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Automated Traffic Signal Penalty System using IoT and Machine Learning

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Abstract

In the current developing nation with an increase in population there is an increase in the number of traffic rule violations. Maintaining these traffic signal rule violations has always been a monotonous and time-consuming task. Although the current traffic management system is automated, the increasing population and use of vehicles and the diversity of number plates makes this task more difficult. The primary objective of this paper is to control these traffic rule violations precisely and cost friendly. The proposed paper includes an automated system which uses ultrasonic sensors and a camera which is connected to Arduino to capture video and take snapshots of vehicles. This paper presents automatic recognition of number plates of vehicles that mainly cross the pedestrian crossing when the signal is red. This could be done by implementing various machine learning techniques and image processing techniques for number plate detection and character recognition making this task much quicker and easier to identify number plates. Once the vehicle number is recognized from the number plate, a SMS will be generated on the registered mobile number on the number plate stating the details of the traffic rule violation that has occurred. This paper proposes a more cost effective and efficient automatic system to ensure more safety on roads especially near the pedestrian crossing.

Keywords: *Ultrasonic Sensors, Arduino, Machine Learning, Image Processing, SMS*

1. Introduction

India is a developing country which increases the number of personal as well as commercial vehicles. The increase has led to more traffic at signals causing congestion. This congestion increases with an increase in the number of accidents and traffic rule violations enormously. Overseeing traffic rule violations has consistently been an exceptionally troublesome job. These issues cause disturbance to the whole system and also devours our valuable time. So, to enhance the current ongoing traffic management system this paper proposes a solution which is more advanced. This paper includes various advanced technologies to handle casualties that mainly occur near the pedestrian crossing. So, the paper presents an automated system which keeps track of all the vehicles that cross the signal when the signal is red. This is done by snapping the number plates of the vehicles that are on or crosses the stop line with the help of ultrasonic sensors that are installed on and above the stop line. This automated system is proposed for the betterment of the society by bringing road discipline which further can decrease the number of road accidents that may occur.

2. Review of Literature

Nikita Prabhu et.al [1] describes a system that is divided into 3 parts. First part is a standalone system connected to the ignition system module of the car, second part is another standalone system which is connected to the traffic signal ends and the third part is the RTO unit. For the car ignition part, the owner of the vehicle has to install a RFID card which holds the driving licence in it and is placed near to the reader. This unique RFID card helps in detecting the vehicle and its owner.

Amey Narkhede et.al [2] proposes a framework that has a guideline target which controls traffic rule infringement precisely and cost viably. The paper presents Automatic Number Plate Recognition (ANPR) strategies and other picture control methods utilized for plate restriction and character acknowledgment which assists with recognizing number plates quicker and simpler.

Aditi Dambe, Upasana Gandhe, Varsha Bendre [3] presents a system which is designed to bring about punishment consequently to the vehicle driver for infringement of traffic rules. The punishment will be naturally charged to the vehicle proprietor if PUC has lapsed or if the vehicle is on zebra crossing when the sign is red. Also, it focuses on bringing discipline on roads by stopping the car if the car driver

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does not carry a legid license or if the driver is intoxicated. So, this is an attempt which can help to reduce road accidents which is being the major problem now-a-days.

Suyash Bharamb et.al [4] provides a solution which uses active RFID tags that would be mounted on each individual vehicle that monitors the vehicle's movement and which will help in reducing the accident rates in the country.

Aditi Yadav et.al [5] proposes a solution to build a traffic management system which is adaptive to the current scenario in a lane. This paper keeps track of the total number of vehicles in a particular lane and accordingly manages the traffic signal by adjusting the time signal by calculating the average congestion on the signal.

3. Proposed Solution

This paper proposes a system that monitors the traffic signal violation by vehicles that takes place on the pedestrian crossing. This system is categorized into five modules. The first module includes the capturing of vehicles that cross the stop line when the traffic signal shows the stop signal (red light). This capturing is done by placing ultrasonic sensors on the stop line and also on the extended traffic signal that is parallel to the road. These sensors are activated once the signal turns red. Once the sensor detects the vehicle, it will give an alert to the camera that is installed on the opposite signal and this camera will take snaps of the image and store those images for the next module. The second module is object (vehicle) detection from the stored image by converting it to gray-scale and then extracting the rectangular image of number plate of each vehicle. The third module is character recognition which identifies each character from the number plate and stores them in a database. The fourth module is creating a database that stores all the vehicle details which further helps is allocating penalties to violating vehicles. The last module sends an alert message on the registered phone number of the owner of the vehicle regarding the violation they have done and penalty they have been charged. The block diagram below gives a brief idea about the paper.

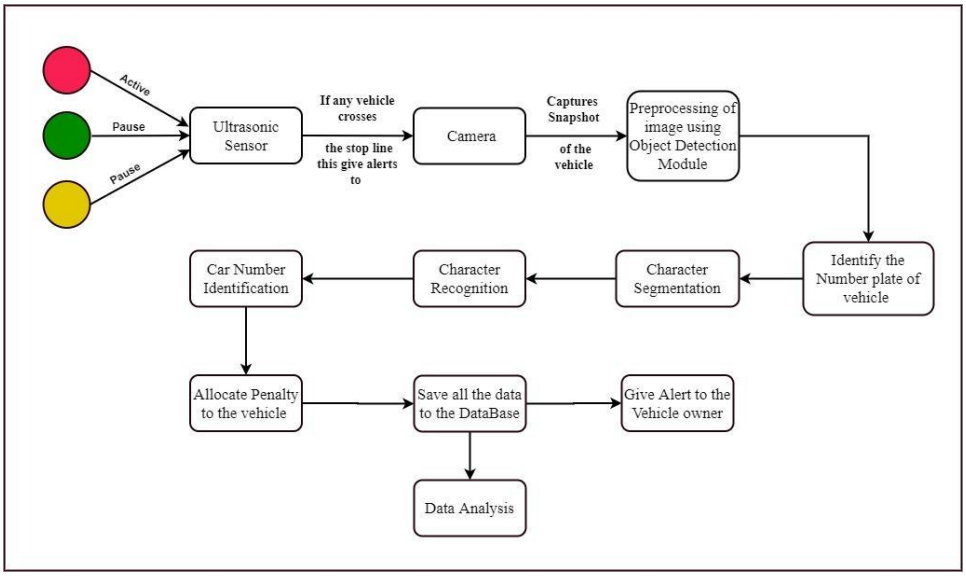

Figure 3.1. Block Diagram

Features that are likely to be fulfilled by this paper are:

- Object Detection through cameras on overhead signals.
- Easy recognition of number plates of every vehicle that violates the traffic signal.
- Assigning penalties on the registered mobile number of the owner of the vehicle.

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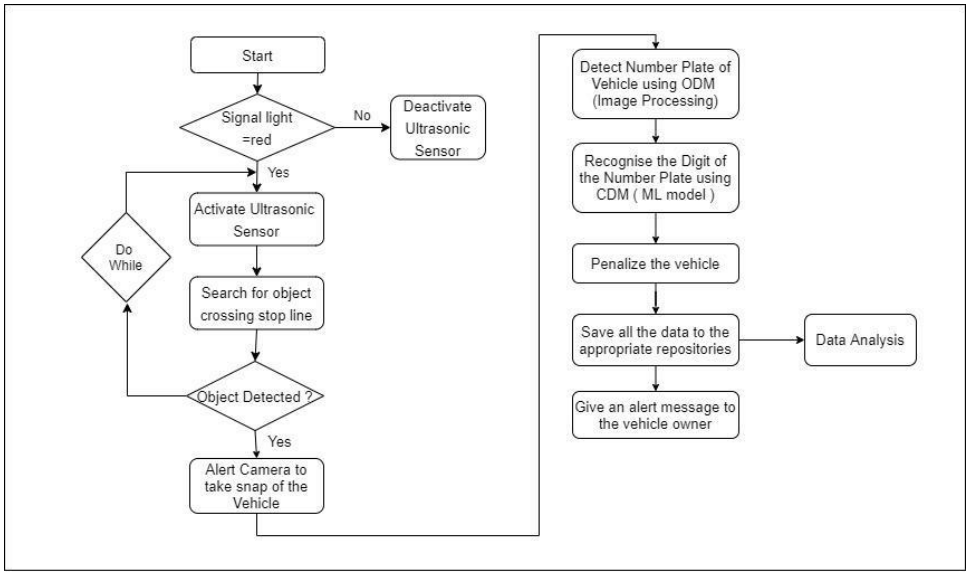

Figure 3.2. Flow chart

4. Methodology

4.1 Arduino

Arduino is an open-source arrangement used for building hardware projects. Arduino involves both a physical programmable circuit board (as often as possible insinuated as a microcontroller) and a touch of programming, or IDE (Integrated Development Environment) that abrupt spikes popular for your PC, used to create and move PC code to the physical board. The Arduino kit has been very standard with people basically starting with devices, considering current conditions. Hardware devices include cameras, ultrasonic sensors, LDR and LEDs.

4.2 Object Detection

Making precise AI modules for limiting and distinguishing different items of a solitary image stays a center test in PC vision. The TensorFlow Object Detection API is an open-source framework dependent on TensorFlow that makes it simple to develop, prepare and send object location models. This model specifically will detect all the vehicles in a given area of violation once the traffic signal is RED. We also use COCO which is a huge image dataset intended for object recognition, division, individual key points discovery, stuff division, and subtitle age. This package gives Python, and Lua APIs that help with stacking, parsing, and picturing the comments in COCO.

Figure 4.1. Unique Object Detection

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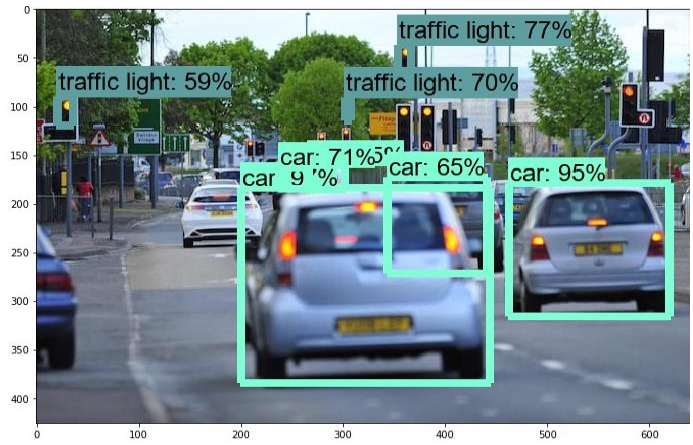

Figure 4.2. Many Object Detection

4.3 ANPR (Automated Number Plate Detection)

In this model, the output of the previous model is used as input in the form of an image. That image is firstly converted to a gray scaled version of itself using OpenCV tools. Then that gray scaled image is converted to its threshold values. Then the contours are set for these threshold images. After that, the area having multiple characters is selected as the licensed number plate.

When the characters on the number plate are distinguished at that point the model converts each selected image of the number plate to its gray scaled version, then to its threshold version and later each character is selected from that image by selecting each contour. Lastly, the model uses KNN algorithm for character recognition. And then all the characters are appended one after other and then the string is given as a result.

Below are the pseudo codes that are used for number plate recognition.

```
def loadKNNDataAndTrainKNN():
    allContoursWithData = []
    validContoursWithData = []

    try:
        npaClassifications = np.loadtxt("classifications.txt", np.float32)
    except:
        print("error, unable to open classifications.txt, exiting program\n")
        os.system("pause")
        return False

    try:
        npaFlattenedImages = np.loadtxt("flattened_images.txt", np.float32)
    except:
        print("error, unable to open flattened_images.txt, exiting program\n")
        os.system("pause")
        return False

    npaClassifications = npaClassifications.reshape((npaClassifications.size, 1))
    kNearest.setDefaultK(3)
    kNearest.train(npaFlattenedImages, cv2.ml.ROW_SAMPLE, npaClassifications)

    return True
```

Figure 4.3.1. Pseudo code for loading KNN algorithm

```
def preprocess(imgOriginal):
    imgGrayscale = extractValue(imgOriginal)

    imgMaxContrastGrayscale = maximizeContrast(imgGrayscale)

    height, width = imgGrayscale.shape

    imgBlurred = np.zeros((height, width, 1), np.uint8)

    imgBlurred = cv2.GaussianBlur(imgMaxContrastGrayscale, GAUSSIAN_SMOOTH_FILTER_SIZE, 0)

    imgThresh = cv2.adaptiveThreshold(imgBlurred, 255.0, cv2.ADAPTIVE_THRESH_GAUSSIAN_C,
                                      cv2.THRESH_BINARY_INV, ADAPTIVE_THRESH_BLOCK_SIZE,
                                      ADAPTIVE_THRESH_WEIGHT)

    return imgGrayscale, imgThresh
```

Figure 4.3.2. Pseudo code for gray scale image and threshold image conversion from original image

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```
def drawRedRectangleAroundPlate(imgOriginalScene, licPlate):

    p2fRectPoints = cv2.boxPoints(licPlate.rrLocationOfPlateInScene)

    cv2.line(imgOriginalScene, tuple(p2fRectPoints[0]), tuple(p2fRectPoints[1]), SCALAR_RED, 2)
    cv2.line(imgOriginalScene, tuple(p2fRectPoints[1]), tuple(p2fRectPoints[2]), SCALAR_RED, 2)
    cv2.line(imgOriginalScene, tuple(p2fRectPoints[2]), tuple(p2fRectPoints[3]), SCALAR_RED, 2)
    cv2.line(imgOriginalScene, tuple(p2fRectPoints[3]), tuple(p2fRectPoints[0]), SCALAR_RED, 2)
```

Figure 4.3.3. Pseudo code for drawing a rectangle around the selected number plate

4.4 SMS Model

The SMS model shoots a message to the registered mobile number of the number of vehicles. The SMS would be sent when the vehicle is found to be violating the traffic signal.

5. Results

Given below are the screenshots of the implementation of the proposed system described in the paper.

Figure 5.1. Image of car used for ANPR

Figure 5.2. Gray-Scaled Converted Image

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Figure 5.3. Gray-Scaled Image converted to threshold level1

Figure 5.4. Image converted to threshold level2

Figure 5.5. Image after removing inner contours

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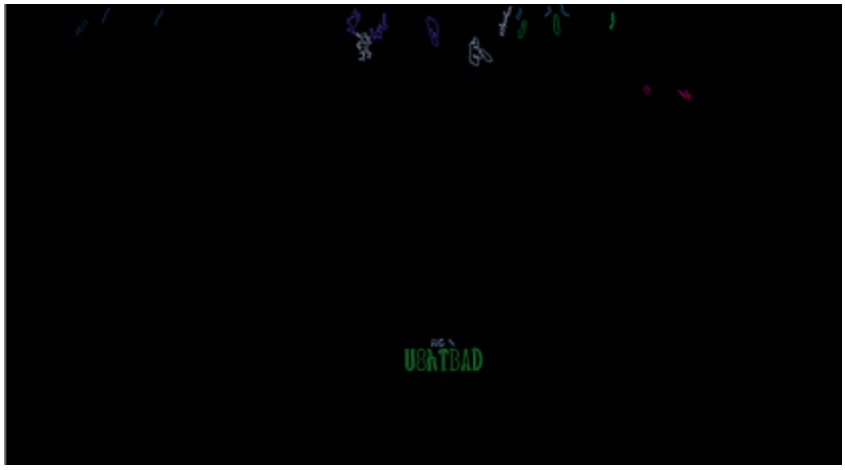

Figure 5.6. Image showing the region having a possibility of a group of characters together

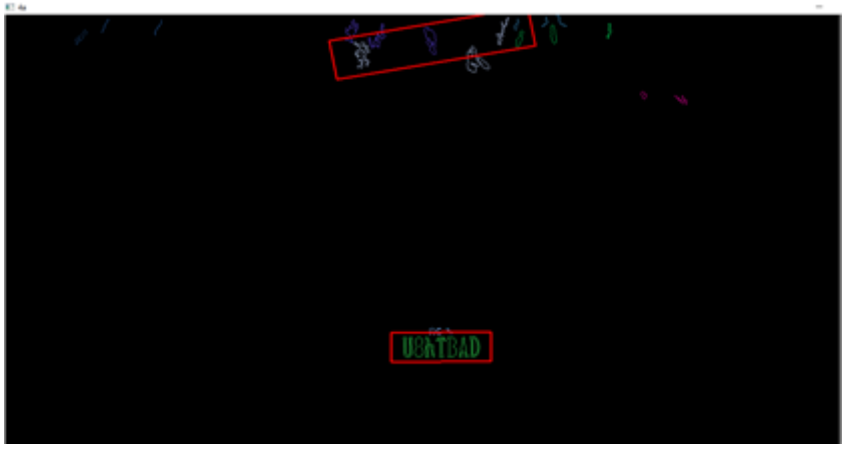

Figure 5.7. Image highlighting the region having a possibility of a number plate

Figure 5.8. Identification of Characters from a number plate

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Figure 5.9. Result showing the letters of number plate

```
8 possible plates found


possible plate 0, click on any image and press a key to continue . . .
possible plate 1, click on any image and press a key to continue . . .
possible plate 2, click on any image and press a key to continue . . .
possible plate 3, click on any image and press a key to continue . . .
possible plate 4, click on any image and press a key to continue . . .
possible plate 5, click on any image and press a key to continue . . .
possible plate 6, click on any image and press a key to continue . . .
possible plate 7, click on any image and press a key to continue . . .


char detection complete, click on any image and press a key to continue . . .


license plate read from image = U8NTBAD
```

Figure 5.10. Result giving the characters of number plate

6. Conclusion

In this way we have thought of a usage of a framework which will automatically cause punishment for infringement of traffic signal principles and thus will prompt a restrained traffic in our nation. We trust these endeavors will help in limiting numerous issues identified with traffic which carries unsettling influence to the entire traffic system and will help in diminishing the quantity of catastrophe; congested roads which devour our valuable time, and will likewise lessen contamination up to some extent.

In this paper we propose a system that monitors the vehicles that cross the signal when it indicates Red by installing a camera on the traffic signal and an ultrasonic sensor overhead the stop line which will keep note of all the vehicles that violate the traffic signal.

7. Future Aspect

The system will work quite well however, there is still room for improvement. Currently there are some restrictions regarding various parameters like pace of the vehicle, content on the vehicle number plate, overlapping of vehicles which can be further eliminated by upgrading the current algorithms. Also, with the help of data collected by the system it becomes easier to analyses the data and understand the traffic controlling in an area and also know about the sincerity of the vehicle driver around a particular area.

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This same system can be very well used for other violations done by the vehicles like over speeding, breaking standard rules and regulations and thus making the up gradation of the system more frequent and necessary.

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