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Smart Covid-Assist Bot using Image Processing

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***Abstract*— This paper presents the Smart Covid-Assist Bot using Image Processing which is an embedded IoT (Internet of Things) based project consisting of electronic and mechanical components. The Covid-Assist Bot consists of many features and can create a huge impact on the spread of this pandemic. It can monitor and store the temperature details in the database and can also be used to sanitize the entire surface using UVC and disinfectants. All the data from the sensors can be stored and used later. The cost of the bot is very low and has more features when compared with the robots and products available in the market. The accuracy is also high and compactable. The physical structure of the Covid-Assist bot has been drawn using the TinkerCad software. This paper covers the working principle, material and method used, circuit diagram and model structure.**

Keywords*— *Covid-Assist bot, IoT, image processing, sanitizer, pandemic.

I. Introduction

The world has been facing a deadly pandemic in the name of COVID-19 for more than a year. People all over the world are affected by every means due to the lockdown imposed. People find it very difficult to gain the usual confidence in livelihood and safety and are hoping for the eradication of this deadly virus. The government has implemented lockdowns for the people's safety, but various administrative bodies such as private organisations, hospitals and even the government itself are in a demand for workers and employees, in order to provide their day-to-day services. The doctors and health care workers play an indispensable role in saving lives and their services couldn't be paused in this period. The pandemic has been so devastating not only to the least developed countries; we are also made aware of the effects in the US, which is considered to be the most advanced country in the world. Countries like India have to struggle a bit more due to its population and must have effective measures in handling this situation. The usage of masks, sanitizers, gloves are all made mandatory in order to avoid the spread of the virus and the people are asked to maintain social distancing, since the COVID-19 spreads mostly through direct contact [1]. Even if proper awareness is spread across the vast majority, their responsibility is what matters. The people must be responsible for their activities and shall not be responsible for the spreading of the virus. The companies, factories etc., have the responsibility for the safety of their employees and hence have employed their security staff to check for their masks and sanitise them. It is good but humans are always error-prone and they in turn have to take care of their health. A health concerned staff will be more cautious in his/her health and may not work properly. So, a virtual assistant or a bot which takes care of all the above work including face mask detection, temperature monitoring, and providing sanitizers will be an effective solution. If it could also authenticate and log the users into a database, the bot will be helpful not only during the pandemic but also for all occasions. Many schools, colleges, factories, companies, and workspaces can be effectively maintained and monitored using an effective assistant. In this work, we have proposed such a bot which works on a raspberry pi controller and uses a camera to detect facemasks and thermometers for checking temperatures. A sanitizer is also attached to the bot and it can move across spaces in order to sanitise an entire room or a desired area like a carpet, a table etc. The college students, company employees etc., will always carry an ID card with them and hence authentication using a barcode present in their IDs is very simple and makes the optimal use of the existing structure present. It doesn't need any additional sensors or special tags and will surely be a quick implementation. This bot will surely suit the needs of various institutions and organizations and can make the day-to-day activities much easier and make people spend their time more productively.

II. Material and Method

The Proposed idea is to develop a covid-assist bot, which is helpful in many applications and could also help to measure body temperature (contactless body temperature) and detect the people whether they are wearing the mask or not. In the centre of the bot, an automatic touchless hand sanitizer dispenser is given. The camera module present on the top is used to scan the barcode of the user and log the authentication in a database. It can help to store the temperature and time of attendance in the respective person's column and that data can be used for future contact tracking and health monitoring. In this bot, Raspberry pi is used for processing and controlling all the sensors and modules. A pi camera module is used to capture the image of people's faces and objects. An ultrasonic sensor is used to detect the object and it is connected to the servo motor. If the ultrasonic sensor detects the object, the servo motor is made to move from upper to lower direction (90 degrees to 180 degrees).

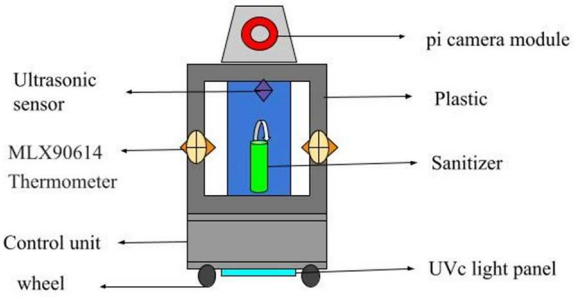

Fig. 1 Proposed Model for Covid-Assist bot

The MLX90614 infrared thermometer sensor is used to measure the temperature without direct contact with the

person. UVC light is used to sanitize the surface. All the parts of the bot are made using plastic, cardboard and aluminium to reduce the weight of the entire system. The wheels are powered using a DC motor, which controls the movement and direction of the bot.

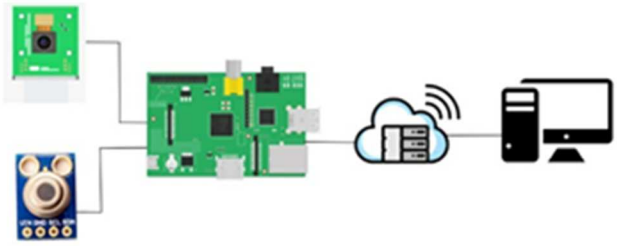

Fig. 2 Basic Architecture for Covid-Assist bot

Materials and software used in this system are Raspberry Pi, Pi camera, Ultrasonic sensor, MLX90614 infrared thermometer, DC motor, Servo motor, OpenCV, Blynk app and ThingSpeak. The Raspberry Pi 3 model B+ is a low cost, credit-card sized computer that also plugs into a display. The model 3B+ is a more powerful processor, 10x faster than the first-generation Raspberry Pi and 40 times faster than an Arduino. It has a 1.4 GHz 64-bit Quad-Core Cortex A53 (ARMv8) CPU, 802.11.b/g/n/ac Wireless LAN, Bluetooth 4.2 (Bluetooth Low Energy) and 1GB RAM. It also supports 4 USB 2.0 ports, a full-size HDMI port and has a 40pin extended GPIO to enhance our "real world" projects. The Raspberry Pi Camera Module v2 is a high quality 8-megapixel Sony IMX219 image sensor custom designed add-on board for the Raspberry Pi, featuring a fixed focus lens. Its dimensions are 25mm x 23mm x 9mm with a weight just over 3g. It is capable of capturing 3280 x 2464px static images, and also supports 1080p30, 720p60 and 640x480p90 video.

The MLX90614 is an infrared thermometer for non-contact temperature measurements. It is a small size, low cost, easy to integrate sensor, factory calibrated in a wide temperature range (-40°C to 125°C for sensor temperature and -70°C to 380°C for object temperature). It has a high accuracy of 0.5°C over a wide temperature range (0 to +50 C for both Ta and To). Ultrasonic sensors measure the distance using ultrasonic waves. The sensor emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic sensors measure the distance of the target by measuring the time between the emission and reception. A servo motor is a rotary or linear actuator that allows precise control of the angular or linear position for specific velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It is mainly used in applications such as robotics, CNC machinery or automated manufacturing. DC Motors converts electrical energy into mechanical energy. Their direction can be easily controlled by changing the supply polarity. The 8W UVC disinfectant tube from Philips has been tested by the NABL government approved labs and is proven to kill up to 99.9% germs. Boston University also claims that the Philips tube can be used to kill COVID-19 germs too.

OpenCV is a popular, open-source library used across various programming languages for image processing in real time. It is powerful and comes with a lot of algorithms and features. It can be used to process pictures, videos and real time content from web cameras or live streams. In this project, OpenCV is used to process the images continuously taken using the camera module. We use the cloud services for storage purposes. We can store all the data from the sensors in the cloud so that it can be made more accessible, manageable and can be visually interpreted easily. It can be an advantage, considering the remote user can access and view the data using any device or pc connected using the internet. ThingSpeak is a platform designed specifically for IoT analytics, that allows us to analyse, visualise and aggregate live data in the cloud. It also provides instant visualisations for the data sent by the sensors to the cloud. ThingSpeak is preferred for this project as it is commonly used for systems involving analytics like prototyping and proof of concept IoT systems. Blynk is another platform that allows you to easily build interfaces to monitor and control your hardware projects from your Android device and iOS. You can create a new project dashboard and can control the hardware through the blynk app.

III. Circuit Diagram and Working

In the design of the prototype, the Raspberry pi camera will capture the images and videos and send the data to the Raspberry pi (interfaced through a USB cable) for analysis. The Bot detects whether the people wear masks or not and if they aren't wearing a mask, the bot will notify the person to wear the mask. After that, the user has to scan the barcode in their IDs and the user details will be shown in the display. Only after the barcode is successfully scanned, the MLX90614 infrared thermometer will be turned on. MLX90614 will measure the person's temperature and after measuring the data, it will be stored in the respective person's column in the database [2]. If the temperature is high, the alert message will be sent to the respective administration. At the centre of the bot, an automatic hand sanitizer dispenser is available which is controlled by a servo motor placed on top of the tap of the dispenser bottle. The person doesn't need to apply any external pressure to the sanitizer bottle tap. He/she is expected only to place their hand in front of the sanitizer dispenser bottle and the ultrasonic sensor will automatically detect the hand movement and it triggers the servo motor. The servo motor moves from upward to downward direction continuously, thus creating a pressure on the tap of the bottle and thus dispensing the sanitizer liquid. If the person takes their hand away from the ultrasonic sensor, the servo motor will be stopped automatically. At the bottom of the bot, the UVC light panel will be placed to sanitize the surface. The bot itself sanitizes the surface with the help of the pi camera module and the ultrasonic sensor. The pi camera detects the object and the ultrasonic sensor measures the distance between the bot and the object. Thus the ultrasonic sensor is used in two modes: 1) To detect the hand for dispensing sanitizer and 2) To compute the distance between the bot and the object during its motion. If the bot starts moving, the position of the ultrasonic sensor will be automatically changed and stops sending the signal to the servo motor. At that time, it is used to measure the distance between the bot and the objects. If the bot is stable, it continues to work as an automatic sanitizer dispenser.

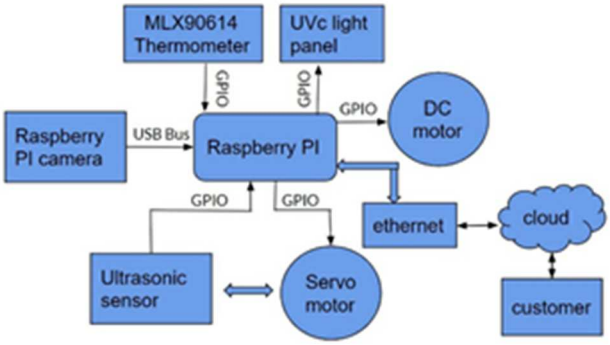

Fig. 3 Hardware Layout Covid-Assist bot

IV. Image Processing

A. Barcode Detector

The Pyzbar library is a python only 1-dimensional barcode and QR reading module [6]. In this project, the barcode in the user's id is first taken using the camera using OpenCV. The image(s) is then scanned using the decode function provided in the pyzbar module from the same library. Then, the barcode is highlighted and the scanned data is obtained Fig (4).

Fig. 4 barcode scanner and detector

B. Face Detection

Computer vision has become an easier and efficient way of monitoring living and non-living things. Its community is constantly growing as it opens a new fun-filled world providing computers to (make them) automatically see things as we see. Here the OpenCV python library and machine learning using TensorFlow have been utilised to detect the faces of users and to identify whether they are wearing masks or not. It also allows every utility to use the pi camera module to satisfy our needs. In order to detect the faces, the HaarCascade is used, which is a feature-based cascade classifier [3] known for its efficiency in detecting objects. HaarCascade is an algorithm used to detect objects and faces using edge and line detection [5]. It uses the haar features Fig (5) to try and differentiate various parts of an image and thus extract a pattern or feature from it. The algorithm has helped to provide open-source ML models, which uses the algorithm and are trained upon lots of labelled data to detect various objects like faces, eyes, upper and lower body, number plate etc. It works similar to a kernel by constantly traversing through the pixels of the image to check for features. Mathematically, it is defined as the difference between the sum of all pixels in the darker area of haar feature to the sum of all pixels in the brighter area of haar feature [4].

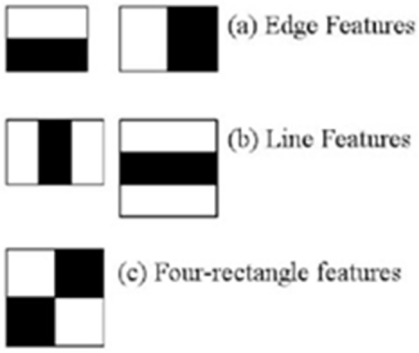

Fig. 5 Haar features (source: OSCV - Cascade Classifier)

The HaarCascade for detecting faces is implemented here, which helps in identifying the faces of users. The detected face region is then utilised to check the usage of masks using the ml model built on MobileNetV2 [7], which is a convolutional neural network architecture upon which image classifying models can be built. The model is then trained, validated and tested, and then deployed to predict the presence of masks in user faces detected from the previous HaarCascade model. The model was trained for 20 epochs, and the training accuracy obtained were 0.9201 (92.01%) for the 1st epoch and 0.9826(98.26%) for the 20th epoch. The model was tested with unseen images Fig (6) Fig (7) and got an average of 98.75% accuracy. The camera module along with OpenCV is also used to assist the bot's mobility, by detecting the obstacles and their distance in the path of the bot.

Fig. 6 Final output displayed by the ML model for face detection and mask indication

Fig. 7 Predicting the usage of masks on unseen images using the HaarCascade and ML model

V. ULTRAVIOLET C(UVC)

A. UVC In India

The capacity of the UVC light makes it the strongest competitor for utilization in crowded spaces or in public where the infection could remain for a long time and spread. Schools, bus and railway stations, air terminals and theatre lobbies can conceivably and securely be without causing any cell harm to people which is a risk inherent in ordinary germicidal UV lights. This is an amazing, yet reasonable methodology for avoiding airborne viral diseases and protecting general well-being. India is additionally equipped towards utilizing UVC light for its battle against COVID-19. The Defence Institute of Physiology and Allied Sciences (DIPAS) lab and Institute of Nuclear Medicine and Allied Sciences (INMAS) lab of DRDO have structured and created the Ultraviolet-C Light-based sterilization box as shown in fig (6) and handheld Ultraviolet-C (bright light with frequency of 254 nanometres) gadget for killing microbes [8].

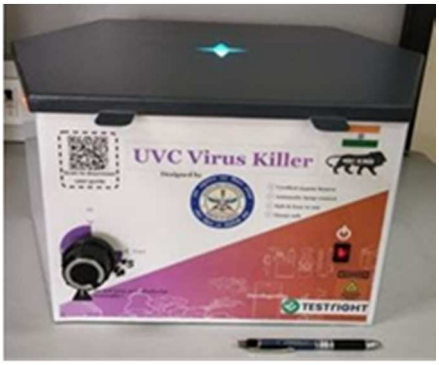

Fig 8: UVC Virus Killer (source: DRDO, Ministry of Defence, Government of India)

B. Frequency Range Used In UVC To Kill Bacteria

Bright light (UV) with a frequency shorter than 300 nanometres is incredibly viable in killing microorganisms. The best sanitizing scope of UV is inside the UVC. This range, somewhere in between 200 nm and 280 nm, is called germicidal UV irradiation or UVC [9]. UVC light has been in use for over 40 years including wastewater treatment, air treatment, sanitising drinking water, sanitising pharmaceutical items and against surfaces consisting an entire set-up of human microbes. All the microbes and infections tried to date (a large number throughout the years, including different infections) react to UV cleansing [10]. However direct exposure to ultraviolet rays will cause premature aging of the skin and signs of sun injury like wrinkles, leathered skin, liver spots, keratosis, and solar elastosis. Natural or man-made UVC will cause sunburn and even cause eye problems.

C. Reducing The HE Spread Of Covid-19 Using UVC:

SARS-CoV1, MERS-CoV are close relatives of COVID-19 coronavirus. These types of viruses can be inactivated with the help of UVC with a germicidal range specifically between 200-280nm. After analysing the present disinfection records and experimental evidence, scientists have claimed that the UVC disinfection techniques can play a crucial role in the multiple barrier approach towards reducing the transmission [11] [12]. To reduce the chance of being infected after coming into contact with the COVID-19 virus, UVC is one among the disinfectants to treat the air, water and the surfaces nearby [10]. As a disinfection measure, experts and professionals across the world have developed guidance to implement the usage of UVC technology effectively, which will greatly help to reduce the transmission of COVID-19.

VI. 3D DESIGN USING TINKERCAD

The thinker cad software is used for designing a 3D model view of a smart covid assist bot. The Thinker cad software is worked on (CSG) constructive solid geometry technology, this helps us to create a complex model effortlessly, combining all small objects to create a big structure model. We can add inbuilt components & objects into a model. Compare to paid 3D printing software this consist of many features and great option for intermediates to develop their 3D modelling through this platform. In the Fig (9) Front and back view of the covid-assist bot, the temperature sensor and camera are placed in the front of the bot. The automatic sanitizer dispenser is placed in the centre place of the bot. Fig (10) Fig (11) Top and side view of the Covid-Assist bot shows that, the control unit is placed in the bottom of the bot.

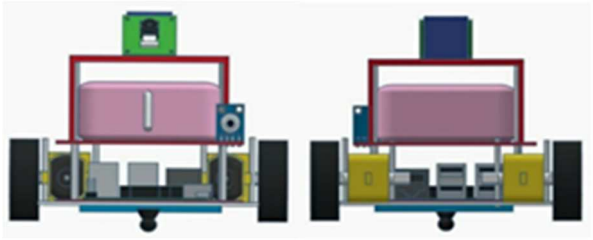

Fig. 9 Front and Back view of Covid-Assist bot

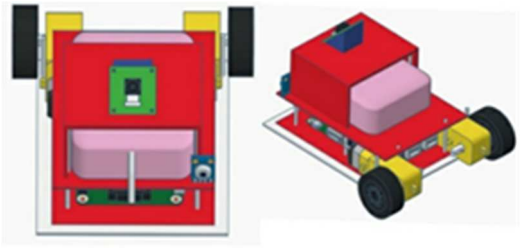

Fig. 10 Top and side view of Covid-Assist bot

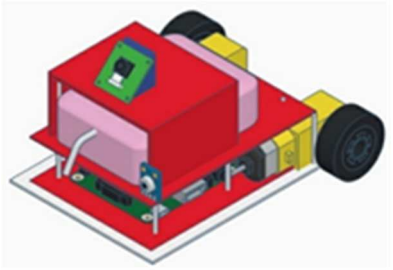

Fig 11: Side view of Covid-Assist bot

VII. FUTURE SCOPE

As we live in the cyber era, the authentication methods we use must become more secure and simpler to use. Various technologies nowadays move towards biometrics, as they provide a unique, simpler but secure way of authentication. Since this project involves using the camera module to detect faces and masks, an iris biometric will be helpful as it allows authentication on the go, without the need for additional tags or ids [13]. Iris recognition is accepted across the globe for its extremely secure authentication, as it is virtually impossible to replicate the pattern. It also allows the user to

not remove the gloves or masks for recognition. The movement of the bot can be made customised so that the bot will sanitise only the regions specified and not the whole room. Voice outputs and control can also be added to make the bot an assistant rather than an automated machine [14]. It will drastically improve the quality of the bot and removes the need for human intervention. The smart bot can also use a camera and a Wi-Fi module to map the entire room using SLAM and determine the exact position of the person [15].

VIII. CONCLUSION

The entire people of the world have come together to a common cause: eradicating the COVID-19. Similarly, the proposed model is an integration of various individual models that have come together to solve the same problem and assist the people in succeeding their motive. Every functionality provided has been proved to be effective in obtaining their desired purpose. They are simple yet useful purposes which are effectively made to work together in this bot. The multi-purpose approach of using components such as using camera module for detecting face masks, barcodes as well as obstacles and using the ultrasonic sensors for detecting the presence of hands and obstacles shows that the components are used with practical knowledge and the redundant sensors are avoided, so the efficiency, power consumption and processing power are always taken into consideration and are well utilised. This bot will prove to be an effective assistant in monitoring people during these hard times and will play a major role in protecting their safety. Its presence will surely insist the people about their responsibilities and to wear masks, sanitise their hands and to maintain social distancing.

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