Preliminary Experimental Results from the Design and Implementation of a Traffic Violation Detection System

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ABSTRACT

Traffic violations are becoming a major concern due to urbanization, making it difficult for traffic enforcement authorities to prosecute perpetrators. The increasing number of cars on city roads has led to serious traffic violations and caused significant damage, injuries and loss of lives. This paper proposed a traffic violation detection system aimed to improve road safety and enforcing traffic regulations. The system detects speeding and red light violations. By deploying cameras and sensors within the mini traffic environment, the system captures real-time images and videos of vehicles involved in violations. Detected violations trigger the fines that are issued to respective offenders.
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Keywords— Traffic violation, Detection, System Design, Road safety.

1. INTRODUCTION

Traffic violations are becoming a major issue in many cities as the world becomes more urbanized, making it difficult for traffic enforcement authorities to prosecute perpetrators. The increasing number of cars on city roads has led to serious traffic violations and caused significant property damage and injuries that can threaten lives. The volume of traffic on roadways in Ghana urban cities have resulted in various degrees of traffic rule violations especially jumping red lights and exceeding speed limits. Most traffic accidents are caused by driver inattention, distraction from in-vehicle activities, and fatigue. Drivers may not be fully aware of these factors or their impact on their driving performance, leading to unintentional traffic violations such as speeding or ignoring stop signs [3].

These violations often occur due to a lack of concentration rather than a deliberate intention to break the law. To effectively address traffic violations and overcome the limitations and errors of human traffic operators, efficient traffic violation and license plate recognition systems are necessary. These systems use various computational approaches to read characters, such as alphabets, numbers, or alphanumeric, and this will help to improve processing time and reduce computation load on the system [4]. By helping to apprehend traffic offenders, these systems can ameliorate the traffic violations management, make drive more cautious of their driving performance and therefore reducing the number of violations and the related road crashes.

The increasing number of cars in Accra and other cities causes high volume of traffic and implies that traffic violations become more critical nowadays in Ghana. Drivers engage in reckless or aggressive behaviors, such as speeding, tailgating, or making illegal turns. They also tend to get affected by fatigue or simply get distracted by in-vehicle activities like texting, eating or loud music [5].

Traffic violation detection systems are used to identify and enforce violations of traffic laws and regulations, with the goal of improving road safety and reducing the number of accidents and injuries resulting from such violations [6]. There are various approaches to traffic violation detection, including automated systems that use technologies such as cameras, radar, and sensors, as well as manually operated systems that involve law enforcement officers patrolling the roads and stopping vehicles to issue citations.

This proposed Traffic violation detection systems is cost-effective detection system that helps both offenders and authorities to be aware of violations and take appropriate actions. In this paper, we proposed a detection system that combines speed monitoring system and red light monitoring system. The system uses a sensor based approach, computer vision based approach and automatically detect when a driver has exceeded the speed limit or violated the red light. Violation management system is also used to notifying authorities where the violation will be approved sent to the offender.

The paper is arranged as follows. Section II provided the Design Methodology of the Proposed Model. Section III presented the results obtained from the proposed design. Section IV concluded the paper.

2.. DESIGN METHODOLOGY OF THE PROPOSED

The proposed detection system used Raspberry Pi as the main controller for the traffic violation detection system. Python was used as the programming language for the Raspberry Pi. The Raspberry Pi was connected to two ultrasonic sensors, a traffic light module, and a Raspberry Pi camera. These components were used to detect traffic violations such as speeding and running red lights. When a car was detected breaking the speed limit or running a red light, the Raspberry Pi activated the camera to capture images of the offending vehicle. Additionally, a file watcher was used to check a specific directory for new images captured by the camera. These images were then uploaded in real-time to the Violation management system website, where authorities could view the images and issue fines to offending drivers.

Raspberry Pi
A Raspberry pi is defined as a minicomputer that is interoperable with any input and output hardware device like a monitor, a television, a mouse, or a keyboard, effectively converting the set-up into a full-fledged PC at a low cost. It is suited to IoT devices due to their small size and exhaustive capabilities The Raspberry Pi embedded system was an integral part of the traffic violation detection system for this research.

This provides the necessary computing power and interfacing capabilities to control and monitor the hardware components. Its flexibility and affordability make it an excellent choice for a wide range of embedded systems projects.

Ultrasonic Sensor

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

Raspberry pi Camera

The Raspberry Pi camera module is a small camera that is connected to the Raspberry Pi board. It is a high-quality camera that is capable of capturing clear images and video. The camera module used in this traffic violation detection system is the Raspberry Pi Camera Module V2. The camera module has a resolution of 8 megapixels and is capable of capturing high-quality images at a maximum resolution of 3280 x 2464 pixels.

Traffic light module

A traffic light module is an electronic device that controls the operation of traffic lights at intersections and other locations where traffic needs to be regulated. The module typically consists of a microcontroller or other processor that receives input from sensors or switches indicating the state of the traffic, and then generates output signals to control the operation of the traffic lights.

Process Flow Chart of Violation Detected.

1. Check the Signal: If signal is red then start capturing the video to search for any violators. If not then do not capture anything.
2. Check for Violation: If any violation occurs the only save those vehicle images who had done violation into the database for further processing
3. Extract Number Plate from Vehicle Image:
4. These information are sent to the violation management database systems
5. Thereby notify the necessary authorities where fines are issued and email to the offender.
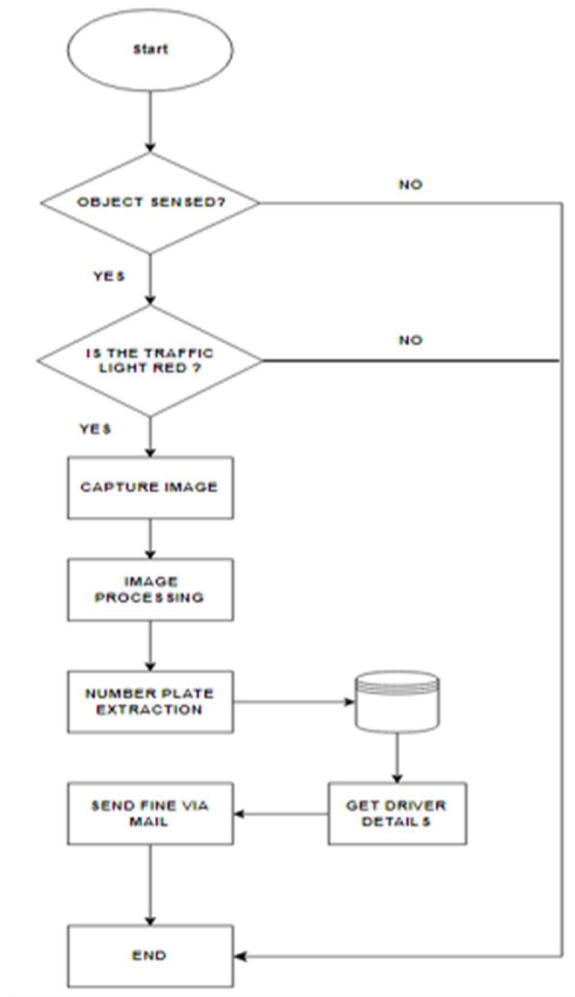
Figure 1: Process Flow Chart of Violation Detection

3. PRELIMINARY EXPERIMENTAL RESULTS

The traffic environment simulated real-life traffic scenarios, providing a controlled setting for testing the violation detection system. It accurately replicated normal road conditions, traffic signals, and vehicle movements, ensuring a realistic and reliable evaluation of the system's performance. The prototype **tools** can generate accuracy detection of an image of the license plate number of the vehicle in violation of more than 90 percent. In contrast to previous research [7, 8], the level of accuracy of detection of images ranging from 60-70 percent.
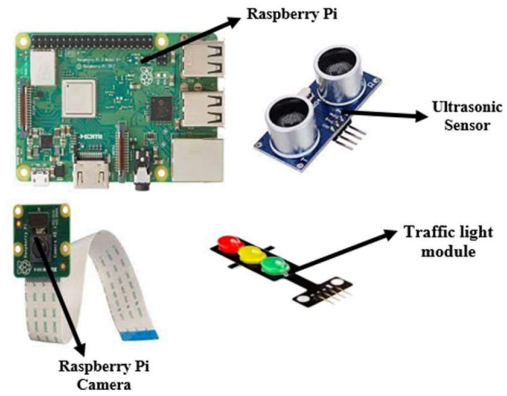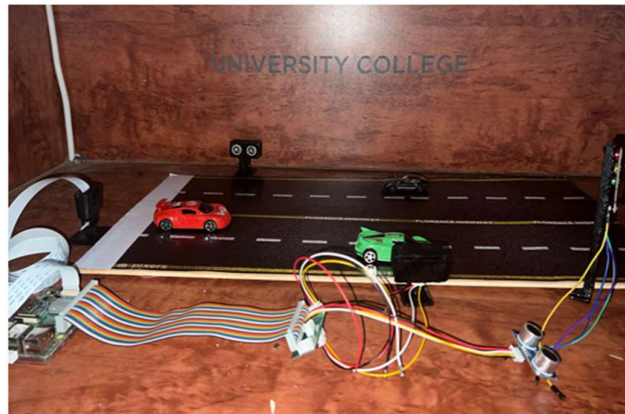
Figure 2: Proposed Technical Components

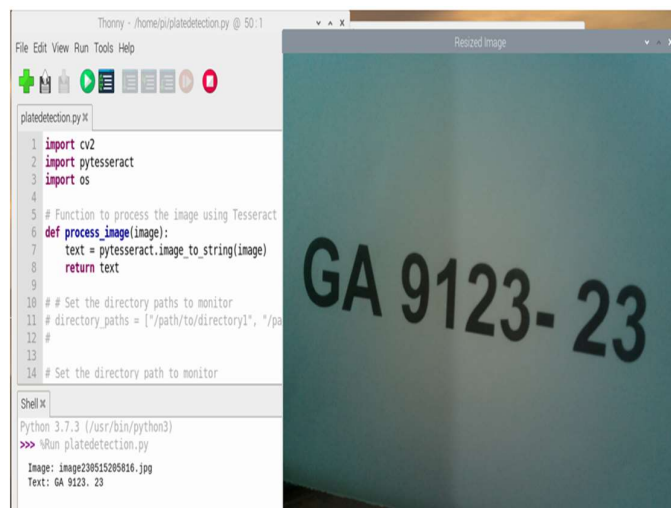Figure 3: Prototype of Traffic violation detection Simulation Environment

Figure 4: License Plate Extraction

Table 1: Preliminary Vehicle Traffic Violation Detection Log

Serial No.	Plate Number	Time	Accuracy
1	GA 9123 -23	2023-05-18 21:33:40	95%
2	CD 9368 1	2023-05-18 21:35:50	90%
3	ER 7959 18	2023-05-19 13:35:21	91%
4	WR 9247 N	2023-05-19 10:10:37	89%
5	GV 377-14	2023-05-20 08:03:11	92%

4. CONCLUSION

We have design a system that can detect traffic violations and the result of the detection of the offense can be stored automatically and recorded in the database. The level of accuracy and the detection of vehicle number plate and image processing is 90%. This system will help to apprehend traffic offenders, make drivers more cautious of their driving performance and therefore reduce the number of violations and the related road crashes.

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