IOT ENABLED SMART DOORS THROUGH FACE MASK DETECTION

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Abstract: **COVID 19 pandemic is causing a global health epidemic. The most powerful safety tool is wearing a face mask in public places and everywhere else. The COVID 19 outbreak forced governments around the world to implement lockdowns to deter virus transmission. In this paper, an IoT-enabled smart door that uses a machine learning model for face mask detection. Evaluation of the proposed framework is done by the Face Mask Detection algorithm using the TensorFlow software library.[1] The proposed framework capitalizes on the MobileNetV2 face detection model to identify the faces and their corresponding facial landmarks present in the video frame. The proposed methodology demonstrated its effectiveness in detecting facial masks by achieving high precision, recall, and accuracy.[2] In the field of computer vision, this is a common research direction by extracting features directly from the detection region and then using machine detection learning algorithms to identify and recognize[3]. This proposed system can detect the users from COVID 19 by enabling the Internet of Things (IoT) technology.[1]**

Keywords: **Face mask detection, Deep learning, Internet of things, Arduino, MobileNetv2, Tensor flow, Keras, OpenCV, Pyfirmata**

I.INTRODUCTION

Coronavirus sickness (COVID-19) is an overpowering contamination achieved by a recently discovered Novel Corona Virus Disease-19(Covid - 19). Coronavirus causes respiratory disappointments including injury of the heart liver, and kidneys, and its leadings to death. Most by far spoiled with the Coronavirus diseases will experience delicate to coordinate respiratory affliction and recover without requiring uncommon treatment. For all this reason, one should close a face with mask. The principle motivation behind wearing a facial mask is to stop the spreading of the infection through beads that are coming out while talking, sniffling, or hacking.[8]During the surging COVID-19 pandemic, governments of many countries require face mask wearing in public area, such as public transport. Computer vision is often utilized in security system to detect mask wearing before entering a building. Face mask detection system through artificial intelligence has been shown to be an effective solution.[6] At the entrances to any city, workplaces, malls, and hospital gates, temperature and mask checks are also necessary.[1]

Here we present a detecting of face mask model that depends on PC vision and deep learning. The proposed model can be incorporated with observation cameras to block the COVID-19 transmission by permitting the identification of individuals who are wearing face masks not wearing a facemask. The model is a combination of deep learning and traditional machine learning techniques with the tensor flow, Keras, and OpenCV.[8]We use OpenCV – OpenCV is an open-source library which is primarily used for Computer Vision Applications. This contains many functions and algorithms for Motion tracking, Facial recognition, Object Detection, Segmentation and recognition and many other applications. Images and real time video streams can be manipulated to suit different needs using this library. [9]Tensorflow-It is an open-source machine learning framework to build and train neural networks. It has a collection of tools, libraries and community resources which helps in easy building of deployment of ML powered applications. This is developed and maintained by Google and was released in 2015.[9]

The camera is used to scan for mask wearing person. The Arduino processes the sensor inputs and decides whether the person is to be allowed. In this case the system operates a motor to open the door allowing the person to enter the premises [6].Face masks are an effective method to control the spread of virus. It had been found that wearing face masks is 96% effective to stop the spread of virus. The governments, all over the world, have imposed strict rules the everyone should wear masks while they go out. But still, some people may not wear masks and it is hard to check weather everyone is wearing mask or not. In such cases, computer vision will be of great help.[9]In this paper, the MobileNetV2 was applied to perform the CNN to recognize whether a person wears a face mask properly, wears a face mask incorrectly, or does not wear a face mask.[8]

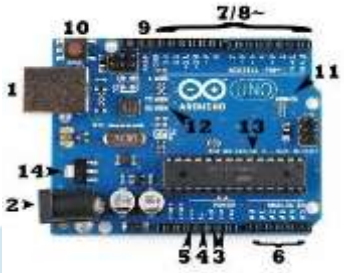
I. LITERATURE REVIEW

1. IOT

I. Arduino

Arduino is an open-source hardware and software company, project, and user community that designs and manufactures singleboard microcontrollers and microcontroller kits for building digital devices Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The boards feature serial

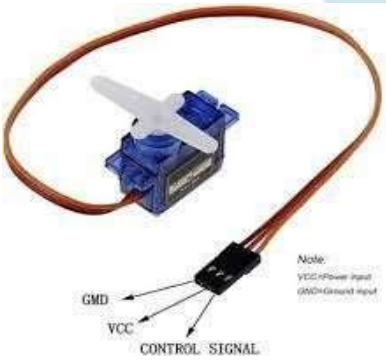
communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino language, inspired by the Processing language and used with a modified version of the Processing IDE. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) and a command line tool developed in Go.



Arduino Uno SMD R3	
Developer	arduino.cc
Manufacturer	Arduino
Type	Single-board microcontroller
Operating system	None (default) / Xinu
CPU	• Atmel AVR (8-bit) • ARM Cortex-M0+ (32-bit) • ARM Cortex-M3 (32-bit) • Intel Quark (x86) (32-bit)
Memory	SRAM
Storage	Flash, EEPROM
Website	arduino.cc

II.Servo motor

A servomotor (or servo motor) is a simple electric motor, controlled with the help of servomechanism. If the motor as a controlled device, associated with servomechanism is DC motor, then it is commonly known as a DC Servo Motor. If AC operates the controlled motor, it is known as a AC Servo Motor.



A servomotor is a linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. It consists of a motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

III. Camera

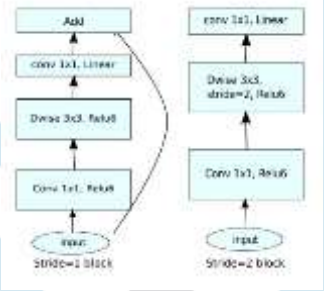
The ESP32-CAM provides an inexpensive way to build more advanced home automation projects that feature video, taking photos, and face recognition. The ESP32-CAM is a small size, low power consumption camera module based on ESP32. It comes with an OV2640 camera and provides onboard TF card slot. The ESP32-CAM can be widely used in intelligent IoT applications such as wireless video monitoring, WiFi image upload, QR identification, and so on.

2. Deep Learning

I.MobileNetV2 Model

MobileNetV2 is a convolutional neural network architecture that seeks to perform well on mobile devices. It is based on an inverted residual structure where the residual connections are between the bottleneck layers. The intermediate expansion layer uses lightweight depthwise convolutions to filter features as a source of non-linearity. As a whole, the architecture of MobileNetV2 contains the initial fully convolution layer with 32 filters, followed by 19 residual bottleneck layers.

In MobileNetV2, there are two types of blocks. One is residual block with stride of 1. Another one is block with stride of 2 for downsizing. There are 3 layers for both types of blocks. The first layer **is** 1×1 convolution with ReLU6**.**The second layer is the depthwise convolution.The third layer is another 1×1 convolution but without any non-linearity**.** It is claimed that if ReLU is used again, the deep networks only have the power of a linear classifier on the non-zero volume part of the output domain. And there is an expansion factor t. And t=6 for all main experiments. If the input got 64 channels, the internal output would get 64×t=64×6=384 channels.



Python Libraries

I.Tensorflow

It is an open-source machine learning framework to build and train neural networks. It has a collection of tools, libraries and community resources which helps in easy building of deployment of ML powered applications. This is developed and maintained by Google and was released in 2015.[10]

II.Opencv

OpenCV is an open-source library which is primarily used for Computer Vision Applications. This contains many functions and algorithms for Motion tracking, Facial recognition, Object Detection, Segmentation and recognition and many other applications. Images and real time video streams can be manipulated to suit different needs using this library. [10]

III.Keras

Keras is an open-source high-level Neural Network library, which is written in Python is capable enough to run on Theano, TensorFlow, or CNTK. It was developed by one of the Google engineers, Francois Chollet. It is made user-friendly, extensible, and modular for facilitating faster experimentation with deep neural networks. It not only supports Convolutional Networks and Recurrent Networks individually but also their combination.

IV.Pyfirmata

PyFirmata is basically a prebuilt library package of python program which can be installed in Arduino to allow serial communication between a python script on any computer and an Arduino. This python package can give access to read and write any pin on the Arduino.

V.Imutils

A series of convenience functions to make basic image processing functions such as translation, rotation, resizing, skeletonization, and displaying Matplotlib images**.** Images can be shifted in a variety of positions and directions using the OpenCV and Imutils packages.

III.WORKING

Face mask detection has become a critical computer vision task to control the infection, yet mask detection research is limited. So, real-time detection of the mask is proposed using a deep learning approach with an automated door entry control system. Deep learning plays a major role in Natural Language Processing, object identification, and facial recognition. The proposed system with the face net model incorporates mask detection efficiently and accurately. To detect the presence of a face mask, the trained face mask classifier is applied to the live video stream. The data from the detection phase is passed to an automated door entry control

mechanism to control the entry of the people. The experiment is conducted, and the results are obtained. From the results, it is inferred that the system recognizes the presence of a mask and ensures safety through the automated door entry mechanism.

The face is captured and the blob is constructed from the image that depicts people with and without wearing masks [1]. This blob is passed via network to achieve face detection from the extracted blob and the trust (i.e., probability) is also associated with extracted detection. The weak detection is filtered to ensure that the confidence (probability) is more than min degree of reliability so that face ROI (Region of Interest) is extracted and switched to RGB format from BGR format and it is reformatted to 4 × 224, and then pre-processing is done.

The training process is also known as backpropagation. The training step is very important for the model to find the weights that best accurately represent the input data to match its correct output class. Thus, these weights are constantly updated and moved towards their optimal output class. In this study, a Face Mask Detection Dataset was used to train the CNN model. During the training process, training datawas split into smaller sizes of batches of 100. Batch size includes splitting the whole dataset into a chain of the reduced amounts of data fed into the model one at a time. Splitting the training dataset into batches helps in training the model faster and controlling the gradient error accuracy. Likewise, the learning rate of 0.001 has been applied to set the size of a step in the direction of the minimizing the loss function. The optimization algorithm, forward pass, loss function, backward pass, and weights updates are followed to train the model from the labelled data.

I. Algorithm

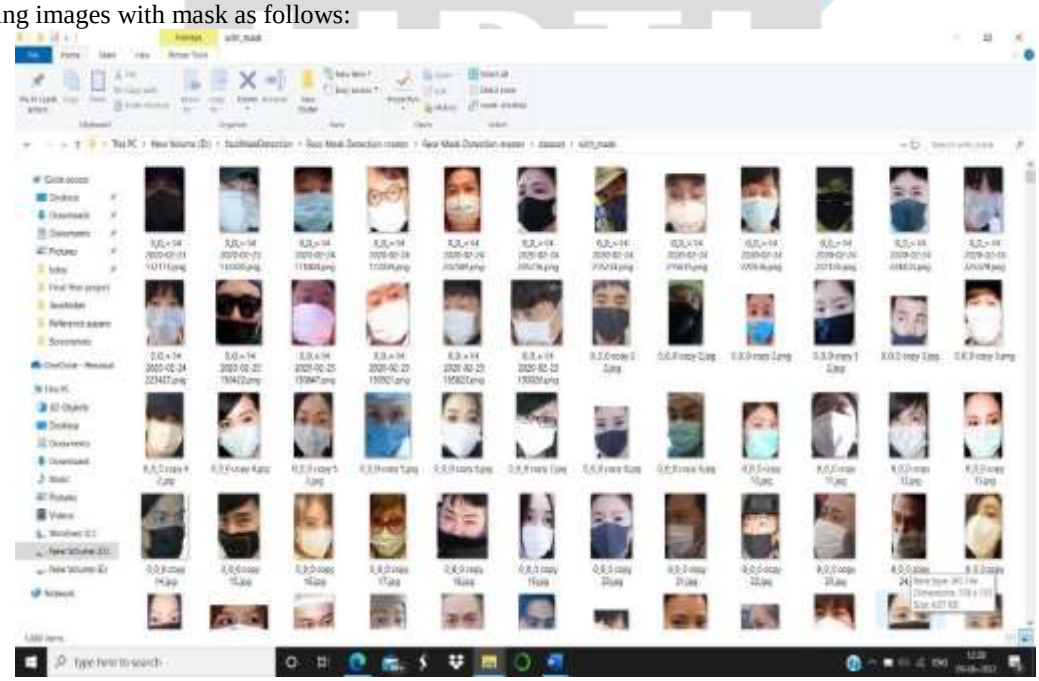
Steps to Detecting face mask

Step1: input face mask dataset
Step2: Train the dataset with python libraries
Step3: rearrange the dataset to disk
Step4: load dataset from disk
Step5: Detect faces from image/video stream
Step6: determine with or without mask
Step7: output the result

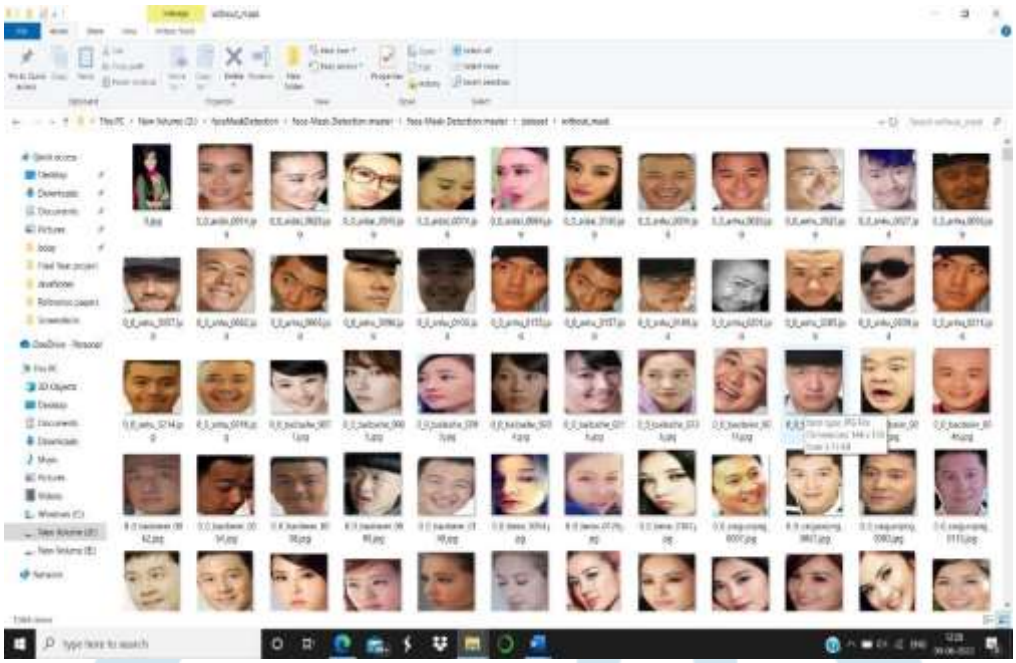
II. Dataset collection

The images used for training and testing the model were obtained from the internet. To create this dataset, they took regular photographs of people's faces and then used a custom-designed computer vision Python script to apply face masks to the pictures, yielding an artificial dataset. Facial landmarks allow the users to instantly infer the position of facial components such as the eyes, nose, eyebrows, mouth, and jawline. Then, using facial landmarks, the dataset of faces wearing masks can be created. To determine the bounding box region of a face in an image, start with an image of an individual who's not wearing a face mask and then apply face mask detection. The face is captured and the blob is constructed from the image that depicts people with and without wearing masks [1].

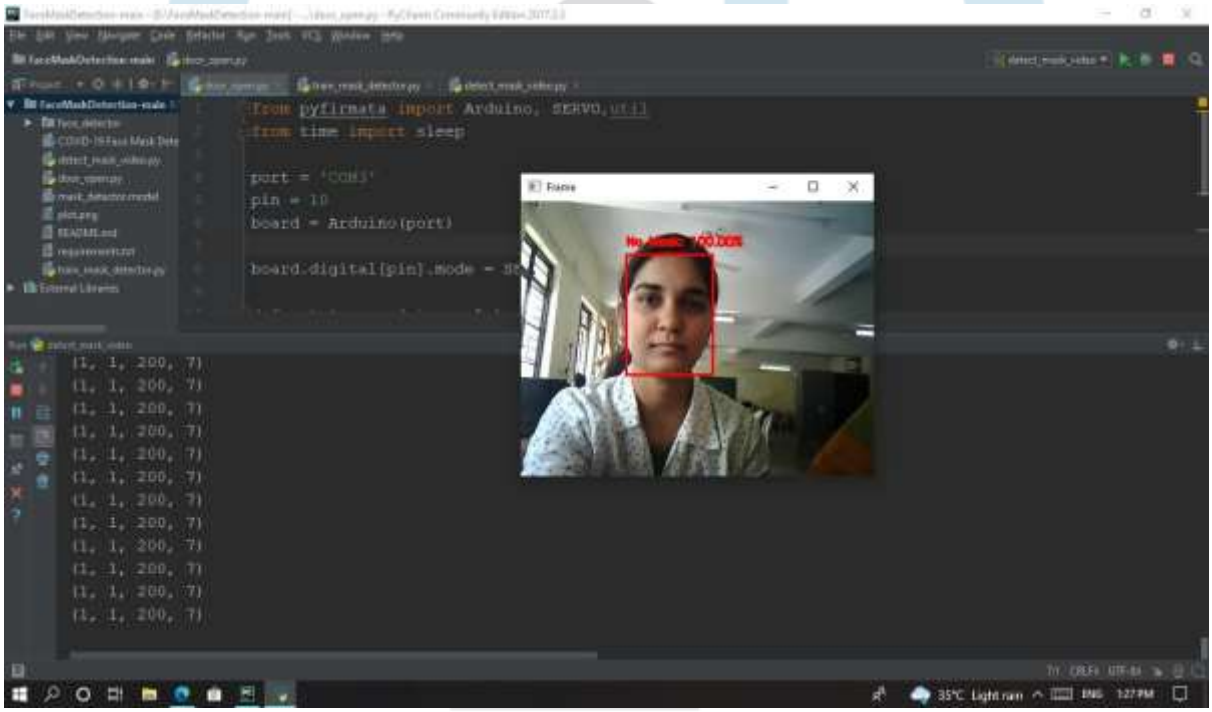
Dataset containing images with mask as follows:

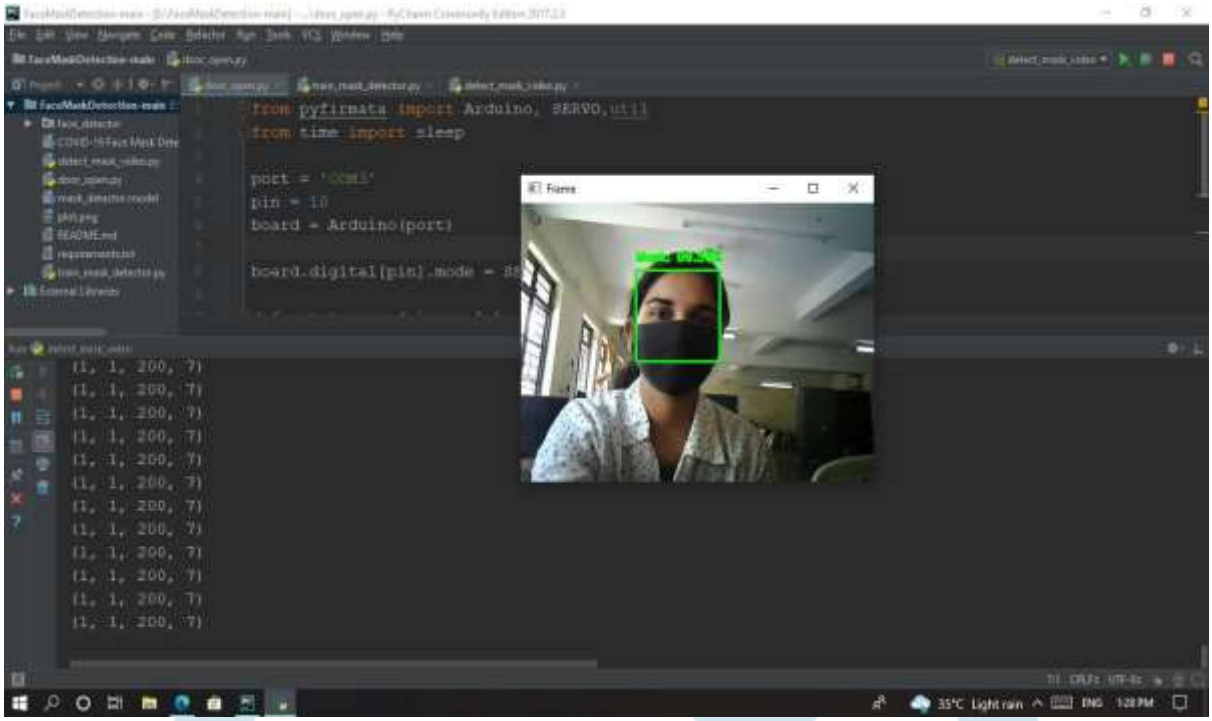


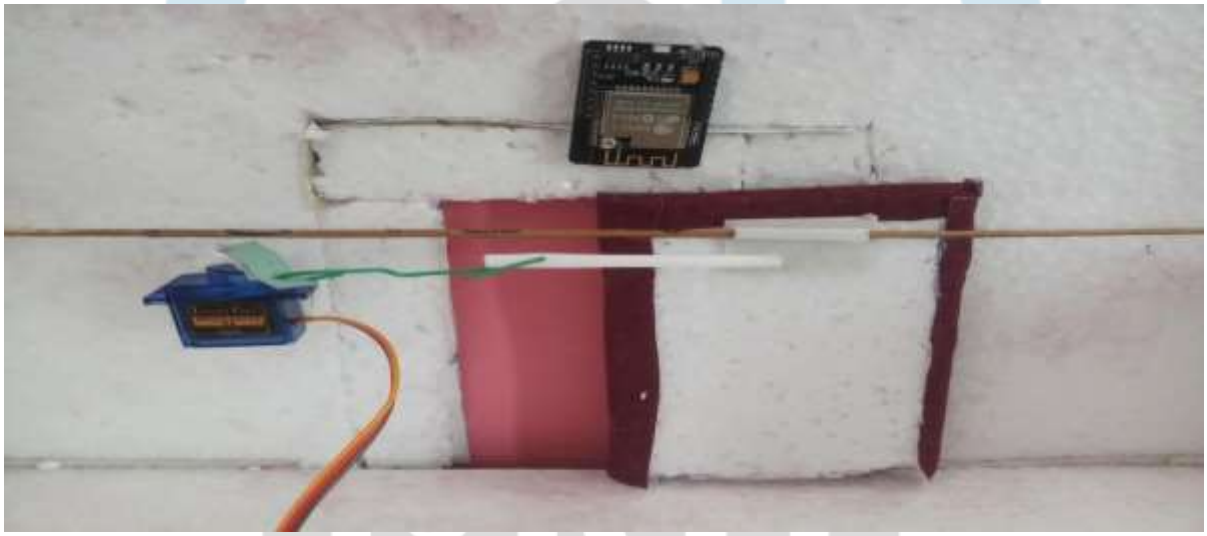
Dataset containing images without mask as follows:



III. Result


from pyfirmata import Arduino, SERVO,util
from time import sleep
port = 'COM3'
pin = 10
board = Arduino(port)
board.digital[pin].mode = S
Frame
No Mask - 20.00%
(1, 1, 200, 7)


from pyfirmata import Arduino, SERVO,util
from time import sleep
port = 'COM3'
pin = 10
board = Arduino(port)
board.digital[pin].mode = SE
Frame
(1, 1, 200, 7)



The green box indicates the person is wearing the mask. The red box indicates the person is not wearing the mask. If person is wearing mask then only door will get Opened.

IV.CONCLUSION

Due to the urgency of controlling COVID-19, the application value and importance of real-time mask and social distancing detection are increasing. This work reviewed, firstly, many research works that seek to surround COVID-19 outbreak. Then, it clarified the basic concepts of deep CNN models. After that, this paper reproduced the training and testing of the most used deep pretrained-based CNN models(MobileNetV2) on the face mask dataset.This embedded vision-based application can be used in any working environment such as public place, station, corporate environment, streets, shopping malls, and examination centers, where accuracy and precision are highly desired to serve the purpose.

In future works, we will exploit this methodology on smart sensors or connected RP nodes that will be considered as an Edge Cloud to collect multimedia data, e.g., an autonomous drone system, which can provide capture (by the camera) of the detected objects from different angles and send them to the Edge Cloud system to be analyzed.

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