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Estimated Outcome of Application of Split Cycle Offset Optimization Technique (SCOOT) & Reduction of Frequency of Buses

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ABSTRACT:
Streets are the arteries of urban communities. They are the ones which provide mobility for men and material. They are also used for water, sewerage, telecom, electricity distribution among other things. They also to a large extent determine the character of the city. Well-designed and well-maintained streets can make a perceptible difference to the quality of life. In this paper, we deal with streets in the urban and semi-urban context. Streets and roads are used interchangeably to mean the same thing. Our focus SCOOT is the world leading adaptive signal control system. It coordinates the operation of all the traffic signals in an area to give good progression to vehicles through the network. Whilst coordinating all the signals, it responds intelligently and continuously as traffic flow changes and fluctuates throughout the day. IT removes the dependence of less sophisticated systems on signal plans, which have to be expensively updated.

Key words: electricity, scoot, signal control system

INTRODUCTION:

Split Cycle Offset Optimization Technique (SCOOT) is the world's leading adaptive traffic control system. It coordinates the operation of all the traffic signals in an area to give good progression to vehicles through the network. Whilst coordinating al the signals, it responds intelligently and continuously as traffic flow changes and fluctuates throughout the da. It removes the dependence of less sophisticated systems on signal plans, which have to be expensively updated.

The Split Cycle Offset Optimization Technique (SCOOT) is an online signal timing optimizer. IT was developed in 1973 by the Transport Research Laboratory in the United Kingdom, it has been implemented into real-world application since 1979.

Optimizers: three optimizers which are adapting – the amount of green for each approach (Split), the time between adjacent signals (Offset), and the time allowed for all approaches (Cycle Length).

NEED FOR SCOOT

Traffic congestion is an ever increasing problem in towns and cities around the world and local government authorities must continually work to maximize the efficiency of their highway networks whilst minimizing any disruptions caused by incidents and events.

Modern traffic signal control provides an important tool in the traffic manager's toolbox for managing the highway network and SCOOT is the world leading adaptive signal control system that responds automatically to fluctuations in traffic flow through the use of vehicle detectors. Many benefits are obtained from the installation of an effective Urban Traffic Control system utilizing SCOOT, both reducing congestion and maximizing efficiently which in turn is beneficial to the local environment and economy:

- World leading adaptive control system

- Customized congestion management
- Reductions in delay of over 20%
- Maximize network efficiency
- Flexible communications architecture
- Public transport priority
- Traffic management
- Incident detection
- Vehicle emissions estimation
- Comprehensive traffic information

How SCOOT Works:

Information on the physical layout of the road network and how the traffic signals control the individual traffic streams are stored in the SCOOT database. Any adaptive traffic control system relies upon good detection of the current conditions in real-time to allow a quick and effective response to any changes in the current traffic situation.

SCOOT detects vehicles at the start of each approach to every controlled intersection. It models the progression of the traffic from the detector through the stop line, taking due account of the state of the signals and any consequent queues. The information from the model is used to optimize the signal to minimize the network delay.

When vehicles pas the detector, SCOOT receives the information and converts the data into its internal units and uses them to construct "Cyclic flow profiles" for each link. The data from the model is then used by SCOOT in three optimizers which are continuously adapting three key traffic control parameters – the amount of green for each approach (Split), the time between adjacent signals (Offset) and the time allowed for all approaches to a signaled intersection (Cycle time). These three optimizers are used to continuously adapt these parameters for all intersections in the SCOTT controlled area, minimizing wasted green time at intersections and reducing stops and delays by synchronizing adjacent sets of signals. This means that signal timings evolve as the traffic situation changes without any of the harmful disruption caused by changing fixed time pans on more traditional urban traffic control systems.

TRAFFIC MANAGEMENT

Throughout its life SCOOT has been enhanced, particularly to offer an ever wider range of traffic management tools. The traffic manager has many tools available within SCOOT to mange traffic and meet local policy objectives such as : favoring particular routes or movements, minimizing network delay, delaying rat runs and gating traffic in certain areas of the city. Because of its efficient control and modeling of current conditions, SCOOT has much more scope to manage traffic than less efficient systems. For instance, buses can be given extra priority without unacceptable disruption to other traffic.

FEATURES:

(1) Bus Priority: A facility has been introduced to integrate active priority to buses or other public transport vehicles. The system is designed to allow buses to be detected either by selective vehicle detectors or by an automatic vehicle location (AVL) system. Differential priority is given, that is, extra priority for some, less (or none) for others. eg. no priority for buses running on time, moderate priority for late buses, high priority for very late buses. The bus must be able to indicate its category to SCOOT.

(2) Automatic SCOOT Traffic Information Database (ASTRID): SCOOT is a valuable source of traffic information with its network wide detectors allowing a large amount of data to be obtained without large additional costs. The ASTRID database system has been developed to use information from SCOOT to provide a historical background of traffic conditions. The system continuously monitors and stores traffic conditions for later retrieval and analysis. The system can also act as a reference against which to compare current traffic conditions. Data displayed by ASTRID is either collected directly from SCOOT or calculated from stored information. The user can access and display both types of data in the same way.

(3) INGRID: INGRID is a real time automatic incident detection system which uses algorithms to detect incidents. Techniques have been developed to assess the effect of a detected incident on the network.
There are two algorithms which are used to detect incidents. One examines current traffic data for sudden changes in flow and occupancy. No reference data is required for this algorithm.
The other algorithm uses historic reference data provided by the ASTRID database. For all SCOOT detectors in the network a daily profile of the expected flow and occupancy in each 15 minute period is stored and automatically updated in the ASTRID database. The algorithm detect incidents by comparing the current traffic situation with that expected from the historic reference data in ASTRID. The algorithms use standard deviations and mean values to determine a confidence level against which to assess the current data. An incident is indicated if the conditions are satisfied for one minute. When the conditions are satisfied for three consecutive minutes more weight is given to the incident report. Both algorithms require data on the flow and occupancy over loops on consecutive links to detect an incident in the road space between them. Incidents are indicated during the following conditions:
Decrease in occupancy and flow at the downstream detector
Increase in occupancy and a decrease in flow at the upstream detector.
For best results the routine requires the flow and occupancy data for each traffic signal cycle.

(4) Logic to allow emission to be taken into account by the SCOOT optimizers: The SCOOT kernel has been modified so that the user can choose the objective function used in the offset optimizer. IT can be changed from the normal one of a weighted sum of delays and stops to the weighted sum of estimated emissions.

(5) Puffin pedestrian facilities : Puffin (Pedestrian user friendly intelligent) crossing are intended to become the UK standard for signal controlled pedestrian facilities at stand-alone crossing and junctions. Unlike pelicans, there is no flashing amber period, instead the length of the red to vehicles is variable depending on the time that pedestrians take to cross the road. IN SCOOT MC# the kernel has been modified to model the variable inter green period that follows the pedestrian invitation to cross stage rather than assuming it runs for a fixed length. SCOOT MC3 accurately models the on-street behaviour of Puffins and Puffin pedestrian facilities and thus provides improved control and reductions in delay to vehicles.

(6) Congestion supervisor: Form the outset the optimizers in SCOOT have acted to help to control congestion. Over the years a number of additional facilities have been provided. These congestion management features have been enhanced in SCOOT MC3 by the addition of a congestion supervisor. The supervisor runs continuously in the background searching for and analyzing congestion problems. IT will report its results and help the engineer to make optimal use of all the facilities that are available in SCOOT to manage congestion.
The congestion supervisor has been developed based on the information already available within the SCOOT system. The aim of the supervisor is to continuously monitor congestion throughout the SCOOT controlled network, to identify links causing serious problems and to diagnose the probable reason for congestion emanating from those links. The congestion problem and the recommended action to take will then be reported to the users either directly from SCOOT or through a supervisory system. Overall the aim of the congestion supervisor is to target regularly recurring congestion rather than congestion caused through incidents.

- Identify nodes that are the cause of the congestion problem
- Calculate congestion offsets on 'short' links
- Identify possible changes to congestion importance factor
- Diagnose problems when there are faulty links

- Report/diagnose problems where the degree of saturation is low
- Diagnose and report where a junction is overloaded

SCOOT features:

- Bus Priority
- ASTRID - Automatic SCOOT Traffic Information Database
- INGRID - a real time automatic incident detection system which uses algorithms
- Logic to allow emissions to be taken into account by the SCOOT optimisers
- Puffin (Pedestrian User Friendly Intelligent) pedestrian facilities
- Congestion supervisor

Advantages and Disadvantages

- Advantages of Actuated Signals
  - They can reduce delay (if properly timed).
  - They are adaptable to short-term fluctuations in traffic flow.
  - Usually increase capacity (by continually reapportioning green time).
  - Provide continuous operation under low volume conditions.
  - Especially effective at multiple phase intersections.

- Disadvantages of Actuated Signals
  - If traffic demand pattern is very regular, the extra benefit of adding local actuation is minimal, perhaps non-existent.
  - Installation cost is two to three times the cost of a pre-timed signal installation.
  - Actuated controllers are much more complicated than pre-timed controllers, increasing maintenance costs.
  - They require careful inspection & maintenance to ensure proper operation.

EXPECTED RESULTS OF SCOOT

Once put into place, this system will increase the efficiency of the already existing BRT system. A lane that is solely devoted for buses can now be put to use by giving priorities to the buses and bus users. Once the quality and punctuality is improved, the number of users will automatically increase. The expected results of SCOOT are given below:

- Once put into place, this system will increase the efficiency of the already existing BRT System. A lane that is solely devoted for buses can now be put to use by giving priorities to the buses and bus users. Once the quality and punctuality is improved, the number of users will automatically increase.
- A system like SCOOT, which will give priorities to buses would encourage users to use it, thereby reducing the vehicle population on the road, and the PCU, not to mention the environmental benefits.
- From the information obtained from Katraj Bus Depot, the number of buses that follow the path of Katraj to Swar gate are 45
- Ideally speaking the frequency is of roughly 1.5 minutes per bus. However, due to delays or breakages or due to any other causes, approximately 10 percent of these buses are cancelled and almost 50 to 60 percent are late, with three buses following one after the other.
- Using the SCOOT plan, since the buses will be given priority, and if the frequency of the buses is reduced to about 45 seconds, the number of buses increases to about 80 buses during the peak hour.
- London, the capital of United Kingdom, being one of the best in the world when it comes to public transport and BRT systems, has a frequency of 30 seconds and is 97.7% efficient

- By increasing the bus numbers, the total available seats increases to =80* 40 + (.4*40*80) = 4480 taking 4500 where, the number of seats per bus is taken as 40, and there is a 40 percent extra added for the people standing.
- it is further assumed that this number of passengers is divided in the ratio of 5:1:1.5 among two wheelers, three wheelers and four wheelers; the percent reduction in use of two-wheelers is 33.33 percent, of three-wheelers is 36% and that of four wheelers is 32% =0.5[1567]+1[336/1.2]+1[447/1.2)]=1436 PCU
- Therefore, it can be seen that simply by doubling the number of buses, the PCU value can be reduced to approximately 30% of the carriage way.
- This point to a reduction of approximately 41 PCU per bus, that is the space occupied by 41 cars.

REVIEW OF LITERATURE:

Mittal & Sarin (2005) emphasize that the only alternative to increasing the road capacity is to maximize the existing available infrastructure and to get optimum returns from new investments on highway building. Intelligent transport systems provide opportunities to achieve this. In order to achieve better safety and decrease the number of accidents, injuries and fatalities, new approaches to highway safety are required. ITS technologies can be applies to reduce traffic exposure, reducing the probability of crash occurrence, and minimizing the consequences of a crash. There is great potential in India for these technologies. IT is a new traffic concept that links people, roads and vehicles in info-oriented multimedia society. It is a movement of information for the movement of people and goods. ITS is an application of modern computer, communications and vehicle sensing technologies to productivity and information.

Nesamani & Subramanian (2009) are emphasizing on the importance of factors influencing speed of urban arterial in designing better roadways. Speed of vehicles depends on number of factors such as vertical grades, median type and horizontal curves with or without transition, sight distance and super elevation. Urban arterial are for through traffic on a continuous route. Mobility is its primary function with controlled access parking. Traffic on Indian roads is of heterogeneous in nature. In recent study the speed of vehicles decreased in the range of 5 5o 8.5% when the shoulder condition changes from bad to worse in highway links. The speed should be varying always if this not it creates a problem of congestion, accidents, emission of rays, it is divided into peak period and off-peak period. Peak period represents the congested traffic conditions and off-peak period represents the relatively free flow conditions in off-peak period, speed was mostly ranging between 20 & 40 km/h and average speed was similar to that during peak period and average accelerating and declaration were high during peak period. This might be due to lesser headway between vehicles, compared to the off-peak period. In is mentioned that in mornings, peak-period traffic tends to move in the same direction and during the same time period of the day. In the evening peak-period, thee is a relative flexibility and a traffic gets distributed and staggered across time period. However, during both peak and off-peak period, the v/c ratio is more than the 1 in majority links.

Oxley (2010) suggests that pedestrians are considered vulnerable road users largely due to their lack of protection and limited biomechanical tolerance to violent forces of hits by a vehicle. In a collision with a vehicle, pedestrians are always the weakest party and are at a greater risk of injury or death compared with most other road users. In Western Australia there were in total 104 pedestrian death and over 950 serious injuries between 2004 and 2008, representing approximately 10% of all road deaths and approximately 9% of all serious injuries. The Safe Systems approach to road safety emphasizes safe drivers in safe vehicles traveling on safe roads at safe speeds. This basic premise aims to eliminate fatal crashes and reduce serious injury crashes through the provision of a safe, crashworthy system that is forgiving of human error and accommodates vulnerability to serious injury. Pedestrian safety has long posed a major challenge to road safety authorities. However means to improve the safety of pedestrians include : constructing traffic calming to protect pedestrians

; providing additional shared paths ; reducing speed limits in areas of high pedestrian activity such as strip shopping precincts ; educating the community on the rights and responsibilities of all road users ; including shared paths and upgraded pedestrian facilities in major infrastructure projects ; nominating pedestrian and cycling infrastructure ; and promoting the manufacture and purchase of more pedestrian-friendly vehicles.

Gupta R. K. (2012) paper identifies the deficiencies in the existing signal systems and describes how MaDSS can overcome them. With the ever-increasing vehicular population, the demand too has increased tremendously. This has brought about a reduction in the efficiency of traffic signal systems. Traffic signal have gone from being traffic controllers to queue generators. Signals are now being blamed for the long queen formations and pollution at intersections. Queues are not only formed but also lengthened at signalized intersections, resulting in accumulation of traffic. This accumulated traffic stays in the queue longer that it ideally should. The reason being, the number of vehicles leaving the queue is far less than those joining.

Saxena, R. K (2013) concluded that final product of this research, the Texas Guide for Retrofit and Planned Bicycle Facility Design, allows the user to input basic roadway and traffic data into a Microsoft Excel workbook and generate two measures to identify the operational performance of an on-street bicycle facility. The first measure provides a rating from 1 to 6 of a cyclist's comfort level on a given roadways segment, as well as a descriptive label of the comfort rating. The second measure developed from this research project allows users to predict the physical location of both cyclists and motorists during passing events.

FUTURE SCOPE:

A big concern on top of urban transportation planner's mind is how to speed up the traffic: putting more buses on the road will jam the roads even worse and deteriorate the air; building more subway is costly and time consuming. Well, here is an cheaper, greener and fast alternative to lighten their mind up a bit: the straddling bus, first exhibited on the 13th Beijing International High-tech Expo in May this year. In the near future, the model is to be put into pilt use in Beijing's Mentougou District.

Proposed by Shenzhen Hashi Future Parking Equipment Co., LOtd., the model looks like a subway or light rail train bestriding the road. It is 4-4.5 m high with two levels: passenger's board on the upper level while other vehicles lower than 2 cm can go through under. Powered by electricity and solar energy, the bus can speed up to 60 km/h carrying 1200-1400 passengers at a time without blocking other vehicles' way. Also it costs about6 500 million yuan, about 477 crore Rupees to build the bus and a 40 km-long path for it, only 10% of building equivalent subway. IT is said that the bus can reduce traffic jams by 20-30%.

The straddling bus combines the advantages of BRT, it is also a substitution for BRT and subway in the future. As you all know, the majority of vehicles on the road is car, and the shortest, also the ar. Normally the overpass is 4.5-5.5 m high. The highlight innovation of straddling bus is that it runs above car and under overpass. Its biggest strength is saving road spaces, efficient and high in capacity. It can reduce up to 25-30% traffic jams on main routes; running at an average 40 km/h, it can take 1200 people at a time, which means 300 passengers per cart.

Nowadays many big cities have remodeled their traffic signaling system, to prioritize public buses, that is to say when a bus reaches a crossing, red light on the other side of the fork will turn on automatically to give buses the right of way. The straddling bus can learn from this BRT method. The car can make the turn with the bus if that is the direction it wants to go too; if not, the red light will be on to stop the cars beneath while the bus takes the turn.

The bus is 6m in width and 4-4.5 m high. How will people get off the bus if an accident happens to such a huge bus? Here the most advanced escaping system in the world is introduced. In the case of fire or other emergencies, the escaping door will open automatically, similar to an aircraft; planes are equipped with inflated ladder so people can slide down on it in emergency. It is the fastest way to escape.

The bus can save up to 860 ton of fuel per year, reducing 2640 ton of carbon emission. Beijing's Mentougou District is carrying out a eco-community project, it has already planned out 186 km for our straddling bus. Construction has begun in 2011.

Fig. 1: Showing body of the straddling bus

Fig. 2: Showing the model of the Straddling Bus

SOLAR ROADWAYS:

A US engineer is looking to turn roads and car parks into one giant solar energy plant with the help of his small start up, Solar Roadways. The man behind the project, Scott Brusaw, has gained some influential followers in science and the US government who have become involved in funding his idea, potentially making it a viable and important technology. So far, Brusaw has received significant funding from the US Federal Highway Administration to develop his early prototypes for the solar road panels, which are created by using a combination of plexi-glass, solar panels, and circuitry and LED lights.

An Idaho-based company called Solar Roadways has been attempting to solve this energy crisis in its distinctive way. According to Scott Brusaw of Solar Roadways we can counter the energy crisis by adopting a unique method. The good news is they are getting universities and research labs interested in their venture. This company is also working on a 45 mile prototype between Coeur D'Alene and Sandpoint, Idaho. By now we can gauge that this project is not chap. But Scott said four companies have expressed interest in this p9roject. Electrical engineering by profession, and also the founder of the company, he believes that if the US interstate Highway system can be exchanged with his system with a solar cell efficiency of 10 percent, it could power the whole country.

These Solar Road Panels will generate and restore energy for our homes and businesses. The added side effect will be a fifty percent cut in the greenhouse gases. Scott envisions about the interconnected and intelligent multiple Solar Road Panels. He predicts a future where interstate highways, state routes, downtown streets, residential streets, or plain dirt or gravel country roads will be having Solar Road Panels catering to the energy needs of homes or business units. Scott's Solar Roadway will be an intelligent, self-healing, decentralized power grid.

Solar Roadways will facilitate the use of electric cars too. A major problem of electric cars is their refueling or recharging. Since Solar Roadways will have plenty of electricity charging of electric cars won't pose any major problems.

Replacement of "normal" roads with Solar Roadways will generate green color jobs and give a required push to solar manufacturing industry. Another added benefit will be safety of drivers and wildlife. Since the roads will be intelligent roads they can warn drivers of impending dangers and wild animals venturing on the roads thus reducing the number of road accidents. Drivers can even be cautioned about the potentially dangerous drivers !

The image below depicts an area in England where solar rod studs light up the lines on the road and according to a recent study they have reduced night time accidents by 70%.

Fig. 3: Showing how the LED can show signs and signals

Fig.4: Artist's rendition of Sandpoint, Idaho – Home of Solar Roadways

CONCLUSION:

Pune is one of the boomtowns of India, and it will continue to be a boomtown for many years to come. One of the attributes that come with being a boomtown in this era is amorphous, amoeba-like growth. Change happens relatively fast, and our infrastructure needs to be as flexible as possible.

SCOOT has been implemented in over 200 towns and cities in our 14 countries around the world, giving benefits in reduced congestion and delay. These have been demonstrated several times with detailed studies highlighting the effective of SCOOTA urban traffic control as a tool for management of traffic and congestion. Cities like Worcester and Southampton in United Kingdom showed delay reductions of 23% and 30% respectively. In unusual conditions in Toronto following a baseball game, delays were reduced by 61%, demonstrating SCOOT's ability to react to unusual events. Trials of the bus priority features in London have shown additional average reductions in 1200 people at a time, which means 300 passengers per cart. Another strength of straddling bus is its short construction life cycle : only 1 year to build 40 km.

The other measure is the use of solar roads, which is being developed by an American scientist Scott Brusaw, and is now a government funded project. These roads will not only generate electricity for our homes and schools, but will also lead to a reduction of fifty percent in green house gases.

Solar roads will be designed as a three-layer system. The surface layer will be tough enough to bear the onslaught of weather and vehicles. The upper layer will be translucent and hence will be able to let the sunlight pass by. The middle layer will consist of large array of solar collecting cells. These cells will also store solar energy for later use. This middle electronic layer will be fitted with microprocessors that will control lighting, communications, monitoring etc. The third base layer will distribute power collected by the electronics layer to the units connected to the Solar Roadways.

It has become extremely critical to find alternative solutions to combat traffic problems. As an effective transport system is vital for a successful society and economy, and a good quality of life. However, the growth of transport is widely believed to have damaging effects on our environment, and in particular the atmosphere. Pollutants that are emitted from other vehicle scan lead to human health problems, poor air quality, acid rain and global warming. To maintain the standard of transport that is required for society and the economy to function efficiently without placing too much pressure on the environment. It is necessary for governments to take up projects that will take these factors into account, and find feasible solutions that can be devised to achieve the desired results. Implementation of solutions like SCOOT and improvement of the safety facilities, along with the BRT buses will significantly help the aim of achieving a cleaner, greener and a happier city.

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