Smart Traffic Police Helmet: Using Image Processing and IoT

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Abstract. Traffic is a major issue in any major city, and Hyderabad is no different. The Hyderabad traffic police commission is doing its best to control the traffic in the country with 2nd largest population in extreme conditions like heat and pollution. To help the traffic commission, who are controlling the traffic every day under the scorching sun, we have built a multi-purpose helmet that can help the traffic police while on duty. The helmet is installed with a camera and raspberry pi. Instead of using a handheld smartphone to take the picture of vehicles, the helmet snaps a high-resolution picture using a button. These pictures are sent to the AWS cloud using a pre-configured raspberry pi. These images are processed in the cloud where information like the number plate, color, and vehicle types is extracted. All these images can now be filtered according to date and time and viewed on a user-friendly interface.

Keywords: IoT · Image Processing · On-road Traffic · AWS

1 Introduction

At present time, humanity is facing a lot of issues, and one of them is the rapid increase in traffic congestion on daily basis. The reports say the increase in traffic jams is due to a high volume of vehicles, improper infrastructure, and unreasonable growth allocation. The huge number of vehicles, which is the main source of congestion in traffic, is the result of population overgrowth as well as economic development. To address the issue, the government can encourage people to make use of public transportation and also use bicycles. Governments in certain regions in Asia, such as Vietnam, have implemented laws to limit the number of automobiles a household may own [17]. These strategies mentioned above are effective. Offices, educational institutions, and hospitals are often located near the center of the city, making many people crowded during rush hour. The current population of India is 1.4 Billion as of 2022, which is based on the latest UN data [1]. The steady increase in the population of the country has led to a steady increase

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in traffic congestion as well. There is a steady increase in the number of vehicles owned by a family and individuals. As India's economy is quickly growing, so will the incomes of the family [18, 19]. So they can own more vehicles.

Apart from the rise in vehicle numbers, the roads are narrow and sometimes of poor quality, so swiftly controlling and clearing the traffic is an essential job of the traffic policemen. For this, the traffic policemen require good equipment to help them quickly apprehend the traffic rule violators, and quickly clear the traffic. Traffic causes a lot of frustration and inconvenience, so some might drive at speeds higher than permitted on that road to reach their destinations quickly, and also jump signals. These might lead to accidents on densely packed roads. Therefore, for the well-being and safety of both the traffic policemen and the people, traffic rules must be implemented strictly and the traffic violators must be fined. Stopping and fining the traffic rule violators is also sometimes difficult, due to traffic congestion. So systems that can automatically detect two-wheeler riders without helmets can also help traffic policemen [8–12]. These systems could also help traffic policemen quickly issue challans to traffic violators. Some systems could be modified to help implement these features [13, 14, 16].

Therefore in this paper, we have proposed an idea for a smart traffic helmet designed specifically for traffic policemen to increase their working efficiency and improve traffic management using IoT, cloud computing, and image processing. The Internet of Things (IoT) plays a major role in various applications such as agriculture [5], traffic control, providing safety for two-wheeler riders [4, 6, 7, 15], autonomous systems, and a variety of fields.

The prototype of the helmet has a raspberry pi camera attached to the helmet which takes images of the vehicles breaking the traffic rules (jumping the signals, and speeding) using various buttons available to the traffic policeman. The images taken are sent to the cloud where Machine Learning algorithms are applied to extract the vehicle's number plate. Other vehicle information such as vehicle type (bus, car, or truck) and the color of the vehicle is also determined. Vehicle image centering is also applied where the vehicle in the center of the image captured is focused on and the irrelevant background information is eliminated. Now all the images can be viewed on a user-friendly interface and can be filtered according to any date and time took. The paper aims at presenting a solution for solving the problem of congestion by providing proper equipment to traffic policemen.

2 Literature Review

Dikshant Manocha et al.; discussed in the paper ways to detect two-wheeler vehicles breaking traffic rules and give them a UI to pay their challans on time. Two-wheeler vehicles are separated from other types of vehicles. Then check if the rider's wearing a helmet using Open CV. If anyone is found not wearing a helmet, their number plate is processed using OCR. The challan generated is sent to the email and mobile phone of the vehicle owner, and they can pay it on the website or an app will also be provided to pay their challans [2].

Sarthak Babbar et al.; discussed in the paper that being able to identify the car and its respective owner is a tough job. Therefore, they have proposed a automatic number plate detection that can help solve this problem and control traffic. ML and Image Processing have been used to design the system proposed in this paper. A system that can improve detection in harsh conditions such as overexposure and dim lighting. The pictures are preprocessed using techniques such as binarization and grayscale. Next, the picture is passed for plate localization, for extracting the number plate using ratio analysis and CCA. Noise from the number plate is removed using filters. Characters contained in the number plate of the vehicle are then segmented using ratio analysis and CCA. Finally, then, the characters recognized are compared using multiple techniques such as Linear SVC, Extra Tree Classifier, Poly SVC, RBF SVC, KNN, LR + RF, and even SVC + KNN. These techniques help detect number plates under harsh conditions [3].

Divyasudha N et al.; have reviewed recent trends in the development of the Smart Helmet system. This system is used for preventing, accidents on bikes and identifying bike accidents to save lives. And, the system proposed in this paper, is to be used in the mining industry for the safety of the miners from the various hazards and to help alert the miners from toxic gases in there. The paper also helps address the intelligent motorbike system which informs riders about trucks and buses to avoid collisions [4].

3 Methodology

The main objective of this paper is to propose a method to reduce the workload of traffic policemen by quickly providing the necessary information to them. The following is the information considered to be provided to traffic policemen, which could be helpful to carry out their jobs: (i) Find the vehicle type and color; (ii) Find the vehicle number; (iii) Provide the information on the website, so that the traffic rule violators can be caught immediately.

For the prototype of the helmet, we have fixed the raspberry pi, camera, and power supply to the helmet. The remote contains 3 buttons primarily.

The buttons have the following functions: (i) To take the picture of the vehicle jumping the traffic signal; (ii) To take the picture of the vehicle speeding; (iii) To capture the video. The video starts recording once the button is clicked and stops recording after the button is clicked again.

With a press of a button on the remote, which is attached to the raspberry pi module, a picture/video of the vehicle is taken. The raspberry pi names the image according to a particular format, with all the relevant information like (i) Image name; (ii) Date and time in format - DD_MM_YYYY_HH_MM_SS; (iii) The place the picture was taken.

After the image name is formatted with relevant information, the pre-configured raspberry pi sends it to the AWS cloud s3 service buckets (storage location). The raspberry pi is already pre-configured to the AWS cloud account. The image is stored in a bucket in s3, let's call it for now "first bucket". After the successful upload of the image to this s3, the image triggers another AWS service called lambda.

This lambda consists of all the necessary code to process the image which we will be receiving from the raspberry pi. As shown in Fig. 1, the code is containerized using docker in an AWS service called EC2 and this docker container will be uploaded to ECR, and a lambda function will be built using this uploaded container. This lambda function processes the image in two stages. In stage one, the image targeted is identified by taking the vehicle which is closest to the center of the image. The coordinates of the vehicle along with the vehicle type are identified. The image is passed to the pre-trained

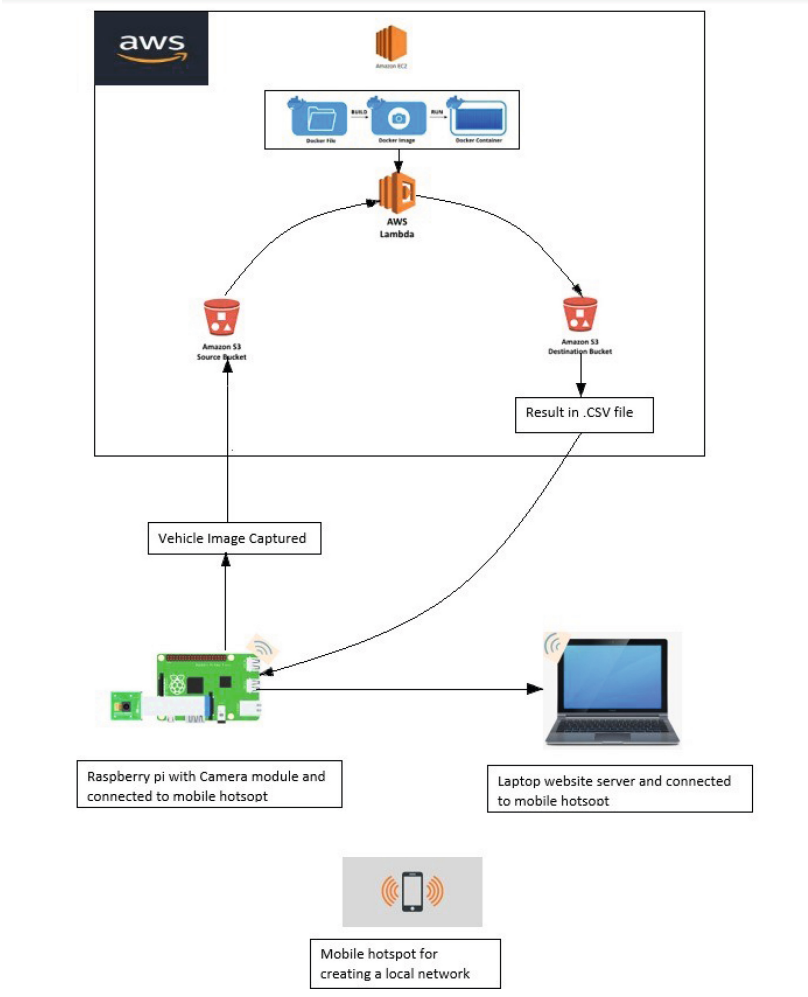

Fig. 1. The vehicle images sorted according to a specific date

YOLOv4 object detection model to get the coordinates of the vehicles. The coordinates of the vehicle are used to process only the target image to find the vehicle type. The vehicle type is now added to a CSV file along with the image name. Then the image is passed to the next stage.

In the final stage, we have two processes. In the first process, the color of the vehicle in the image is identified using the functions in the PIL library. In the second process, the vehicle number plate is identified using a custom-trained YOLOv4 model. The model was trained using the data from Open Images Dataset V7. The characters in the number plate are read using the tesseract OCR. The results are written to a.csv file and stored in another AWS s3 bucket, let's call it the "second bucket".

The raspberry pi constantly checks for the updates in the "second bucket", and once raspberry pi identifies that the file is updated, it downloads the file and sends the image along with the rest of the information to a website server. The raspberry pi downloads this.csv file and reads the results and organizes the results before sending them to the website server.

For simplicity purposes, we have kept the website server and raspberry pi in the same network. But this can be easily changed according to need. Once the information is sent to the website server, raspberry pi terminates the program. The computer has a local server that hosts the website. Finally, the image is displayed on the website along with the results.

The result on the website can be filtered using three filters: (i) Color of the Vehicle; (ii) Type of the Vehicle; (iii) Date the picture was taken.

4 Experimental Results

4.1 Experiments

1. First if multiple vehicles are present in the image, the centering feature is used to find the targeted vehicle and find the number plate. If we look at the image below, the number plate is successfully extracted: "MH14JA8374" along with the type and color of the vehicle (Fig. 2).

Fig. 2. Example of a picture taken by the camera module

2. The result is shown on the website as shown below: We can see the vehicle number, along with the offense committed by the vehicle, the color, and the type of vehicle. In Fig. 3, we can see that we can filter the images, by date, vehicle color, and by vehicle type. The date is mandatory. It takes approximately 2 min for the new batch's first image (which is sent after nearly 3 to 4 h after the last batch's last image) to be processed, but the next images will be processed within 1 min. The traffic policemen in the meantime the images are getting processed can keep taking pictures of the vehicles (Fig. 4).

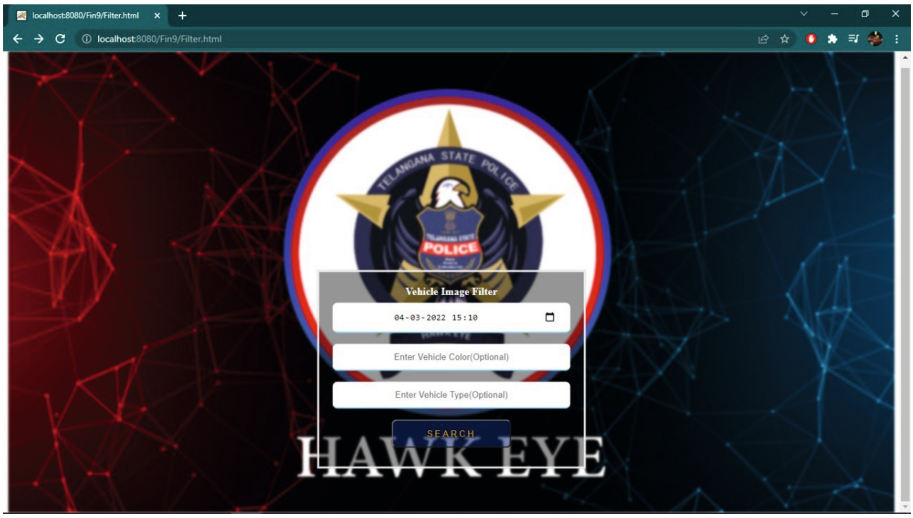

Fig. 3. The user-friendly UI to view and filter image

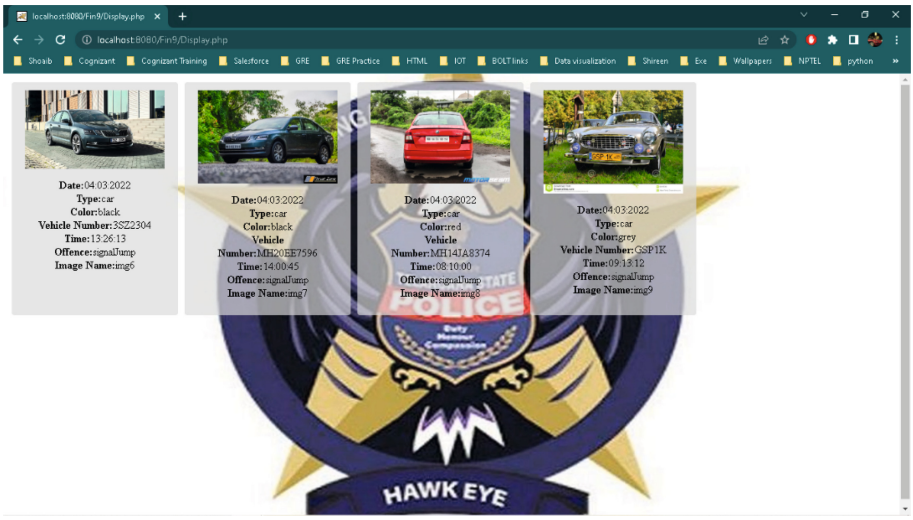

Fig. 4. The vehicle images sorted according to a specific date

5 Conclusion and Future Work

The primary objective of making the helmet is for improving the efficiency of the traffic policemen who relentlessly work in traffic, make people follow traffic rules and ensure their safety, and improve traffic management to avoid accidents. The number plates of the vehicles in the images taken using buttons have been successfully extracted and these images with the number plates can be accessed from anywhere and anytime by authorized officials with a web interface where they can view all the images taken by the traffic policemen and filter them out according to date and time took.

By transmitting the data to the website server, the traffic policemen can immediately stop the vehicles which are violating the traffic rules. This will help the traffic policemen to strictly control the traffic and collect the challans properly. Since the camera is fixed on the helmet, it is also possible for the traffic policemen to pursue the violators on bikes in serious cases.

The Future Scope could be to be able to extract different details from the vehicles aside from the vehicle number plate like the manufacturer of the vehicle. To be able to pre-process and extract details from multiple vehicle types and not only cars like bikes, autos, trucks, and buses will also help a lot. Using a camera that will be able to take pictures at night and a high-resolution camera that can take pictures that are very far and still able to extract the vehicle number. Making this website secure and accessible easily to authorized personnel is also a very important feature that can be considered.

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