**SMART ROAD CROSSING SYSTEM**

**USING IMAGE PROCESSING TECHNIQUES**

**A thesis by**

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**AUTHOR’S DECLARATION**

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University or equivalent institution, and that to the best of my knowledge and belief, contains no material previously submitted or written by any other person , except where due reference is made in the text of this thesis.

I carried out the work described in this dissertation under the supervision of Mr. PPNV Kumara and Mr. DMR Kulasekara.

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**ABSTRACT**

The people in every country use different types of road crossing methods. Like pelican crossings, puffing crossings, two-way crossings, zebra crossings etc. In many countries, zebra crossings are most popular method. In Sri Lanka also the situation is same. But we can see some pelican crossings also in few urban areas. Those systems have a push button for pedestrians and when they want to cross the road they have to push it and wait for a given time until the system allow them to cross the road. But those kind of systems have few problems. They are not flexible. And not user friendly. They can be waste the time of pedestrians and also drivers. My proposed system is much better and flexible than the existing systems in Sri Lanka. . The system is designed by using python 2.7.13 platform and for the image processing part, I have used OpenCV 3.0.0 libraries and Haar-cascade technique. It uses a push button to start the system and then two camera feeds taken by the system to detect pedestrian count and vehicle count. Then it uses the algorithm to decide when the system should allow pedestrians to cross the road. The waiting time for the pedestrians will be differ according to the pedestrian count and vehicle count in that specific time. This method can save time for both pedestrian and vehicles. And also it will help to reduce the traffic on the road.

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**CHAPTER 1**

**INTRODUCTION**

* 1. **Introduction**

In the modern world, road traffic and pedestrian safety is a big problem. In the Sri Lanka also the situation is same. Road crossing plays a vital role regarding this problem. We could see many road accidents while crossing the roads. And it also effects to the road traffic. In this paper we have proposed a new smart road crossing system with dynamic schedule of waiting time and road crossing time according to the count of vehicles and pedestrians.

* 1. **Problem in Brief**

In Sri Lanka we use zebra crossings to cross the road. There are no special kind of traffic light systems for many areas except some popular main cities like Colombo, Kandy etc. In those systems, we have a button to press before crossing the road. Then it will wait a fixed time period and put red signal light for the vehicles and allow a fixed time for pedestrians to cross the road. The waiting time and the road crossing time is fixed no matter the count of the pedestrians or the count of the vehicles. Those systems are not user friendly and flexible, and they are wasting the time of drivers and pedestrians.

The proposed system is specially design for reducing those drawbacks in the present system. For that we are using two cameras to detect vehicles and pedestrians. After a person push the button to cross the road the system first check the vehicle density on the road by using first camera, then system detects the number of people in the waiting area by using the second camera. Then according to the number of people and the vehicle density system will run an algorithm to decide which party should get the priority and decide how long those people need to wait to cross the road.

* 1. **Aim**

The aim of this project is to develop a time saving, flexible, accurate, smart road crossing system using image processing techniques.

* 1. **Objectives**
* System should start by pressing push button
* System should be able to detect and count people and vehicles
* System should have an algorithm to control signal lights
* System should be able to process quickly to get the output
  1. **Hypothesis**

The system will reduce the road traffic and it will save the time of vehicles and pedestrians.

* 1. **Summary**

Within this chapter, the introduction to the project including the background of problem domain, aim and objectives, and a brief account on solution is mentioned. The chapter 2 is on existing solutions to the problem domain by comparing those to the solution provided by this system. Chapter 3 discuss the technologies used for the system. It will follow up chapter 4 which describes the approach to the problem identified. A detailed description on the analysis and design is included in chapter5. The project implementation is included within the chapter 6. A discussion about the final outcome and interpretation of results obtained is stated in chapter 7. Finally, the report includes the references and a collection of appendixes.

**CHAPTER 2**

**LITERATURE REVIEW**

**2.1 Introduction**

This chapter includes a full description about background research carried out within the relevant areas of the designed system. Other existing systems in the world and in Sri Lanka and their drawbacks and how the proposed system is better than those systems are discussed in this chapter.

**2.2 Available Road crossing Systems**

In the United Kingdom and certain parts of the Commonwealth of Nations like Sri Lanka, animal names are being used to name Road Crossings. Zebra crossing is the most popular name which we use to distinguish Road Crossings.

A traditional zebra crossing consists of wide longitudinal stripes on road (perpendicular to the crossing route), often with Belisha beacons. But in Sri Lanka we can’t see those kind of Belisha beacons. We can see only the zebra crossings. In those zebra crossings, Pedestrians may cross at any time, while drivers must give way to pedestrians who demonstrate intent to cross. This type of crossings are not suitable for urban areas where we can see big traffic. And they are not a safe for the pedestrians. Now we can see, there are some advanced road crossing systems in Sri Lanka.

When we travel in Colombo, we can see there are zebra crossings which have traffic light system to control the vehicles and pedestrians. In those systems are working according to pre-defined program. Which means, someone has programed this system to when it allow vehicles to go and when it allow to people to cross the road.so in regular intervals the system stops vehicles and allow people to cross the road. This system is better than normal Zebra crossings, but it has some week points. People have to wait until the system let them to cross the road, even there is no vehicle on the road. And in other hand system will stop vehicles, even there is no pedestrian to cross the road.so it will waste the time of drivers and pedestrians.

As a solution for the above problems, people have attached a push button system to the above road crossing system. We can see those kind of systems in Kollupitiya, wellawatte, Bambalapitiya, etc. but still it has some limitations. People have to press the button and wait until the system put red light for vehicles and green light for pedestrians to cross the road. The system has a fixed time to start this process. So even there is no vehicle on the road, the system will wait that time to let the pedestrians to cross the road. It is a waste of time for the pedestrians. And if someone press the button and then he change his mind and walk away, but still the system does not know about that. It will put red light for the vehicles. So it is not an effective system.

There is a road crossing system in UK which is much similar to the proposed system. It uses sensors to detect vehicles and a camera to detect pedestrians. According to those detection it control the signal lights. This is much better system than the systems which we talked before. But we have identified some drawbacks of that system. It uses metal detecting sensors or pressure sensors to identify vehicles. Using those kind of sensors the system can identify weather vehicles on the road or not. But to detect vehicles, camera is the most effective method. And using a camera feed system can identify the density of the vehicles.so the proposed system is using a camera to detect vehicles as well as pedestrians. So the proposed system can identify the density of the vehicles and the count of the pedestrians, according to those details the system will use its algorithm to control the signals. There is no other system which is using that kind of dynamic scheduling technology. The proposed system is very flexible system because according to the density of vehicles or the number of pedestrians, system give priority to one of them and according to that system will decide when it put red lights to the vehicles and allow pedestrians to cross the road.

**2.3 Which Technologies to Adopt**

We can find wide range of sensor technologies which can use to detect vehicles on the road. There is a paper[1] which has described some of the most common and some developing technologies. Video Image Processors (VIP) are the first thing they have described here.it can be used to track vehicles. It is one of the advantage of this method. But weather, shadows, reflection from roadway surface can cause for the detection correctly. In this paper there are few other methods also like, Infrared Detectors, Ultrasonic detectors, Passive Acoustic Detector Arrays, Piezoelectric,  Magnetic Detectors, etc.

There are two types of sensor [2], Active sensors and Passive sensors. Lasers, Lider, millimetre-wave radars are called as Active sensors. Optical sensors are usually referred to as passive sensors. Optical sensors are more useful, cost effective and reliable than the active sensors. So for the proposed system, we used cameras as optical sensors, to detect vehicles and pedestrians.

For the proposed system I have decided to use python as the programming platforms and OpenCV libraries for vehicle and face detection tasks. As they are most suitable for dealing with the optical sensors and Image processing techniques.

**2.4 Existing systems which have used Image Processing techniques**

After studying many research works, I could find many systems which have used various image processing techniques to do various kind of tasks. I divided them into four categories.

1. Vehicle detection and Tracking
2. Lanes Analysis
3. Traffic Light Control
4. Human detection and Tracking

This section contains the more details about those three areas and invented systems under those areas.

**2.4.1 Vehicle detection and Tracking**

In many researches this vehicle detection technique has used for many tasks like, for finding the traffic on a road, identify lanes, count the vehicles on the road, find the vehicle flow on the road etc. Fully automated real time vehicles detection and tracking[3] has presented a fully automated system for traffic surveillance using image processing techniques. It can count passing cars, decide their direction and find the lane which they are taking. The main goal of the system is to create statistics of traffic on a road which is monitored by a camera. They have used a Mixture of Gaussians background subtraction for the motion detection and Shadow removal is used for higher accuracy of the motion detection. Noise in the detected motion is removed by morphological opening followed by morphological closing. They use motion detection because its speed. Kalman filter is used for prediction of the new position of a car and for associating cars. In the Traffic surveillance system for vehicle flow detection paper[4] , they have used the combination of background subtraction and edge detection method for the detection of traffic. They used sobel operator to compute the edge information of the full frame. Then they have used the Morphological method to make the motion parts easier for tracking. In their system they have used a stationary camera for capture the video.

There is another research[5] which done by Ankita Panda and his colleagues in India, used image processing techniques for their system that estimates the size of traffic in highways by using image processing has been proposed and as a result a message is shown to inform the number of cars in highway. They have implemented the system by using the Matlab software. They process the video signal and image acquisition by using Matlab. And then select the target area where the vehicles could be present by image cropping technique. They convert the reference image and actual image in to grayscale and from the difference of both images they detect the vehicles. They also have used a stationary camera for capturing the images and they have used GPS technology to handle emergency vehicles.

There is another interesting research (Kamath and Khanna, 2012) which has used image processing and particle analysis to detect the vehicles on the road. They have developed the system by using LabVIEW. It focusses on methods of image processing and computer vision using pre-defined modules of pattern analysis and image filtering with a user-friendly interface for data calibration. Usage of graphical programming enables easy debugging, easy calibration and hence ensures greater accuracy. This method use various pre-defined image processing modules and algorithms to get a more advanced image from road traffic camera footage like colour plane extraction, image reversal, Gray morphology, Grayscale thresholding, Image masking and arithmetic operations.

In ‘**Real time traffic light control using image processing’**[6] **also they have used image processing techniques to detect the vehicles on the road. They have used RGB to Gray conversion method, Image enhancement method, and edge detection method.**

“Automatic Traffic Estimation Using Image Processing” is another system[7], which used image processing techniques to detect vehicles on the road. They have used a web camera for capturing the images. Matlab used for the implementation. The algorithm are as follows: Receiving video via camera and convert video input to two images, RGB to Grayscale conversion on received images, image enhancement and Morphological operations.

There is a another system[8], contains of cameras that are fixed in roads which are prone to traffic. The camera constantly monitors the traffic by capturing videos. The system will extract frames at specific time intervals. The sequential frames are compared and based on some parameters we decide whether there is a traffic jam. This system is flexible, reliable and cost-effective. Using the information obtained they will be developing an android application in which the user will find the density of traffic at the destination.

**2.4.2 Lanes Analysis**

Some main image processing approaches which used to lane analysis are considered and reviewed in this section. In many researches have used various types of methods to detect lanes on the road. But the best way is using image processing techniques for that. In most cases they have used a stationery camera feed for capturing the road and analyse the lanes.

In Traffic Surveillance System for Vehicle Flow Detection[4], first they detect the vehicles on the road using image processing techniques, then they assume that, if a vehicle moves regularly, its center will be very close to one of the lane centers. When more vehicles are collected, their trajectories will be gradually close to the central lines of lanes. So, they construct a vehicle histogram for estimating all preferred lane centers. The vehicle histogram is obtained by recording the frequencies of vehicles moving at different positions across different frames.

**2.4.3 Traffic Light Control**

Traffic is the major problem in a country because of the growth in number of vehicles. The increase in number of vehicles resulting to the need of a smart system that could well handle traffic lights based on the density of traffic. There are several techniques which use in the world. There are some systems which use fuzzy logic to control the traffic light timings[9]. And also we can find some systems which have done by using Multi-Agent based technology[10], [11]. In this section we review some traffic light control systems which has used image processing techniques.

**In the ‘Traffic Light Control System Using Image Processing’**[12] **has discussed about some of the existing traffic light control systems and their drawbacks. And also they have mentioned some Edge detection techniques like Sobel, Prewitt, Robert, and Canny. They have divided those edge detection methods in to two types, Gradient based classical operators (Robert, Prewitt, and Sobel) and Laplacian based operators (Canny).**

**There is another research[6] has done to control traffic light, which detect the edges using Prewitt edge detection method. Then they match the reference image and the captured image. They control the traffic light according to the percentages of matching.** In this project a USB based web camera has been used, and a general purpose PC has been used as a central unit for various image processing tasks. MATLAB version 7.8 used as image processing software comprising of specialized modules that perform specific tasks. Parallel port driver has been installed in the PC for the interfacing between the hardware prototype and software module.

In the “Image Processing based Traffic Light Control” system[13], they tried to provide a self-changing traffic management strategy. So it will in to continuously changing real time traffic. In here according to the traffic density on the road, traffic light will change. They have used Matlab for the implementing the entire algorithm. RGB to Grayscale conversion, green colour subtraction, Threshold techniques are used in here.

There is an another research[14] which used image processing techniques to control the traffic lights. Proposed system will be working based on traditional system along with automatic signalling. System will have simulated vision with the help of digital camera attached on motor for its rotation to face lanes and sense the traffic. The camera is controlled by PC over microcontroller to change its direction in steps of 90 degree to face each lane and capture image. This image of lane will be processed using image processing techniques to approximation traffic load.

**2.4.4 Human face detection and Tracking**

If we give an definition for face detection, determining whether or not there are any faces in the given arbitrary image or video stream and, if present return the face location and extent of each faces[15]. We can identify few challenges when detecting faces they are given bellow.

* Pose
* Presence or absence of structural components
* Facial expression
* Occlusion
* Image orientation
* Imaging condition

There is a survey on face detection, extraction and recognition[16]. It has shown that, face recognition systems are containing three steps. They are detection, Feature extraction, and Face Recognition. Face recognition is a challenging problem because up to date there is no technique that giving a robust solution to all situations. There is a research[17] for face recognition which has used an image-based method towards artificial intelligence by removing redundant data from face images over image compression using the two-dimensional discrete cosine transform (2D-DCT). They have use Matlab for this system.

There are many face detection algorithms like Neural Network, Sparse Network of winnows (SNoW), Support Vector Machine (SVM), Adaboost, Viola-Jones[18] etc. Adaboost relies on committee of weak classifiers to form a strong one over a voting mechanism. But it could not meet predefined classification target in error terms[19]. Viola-jones algorithm is a highly efficient algorithm because of integral image and attentional cascade techniques[20]. And it work with a reasonable computational budget.

**2.5 Summary**

This chapter discussed aboutthe existing road crossing systems in Sri Lanka and few other countries and what technologies they have been used for those systems and how the proposed system will be different from those existing systems and what technologies will use for the proposed system. And some image processing techniques and how they have been used for other systems are also discussed in this chapter. The next chapter will explain about the approach to the proposed system.

**CHAPTER 3**

**APPROACH TO THE PROPOSED SYSTEM**