CS4202 - Research and Development Project

ViDasa

Vision Based Pedestrian Crossing Controller

Project Supervisor

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Overview

Traffic congestion in urban areas has become a key problem in many countries including Sri-Lanka. Due to this problem huge number of people suffer in their day-to-day life, desperately wasting their valuable time on roads trying to get to their destination. Also it affected Industries, cooperate sector, and government sector causing drop of productivity which directly result in degradation of economical figures in a country. When it comes to developing countries like Sri-Lanka the effect of this particular issue becomes worse. Unlike developed countries, spending a lot of money and resources on traffic congestion reduction is not very feasible and desirable by third world countries. In spite of the difficulties third world countries should some how take measures to reduce traffic congestion in urban areas if they are to thrive for development.

There are two key solutions for the high traffic congestion which should go hand in hand. One is to construct new roads, renovate already existing roads, and developing alternative transportation methodologies. The second option is to provide efficient traffic controlling. Obviously the first option costs a lot of money and resources, so the developing countries like Sri-Lanka find it difficult to spend a lot in the second option. In that circumstances our Vision Based Pedestrian Crossing Controller which is low cost (in installation, maintenance, and upgrading) but effective, and has quite number of extended usages, comes in handy.

The aim of the project is to develop a software system that analyzes the real-time video footage taken by a / set of Closed-Circuit Television (CCTV) camera(s) mounted at the pedestrian crossing and generate parametric signals to be sent to the traffic light controller. The decision should be based on number of Pedestrians waiting to cross the road on both sides and vehicle movements in terms of average speed of arrival and type of vehicle (i.e. motor-cycle, large vehicles, small vehicles etc.). In addition Vehicles violating the red light condition & other traffic rules such as overtaking on pedestrian crossing will be detected and identified. Furthermore all the statistical data derived from the real-time video footage will be sent to a central system.

Nowadays CCTV cameras are more common and used in many places for various purposes. Security is one of the major purposes among variety of other purposes. In the proposed Vision Based Pedestrian Crossing Controller we are planning to use several cameras at pedestrian crossing that can also be used as security surveillance cameras as well. Other than that already mounted CCTV cameras by roads can be utilized in optimizing the generated parametric signals further more.

Extended usages of this system provide solutions for the early mentioned problem of traffic congestion in urban areas. Statistical data that is sent to a central system by each Vision Based Pedestrian Crossing Controller can be used to provide real-time traffic condition updates on different roads and areas for interested parties. Also the statistical data can be used to come-up with traffic models, planning day-to-day traffic handling, and recognizing traffic patterns in specific areas that would be helpful in planning new road constructions, renovating roads, and developing other alternative transportation methods.

All in all the proposed Vision Based Pedestrian Crossing Controller in the following sections of this proposal is an ideal cost effective tool for pedestrian controller especially for developing countries not only because the system being low cost and provide adaptive traffic light controlling but also because it has many extended usages that comes handy in reducing overall congestion and providing efficient, less time consuming transportation for all the interested parties and individuals.

Introduction

As number of vehicles in a country increases, the need for better vehicle traffic controlling methods arises. From the early days manual traffic controlling has been a good solution for some extent but with the limitation of manual traffic controlling there had been a trend on automatic traffic controlling. Although automatic traffic controlling methodologies have been experimented and implemented for a long time still manual traffic controlling is playing a major role in traffic controlling on roads. Prevailing automatic traffic controlling systems can be categorized into two parts,

1. Fixed Time Control
2. Dynamic Time Control

Typical Dynamic Time Control use following methodologies for vehicle and pedestrian detection,

i. In-pavement detectors (sensors are buried under the ground)
ii. Non-intrusive detectors (over road detectors such as cameras, electromagnet waves and acoustic sensors)
iii. Non-motorized user detection (manually press button or give command vocally to audio detectors)

These methodologies have various drawbacks when we consider them individually. High installation and maintenance cost in In-pavement detectors, user-unfriendly and inefficient behavior

in Non-motorized detectors, and difficulty in maintaining and installing Non-intrusive detectors except for cameras, are some of the drawbacks in above listed detectors.

Fixed Time Controllers don't address the issue that we described at the beginning [1, Overview] because it doesn't provide adaptive traffic controlling which is an essential requirement for reducing traffic congestion on roads. Therefore we could identify the necessity of an adaptive traffic controlling system. Vehicle and pedestrian detection is a key component of an adaptive traffic controlling system. In achieving that goal easy installation, maintenance, and upgrading should be preserved. There we can conclude that the vision based traffic controlling systems apparently the best desirable solution for an adaptive traffic controlling system.

As we refer the literature on already developed adaptive traffic controlling systems we can identify several key systems developed by various parties. Those systems have their own advantages and disadvantages. When it comes to developing countries like Sri-Lanka, the compliance of those systems are quite questionable. The very reason is the high cost in installation and maintenance. When it comes to low cost solutions, accuracy and reliability figures are low. Let's have a look at on some of those major adaptive traffic controlling systems available.

I. Meadowlands Adaptive Signal System for Traffic Reduction(MASSTR) [2]

- Uses cameras, controlling software and wireless and fiber optics communication
- Has high installation cost
- Timing is determined by the flow of traffic

II. InSync adaptive traffic control system [3]

- Works with existing traffic control cabinets and controllers
- Has two hardware components, IP video cameras and a processor
- Low cost compared to MASSTR

III. Split Cycle Offset Optimisation Technique (SCOOT) [4]

- Uses other vehicle detectors other than cctv cameras
- Give less priority for pedestrians and bicyclist
- Use online computer
- Wireless communication
- Expensive to install and maintain

IV. Sydney Coordinated Adaptive Traffic System (SCATS) [5]

- Use detectors such as inductive loops in the road pavement for vehicle and push button to pedestrians
- Inputs can be not accurate as system uses electronic sensors
- Highly expensive to install and maintain

In most of the available systems their main concern is the traffic flow and give less priority for the pedestrians. When generating signals to be sent to the signal lights most of the systems just go through very simple logic without much care for optimizing the signal decision. Also to reduce the traffic congestion effectively traffic controlling systems need to consider not only the traffic flow but also the types of vehicles. For an example it takes significant amount of time for a long-vehicle to accelerate than a car or van. So if there are long vehicles better let them pass. But in the meanwhile it is not practical to keep the pedestrians wait for a long time as well because then the pedestrians will tend to violate red light conditions that can result even in catastrophic scenarios worsening the traffic congestion.

Considering all the above facts and with the guidance and initial idea of Dr. Chathura de Silva, we came up with a proposal to develop a Vision Based Pedestrian Crossing Controller that can be further developed to a complete Vision Based Adaptive Traffic Controlling System with little more extra effort . In the remaining sections of this document, it further elaborates and defines the scope of the proposed idea under the topic 'Proposed Solution' while under the 'Motivation' section it describes the motivation and encouragement for the proposed pedestrian crossing controller. In 'Methodology' part it describes in an abstract level how the system going to work and main components of the proposed system where 'Project Evaluation and Testing' section clarifies the main concerns in testing and evaluating the developed system. While 'Deliverables' section states the last deliverables of the project, ' Timeline' section shows a Gantt-Chart of our project schedule. As the last part one can finds the references and abbreviations.

Proposed Solution

Proposed Vision Based Pedestrian Crossing Controller is a software system that will basically detect the pedestrians waiting to cross the road and analyze the traffic flow and the types of vehicles and come-up with optimum traffic light signals to be sent to the traffic light controller. This will happen repeatedly on real-time ensuring the efficient and adaptive traffic and pedestrian controlling.

Several CCTV cameras will be mounted at the pedestrian crossing as required and the video footage coming from those CCTV cameras will be analyzed and will extract following information on real-time.

1. No of Pedestrians waiting to cross the road on both sides and pedestrian movements on the the crossing.
2. Vehicle movements in terms of average speed of arrival and the types of vehicles (i.e. motor-cycle, large vehicles, small vehicles etc)
3. Vehicles and pedestrians violating the red light condition & other traffic rules such as overtaking on pedestrian crossing.

Then based on the observed parameters a small AI which is specifically designed to generate controlling signals will generate controlling signals to be sent the traffic light controller. In the mean time statistical data will be sent to a central server for further use and for persisting them. Identified vehicles' details violating the red-light condition & overtaking on pedestrian crossing will also be sent to the central system with the timestamps.

When the green-light is on for the traffic and red-light for the pedestrians the software system will analyze the number of pedestrians waiting to cross the road, the traffic flow, and the types of vehicles in the traffic flow and make decisions based on those parameters. While the red-light is on for traffic and green-light on for pedestrians the system will analyze the pedestrian movements on the crossing and take decisions based on those parameters. In both cases the system will simultaneously analyze the video footage for vehicles and pedestrians violating the red-light conditions. Additionally it will check for overtaking of vehicles on the crossing.

Motivation

Lack of a reliable adaptive traffic light controlling system for low cost that can help effectively in reducing traffic congestion is the main motivation for the proposed Vision Based Pedestrian Crossing Controller. In that case you'll wonder why we stick to a pedestrian crossing controller without going for a complete traffic light controlling system. There are several reasons, first we want to scope down the idea where we would be able to implement a working system within the time constraints and also we want it to provide reliable and adaptive traffic controlling, effectively reducing traffic congestion, as the next reason we want to build a software system that can be easily extended to a complete traffic light controlling system with little more extra effort.

There are significant number of advantages of the proposed system thus compliance to developing countries like Sri-Lanka is high. In the following we have listed down the advantages of this system over others,

1. low installation cost
2. easy setup
3. easy configuration
4. low maintaining cost
5. adaptive traffic light controlling which results in less traffic congestion
6. Many extended usages

Extended Usages

Since the Vision Based Pedestrian Crossing Controller sends statistical data to a central system, those details could be used to provide traffic condition updates on different roads and areas. This would provide an added advantage for motorists and pedestrians when they plan on their journeys. The interested parties would be able get normal traffic patterns and real-time updates on ongoing traffic conditions.

The relevant authorities basically the traffic police would be able to come up with traffic models and day-to-day traffic handling plans using statistical data received from Vision Based Pedestrian Crossing Controllers. Furthermore recognizing traffic patterns in specific areas, and handling traffic on special days using real-time statistical traffic data could also be highlighted as extended usages

Methodology

There will be four main components of the Vision Based Pedestrian Crossing Controller software system.

1. Vehicle detection and classification package
2. Pedestrian detection package
3. Traffic rule violation detection package
4. Decision making and Controlling package

Vehicle detection and classification package will pass the detected average speed of the traffic flow

and the vehicle types to the Decision making and Controlling package. With parallel to that Pedestrian detection package will pass either the number of pedestrians waiting to cross the road or the pedestrian movements on the crossing. Simultaneously Traffic rule violation detection package will pass identified vehicles' details that violate traffic rules and the timestamps indicating the time of the occurrence of the violation.

Decision making and controlling package will generate the optimal adaptive signals to be sent to the traffic light controller. If there are any information regarding traffic rule violation the controlling package will send them to a central server. Statistical data received by the controlling package will also be persisted in the same central system.

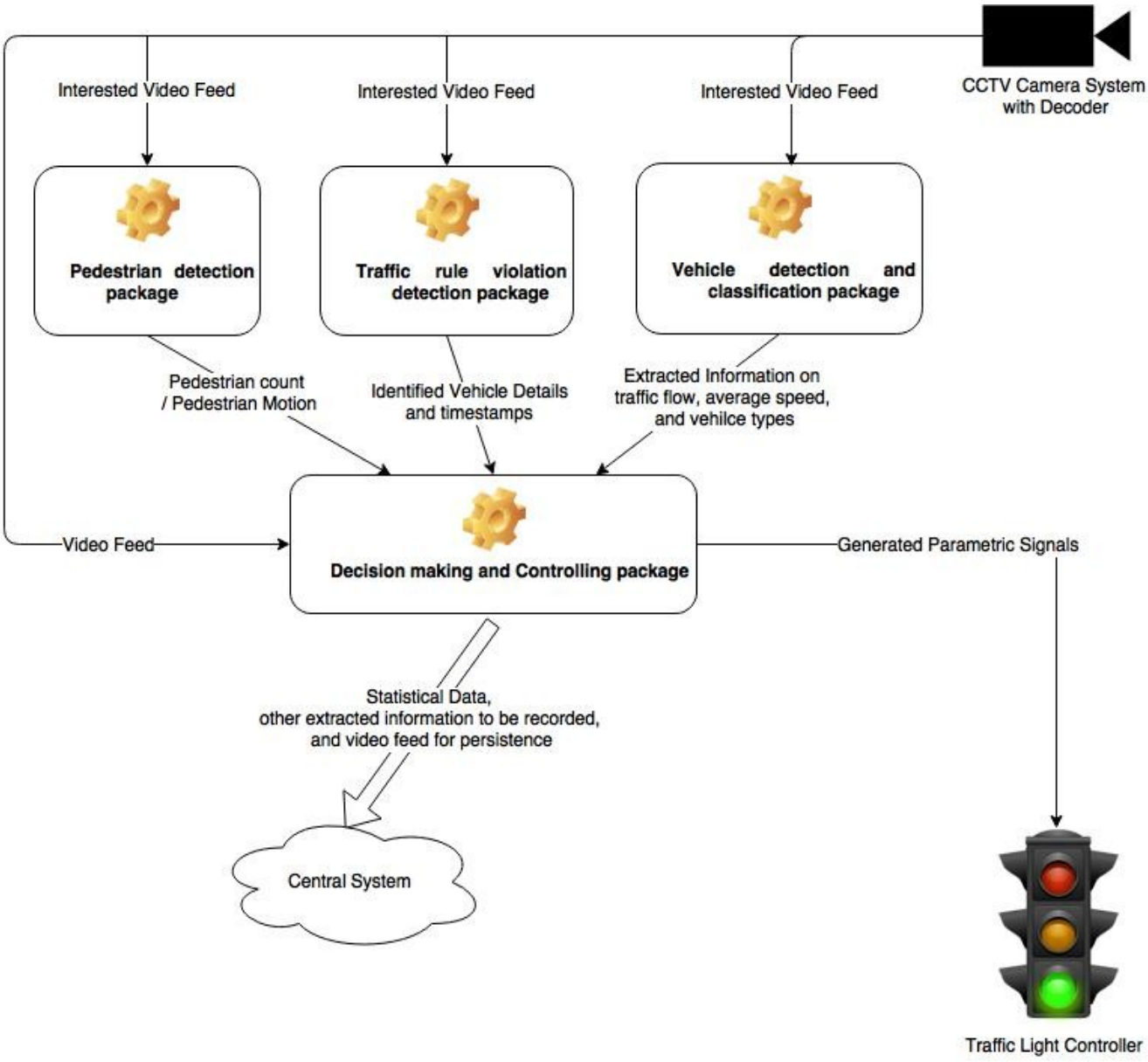


Figure 5.1

Methodology Block Diagram

Project Evaluation and Testing

Testing will be carried through out the whole process of implementation. While developing algorithms and individual packages those will be tested separately for their robust behavior and then at the integration of the packages the system will be tested for any integration issues. Finally after implementing the configuration tool the whole software system will be tested for robust and expected behavior.

Since the software system is intended to run against a real-time video feed, performance should be monitored and evaluated (if performance is weak, necessary measures would be taken ensuring the robust functioning). In performance evaluation we need to ensure the software system runs on the intended hardware smoothly without getting stuck.

Accuracy of the system is also important as the performance. Keeping that in mind we plan to evaluate the accuracy and reliability using following plots.

- correct detections should be plotted against correct decision making
- erroneous detections should be plotted against correct decision making
- erroneous detections should be plotted against erroneous decision making

Easy setting up of the system and User-friendliness of configuration tool will be evaluated by identifying a relevant group of people, giving them chance to experiment with the configuration tool, and getting feedback.

Deliverables

Implemented software system

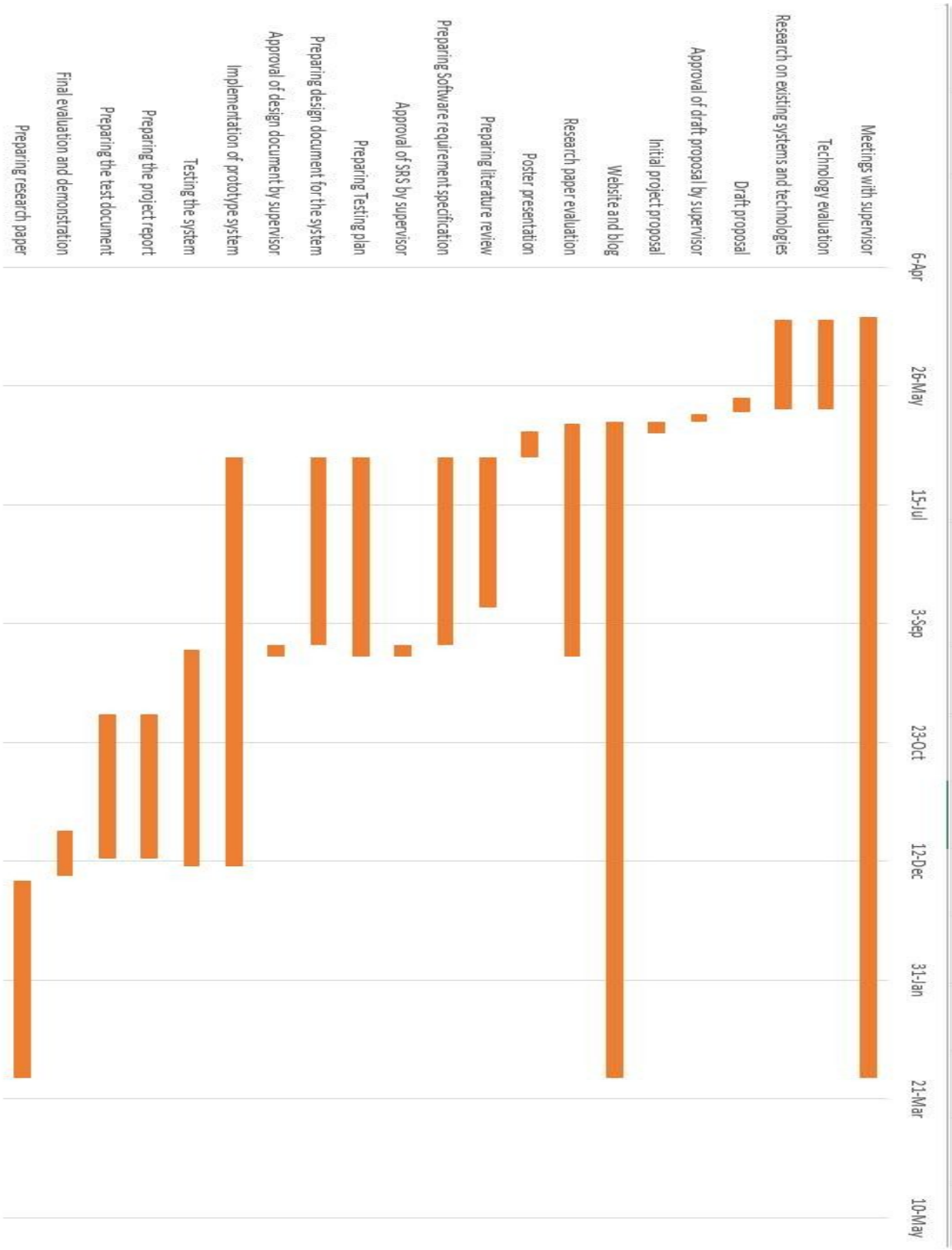
Documentation

Final project report

Research paper

Project Website

Timeline


Meetings with supervisor
Technology evaluation
Research on existing systems and technologies
Draft proposal
Approval of draft proposal by supervisor
Initial project proposal
Website and blog
Research paper evaluation
Poster presentation
Preparing literature review
Preparing Software requirement specification
Approval of SRS by supervisor
Preparing Testing plan
Preparing design document for the system
Approval of design document by supervisor
Implementation of prototype system
Testing the system
Preparing the project report
Preparing the test document
Final evaluation and demonstration
Preparing research paper
6-Apr
26-May
15-Jul
3-Sep
23-Oct
12-Dec
31-Jan
21-Mar
10-May

References

[2] Masstr.njmeadowlands.gov, 'Meadowlands Adaptive Signal System for Traffic Reduction(MASSTR)', 2015. [Online]. Available: http://masstr.njmeadowlands.gov/. [Accessed: 15- Jun- 2015].

[3] Reggie Chandra, Chris Gregory. (2012, March) InSync Adaptive Traffic Signal Technology: Real-Time Artificial Intelligence Delivering Real-World Results . [Online]. Available: https://rhythmtraffic.com/paper

[4] Scoot-utc.com, 'Split Cycle Offset Optimisation Technique (SCOOT)', 2015. [Online]. Available: http://www.scoot-utc.com/. [Accessed: 15- Jun- 2015].

[5] Scats.com.au, 'Sydney Coordinated Adaptive Traffic System (SCATS)', 2015. [Online]. Available: http://www.scats.com.au/. [Accessed: 15- Jun- 2015].