Helmet, Seat Belt and Mask Detection Using Deep Learning for Quadcopter Drone

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Helmet, Seat Belt and Mask Detection Using Deep Learning for Quadcopter Drone

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Abstract. The presented model is a concatenation of multitudinous problems of human safety either regarding tO health or traffic. Moreover, it gives a solution to avert any accidents or health issue problems like Corona Virus. In current scenarios people are trying to avoid safety measures which in turn results in ma- jor casualty or their deaths. Therefore, it is highly stipulated to adopt the ad- vanced traffic management system, which includes seat belt, helmet and mask detection. The proposed model is designed in such a manner that it is capable of detecting seat belt, helmet and mask using OpenCV (Open-Source Computer Vision Library) and deep learning algorithms at the same time remotely. The system proffered here can be operated automatically and manually both, de- pends on the condition. It obligates everyone on the road to wear seat belt, hel- met and mask to avoid any casualty or deaths due to accidents and corona virus. The interpreted process also enables to detect the mask of all the pedestrians on the road. The whole system is processed by the help of a high-end quadcopter camera which is flying at a particular height. In this paper we solved the prob- lem of traffic surveillance system and criminal activity tracing by making it op- eratable from a single point. Furthermore, these activities are recorded in the highly secured control rooms database, which operate multiple drones at a time. These databases are only accessed by the higher government officials for secu- rity purposes whenever they want to avoid any accidents and to punish the law breakers for public safety.

Keywords: Seat Belt, Helmet, Mask, Deep Learning, Quadcopter Drone, Traffic

1. Introduction

In today's world, our every technology needs to be multi-tasking, that's why the proposed system also initiates to make an advanced multitasking system for traffic. On December 31, 2019, a new virus was subsequently named the "COVID-19 virus" was identified and after some days it was declared as global pandemic due to which WHO encourages individuals to take some major precautions and wearing mask was one of them [1-3)]. Nowadays it's compulsory to wear mask while going outside. Apart from this people also don't follow the traffic rules properly which leads to accidents and causalities. The presented model Helmet, Seat Belt and Mask Detection using Deep Learning for Quadcopter Drone detects three things at a time that includes masks, helmets and seatbelts, to avoid any kind of accidents or deaths and also to help preventing the spread of novel coronavirus. In this 21st century some people out there or most of them specially youngsters love to break rules and feel proud of it. Breakingrule is like a trend in today's world, this mainly happens in highways or the roads that are not mapped by traffic police, evading traffic rules are the main reasons for accidents on highways and not wearing mask is the reason for out breaking coronavirus cases. This system is strictly made for such kind of people who violates these rules onhighways or any other road, it pressurizes them to wear helmet, seatbelt and mask. Such kind of people intentionally or unintentionally just for the sake of smartness avoid wearing such safety equipment's and they do not realize that this may cost their life. Moreover, the whole model works with a Quadcopter drone for better surveillance and criminal activity tracking. It can be operated manually and automatically both, and for height adjustment it uses altitude control algorithm [2)].

This system works automatically and as the name suggests that it's also a surveillance system, so the surveillance can be done in an easy and effective way. In addition, it helps in detecting all possible violations from not wearing seat belts or helmets and masks too even without the help of any traffic police and captures the image of rule breaker within a second, so that strict action can be taken against the culprit by higher authorities and traffic police. The public should be aware of the consequences thatthey have to face while violating this

traffic and COVID-19 rules. Wearing seat belt, helmet and mask should be made necessary and those violating the laws must be punished strictly.

2. Literature Review

In the present situation, whole world is dealing with the global pandemic known as COVID-19, keeping this in mind many actions were taken for public's health and safety, there were declared a worldwide lockdown so as to stop the spread of this deadly virus. So, to ensure safety it is advice to wear face masks as well. The pro- posed model is focused on these types of safety measures during traffic with some enhanced technologies and deep learning algorithms (i.e., YOLO and TensorFlow). According to various studies it has been found that till now many systems have used method of ultrasonic sensors for detection of helmets [3-5]. Some systems detect only one thing at a time that is either seat belt or helmet as they cannot detect both of them together at a time 4-[6]. Moreover, at present many mask detection systems were made for detecting mask, like a system were made using deep learning and consist of rasp- berry pi4, MobileNetV2 etc., for detecting mask and distance between one person to the other. But this system is not robust as compared to the presented model, as previous systems cameras were not movable and it can work only if the person is standing or walking on the road [7-9]. Many systems have used deep learning technology for detecting mask but it can only detect mask in public and not of the vehicle drivers [10-13].

The proposed system can be used on roads and highways both. As compared to the other previously proposed systems that uses only OpenCV or simple deep learning pre-trained models [14-17], the proposed system enhanced the traffic management system with a combination of two different deep learning frameworks, i.e., YOLO and TensorFlow. It detects all three of the things seat belt, helmet and mask of vehicle drivers together at a time with the help of a drone camera that has been programmed and operated from a control room. It can also be used for detecting any criminal activity taking place on roads and highways and due to this it can be also called as criminal activity surveillance system. Once it detects any person violating the law or any criminal activity, it directly shows the image to the in charge that is in control room, so that strict action can be taken against them. The images are labelled with accuracy graphs. For detecting seat belt, helmet and mask of fast-moving vehicles more accurately without the help of traffic police or any other government official a prototype has been developed. The presented paper helps to reduce the negligence of Traffic rules and safety measures by common people and officials. It put a pressure on public and any other higher government officials (VIP's) to follow the traffic and COVID-19rules. Those who violates any of these laws should be strictly punished. The propose system is well maintained, accurate and most important thing is that it is cost effective [18-20].

3. Working

A. At first, there is a control room where the operating systems are setup.
B. The process is triggered and the continuous surveillance get started storing all the database and showing the images in the control room.
C. There is no certain checkpoint fixed in this process, the quadcopter can fly anywhere or it can be fixed at a certain height.
D. After starting the system, the quadcopter starts its process of detection of seat belt, helmet and mask.
E. The mask detection is done using TensorFlow framework while the helmet and seatbelt is detected using YOLO object detection in real time.
F. The detection process consists of two following procedures:
G. The vehicle driver or the motorcyclist any of them is detected without seat belt or helmet and mask, then his/her image is captured and stored in data- base.
H. If they are not violating the law and wearing seat belt or helmet and mask, then his/her image is not captured.
I. Finally, images of people violating the law are stored in different databases of control room according to the area and it also makes it easier for government officials to take action against law breakers.
J. The whole presented setup can be operated in both automatic and manual way, depending on the situation conditions Fig. 1.

4. Methodology

4.1 Quadcopter Drone Specification

The presented system Quadcopter drone is highly-man portable and fully autono- mous. It is launched from different control rooms having its camera screen access. Additionally, there are various parameters which affects the drone, like wind, dust and rain. These types of specifications are listed as follows:
Range: 4 – 5 km
Weight < 6 kg
Wind Resistant: Up to 36 Km/h Maximum Operating
Altitude: 400 m
Altitude on roads and highways: 60 – 100 m
Protection: IP53 Rated for Dust & Water Resistance
Daylight Payload: 720p
Zoom in: 10x Optical Zoom HD Imaging Payload: 15+ MP Multispectral Camera: Optional
Thermal Payload: 640 x 480 pixels

It is capable to automatically return to the control room in case of low battery andhigh winds.

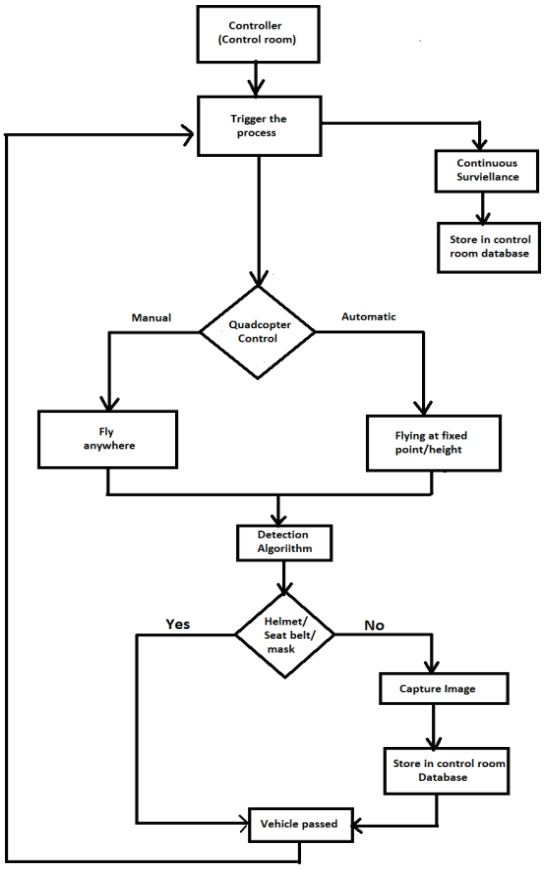


Fig. 1. Flow chart of helmet, seat belt and mask detection.

4.2 Detection and Tracking Using Quadcopter Drone

For helmet, seat belt and mask detection on roads, the drones are fixed at 60 – 100 m altitude. It contains a camera, and the screen is accessed in control room. It is a wire- less screen which shows drone view, setup in control room. Further, for detection, algorithm take that screen is taken as input for algorithm and detection is done on that view in real time. These detections are shown in three separate screens as Screen1 (Helmet Detection) Fig. 6,

Screen2 (Seat Belt Detection) Fig. 7 and Screen3 (Mask Detection) Fig. 8. At the same time, images of law violators are stored in the database.

Moreover, the presented model makes the drone feasible for tracking the criminal activities or law breakers. As to track down any criminal or law breaker, the drone canbe shifted to manual operation and controlled by the controller to follow the culprit even in traffic or populated areas. In addition to this, it can be controlled to a very long range and in case of out-of-range while following criminal, another drone can be assigned from that point [21-23].

4.3 Seat Belt, Helmet and Mask Detection Technique

The proposed system is a deep learning neural network algorithm which is trained to detect helmet, seat belt and mask of every person on the road either he/she is in vehi- cle or a pedestrian.

The following coding language and deep learning frameworks are used in operating system for detection process:

- Python => 3.6 (programming language)
- OpenCV
- YOLO
- TensorFlow

Important libraries to be installed:

- TensorFlow>=1.15.2imutils==0.5.3.
- keras==2.3.1
- matplotlib==3.2.1
- NumPy==1.18.2
- SciPy==1.4.1
- OpenCV-python==4.2.0
- Coco Model (mob_ssd_model)

4.4 Seat Belt and Helmet Detection of Vehicle Driver

The presented system contains algorithms of deep learning object detection library which is implemented on an operating system of a control room Fig. 2.

Initially, the platform is setting up by import the mandatory libraries. Then the dataset is split into two parts (i.e., training and test dataset). Now, for detection process of helmet and seat belt, both the folders are labelled Fig. 3(b), 3(c)), so that, dimension of each detecting object is created in a text file. These text files are attached individually ac- cording to the image, i.e., each image has its own text file. After all, these datasets are trained using YOLO objection detection algorithm and a plot is automatically savedin the database which contains the loss and epochs percentage. Finally, the model is ready for detection of helmet and seat belt which shows the model accuracy which is more than 92% Fig. 4(b)).

Fig. 2: Algorithm of helmet, seat belt and mask detection

4.5 Mask Detection of Pedestrian and Vehicle Driver

First of all, the libraries are installed with pre-requisite programming languages. Then dataset is labelled by cropping the detection part in two parts, i.e., with Mask and without Mask Fig. 3(a).

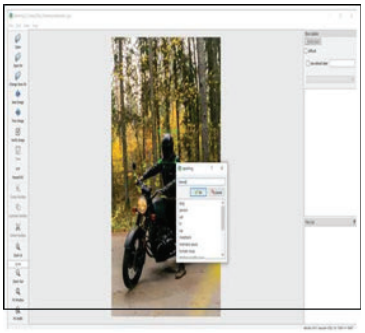


Fig. 3(a). Labelling of Helmet

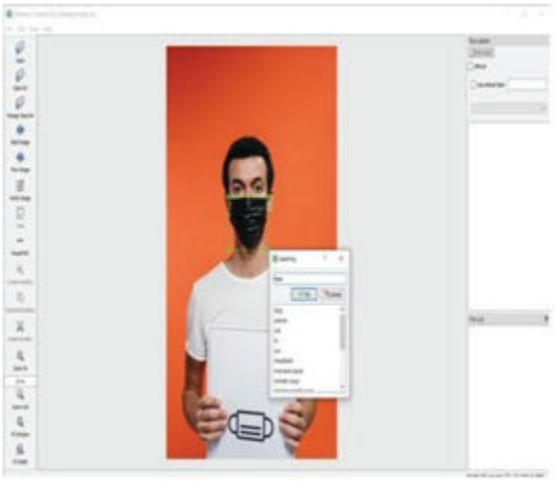


Fig 3(b). Labeling of Mask

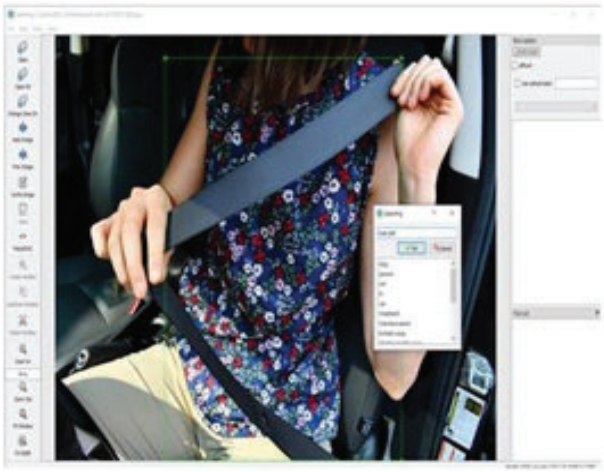


Fig. 3(c): Labelling of seat belt

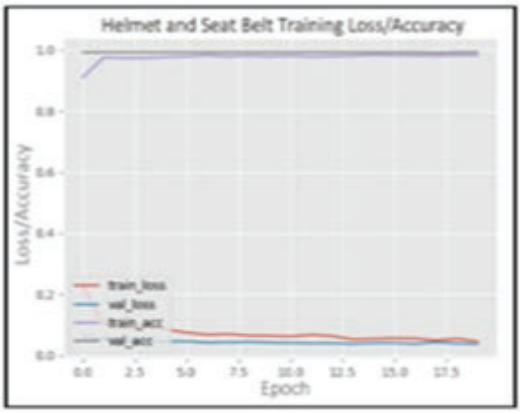


Fig. 4(a). Training/loss helmet and seat belt curve

such a way that, the Quadcopter can be operated manually, like to search and follow the criminal or rule breaker who is trying to escape from police. The presented paper initiates an idea to detect every rule breaker and captures his/her image in the data- base. Each control room have multiple drone controls at a time and can be accessed from a wide range Fig. 5.

4.6 Quadcopter Drone and Surveillance Unit

This unit consists of one Quadcopter drone having inbuilt camera. These drones are adjusted at a particular height in different regions near the control room. It uses the method of improved altitude control system for unmanned control. At that height, it observes every single activity on the roads and send the videos wirelessly to the operating system installed in the control rooms. The proposed system enables the opera- tors to monitor or security check at any period of time. In addition to this, it is used for surveillance purposes in critical situations. The presented model in drone camera output turn also plot the curve of loss and epochs percentage. The overall accuracy of this model is more than 90% Fig. 4(a). This is also embedded in the operating system inside the control room [24-25].

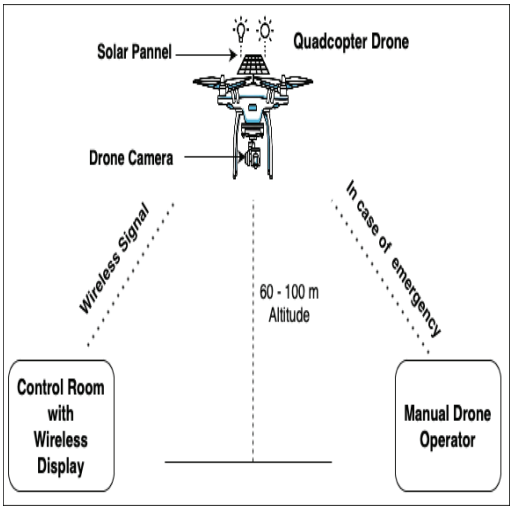


Fig. 5. Quadcopter drone setup

4.7 Storage

Due to such large number of videos and continuous surveillance system, a large number of storages is required. So, different external storage devices of about more than 3TB each are required forproper storage. In the presented system, each operating system has its own storage device i.e., data- base, where pictures and real time videos are stored according to different areas and control rooms.

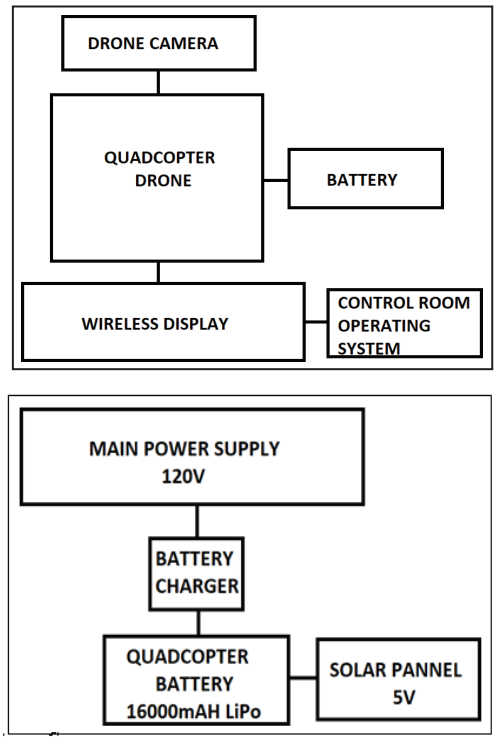
This helps in categorizing the location of the rule breakers and make it more convenient to track down his/her path easily.

4.8 Power Supply

The Quadcopter contains inbuilt 6 cell Lithium Polymer (LiPo) rechargeable battery of about 16000mAh.It provides long time duty to the drone and also it is lighter in weight which doesn't affects the drone speed or flying height. The main power sup- ply of minimum 120V is required to recharge the drone's battery. At particular interval of time, the discharged drones are replaced by the charged ones and in this way, it will not affect any detection or surveillance system. The fast power adapters are used for fast charging. It is also implemented with a small solar panel in it, due to which battery life increases and need less amount of recharging laps.

The presented setup is only for one Quadcopter drone. There are multiple drones un- der the single control room to enhance the security

5. Block Diagram



6. Future Scope

In current scenario, corona is a deadly virus, and mask is one of the most accurate and basic measure of prevention from corona virus. Just like helmet and seat belts are important for protection in traffic, masks are equally important for protection from virus in day-to-day life. So, we have proposed a system which will act as a surveillance unit and monitor the drivers and passenger if they are wearing helmet and seat belts as well as masks. The proposed system will be having a drone camera whichwill act as drone camera will continuously monitor the traffic and it can also be used for various other surveillance unit and in future it can be more advanced according to the requirements. This things such as human or vehicle tracking. For more accuracy, number of datasets can be increased in future with enhanced technologies. The major advantage of using drone camera is that we can move the surveillance unit fromone place to another based on our requirement. It will also help traffic department andboost their efforts in regulating the rules and in imposing the fines on rule breaker even without human interference.

7. Outcome

As explained in presented paper, the derived result is that this model is capable of detecting helmet, seat-belt and mask at the same time. This model is very helpful for the protection of drivers and passengers from traffic as well as corona virus. The above system is trained using a large number of data sets and it has been tried and tested in various environment to observe the outcome in different conditions. It has been observed that the helmet and seat belt detection model is more than 93% accurate and mask detection model is more than 90% accurate. The training of helmet and seat belt model is done using YOLO object detection framework Fig. 6 and 7, while the training of mask detection is done by using TensorFlow Zoo model Fig. 8.

Fig 6: Helmet Detection

The Quadcopter drone inbuilt camera is used for surveillance and criminal tracking purposes. The detection algorithm is performed on wireless screen of drone in real time. This system will trigger or take the image of the person who is not wearing the mask or helmet or seat belt. The proposed model helps in reducing the casualties and deaths in deadly accidents as well as in reducing the

spread of corona virus.

Fig 7: Seatbelt Detection

Fig 8: Mask Detection

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