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Traffic Congestion Monitoring Approach For a Targeted Area Using Blob Analysis with ThingSpeak

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Abstract: Congestion problem is becoming a major problem in many developing countries due to the high populations and uncontrolled on the road vehicles issues. The conventional systems for traffic control mostly apply sensors and timer. Initiatives has been taken including using an under-loop sensor, fuzzy logic and also Artificial Intelligence (AI) to solve the issue. The main objectives of this project are to detect and count the vehicles using an image processing technique. AI method is implemented in the traffic light system. The AI system is very precise in detecting the vehicles in the traffic. Besides, the data of the traffic condition can be stored and monitored by using the ThingSpeak in a real-time. The result shows the system can control the traffic light condition by turning the priority lane to green and also monitoring the traffic condition in the ThingSpeak. As the result, the transportation expenses, time, and reduce air pollution can be reduced.

Keywords: Artificial Intelligence (AI), Web camera, ESP32, Traffic Light LED, IOT (ThingSpeak)

1.0 INTRODUCTION

The problem of traffic congestion is worsening worldwide. As the population expands and cities thrive, so does the number of vehicles on the road [1]. This situation may cause traffic congestion since the traffic systems are unable to meet the traffic needs. During the peak hours, this scenario deescalating, resulting in increased traffic delays, air pollution, and wasted fuel costs [2]. The problem arises when the roads get congested early in the morning as everyone rushes to work or other destinations. To avoid traffic, some residents have to wake up early in the morning, and those residents have to travel long distances to reach their destination. The same is happening in the evening, when everyone returns from work and the roads get congested. This situation causes heavier traffic, and they have to spend more time in their vehicles, [5].

The most effective way to overcome traffic congestion is to use modern technology to manage traffic signals and intelligent roads. Roadways are becoming more efficient and well-managed when smart roads are applied. In addition, the IoT is a system linked to one another over the internet and includes all of the physical objects around us that can solve traffic congestion, [3]. The IoT seems to have the potential to improve traffic flow, driver safety, and transportation costs. Moreover, this implementation technology has been introduced in Malaysia, specifically in Cyberjaya and Kuala Lumpur. However, it has been implemented on a significant road at certain junctions only.

In general, the "Preset Cycle Time (PCT) Controller" and the "Vehicle Actuated (VA) Controller" are the most common technologies that have been installed at numerous Malaysian traffic junctions. However, these technologies still have to be improved since it still requires police traffic to control the congestion on the road [4]. These type of traffic light controllers have restrictions since they do not enable for real-time adjustment yet operate according to the program. [6] Thus, it did not even consider the number of vehicles in the lane with a long line than on the other side of the road during peak hours. Because the road system is inefficient in some areas, implementing a smart road system is crucial to prevent the traffic congestion in specific locations. The researcher uses many advanced solutions to solve these issues, including a PLC timer controller and machine learning. The image processing is one of a commonly used solution to solve the traffic jams.

Therefore, this project introduces an image processing techniques to control traffic condition. In this project, a web camera will be placed at the priority lane and used to determine the number of vehicles by using image processing techniques and OpenCV. The extracted image is then stored in the cloud using the ThingSpeak platform

2.0 METHODOLOGY

The methodology is simplified in the block diagram as shown in Figure 1 and it is further detailed in the flowchart as presented in Figure 2. From the block diagram, the first step is to decide the input, process and output elements. The input for this project is the web camera as the tool to produce the relevant image and process the image. The image is processed using ESP32 and the output is processed in ThingSpeak and generated the programmed output.

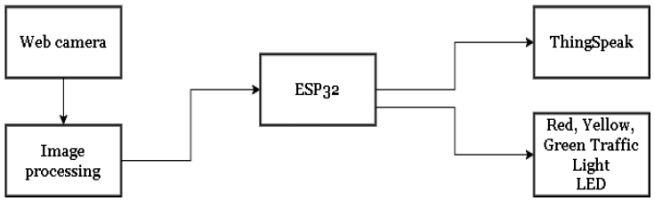

Figure 1: Block Diagram

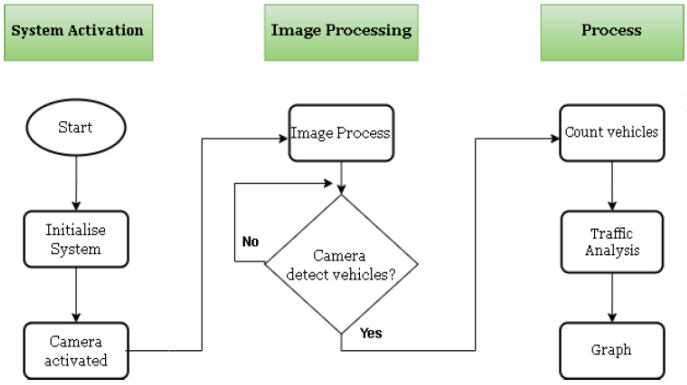

Figure 2: Flow Chart

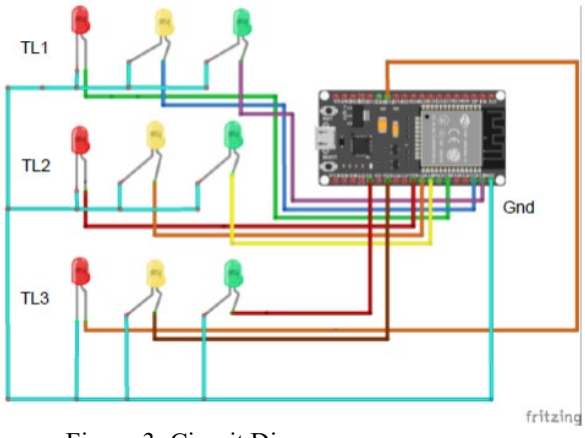

Figure 3: Circuit Diagram

A 2K Full HD web camera is used in this project. Even though the web camera has no brand, but it is able to produce a true colour photos with high resolution pixels. Even in dimly light settings, the video is bright and smooth with excellent clarity. The streaming and recording of the video are also sharper and more precise. In this project, only one web camera will be placed at each of the lane at one time. Then, it will do the image processing process to detect and count the vehicles. It will do the image processing by using a blob detection technique with an OpenCV based. Besides that, the ESP32 WiFi module will be used as a serial connection with the PC to receive and process the data. Then, the Thing Speak platform is used to send the data from the ESP32 to the cloud server to view and analyse the traffic condition in each lane. Also, the traffic light LED will be turn to green, depends on the condition of the traffic.

The technique is detailed out in the flowchart (refer Figure 2) beginning with the system activation. The system activation requires initialization before activating the web camera. Next step is the image processing step where it determines the detection of vehicles. The image will be process in the camera using a blob detection technique. If no vehicles detected, it will return to the image processing. However, if it detected the vehicles, it will do the counting at each of the lane. It will then processes the data captured and shows the traffic analysis by turn the traffic light LED to green, depends on the traffic condition in each of the lane. Then, each of the result in each lane will be display in the graph. It is used as a data storing in the ThingSpeak.

The system's circuit is shown in Figure 3, which was created using a Fritzing Software. This software is simple to use because it displays the input and output pin configuration of the microcontroller. This project use ESP32 microcontroller, therefore the pin connection that is connected with the LED traffic light pin is shown in this software. The traffic light LED is divided into three rows to indicate traffic light LED 1, 2, and 3. Next, the serial connection is made with the PC which it is connected to the ESP32 by using USB wire.

Figure 4 shows the prototype of project. Basically, the project focused on T-junction in residential area. As shown in the figure, the web camera is placed on the project prototype for testing and analysis purposes.

3.0 RESULTS AND DISCUSSIONS

The project experimented three different lanes at one time. The main observation is on which lane will turn to green first. As an outcome, a ThingSpeak is used for both real-time monitoring and data collection throughout the process.

Figure 4: Prototype of the project

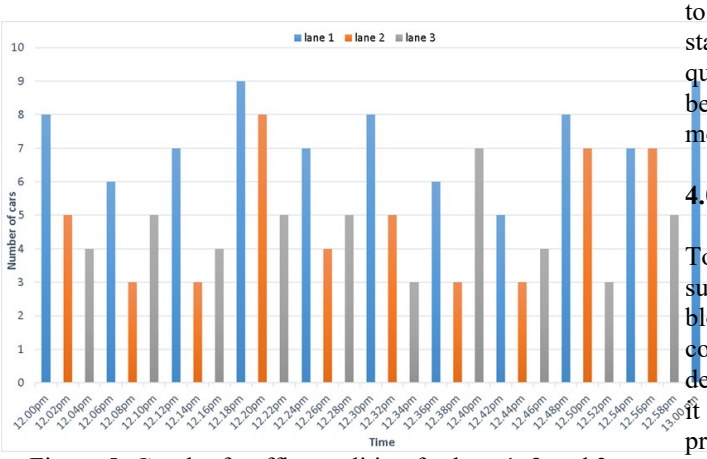

Figure 5: Graph of traffic condition for lane 1, 2 and 3

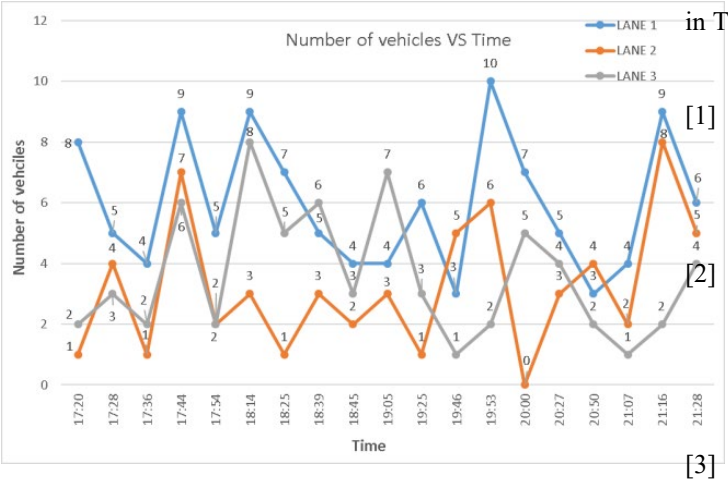

Figure 6: Graph of number of vehicles vs time

Figure 5 presents the plot of the counting number of vehicles based on the detection of the vehicles from 12.00pm until 1.00pm. Based on the graph, it clearly shows that the number of vehicles in lane 1 is more than at the other lane. This is to indicate that lane 1 as a priority lane. Basically, to detect and count the vehicles, a blob detection technique was chosen.

Figure 6 shows the plot of traffic condition in lane 1, lane 2 and lane 3 between the number of vehicles and time. The experiment was taken during 5.20pm to 9.28pm. During this 4 hours and half, a few observations can be made. At the evening, the range between 5.20pm to 6.25pm, the number of vehicles is in a maximum at lane 1. This is shown that lane 1 is a priority lane. At 7:53pm, the number of vehicles increase up to 10 at lane 1 and continue to 7 until 8:00pm. However, in lane 3 the number of vehicles is less than the number of vehicles in lane 2 during this time. However, for lane 2 the number of vehicles maximum at 9.16pm, and 6.14pm for lane 3. For lane 2, at 5.20pm, the number of vehicles is stable until 5:36pm. At 5.44pm, the number of vehicles is increase up to 7 and turn back to normal until 7.54pm. This can be stated that lane 2 is a not too busy in the evening. Lane 3 is quite clear at 7:25pm to 9.28pm. At the evening, the range between 5.20pm to 6.25pm, the number of vehicles is in a moderate at this lane

4.0 CONCLUSION

To conclude, the project's objectives were met successfully. The image processing technique which is the blob detection was used to create and test a traffic light control and monitoring system. The project also includes a detection of vehicles in each junction at one time. Besides, it also includes a traffic analysis in the ThingSpeak. This project made it possible for people to control the traffic condition without any help since it can be monitor in a real-time. The project's findings were achieved and shown in Thingspeak

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