A Project Report
On

Maskit: A COVID-19 Mask Detection System

A Project Work Submitted in Partial Fulfillment of
the requirements for

DEGREE
In

COMPUTER SCIENCE AND ENGINEERING

By

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CERTIFICATE OFAPPROVAL

This is to certify that the work embodied in this project entitled **Maskit: A COVID-19 Mask Detection System** submitted by Bhargav SNV and N Sanketh Reddy to the Department of Computer Science and Engineering, have carried out under my direct supervisions and guidance.

The project work has been prepared as per the regulations of PES University and I strongly recommend that this project work be accepted in partial fulfillment of the requirement for Degree.

Supervisor-

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Certificate by the Board of Examiners

This is to be certified that the project work entitled **Maskit: A COVID-19 Mask Detection System** submitted by Bhargav SNV and N Sanketh Reddy to the Department of Computer Science and Engineering of PES University, Bangalore has been examined and evaluated.

The project work has been prepared as per the regulations of PES University and qualifies to be accepted in partial fulfillment of the requirements for the Degree.

UE18CS313: Internet of Things
Project Title: Mask-It

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Abstract

Internet of Things (IoT) technology has brought a revolution to each and every aspect of a common man's life by turning objects around him into smart and intelligent "things". IoT can connect devices embedded in various systems to the internet. When devices can represent themselves digitally, they can be controlled remotely.

In recent times as the COVID-19 outbreak began, in order to slow down the spread of the pandemic and in a hope to eradicate it completely, the governments of different countries introduced new laws and safely guidelines. These laws include mandatory use of face masks in the public places and social distancing by a distance of 6 feet from others.

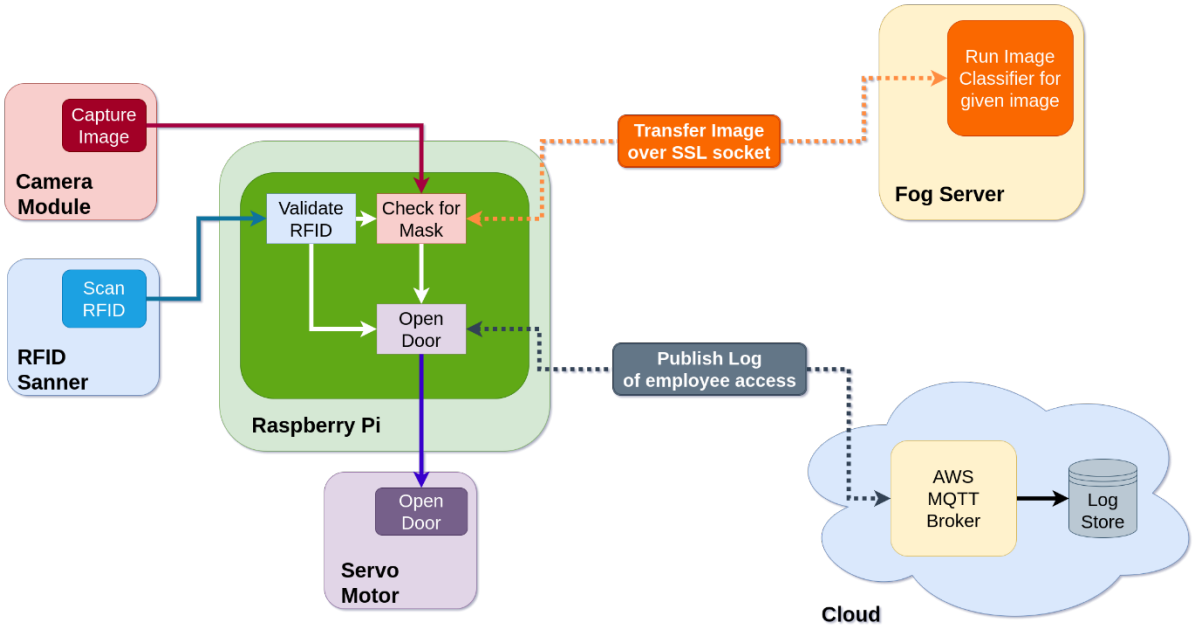
As Engineering students, we hope to leverage our knowledge in IoT to build an Intelligent SOP regulation and attendance logging system that acts as an alternative to the existing fingerprint scanning systems. We thus, not only avoid the single points of contact (the fingerprint scanner), but also make sure that the person entering a building/office/college is wearing a mask.

Introduction

As COVID-19 grows to be threat to reopening of economies, we must ensure to take preventive measures while moving about in public spaces, especially workspaces like colleges and offices. Our project aims to help ensure a few of the directed standard operating procedures (SOPs) to tackle COVID-19. We do so by ensuring employees/students/personals in public spaces are wearing their masks to avoid spread of germs and the virus.

We add this safety check to security mechanisms that already exist in workspaces (ID scanners). Most office workspaces make use of an RFID scanner which validates identity of an individual before providing access into the office. ***Our project aims to build a similar such device, which can identify and validate a person's identity through similar RFID scans and additionally verify if the person is or is not wearing a mask.*** If the said person does have a valid identity (allowed to enter premises) and is following SOPs by wearing a mask which covers his/her mouth and nose, only then do we allow the person entry into the premises. In performing such checks, we aim to smoothen and enforce guidelines which help people avoid the spread of the treacherous virus.

Architecture



The architecture of the project has been visualized above. We make use of a **Raspberry Pi** as the primary micro controller. The Pi is connected to 2 sensors, an **RFID Scanner** and a **Camera Module**. The Pi is also connected to 1 actuator, the **Servo Motor** (the door).

Additionally, the Pi connects to a close proximity **Fog Server** through a secure socket connection. It also connects to the **Cloud** through an active **MQTT** connection.

Components and Functions

Sensors: The sensors used here are an RFID scanner and a Camera Module, their functioning is mentioned below:

- **RFID Scanner**: The RFID scanner is connected to the Raspberry Pi. It is used to scan ID Cards/RFID tags to verify identity of employees/students that wish to enter the workspace premises. Scanned RFID details are sent to the Pi for further processing and validation.

- **Camera Module**: The Camera module too is attached to the Pi. On successful RFID validations, the camera captures an image of the card holder and stores the image in the Pi for later classification.

Fog Server: The fog server is used to run compute intensive image classification algorithms which are not possible on the Pi. On capturing an image, the Pi sends the image to this server, through a secure connection (TCP Socket with SSL encryption). Upon receiving this image, the fog server, runs the classification algorithm on this image, to determine whether or not, the card holder is wearing a mask.

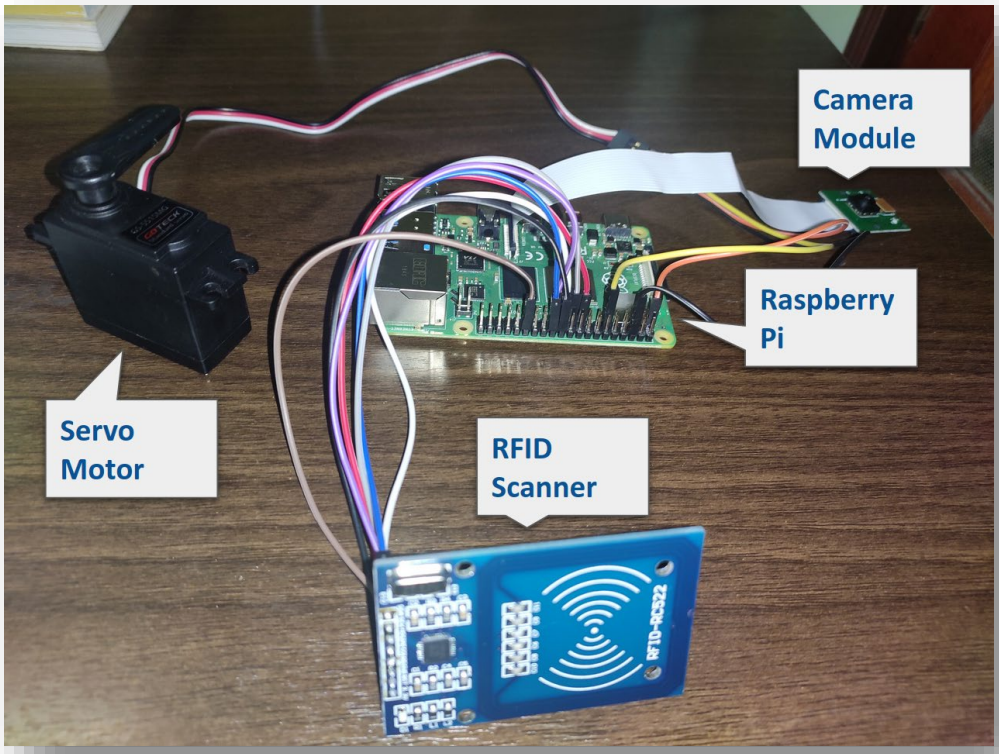
It returns 1 of 3 possible classes (values). These classes are –1, 0, 1. The meaning of these classes are further explained below:

- **Class = -1**: The server sends a value of –1 to the Pi if the classification algorithm could **detect a face, but no mask** was worn to cover the nose and mouth.
- **Class = 0**: The server sends a value of 0 to the Pi, if **no face was detected** at all. In this scenario, the card holder will have to scan the card again and ensure his /her face is captured by the camera.
- **Class = 1**: Ther server returns a value of 1 to the Pi, if the classification algorithm **successfully detected a face and a mask** on the card holder.

MQTT Broker (Cloud): The MQTT Broker runs as a hosted IoT core service on AWS. We make use of this to log details about employees/students that move in and out of the workspace. Once the Pi validates the RFID (ID card) of the employee and verifies that he/she is wearing a mask, the Pi actuates a motor (opens door) and allows entry to the employee. Once entry access is given to the employee, an MQTT message is published to a specified topic, which records the employee's details (SRN for students) and the timestamp at which access was given. The broker then forwards this message to all subscribers of the topic, which in our case is backing store (AWS S3 Bucket) which maintains all these logs.

Actuators: The only actuator present here, is the **Servo Motor**, which is used to open a door and allow access for an employee/student. The servo motor is connected to the Pi, on successful validation of RFID and face scans (mask detection), the Pi rotates the motor which is a simulation of a door opening.

Overall Circuit



Implementation Details

ML Algorithm for Face Mask detection

For training purpose of the implemented face mask detector morphed masked images were not used. Datasets were acquired from previous studies and also from Kaggle and RMFD datasets. The model makes use of **MobileNetV2** architecture which is extremely light weight and meant to work on low compute

devices like embedded systems, mobile phones, raspberry Pi, etc. This not only provided **computationally efficiency**, it also made it easier to deploy the model onto low power/compute systems. This system can therefore be used in real-time applications which require face-mask detection for safety purposes due to the outbreak of COVID-19.

Additionally, while processing data in real-time we need not recompute the model, instead we store weights after letting the model run/learn for 1000 epochs on the dataset which was accumulated. This dataset consists of over 3500 images. We further use these weights to predict if the person in the picture in wearing the mask or not.

Connection between the Microcontroller and Server

A **Secured Socket Layer connection** is established for the purpose of sending and receiving images and data between the devices (Raspberry Pi and the Fog-layer server). We set up the secured socket connection using the SSL library in python. This library provides access to Transport Layer Security (often known as "Secure Sockets Layer") encryption and peer authentication facilities for network sockets, both client-side and server-side. Since SSL uses the RSA public key – private key algorithm for encryption of data, we can assure secure encrypted transfer of data between the Pi and the Server.

Connecting Microcontroller to the cloud

The Microcontroller (Raspberry Pi) is **connected to AWS using the MQTT** connection to store attendance logs. The controller connects to the IoT Core

service offered by AWS. AWS also offers 2 different options for MQTT service, QoS0 and QoS1 (Quality of Service) where QoS0 can only be used when there is a persistent connection between the devices and QoS1 supports offline queuing for when the network goes down and also supports a PUBACK response to indicate successful delivery. We opted and setup our Pi for Qos1 service so that our architecture can be fault tolerant and does not loose data due to internet connectivity fluctuations.

Conclusion

Using IoT and cloud technologies to enforce COVID-19 SOPs has been presented in this project. The system designed has high accuracy for face mask detection, provides real-time logging of access by employees/students and is also highly fault tolerant. This will undoubtedly assist organizations (offices, universities, etc.) with safer and more reliable control systems.

Future scope

Now that we are able to collect real-time data while our application runs, data being the employee/student's photo while wearing a mask along with their respective SRNs/IDs. We will be able to generate a new dataset of the employee/student's picture with their IDs as labels. We can further use this dataset to train a face recognition model in the cloud and upon achieving good accuracies, we have an option of completely replacing RFID scanners with facial recognition systems for attendance.

Acknowledgments

We, (Bhargav SNV and Sanketh Reddy), would like to thank our Professor, Dr. Nagegowda K S and Prof. Charanraj for all the support, mentoring and guidance which made this project possible. Their constant guidance, assistance and providing of resources has been highly influential in the accomplishment of this project.

Source Code

The source code for the project can be found at the link given below:
https://github.com/Gituser143/MaskIt/