 is fed to Arduino Nano. In case the temperature of person is higher than normal temperature, the buzzer starts buzzing.

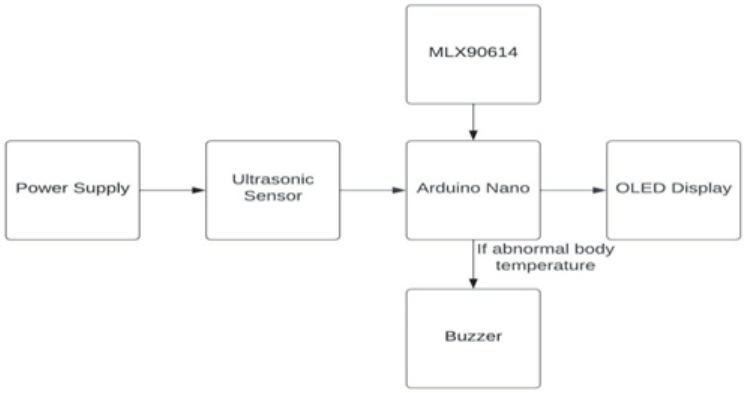

Figure 1. Block Diagram of Temperature Measurement

2.1.2 Methodology of Temperature Measurement

Figure 2 depicts the flowchart of temperature measurement of an object when the object comes in the vicinity of the ultrasonic sensor which in turn is connected to the Arduino

board, and Organic Light-Emitting Diodes (OLED). An ultrasonic sensor measures the distance of the object, and if the distance between the object and the ultrasonic sensor is greater than 25cm, the OLED displays “too close” [3]. If the distance between the object and the ultrasonic sensor is less than 15cm, then the OLED displays “get close”. When an object is within a precise range of 15 to 25 cm, it is detected and reflected by a temperature sensor, i.e., MLX90614, which measures the object’s temperature. If the temperature is normal (36°C), the process is completed; if it is abnormal (greater than 36°C), a buzzer begins to buzz, and the process is repeated. To accurately monitor temperature, MLX90614 requires a threshold voltage of 5.8.

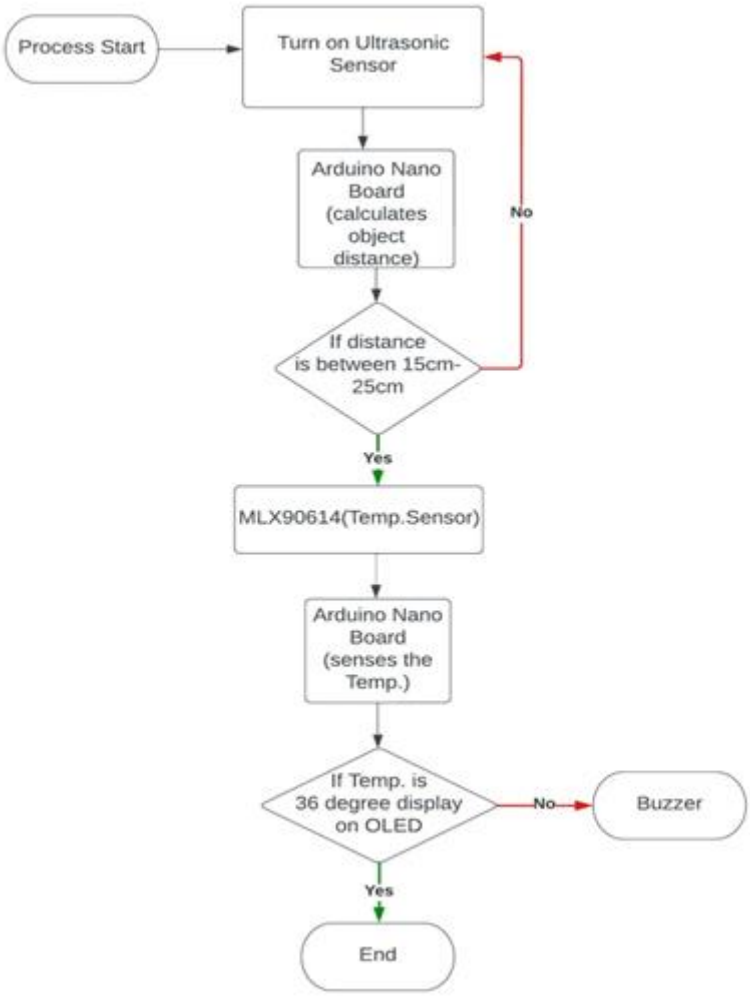

Figure 2. Flowchart of Temperature Measurement

2.1.3 Circuit Diagram of Temperature Measurement

The conventional thermometer is used by way of body contact to measure body temperatures. Contrary to this, MLX90614 is a contactless IR thermometer that does not need contact to assess temperature. Since both the MLX90614 and OLED have SCl and SDA pins

because both are working on i2c, the SDA pin is wired to input PIN 4 of the nano board while the SCL of OLED, and mlx90614 is wired to input PIN 5 of the nano board. Once starter switch is pressed and the target or person is in the reach of an ultrasonic sensor, then MLX90614 scans the degrees and relays on the OLED. A 0.09-inch OLED display is employed in this system. The onsite temperature is supplied directly via "bus line" electronic mode, which considerably enhances the anti-jamming mechanism. Apt onsite temperature assessment in unwholesome surroundings like surroundings regulator, instruments, and electric esculent, require proximity type temperature and measurement. Figure 3 displays the MLX90614 schematics, and also adds an understanding of the general circuit. It is the depiction of a circuit diagram illustrating the circuit design of the system wherein the MLX90614 contactless IR sensor and OLED are bracketed with nano board's analog pin 4 and pin 5. Contactless IR temperature sensor SCL is also bracketed with clock pin and SDA with data pin at the same moment. To an extent, MLX90614 infrared thermometer is a four-pin, SMBus-centered device developed by Melexis company. It flaunts specifications which include low density, broader applications, and pocket friendly.

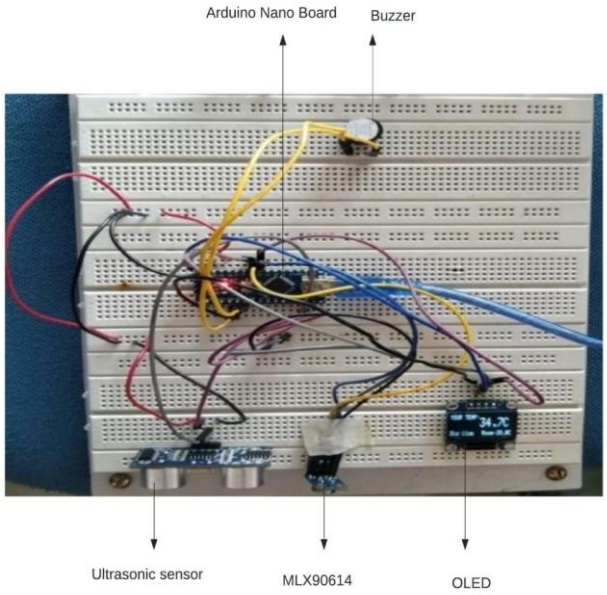

Figure 3. Circuit diagram of temperature measurement at room temperature

2.2 Step 2: Face Mask Detection using Open CV

2.2.1 Introduction

Style of wearing protective masks in open is uprising because of the novel coronavirus throughout the world. In the initial stages of Covid pandemic, the public was accustomed to enduring face masks to safeguard their wellness from environmental pollution.

Researchers tested that wearing face masks prevents Coronavirus transmittance. The public is law-bound to wear face masks. These relevant rules were constituted as an act to counter the aggressive increase in virus and bereavement in several regions. Notwithstanding everything, the activity of control over enormous crowds of the public is becoming increasingly challenging. The control process includes face mask identification in people. Covid-19 virus paved the way for the increase in an incredible degree of global technological collaborations. Machine learning and deep learning, on Artificial Intelligence (AI) can aid to prevent Coronavirus transmission in more methods than one. Artificial intelligence offers Scholars and Medical fraternity to assess large chunks of data to foresee the Covid-19 circulation serving as a beforehand warning system for likely pandemics and save vulnerable populations. Healthcare directly needs provisions to find new technologies such as Neural Networks, Machine Learning, and robotics to help to contain and sometimes anticipate infection. To better understand infection rates and behavior as well as track infections, AI is being used to combat the Coronavirus widespread.

This project makes a magnanimous effort to present a face mask identification design established on computer vision and machine learning. The planned design supports the integration of inspection cameras to arrest the Coronavirus chain passing on, by marking the public who are not wearing protective masks. With Open CV Tensor flow and Keras, the design itself is a combination of machine learning and artificial intelligence methodologies. For quality extraction, deep transfer learning is used in conjunction with three traditional machine learning methods, which are compared to determine the best appropriate algorithms that provide the maximum correctness while requiring the least amount of time in the training and identification processes.

2.2.2 Tools and Technology used in Face Mask Detection System:

Operating System: 64-bit Version of Windows 10.

4GB RAM and a Webcam are included in the hardware.

Programming Tool: Python and OpenCv.

2.2.3 Computer Vision

It is an integrative systematic domain dealing with how the computer can attain top-notch assessments out of digital images and/or visual aids. Considering an engineering perspective, computer vision tries to assess and computerize jobs that the natural specimen

visual system can do. Its functions incorporate procedures for procuring, processing, reviewing, and assessing high-definition pictures and wrenching out of the large span of data from the physical sphere to generate alphanumeric information, for instance, in the form of results. Assessing in this backdrop means the 33 transformations of the visible image into the description of the globe that create an impression of thought procedures and can prompt suitable activity. The image assessment can be meant as the decimation of symbolic information from image data employing designs developed using quantum mechanics, mathematics, and observational learning. Computer vision is a branch of science that studies the fundamental principles of artificial systems that extract data from images.

2.2.4 Tensor Flow

It is open-source free software library that is used in data flow as well as differential programming in a spectrum of applications. It is a typical arithmetic library that is often employed in deep learning applications like artificial intelligence. Tensor Flow contrarily is running on multiple CPUs and GPUs (alongside options of SYCL CUDA modules for overall computation on GPUs). It runs on 64-bit Linux, MAC OS, Microsoft, and Smart Computing systems, which covers highly trading Android and iOS. Its customizable design enables computing to be performed on a wide range of systems (CPUs, GPUs, TPUs) and from the high-end PCs to server clusters to that of edge and portable mobile devices. In the Web input/output mega-seminar held in 2016, Jeff Dean, a computer scientist in Google's AI division stated that 4500 repositories on GitHub (online repository host) traced to Tensor Flow of which 5 pointed toward Google. Unlike libraries like Theano, Tensor Flow was developed and designed for its usage in research projects and production systems not to mention rack brain in web search engine and the entertaining deep dream program. It is able to run on single CPU System GPUs and handheld devices, and highly distributed systems.

2.2.5 Open CV

It is a free and open-source software library for computer vision and machine learning. Assembled under the form of establishing a standard infrastructure for computer vision applications and increasing the use of machine perception in commercial products, there are around 2500 customized techniques, covering a vast range of both ancient and new machine vision and deep learning methods. The techniques may be applied to a variety of tasks including detecting faces, earmarking things, classifying human activities in movies, filtering camera movements, and extracting 3D models of objects among 35 others. Open CV

has over 18 million downloads and has a user community of over 47000 people. Corporations, research organizations, and government agencies equally use the library. Aside from tech behemoths like Google, Intel, Sony, Microsoft, Yahoo, and others, Open CV usage goes from switching street view images together, searching instructions in Israel, assist robotic navigation, detecting swimming pool mishaps in Europe to ring, user interacting art in ultra-metropolitans in New York and Spain, search proofing of remnants, in Turkey runways, and so on. Boasting of C++, MATLAB, and Python interface, it supports Windows, Mac OS, Linux, and Android.

It largely favors real-time vision applications and maximizes SSE and MUX directions whenever they are feasible. A full-blown Open CV and CUDA interfaces are proactively developed at this moment with over 500 algorithms and nearly ten-fold as many tasks which being in seamless compatibility with the algorithms in question. Written in native C++, it also boasts tandem and has a generic approach that works effortlessly with the STL structures. And the top-notch aspect of Open CV is that it has an extensive array of documentation and developer manuals available.

2.2.6 Keras

It is an API, designed and customizable for people unlike robots, and complies with human apt practices which greatly minimize the human cognitive stress borne out of the cognitive tasks. Apart from having sustainable and simplistic APIs, it even lessons the quanta of user actions necessitated for commonplace cases, displaying self-explanatory error messages when such scenario occurs. Keras possesses a sizeable implementation of widely employed neural network construction elements like for instance, targets, algorithms, variety of other utilities, and displaying an image and text-based data working which is far simpler for coding, appropriately for penning artificial neural network code.

2.2.7 Proposed Model

Figure 4 shows the model of face mask detection (Vinitha, 2020 [5]). The proposed methodology focuses on integrating computer vision and deep learning algorithms with the OpenCV, Tensor flow, and Keras library to recognize a person wearing a face mask on an image or video stream. Most of the photos are enhanced using OpenCV. The photographs in the set already have the labels “mask" and "no mask" on them. All the raw input photos undergo the preprocessing methods described below to create clean copies that could be fed to a neural network machine learning model [6].

a) Pre-processing steps:

- Resize the source image (256 x 256).
- Filtering colors (RGB) across the channels (model and MobileNetV2 allow 2D 3-channel images).
- Scaling and normalizing images using the built-in weights of PyTorch's standard mean.
- Cropping the image in the middle and using the 224x224x3 pixel size.
- At long last, transforming them into tensors.

Figure 4. Model of Face Mask Detection

2.2.8 System Design for Face Mask Detection

Recent advancements have made deep neural networks the go-to method for resolving several computer vision issues. A CNN is made up of various parts, including one with a convolutional layer, a pooling layer, and a fully connected layer. It uses the backpropagation method to automatically and fluidly understand the spatial patterns of input. The CNN is extremely parameter-efficient since its kernels are shared across full image locations. These attributes make CNN a potent solution for computer vision issues. CNN is essential for computer vision tasks like pattern recognition because of its low processing cost and capacity to extract spatial information. CNN combines convolutional portions with primary pictures to extract top-level characteristics. The study technique makes use of Deep Learning, OpenCV, TensorFlow, as well as Keras to assist in the detection of faces with masks (Firas Amer, 2022 [7]). Safety is supported by the use of this strategy. The MobileNetV2 and CNN framework are used in the face detection method; it is a lightweight classifier with fewer parameters that can be used in embedded devices like Arduino and Minnow board to identify real masks. The F1 score is 0.95, while the accuracy of the technique is 0.98. By using OpenCV, it is possible

to pre-process images and gain access to the live video stream. Haar-Cascade, a highly effective face detection technique, is also employed for face detection. To identify different facial traits and assess whether a person is wearing a face mask or not, the research makes use of sophisticated learning algorithms. Real-time face mask identification is handled by the system, which also aids in lowering the transmission rate. The system's design is shown in Figure 5 which displays how it operates automatically to prevent Covid-19 spread.

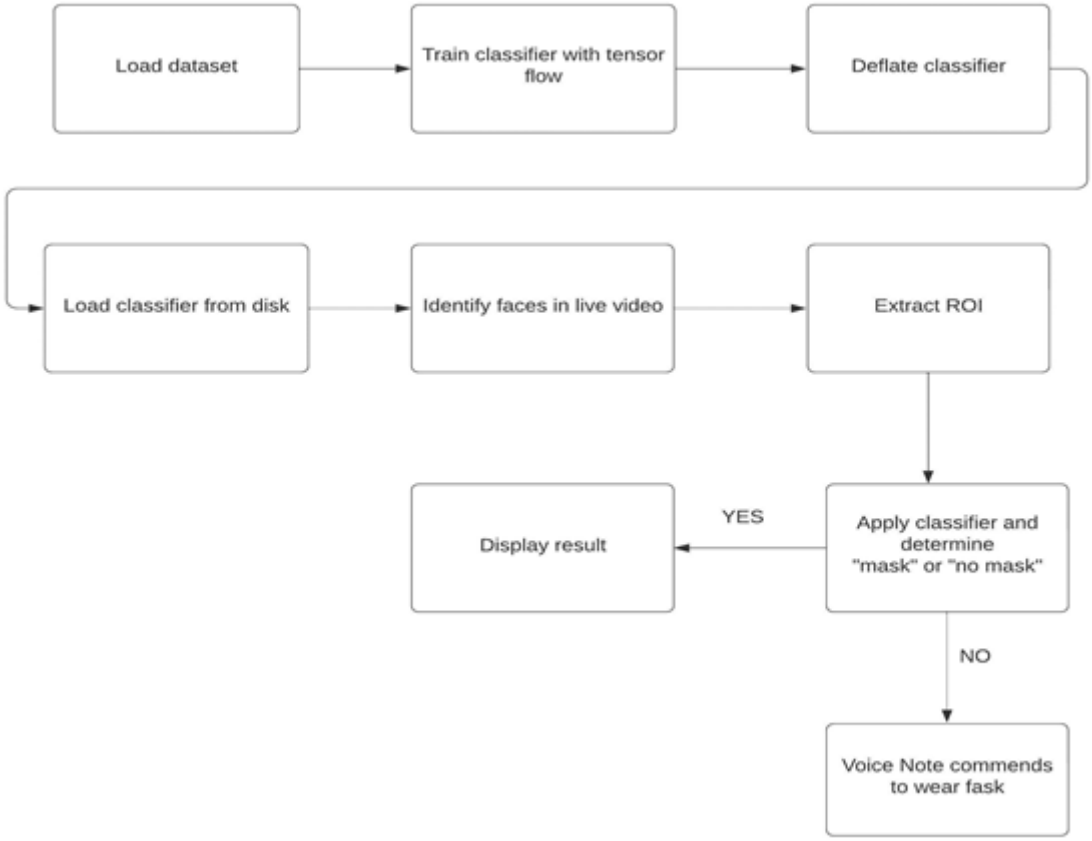

Figure 5. Flow Chart of Face Mask Detection

2.2.9 Webcam

A webcam is a video camera that allows the sequence of data, for example a picture or videotape, via a data network such as the internet. During a video group session with two or more individuals, a webcam can be utilized to record and broadcast livestream. In comparison to most video cameras, webcams have a lower hardness, allowing them to be more affordable, yet the result is adequate for a video chat session.

2.2.10 How face identification works

- Face identification algorithms frequently start by looking for a person's sight.

- Eyes form a valley region and are one of the easiest features to spot.
- Detecting the entire face including the vision, brows, lips, snout, and nostrils.

Once the algorithm has determined that a facial area has been discovered, it can do further assessments to make sure that it has actually identified a face.

2.2.11 Features of Face Mask Detection

- It can find many faces in instantaneous video streaming.
- It makes use of an accumulated array of faces.
- It is powerful and not affected by light.
- High accuracy and very less delay time.
- Cheaper technique of identification.

2.2.12 Results

The results of the code that directly receives input from the webcam is shown below.

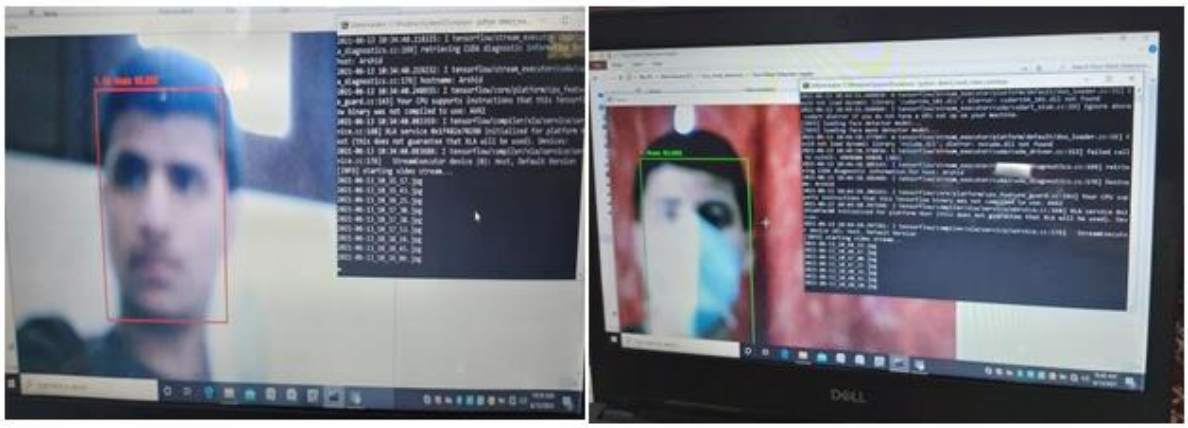

Figure 6. Codes of inputs from webcam

2.3 Step 3: Auto Sanitization Using Arduino Nano

The use of an ultrasonic range sensor can be used to detect and pick barriers (Kunal Singh, 2021 [8]). The Arduino Nano board is compatible with the module. This sensor is positioned at the purification chamber's entrance gate. The pump is controlled by a relay. The electronic circuit is controlled by this relay to automatically control the sanitizer sprinkler pump. People passing through the tunnel structure are automatically sprayed with sanitizer. In

addition, the tunnel must be constructed mechanically. An appropriate tank is also required for holding the sanitizer.

To detect whether a human is present inside the tunnel, an obstacle detector circuit is employed [9]. In the event of human presence inside the tunnel, different nozzles spray sanitizer which is connected to the liquid sprayer pump. As the tunnel gets empty, it halts spraying until the human presence is detected again.

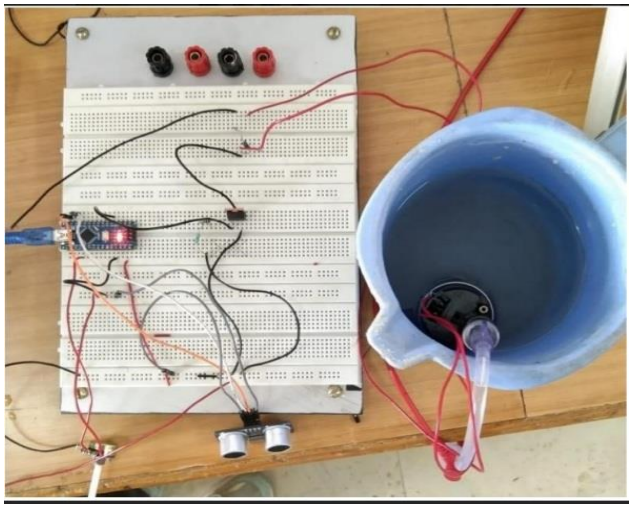

Figure 7. Working Model of Dispensing Sanitizer

3. Conclusion

The pandemic has threatened the existence of life altogether on Earth and thereby urging the administrations to examine the people so that the world would function normally and safely in the presence of the deadly virus. The examinations were done differently: some included only the detection of temperature, some were made for the sole purpose of sanitization, and others were designed to detect the presence of face mask. However, this project is an amalgam of all three projects- body temperature detection, sanitization, and face mask detection. The device introduced for the detection of the temperature is the digital contactless infrared thermometer. The sanitization process is a software-based device circuit and is simulated accordingly that makes the motor to spray. Both the projects run on Arduino Nano boards. For the detection of face mask, the model is trained on an authentic dataset. The project is interfaced in such a way that when a person is detected by the sensor, the process of temperature measurement takes place and the output is given in the form of an audio signal, after which the person proceeds with the detection of the presence of face mask. The output

for the detection of mask is a voice signal. The final part is sanitization which is a precautionary measure.

3.1 Limitations and Future Work

- For specially abled people, future work can be done on displaying the messages through an LCD or LED.
- The developed system can detect the live video streams but does not keep a record. Therefore, data can be stored by incorporating a memory device.
- A GSM module can be used to inform the higher authorities when a person is detected unmasked or is found trespassing.
- Power sources can be replaced with solar panels, so that there is no hindrance in the working of the project.

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Author's biography

Rukia Rahman has completed B.Tech in Electronics and Communication Engineering from MDU Rohtak, Post Graduate Diploma in Instrumentation Technology from University of Kashmir, and M.Sc in Electronics from University of Kashmir. Her research areas include VLSI, Embedded System, AI and Microelectronics.