"DYNAMIC TRAFFIC CONTROL SYSTEM "

Project Report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology

in

Electronics and Communication Engineering

By

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CERTIFICATE

This is to certify that the project report entitled **"DYNAMIC TRAFFIC CONTROL SYSTEM"**, submitted by **Harpreet Singh, Sohajveer singh, Dhendup Cheten** in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

Date : 24th May 2010

DR. T S LAMBA

(Dean)

Certified that this work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma

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Acknowledgement

We are deeply indebted to our supervisor, Prof. T. S. Lamba for his continuous guidance for the completion of our project. Special thanks to our supervisor as well as our panel of Prof. Rajiv Kumar and Prof. Neeru Sharma who insisted mainly on the knowledge of the topic rather than insisting on completion of the project.

We also thanks to Rohit, Sonam Jatsho, Chencho Dorji and Mayank Aggarwal who always gave their helping hand whenever we got stuck anywhere.

Date: 24th May 2010

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ABBREVATIONS

SCOOT - Split Cycle and Offset Optimization Technique

MOVA - Microprocessor Optimized Vehicle Actuation

TSM - Traffic System Management

TOF - Time of Flight

ITV- Intelligent TV

CCD- Charged Coupled Device

FCFS- First Come First Serve

FQ - Fair Queuing

SPF - Shortest Path Forwarding

Abstract

The purpose of the project is to come up with an effective and efficient means to control the uprising road traffic havoc in a smooth and systematic manner. Over time there had being a considerable rise in the number of vehicles. This adds up to the traffic congestion, as in the traffic flow would exceed the saturation level of the roadway, thus further accommodation of motors would lead to jams. This is the major problem faced in metropolitan cities nowadays. A person has to wait for hours due to traffic congestion. Since in such places there is a shortage of spaces, it doesn't make sense to broaden the lanes or any up gradation in the present infrastructures would be irrational. Therefore an automated system is necessary to run the flow of vehicle, considering the just to the users of the highway.

Chapter 1

Introduction

In this project, firstly theory portion has been discussed; then the basics of road traffic and then the terminologies have been familiarized. Then the data on varieties of sensors is shown so as to come up with an optimum sensor to detect the vehicle entering and leaving a particular lane. Further this data is being used by the controllers for processing and finding the best solution for the prevailing traffic. This determines the dynamicity of the control system. The lighting phases are handled in such a manner that its timing changes with the existing traffic condition. This is shown with the help of efficient traffic algorithms.

If the traffic gets uncontrollable at an intersection, then diversion techniques are used to divert the traffic to other routes which are free and leads to the destination for which a user intend to go. Diversion techniques are usually used to buy time for the traffic to diminish. Different diversion techniques have been discussed. Also the works done by researchers has also been referred, to grab an idea for how to undertake the project.

The whole idea is being implicated on simulation. Java is used as the platform for simulating the project. Firstly work has been done on simulating a single vehicle passing through a lane with fluctuating speed. Then adding up to further complexity many vehicles crosses an intersection in accordance to the light phase have been discussed.

Being from Electronics and Communications background the things that were worked upon were not much into our knowledge so we are submitting the report in the partial fulfillment of this project. A solution has been reached for the problem of congestion. Finally provisions have been given on further researches that can be done on the existing projects, and other improvements which can necessarily change the whole overview.

1.1 Hypothesis

In the present scenario, the whole traffic control in India is based on static system, i.e the time for the light phase is being fed to the system at the very first place. This would be efficient at places where there is less traffic, but at metropolitan city, this may be implemented as well, but maintaining a just to the people using the roadway would not be possible. Thus there is a need of advancement in the system, which takes note of the number of vehicles crossing a particular intersection and with the database available; the decision for the light timing is being taken. This makes the system dynamic.

A sensor is being installed to detect a vehicle passing through a lane. Thus this information is taken by the controller for processing purpose. A convenient traffic control algorithm is chosen for regulation of existing traffic. Taking a case on the traffic situation that may occur. If a car is travelling from north to south, and on the other hand there are many cars travelling from east to west direction, would it be justified if we give same waiting time for the cars having different destinations? If that's so, at certain period of time, the intersection won't be used i.e. such case would prevail if we let go the only car travelling from north to south and make the others wait till the waiting time gets over. This would cause traffic jam on east- west course, since in the course of waiting time there might have an addition of more vehicles to the queue. Thus if the control was made dynamic, no sooner the only vehicle passes the intersection the others must be given the chance to cross the crossing, this would contribute to maximum usage of free space available without causing any kind of mishaps. On the other hand, looking at the situation on a different context, would it be just for the single vehicle to wait for all the east-west course vehicles to pass through intersection? It may have to wait for long till the queue diminishes, so for this there's a need of setting a optimum threshold timing for the phases to change, this would give just to the people using the network.

There is always a possibility that there could be a traffic jam on all four directions of the intersection. Therefore certain precaution can be taken into consideration before such hazards takes place. A traffic forecasting becomes a necessary essence for giving the information of whereabouts congestion would be vulnerable. Accordingly diversion are introduced, so to use the free lanes available and for minimizing the congestion at the forth coming intersection. Thus there is an effective usage of free spaces and hence there would be smooth flowing of vehicles.

Chapter 2

Transportation System Management

As the traffic on the existing road system in cities grows, congestion becomes a serious problem. Medium and long term solution like widening of roads, providing elevated fly overs and construction of bypasses and urban express ways seem to be a costly deal and space also becomes a major issue while undertaking such implementations. Thus there is a need of a simple and inexpensive means of handling the existing traffic. The Transportation system management (TSM) is a short term measure that is being adopted to sort out such situation.

2.1 Traffic Management

2.1.1 Scope of Traffic Management Measures

Many of the urban streets carry traffic volumes for which they were not simply designed. This results in time delay, congestions and accidents. The mishaps can be taken care to some extent by controlling the traffic, or by imposing regulatory measures and enforcing management techniques, so as to make the most economic use of the streets. Traffic control measures include traffic signals and these have been already considered. Regulatory measure includes restrictions on speed, parking, and size of vehicles and so on. These are collectively known as traffic management measures. These measures form a part of TSM.

The fundamental approach in traffic management measures is to stick with the exiting infrastructures but a change in the movement in traffic is brought in. In doing so, minor alternations to traffic lanes, curbs etc should be done, and are part of the management measures. The general aim is to reorient the traffic pattern on the existing streets so that the conflict between vehicles and pedestrians is reduced.

Some of the well known traffic management measures are:

1. Restriction on turning movements
2. One way street
3. Tidal flow operations

2.1.2 Restriction of turning movements

2.1.2.1The problem posed by turning traffic

At a junction the turning traffic includes left turners and right turners. Left turning traffic does not usually obstruct traffic flows through the junctions, but the right turning traffic can lock the flow and bring the entire flow to a halt. One way of dealing with heavy in right turning traffic is to incorporate a separate right turning phase in the signal scheme, or to introduce an early cut off or late start arrangement. These schemes have their limitations and result in a long signal cycle. Another solution is to ban the turning movement altogether.

2.1.2.2 Prohibited right-turning movement

Prohibition of right turning movement can be established only if the existing street system is capable of accommodating an alternative routing. Depending upon the existing layout of the street system, three methods are available:

1. Diversion of the right turning traffic to an alternative intersection further along the road where there is more capacity for dealing with a right turn, This scheme is shown in figure 2.1, and is known as T turn. It is often useful for dealing with a difficult right turn from a minor road into a major road. The right turn gets shifted to a minor- minor junction

2. Diversion of the right turning traffic to the left before the junction. This scheme is shown in figure 2.2 and is known as G turn. It is useful for right turn from a major road, since it is converted to a left turn from the major road and a straight over movement at the original junction

3. Diversion of the right turning traffic beyond the junction. This scheme is shown in figure 2.3, and it's known as Q turn. This includes three left turns and requires the driver to travel twice through the original junction. Since only left turns are involved it is considered the least obstructive.

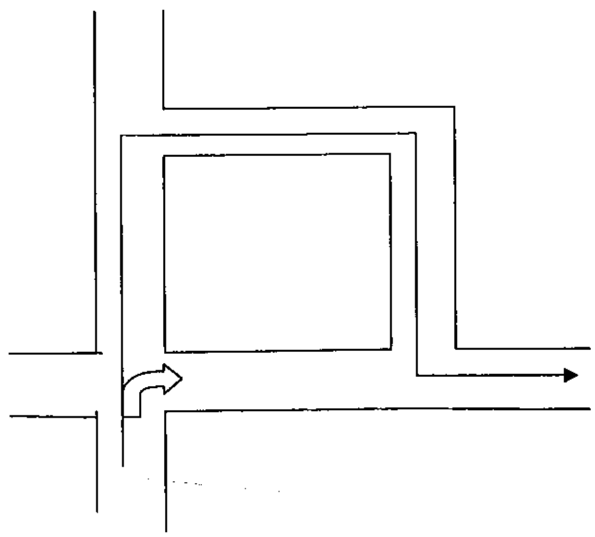

Figure 2.1 T Turn

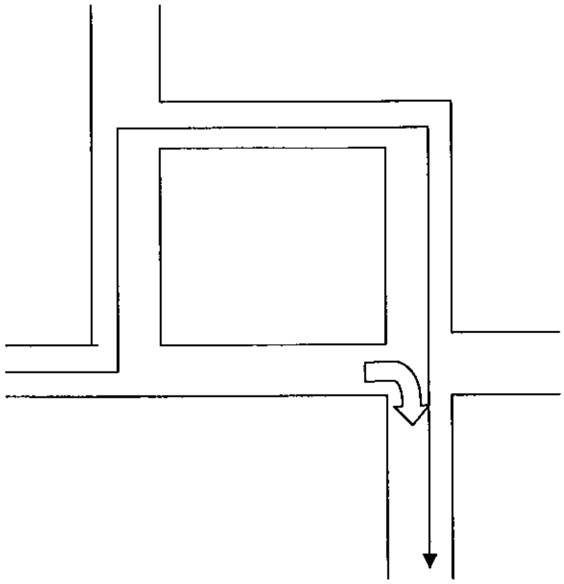

Figure 2.2 G Turn

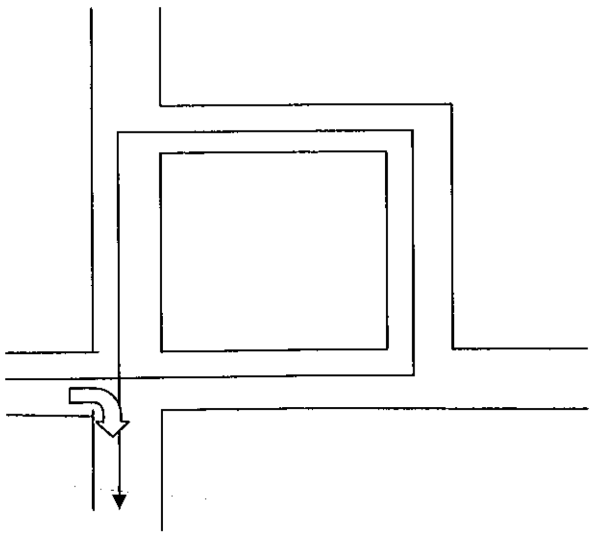

Figure 2.3 Q Turn

Prohibition of right turning movements is known to increase the saturation flow and the capacity of the junction. However, it is also to be taking into consideration, the prohibition of right turn at a junction will not altogether make problems disappear. In fact it may compound the problems at others.

2.1.2.2 Prohibited left-turning movement

Left-turning movement is not obstructive to traffic and it is rare they are prohibited. However, such prohibition may be needed to provide a safe crossing for pedestrians, especially when the pedestrian traffic across the minor road is heavy.

2.1.3 One way Streets

2.1.3.1Purpose

As the name suggest, one way streets are those where traffic movement is permitted in only one direction. As a traffic management measure intended to improve traffic flow, increase the capacity and reduce the delays, one way streets proved to be working good. The method serves well and on the other hand it's the least expensive means one can adapt to for minimizing the arousing traffics in busy areas. In combination with other methods such as banned turning movement one way street of signals and restriction on loading and waiting, the one way street system is able to achieve great improvements in traffic conditions of congested areas.

2.1.3.2 Advantages of one way streets

There is a reduction in the points of conflicts. Traffic movements at junction involved a number of points of conflict. These generate delay congestion and accident hazards. Any schemes where the points of conflicts are reduced in number is thus regarded for better safety and less delay. The figure below gives the point of conflict a vehicles at a junction of two 2-lane 2-way streets (a)and how the same can be reduced by making one street one way (b) and the both the streets one way

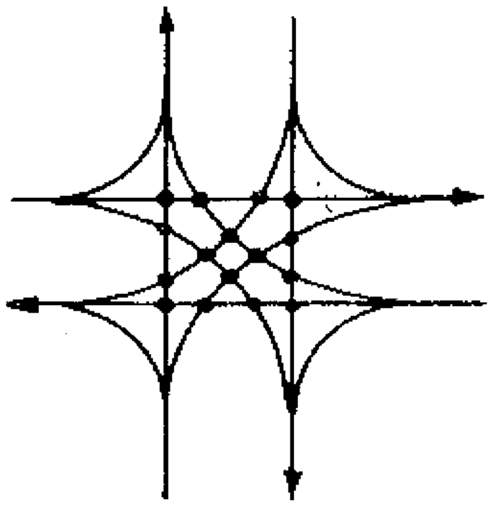

Figure 2.4 2-way 2-lane street:16 points conflict.

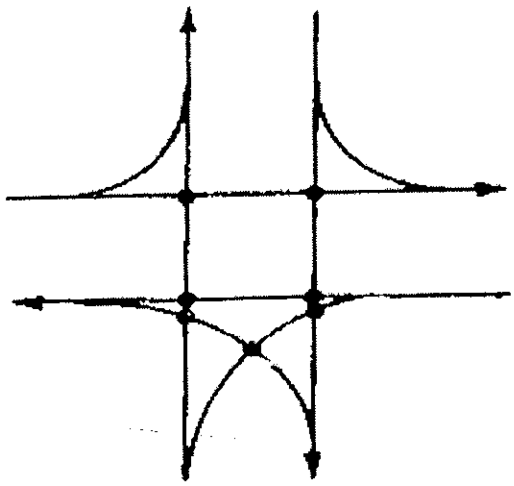

Figure 2.5 One 2-way street and one one-way street: 7 points

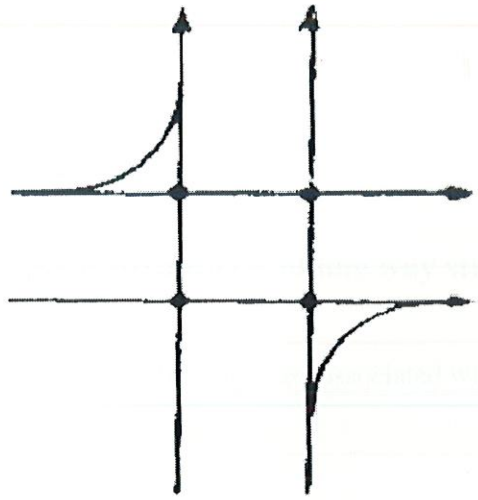

Figure 2.6 Two one-way streets:4 points of conflict

1) Increased capacity. The removal of opposing traffic and the reduction of intersection points of conflict results in a marked increase in the capacity of a one-way street. However, this will not always be the case. We can consider another situation in which there is an increased traffic capacity resulting from utilization of odd traffic lane under one way street operation.

2) Increased speed. Since the opposing traffic is eliminated, drivers can operate at higher speeds; this is further facilitated by the more efficient operation of the traffic signal system that is possible under one way street operation. With increased speeds, delays and journey times get reduced. An overall reduction of 20 percent in journey time has been reported in some London streets which were changed to one way system.

3) Facilitating the operation of progressive signal system, the use of one way street operation offers advantages in designing a system of signals for an entire area. Progressive system design is easy with a pair of one way streets. With progressive system, the flow becomes smoother and the safety is increased avoiding any kind of mishaps.

2.1.3.3 Disadvantages of one way street working

A number of disadvantages are associated with one way street working. Some of there are:

1) Although the journey times and delay are reduced, the actual distances covered by driver increases.

2) Where buses operate on the streets, the stops will have to be relocated and in many instances the passengers will have to walk extra distances. It may happen that the stops will be away from important generators of bus traffic, such as railway station.

3) The excessive speeds that follow as a result of one way operation may be a hazard to residential areas. Thus, while the number of accidents may decrease, the severity will increase with one way operation.

4) A scheme of one way streets will have to, on many occasions, use existing residential streets. If the traffic is heavy, the peace of the area is disrupted. If such case prevails hospitals and schools will be the worst sufferers.

5) One of the most important drawbacks of a one way street operation is the prerequisite need for the availability of a street system can be easily modified to suit that new scheme, Not all the existing patterns are vulnerable to a change over. A gridiron

pattern lends itself easily to the change. Irregular street pattern are difficult to adapt. The difficulties become large at the ends of the one way roads.

2.1.4 Tidal flow operations

2.1.4.1 Description

One of the familiar characteristics of traffic flow on any street leading to the city centre is the imbalance in directional distribution of traffic during the peak hours. For instance, the morning peak, there is a heavy occurrence of traffic flow towards the city centre, whereas in the evening peak brings in heavier flow away from the city centre, In either case, the street space provided for the opposing traffic will be found to be in excess. This phenomenon is commonly termed as "tidal flow". One method of dealing with this problem is to allot more than half the lanes for one direction during the peak hours. This system is known as "tidal flow operation", or "reverse flow operation".

2.1.4.2 Methods

The principle of tidal flow operation can be translated into practice in the following two ways:

1. The first is to divide a greater number of lanes in a multilane street to the in bound traffic during the morning peak and similarly a great number of lanes to the out bound traffic during the evening peak hours.
2. The second requires the existence of two separate streets parallel to each other and close to each other, so that the wider of the two can be set apart for the heavier traffic both during the morning peak and evening peak. In this case the two streets will operate as one way streets.

Chapter 3

Traffic Flow

3.1 Scope

The theory of traffic flow can be defined as a mathematical study of the movement of vehicles over road network. The subject is a mathematical approach to define, characterize and describe different aspects of vehicular traffic.

The subject has virtually grown from the measurements in the field of the various characteristics of the traffic and tends to describe these observer characteristics in precise mathematical language, with a view to understand traffic behavior better. The study is of great importance to a traffic engineer as it provides him with a comprehensive knowledge of vehicular traffic, leading to improved techniques for the control, regulation and management of traffic.

The development of the subject has taken inspiration from various branches of knowledge. Statistics, applied mathematics, psychology and operations research are some of those. The subject is greatly being researched upon and newer theories are emerging.

The first subject covers the relationship between speed, flow and concentration. A number of approaches are available for arriving at this relationship. Road traffic certainly causes congestion. Queuing and delay occurs in all congested situations. Delay causes economic loss since time means money in the modern age. A study of queuing and delay is, therefore of great relevance to a traffic engineer.

The distribution of cars linearly along a road and the study of headways gaps between vehicles will aid the traffic engineer in designing intersections and operating the traffic facilities. The headways and gaps are governed by the arrival pattern of vehicles and the flow of traffic.

3.2 Some definitions

Traffic flow theory is mainly concerned with three measurable characteristics of road traffic, i.e. speed, flow and concentration.

The definition of various terms associated with speed is:

Time mean speed ($\bar{v}_t$) is the average of the speed measurements at one point in space over a period of time.

Space mean speed ($\bar{v}_s$) is the average of the speed measurements at an instant of time over a space.

Flow also known as volume, (Q) is the number of vehicles passing a specified point during a stated period of time. It is usually to express it in vehicles per hour.

Concentration, also known as density, (K) is the number of vehicles present in a stated length of road at an instant. It is usually expressed in vehicles per kilometer length of road per lane.

Space headway, (s), is the distance between the fronts of successive vehicles. It is measured in meters.

Time headway, or simply headway (h), is the time interval between the passage of the fronts of successive vehicles at a specified point. It is measured in seconds.

3.3 Relationship between the Variables

Space mean speed, flow and density are related by the following equation

$$\bar{v}_s = \frac{Q}{K} \qquad \cdots (1)$$

Since concentration (K) is the reciprocal of the space headway ($\frac{s}{1000}$ when expressed in kilometres)

$$\bar{v}_s = \frac{Q \times s}{1000} \qquad \cdots (2)$$

s, the space headway, is related to h, the time headway as follows:

$$s = \frac{h}{3600} \times \bar{v}_s \times 1000 \qquad \cdots (3)$$

3.4 Fundamental diagram of traffic flow

In equation 1 above the concentration K has a theoretical maximum value when vehicle are packed from end to end. The theoretical maximum density is called the jamming concentration, K_j which is the reciprocal of the length of the car. If the average length of cars in a stream is 5m, the jamming concentration

$$K_j = \frac{1000}{5} = 200$$

When the vehicles are packed from end to end, the flow Q is obviously zero. So also, when the concentration is zero, there are no cars, hence the flow is zero. As the concentration slowly increases from zero, the flow also increases and a point is reached when the flow its maximum. The maximum flow that is capable of being accommodated in a road is the capacity of the road. The general form of the Flow-concentration curve, usually known as the fundamental diagram of traffic flow, is indicated below

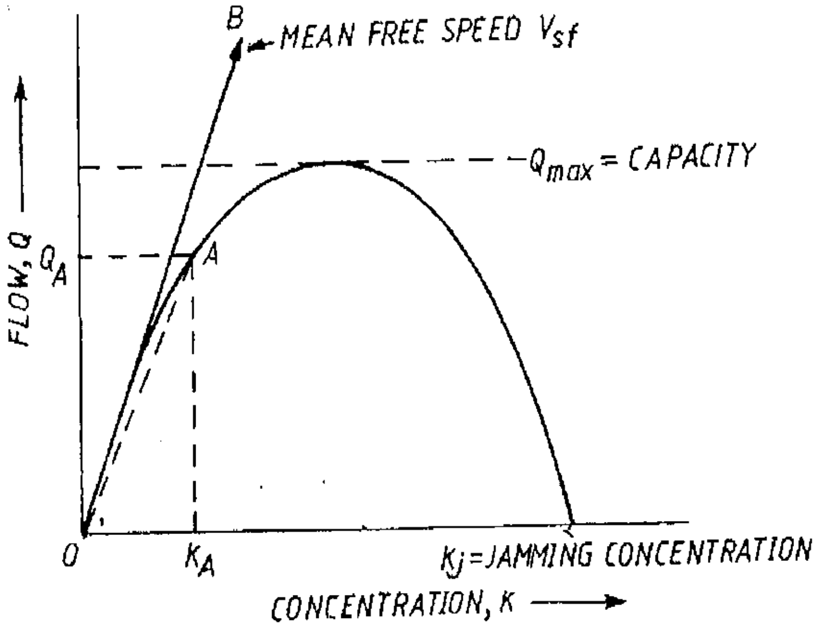

Figure 3.1 Fundamental diagram of road traffic(ref: Traffic engineering- Dr. L.R. Kadiyali)

The exact shape of the flow-concentration curve will depend upon a number of factors. In fact, the curve is a characteristic of a particular road section at a particular time with a particular population of drivers. Since all these can change and assume innumerable combinations, a large number of curves are possible

Since

$$\bar{v}_s = \frac{Q_A}{K_A}$$

The slope of the line joining the origin O to a point A on the curve gives the space mean speed associated with a concentration K_A and a volume Q_A.

The slope of the line OB tangential to the curve at the origin represents the mean free speed $\bar{v}_{sf}$, which is the speed the driver would adopt if there were no interference from the other vehicles.

For simplicity, it is often assumed that the shape of the curve is a parabola. The assumption is true for a straight line relationship between speed and concentration.

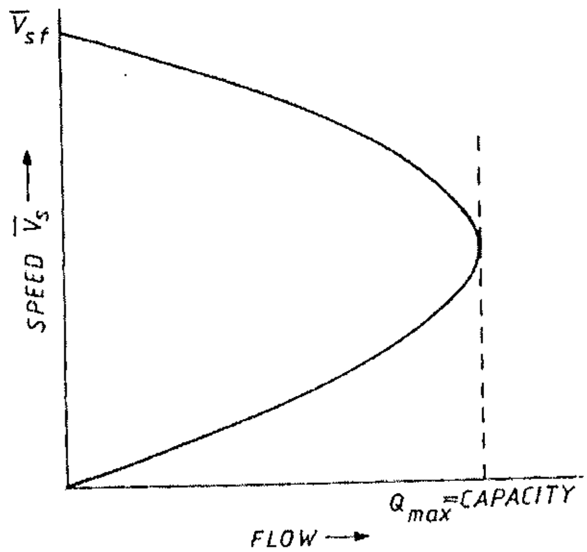

Figure 3.2 Speed flow curve (ref: Traffic engineering- Dr. L.R. Kadiyali)

The curve expressing the relationship between speed and flow will be form as shown in figure 3.2. The speed is zero when the flow is zero and speed is the maximum corresponding to free flow conditions. For intermediate values of speed, the volume varies and has a maximum value, Q max corresponding to the capacity of the road.

The relationship between speed and concentration can similarly be deduced. When the speed is zero, the concentration is at its maximum and this corresponds to K_j, the jamming concentration. Also, when the concentration is zero, the speed is maximum and is the free speed $\bar{v}_{sf}$. The exact shape of the curve joining these two points depends on a number of factors. A straight line relationship yields the parabola shape of the curve relating flow and concentration. Typical speed concentration curves are given the figure below.

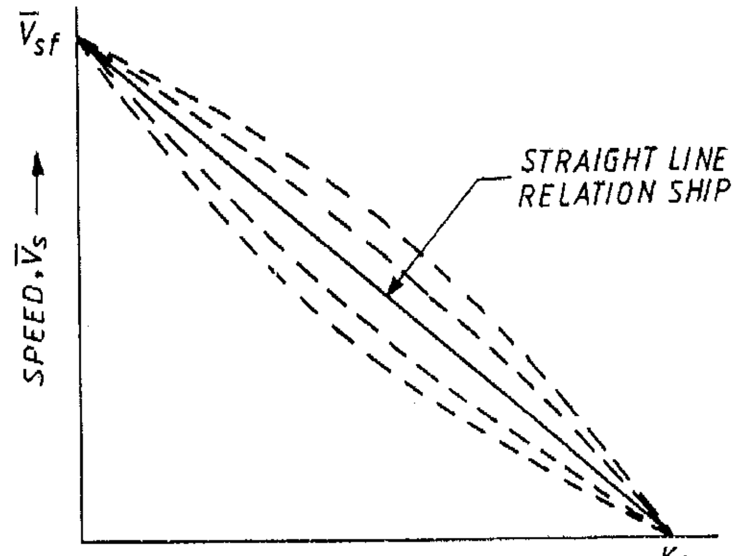

Figure 3.3 Speed-concentration relationship(ref: Traffic engineering- Dr. L.R. Kadiyali)

3.4.1 Linear relationship between speed and concentration

It has been indicated above that a linear relationship between speed and concentration is one of the possibilities. It was found that a linear relationship between speed and concentration of the following form

$$\bar{v}_s = \bar{v}_{sf} - \left(\frac{\bar{v}_{sf}}{K_j}\right)K \qquad \cdots (4)$$

Where v_s= space mean speed.

$\bar{v}_{sf}$=space mean speed for the free flow condition

K_j= jamming concentration

K=concentration

But From equation (1)

$$\bar{v}_s = \frac{Q}{K}$$

Subsitituting the value in above in equation 4

$$Q = (\bar{v}_{sf})K - \left(\frac{\bar{v}_{sf}}{K_j}\right)K^2 \qquad \cdots (5)$$

Also because

$$K = \frac{Q}{\bar{v}_s}$$

Subsituting in equation (4)

$$Q = K_j\bar{v}_s - \left(\frac{K_j}{\bar{v}_{sf}}\right)\bar{v}_s^2 \qquad \cdots (6)$$

Differentiating equation (5) with respect to concentration the concentration when flow is maximum is obtained. Thus

$$\frac{dQ}{dK} = \bar{v}_{sf} - 2 \times \bar{v}_{sf} \times \frac{K}{K_j} = 0$$

$\therefore \qquad K = Kmax.$

$$= \frac{K_j}{2} \qquad \cdots (7)$$

To obtain the speed when the flow is maximum, equation 6 is differentiated with respect to v_s

Thus

$$\frac{dQ}{d\bar{v}_s} = K_j - \frac{2 \times K_j \times \bar{v}_s}{\bar{v}_{sf}} = 0$$

$$\therefore \qquad \bar{v}_s = \bar{v}_s max. = \frac{\bar{v}_{sf}}{2} \qquad \cdots (8)$$

Subsituting the maximum values of K and v, in equation (1) Q maximum is obtained.

$$Q\ maximum = \bar{v}_s maximum \times K\ maximum$$

$$= \frac{\bar{v}_{sf}}{2} \times \frac{K_j}{2}$$

$$= \frac{\bar{v}_{sf} \times K_j}{4}$$

The relation is shown in the curves of the figure below .It also shows the speed flow concentration curves when the speed concentration relationship in linear.

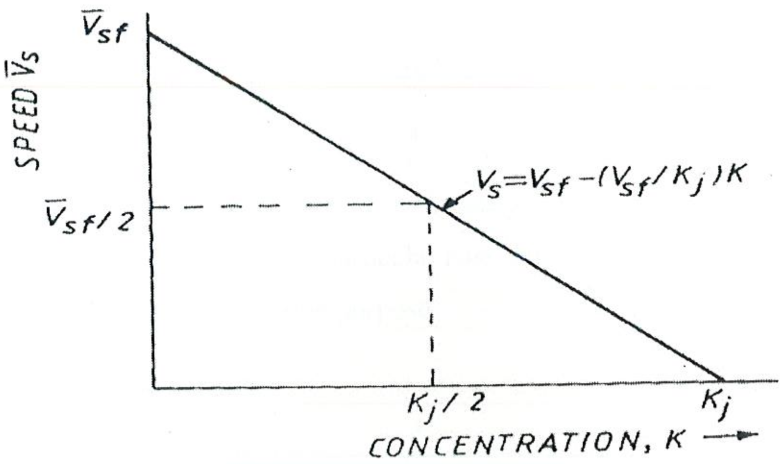

Figure 3.4 Speed vs Concentration(ref: Traffic engineering- Dr. L.R. Kadiyali)

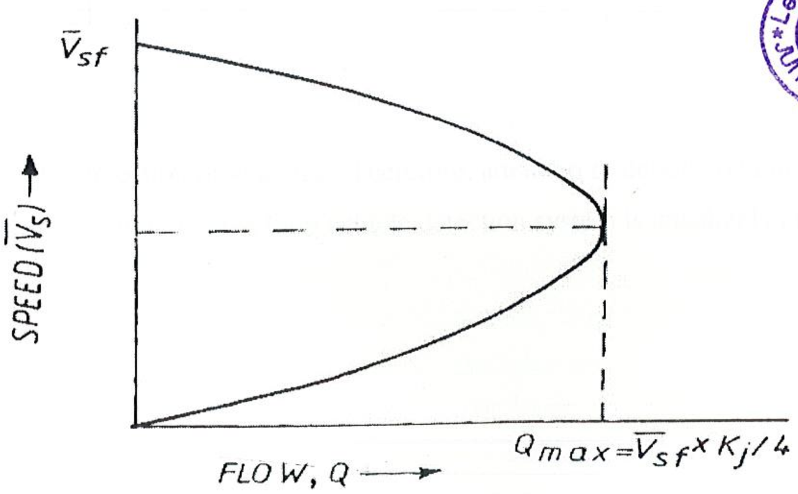

Figure 3.5 Speed vs Flow(ref: Traffic engineering- Dr. L.R. Kadiyali)

Chapter 4

SENSORS

A **sensor** is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. In this project the sensors are used for detection of vehicles passing through a particular lane. The following are the different types of sensors that can be used for detection purpose.

1. Inductive Loop Sensors
2. Ultrasonic Sensors
3. Laser Sensors
4. Image Processing Sensors
5. Infrared Sensors

4.1. Inductive Loop Sensors:-

An inductive loop vehicle detector system consists of three components: a loop (preformed or saw-cut), loop extension cable and a detector. When installing or repairing an inductive loop system the smallest detail can mean the difference between reliable detection and an intermit- tent detection of vehicles. Therefore, attention to detail when installing or troubleshooting an inductive loop vehicle detection system is absolutely critical

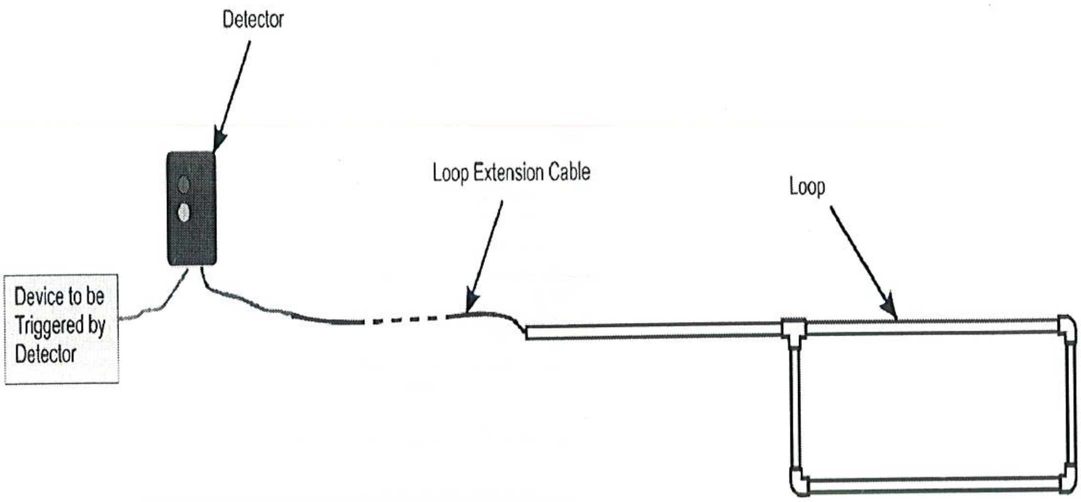

Figure 4.1 Inductive loop Sensor

4.1. 1 Working:-

The preformed or saw-cut loop is buried in the traffic lane. The loop is a continuous run of wire that enters and exits from the same point. The two ends of the loop wire are connected to the loop extension cable, which in turn connects to the vehicle detector. The detector powers the loop causing a magnetic field in the loop area. The loop resonates at a constant frequency that the detector monitors. A base frequency is established when there is no vehicle over the loop. When a large metal object, such as a vehicle, moves over the loop, the resonate frequency increases.

This increase in frequency is sensed and, depending on the design of the detector, forces a normally open relay to close. The relay will remain closed until the vehicle leaves the loop and the frequency returns to the base level. The relay can trigger any number of devices such as an audio intercom system, a gate, a traffic light, etc.

In general, a compact car will cause a greater increase in frequency than a full size car or truck. This occurs because the metal surfaces on the under carriage of the vehicle are closer to the loop. Figures illustrate how the under carriage of a sports car is well within the magnetic field of the loop compared to the sports utility vehicle. Notice that the frequency change is greater with the smaller vehicle.

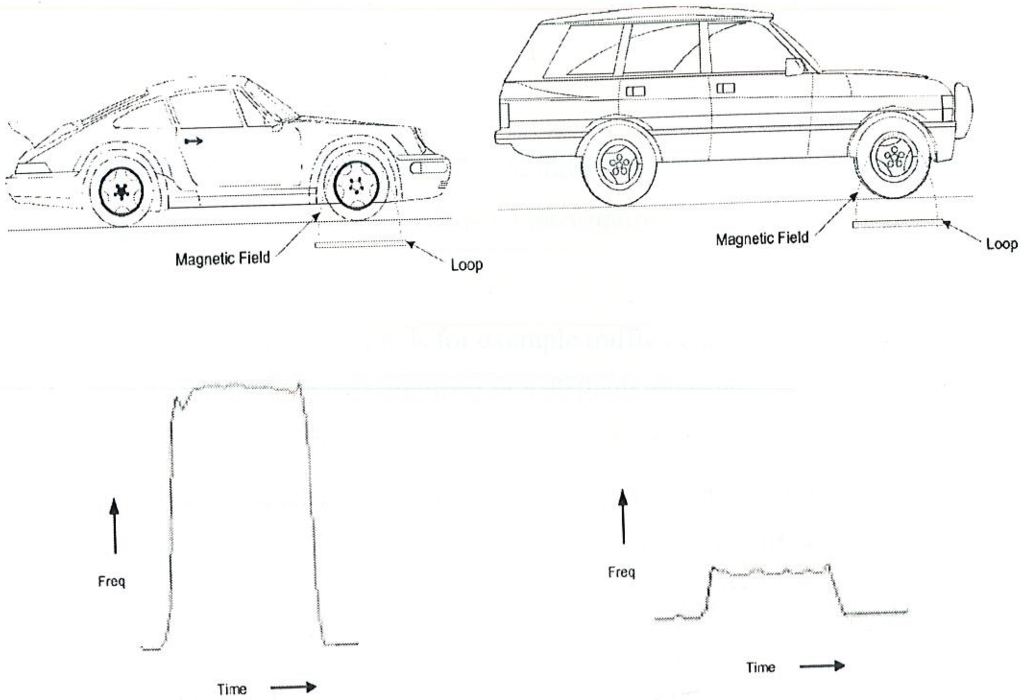

Figure 4.2 Illustration of different weights showing different frequency

Also, it is interesting to note that the frequency change is very consistent between two vehicles of the same make and model, so much so that a detector can almost be designed to determine the type of vehicle over the loop.

There is a misconception that inductive loop vehicle detection is based on metal mass. This is simply not true. Detection is based on metal surface area, otherwise known as skin effect. The greater the surface area of metal in the same plane as the loop, the greater the increase in frequency. For example, a one square foot piece of sheet metal positioned in the same plane of the loop has the same affect as a hunk of metal one foot square and one foot thick. Another way to illustrate the point is to take the same one square foot piece of sheet metal, which is easily detected when held in the same plane as the loop, and turn it perpendicular to the loop and it becomes impossible to detect. Keep this principle in mind when dealing with inductive loop detectors.

4.2. Laser Sensors:-

The laser sensor technology enables intelligent traffic control, as well as vehicle profile measurement, vehicle classification and speed measurement.

Typical application for such sensors is for example traffic control, where many automatic control systems need reliable measurement in a difficult environment.

The highly efficient distance measurement method is based on the flight time of a short, eye-safe laser pulse to the target and back. The principle is known as pulsed time-of-flight (TOF) distance measurement.

The main advantages of TOF measurement include:-

1. Non-contact
2. Non-disturbing nature
3. High speed
4. Accuracy
5. High spatial resolution
6. Wide measurement range.

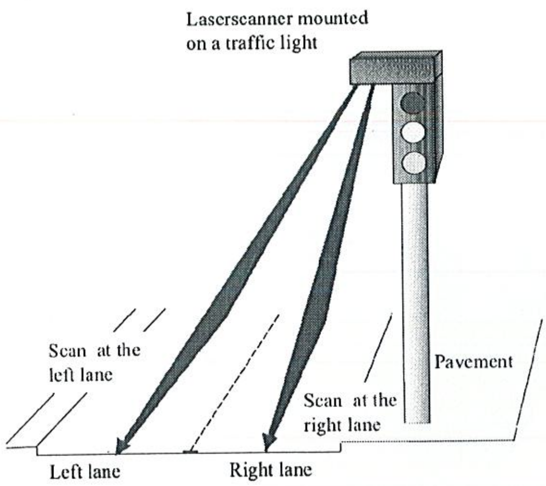

Figure 4.3 Laser Sensor installed on road

4.3. Ultrasonic Sensors:-

Ultrasonic sensors are a simple device. They send out an ultrasonic pulse and then wait for a response. When the pulse leaves the device, it travels through the air until it collides with an object, at which point an echo is reflected back. This echo is then sensed by the ultrasonic sensor.

The time between the sent pulse and the returned echo is used to calculate distance.The emitted pulse has a cone shape and any object the pulse encounters will return an echo. It is not possible to discern between small objects.

4.3.1. Distance Calculation:-

The distance calculation is quite simple. Once the pulse is sent and the echo is sensed, one only needs to use the following equation-

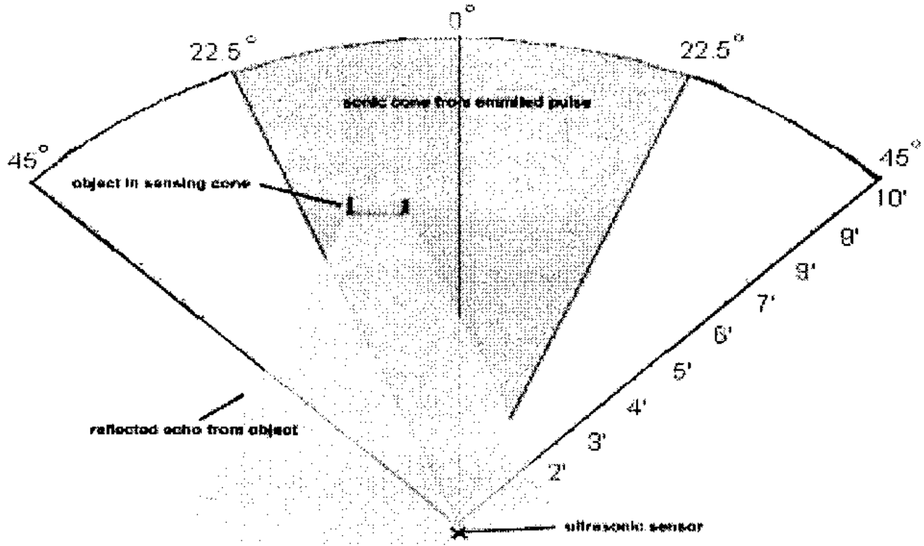

Figure 4.4 Ultrasonic Vehicle Detection

$$Dist = \frac{elapsed\_time \times speed\_of\_sound}{2}$$

4.3.2. Limitations:-

One of the major problems is that anything in the sensors path will return a pulse. There is no way to discern between a 1in pipe and a wall, because both will return an echo.
So it is difficult to distinguish between a moving vehicle and an ordinary object.

4.4. Image Processing Sensors:-

Image Sensor processes an image received from the ITV camera installed aside and above the approach lane at the traffic signal intersection, so it is able to directly measure a spatial area.

Characteristics of Image Processing Sensors-

(1) It is able to measure speed, vehicle type as well as number of passed vehicles on more than one lane at the same time.

(2) It is expected to collect more precise and more detail queue and delay length information because of the direct measurement of them.

4.4.1 System configuration

1 . Camera Unit-Camera Unit is installed above the approach lane.

2. Control Unit-It is installed at the lower part of the pole.

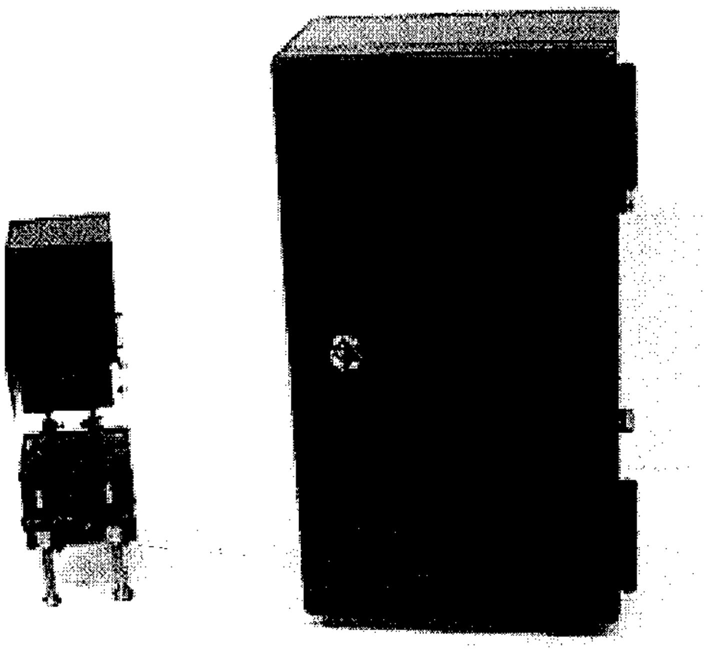

Figure 4.5 Camera Units and Control Unit

4.4.2 Hardware Configuration:-

In the Image Preprocess, we extract data in the sample point positions which were beforehand set like Figure 1from the input image and make a *Sampled-Points Image*. If we set these sample points elaborately, we could reduce whole computation quantity while securing the data which is necessary to measure in precise. Next we detect the status such as existing or moving of every sample point by the combination and by utilizing each characteristics of basic image processing methods such as time difference, background difference and spatial difference.

Main Component of in Hardware Configuration are-

(a) **CCD Camera Unit-**

It is used to take images.

(b) **Amplification Unit-**

Amplification unit does amplification of the image.

(c) **A/D Converter-**

Analog to digital conversion of the data takes place here.

(d) Image Memory-

It is a temporary memory for the storage of the image.

(e) Preprocessing Unit-

Makes a sampled point image and hence performs 3 basic operations:

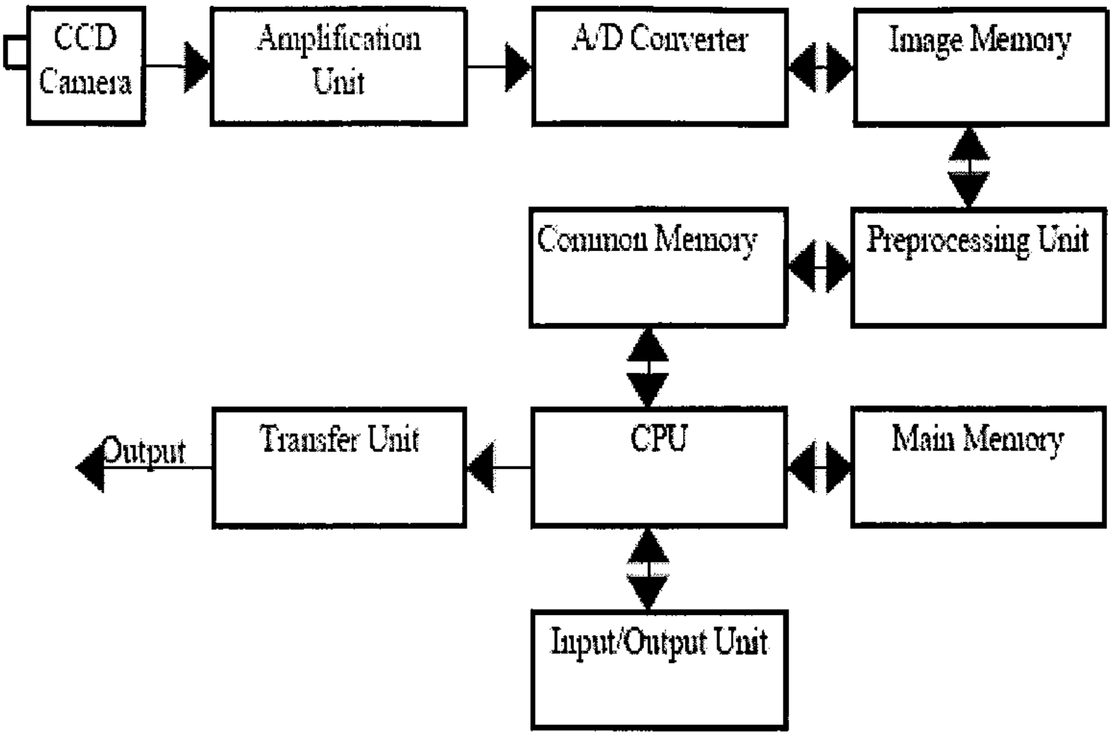

Figure 4.6 Hardware Configuration

1. Time Difference-

It is the method to calculate a difference among two images in time t and time t+alpha and detect change quantity in time alpha.

2. Background Difference-

It is the difference between the empty road and the road when vehicles are present on it.

3. Spatial Difference-

It is a parameter for the measurement of space between two vehicles on road.

4.5. Infrared Sensors-

InfraRed sensor (IR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. IR sensors are often used in the construction of IR-based motion detectors.

Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

All objects emit what is known as black body radiation. It is usually infrared radiation that is invisible to the human eye but can be detected by electronic devices designed for such a purpose.

"Infra" meaning below our ability to detect it visually, and "Red" because this color represents the lowest energy level that our eyes can sense before it becomes invisible. Thus, infrared means below the energy level of the color red, and applies to many sources of invisible energy.

The IR sensor is typically mounted on a printed circuit board containing the necessary electronics required to interpret the signals from the pyroelectric sensor chip. The complete assembly is contained within a housing mounted in a location where the sensor can view the area to be monitored.

Disadvantage: - It is very sensitive and detects everything that cones in between whether it's a vehicle of a person crossing the road. So it becomes very difficult to distinguish.

Chapter 5

CONGESTION IN COMPUTER NETWORKS

5.1 Introduction:-

Computer networks form an essential substrate for a variety of distributed applications. This makes it important to optimize their performance so that users can derive the most benefit at the least cost.

The main problem that computer networks face is congestion.

Congestion: - A network is said to be congested from the perspective of user *i* if the utility of *i* decreases due to an increase in network load.

Now the question comes is that why congestion occur?

The main reasons for congestion are:-

1. Excessive queuing delay
2. Packet loss
3. Decrease in effective throughput

The two main points at which congestion takes place are :-

1. Source – Congestion can be controlled here by flow control algorithms.
2. Switch – Congestion is controlled here by routing and queuing algorithms.

5.2 Different Queuing techniques:-

5.2.1 FCFS (First come first serve) - In this scheme, the order of arrival completely determines the bandwidth, promptness, and buffer space allocations, inextricably intertwining these three allocation issues. Since each user may have a different preference for each allocated quantity, FCFS queuing cannot provide adequate congestion.

The order of arrival completely determines the bandwidth, promptness, and buffer space allocations, inextricably intertwining these three allocation issues.

5.2.2 FQ (Fair Queuing) - Algorithm in which switches maintain separate queues for packets from each individual source. The queues are serviced in a round-robin manner. This prevents a source from arbitrarily increasing its share of the bandwidth or the queuing delay received by the other sources.

In fact, when a source sends packets too quickly, it merely increases the length of its own queue. By changing the way packets from different sources interact, does not reward, nor leave sources vulnerable to, anti-social behavior.

5.3 Different Routing techniques

Process of forwarding a packet to its next hop is called routing. Routing table is a table used to store next-hop information.

Static routing - A program computes and installs routes when a packet switch boots, the routes do not change is called Static Routing. Static routing is simple and has low overhead.

Dynamic routing - A program builds an initial routing table and then alters the table as a condition change is called Dynamic Routing. Most networks use dynamic routing because it handles problems automatically and modifies routes to accommodate failures.

One of the most efficient methods of routing is Dijkstra's Algorithm.

Dijkstra's algorithm:-

Steps involved are:-

1. Finds the distance along a shortest path from a single source node to each of the other nodes in the graph.
2. A next-hop routing table is constructed during the computation of shortest path.
3. Uses weights on edges as a measure of distance.
4. A path with fewest numbers of edges may not be the path with least weight.

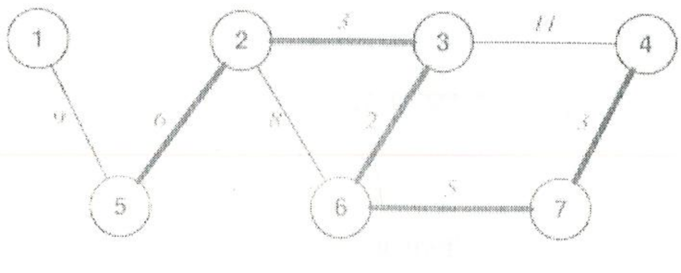

Figure 5.1 The shortest path between 4 & 5 is shown darkened.

The two main routing techniques used are:-

5.3.1 Link-State Routing (SPF):-

It is also called shortest path first or SPF routing. Packet switches sends messages with status of the link. Then messages are broadcasted to all switches. Each switch collects information and builds the graph of the network. Switches use Dijkstra'a algorithm to produce routing table. The advantage of SPF algorithm is that it can adapt to hardware failures.

5.3.2 Distance Vector Routing:-

Distance-vector algorithm uses distributed route computation. Each link in network is assigned a weight and distance to a destination is defined to be the sum of weights along the paths. A packet switch periodically updates the network. Then each message contains pairs of (destination, distance).

Chapter 6
PREVIOUS WORKS

The following two are popularly used systems in traffic control.

1. SCOOT(Split Cycle and Offset Optimization Technique)

2. MOVA(Microprocessor Optimized Vehicle Actuation)

6.1 SCOOT

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 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.

Working

The operation of the SCOOT model is summarized in the diagram below. SCOOT obtains information on traffic flows from detectors. As an adaptive system, SCOOT depends on good traffic data so that it can respond to changes in flow. Detectors are normally required on every link. Their location is important and they are usually positioned at the upstream end of the approach link. Inductive loops are normally used, but other methods are also available.

When vehicles pass 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 sample profile shown in the diagram is color coded green and red according to the state of the traffic signals when the vehicles will arrive at the stop line at normal cruise speed. Vehicles are modeled down the link at cruise speed and join the back of the queue (if present). During the green, vehicles discharge from the stop line at the validated saturation flow rate.

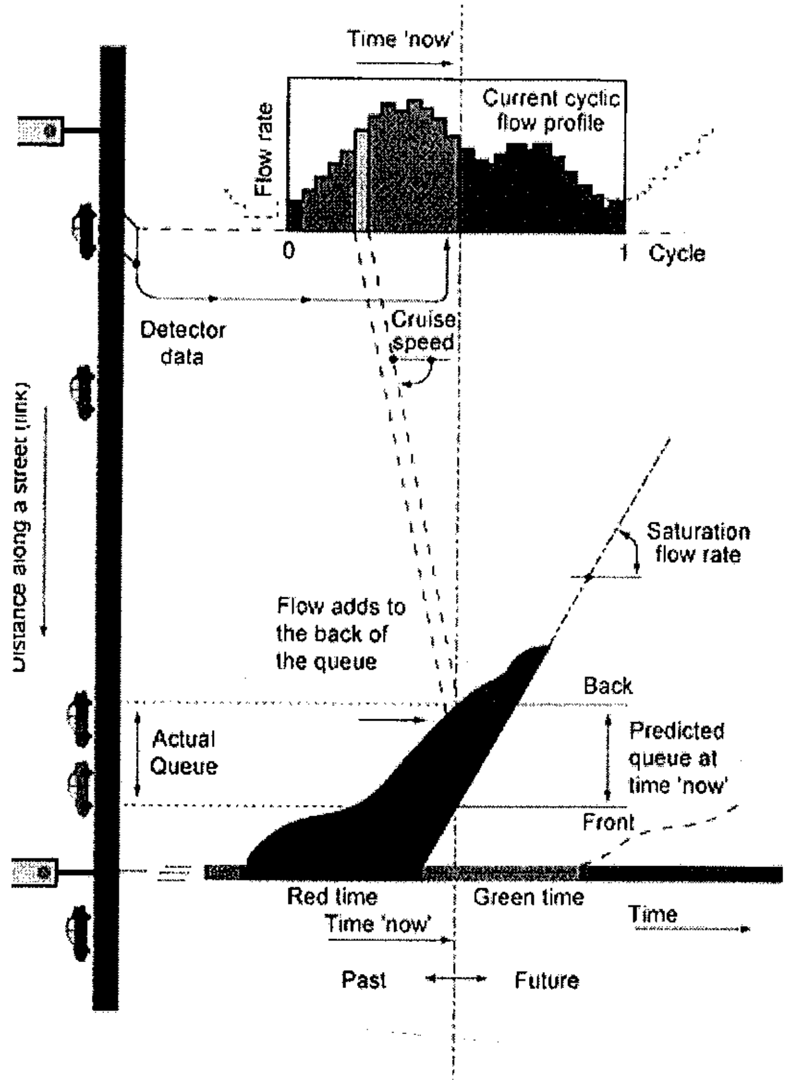

Figure 6.1 SCOOT

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 SCOOT 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 plans 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 manage 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.

SCOOT detectors are positioned where they will detect queues that are in danger of blocking upstream junctions and causing congestion to spread through the network. Within SCOOT, the traffic manager is able to priorities where such problems should be minimized and SCOOT then automatically adjusts timings to manage the congestion.

Where local action is insufficient, the engineer can specify holding areas where queues should be relocated to in critical conditions, gating traffic entering the urban area to ensure efficient operation of critical, bottleneck links. SCOOT will continuously monitor the sensitive area and smoothly impose restraint to hold traffic in the specified areas when necessary.

SCOOT naturally reduces vehicle emissions by reducing delays and congestion within the network. In addition it can be set to adjust the optimization of the signal timings to minimize emissions and also provide estimations of harmful emissions within the controlled area.

6.2 MOVA

This method is more accurate and reliable as there is no estimation done here. The two sensors simultaneously measures or counts the number of vehicle passing through a lane in 2 points, which gives us queue length and one can also calculate the average speed if vehicle using the lane. In the figure below there are two detectors installed in a single lane. Thus one can count the number of vehicles entering and leaving the lane, this would give an accurate and reliable information about the queue formation.

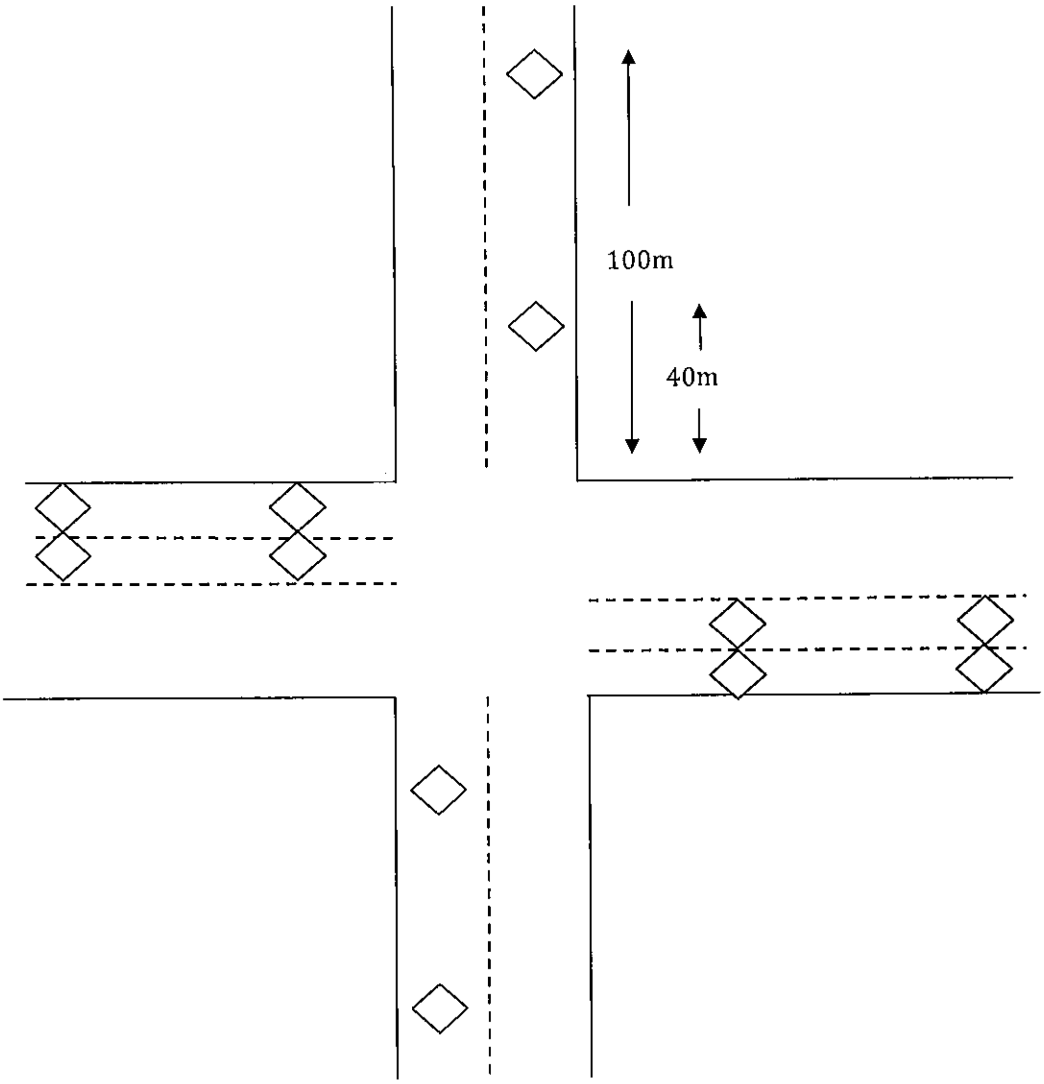

Figure6.2. Detectors location for MOVA

Chapter 7

RESULTS

There are many network congestion control as well as road traffic control policies that have been discussed so far.

The network traffic and the road traffic are similar in many ways, like –

1. On road the vehicle are taken into consideration while in the case of networks there are packets.
2. The main aim in both the cases is to avoid congestions.
3. Also efficient routing techniques as well as traffic control policies are implemented which aim at taking the minimum time for a packet or a vehicle to reach its desired locations.

The following simulations are done taking the road traffic into consideration.

Sensors Proposed –

Laser sensors are proposed here to for installation on road. They can be mounted vertically above the lane and their projection will be downwards. When a vehicle passes through it, the beam is cut and the vehicle is counted.

Advantages – They are cheap and besides that they are easy to install and don't need much hardware or software part.

7.1 Sensing a single car:-

Here in this project , simulation is started with simulating a single car coming towards the crossing. figure 7.1 showing the output of the sensor which is sensing a car at the random time.

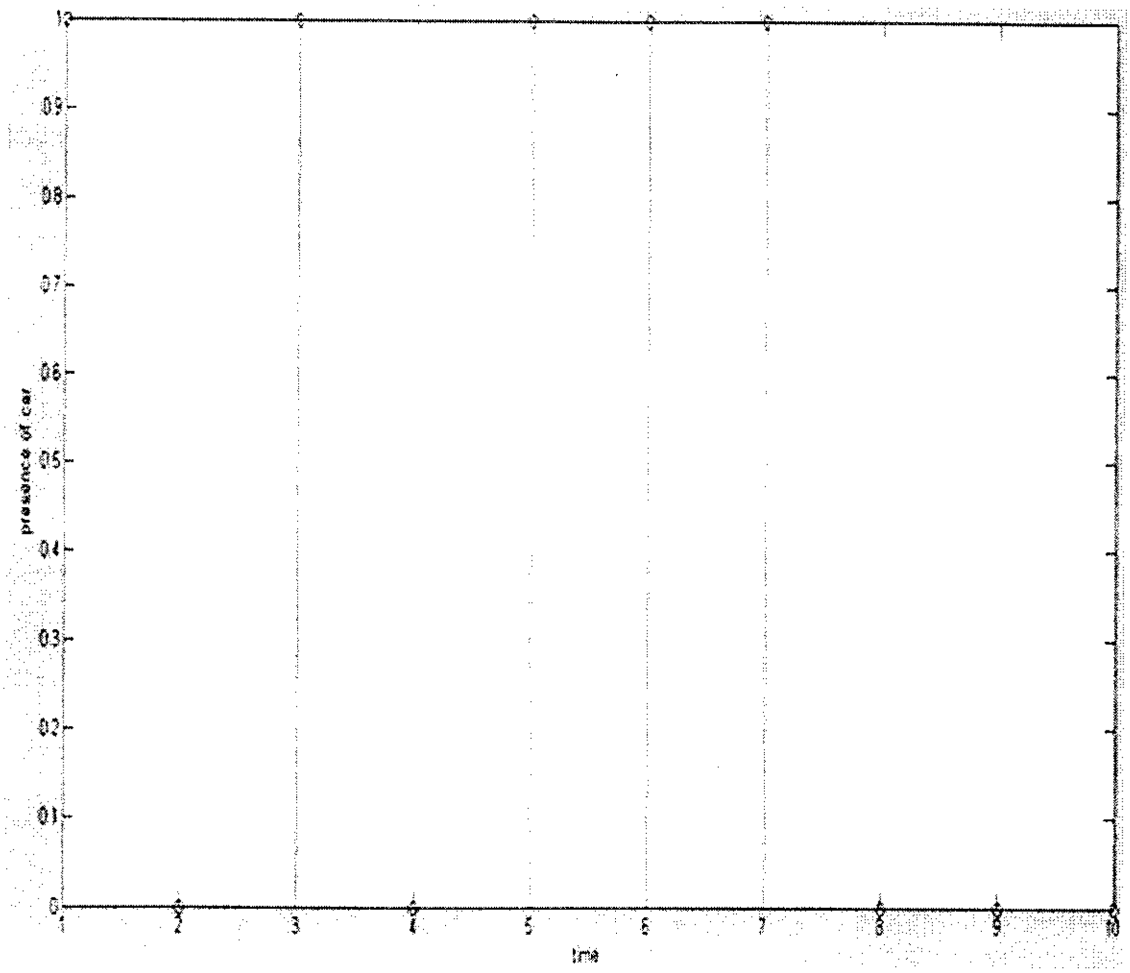

Figure 7.1

7.2. Simulating the traffic on road:-

Figure 7.2 shows the traffic on road coming towards each other from opposite directions. Here alphabets (A-Z) represent vehicles and '.' represent the empty road.

m is the duration of the simulation.

n is the green or red phase of the traffic light of left side.

d is any random variable which represents that in between 0 and d the vehicle can enter the road.

Here in this output d is less, so that traffic is more. Output is shown in the next pages.

```
C:\WINDOWS\system32\cmd.exe
C:\Program Files\Java\jdk1.5.0_06\bin>java semaforo
duration of simulation m:
20
lights in the period of second n:
3
time for state of road on screen d
2
lights in the period of second b:
3
time for state of road on screen c
2
0:0: ....-
                              :+:....0:0
0:1: A...-
                              :+:...A1:1
1:2: BA..-
                              :+:..A..2:0
0:3: ..BA.!
                              :*:.A..B3:1
1:4: C..BA!
                              :*:A..B..4:0
0:5: ..C.BA!
                              :*:A.B...C5:0
1:6: D..CBA-
                              :+:AB...C.D6:1
0:7: ..D..CB-
                              :+:B...C.D..7:0
0:8: E..D..C-
                              :+:...C.D..E8:1
1:9: FE..D..!
                              :*:..C.D..E..9:0
0:10: ..FE..D.!
                              :*:.C.D..E..F10:0
1:11: G..FE..D!
                              :*:C.D..E..F.G11:0
0:12: ..G..FE.D-
                              :+:CD..E..F.G.H12:0
1:13: H..G..FE.-
                              :+:D..E..F.G.H.I13:1
0:14: ..H..G..FE-
                              :+:..E..F.G.H.I..14:0
1:15: I..H..G..F!
                              :*:.E..F.G.H.I..J15:1
0:16: ..I..H..G.F!
                              :*:E..F.G.H.I..J..16:0
0:17: J..I..H..GF!
                              :*:E.F.G.H.I..J...K17:1
1:18: KJ..I..H.GF-
                              :+:EF.G.H.I..J...K..18:0
0:19: ..KJ..I..H.G-
                              :+:F.G.H.I..J...K...L19:0

C:\Program Files\Java\jdk1.5.0_06\bin>
```

Figure 7.2

Figure 7.3 shows the same road simulation but here the d is less , so the traffic is less here.

```
C:\WINDOWS\system32\cmd.exe
C:\Program Files\Java\jdk1.5.0_06\bin>java semaforo
duration of simulation m:
20
lights in the period of second n:
4
time for state of road on screen d
10
lights in the period of second b:
4
time for state of road on screen c
30
0:0: ....-
                              :+:....0:0
8:1: A...-
                              :+:...A1:7
7:2: ..A..-
                              :+:..A..2:6
6:3: ....A.-
                              :+:.A....3:5
5:4: ......A¦
                              :*:A......4:4
4:5: .......A¦
                              :*:A.......5:3
3:6: ........A¦
                              :*:A........6:2
2:7: .........A¦
                              :*:A.........7:1
1:8: ..........A-
                              :+:A..........8:0
0:9: ............-
                              :+:...........B9:0
5:10: B...........-
                              :+:.........BC10:3
4:11: ..B..........-
                              :+:........BC..11:2
3:12: ....B.........¦
                              :*:.......BC....12:1
2:13: ......B........¦
                              :*:......BC......13:0
1:14: ........B.......¦
                              :*:.....BC......D14:6
0:15: ..........B......¦
                              :*:....BC......D..15:5
5:16: C..........B.....-
                              :+:...BC......D....16:4
4:17: ..C..........B....-
                              :+:..BC......D......17:3
3:18: ....C..........B...-
                              :+:.BC......D........18:2
2:19: ......C..........B..-
                              :+:BC......D..........19:1

C:\Program Files\Java\jdk1.5.0_06\bin>
```

Figure 7.3

7.3 Simulating of traffic at intersections and its control

The simulation shown here is a Java based simulation of traffic taken into account three crossings at a time.

The car is represented by a rectangular block and it changes its position w.r.t time. The cars come at random interval of time.

The red yellow and green phases can be manually set during the simulation according to the situation at that time.

7.3.1 Variables considered:-

1. N1- Total no of vehicles moving at an intersection from left to right during the simulation. The vehicle when enters the map at left and exits at right is counted as one.

2. N2- Total no of vehicles moving at an intersection from north to south or vice versa during the simulation. The vehicle when enters the map at north and exits at south or vice versa is counted as one.

3. n1- No of vehicles per minute entering and leaving the map in horizontal direction.

4. n2- No of vehicles per minute entering and leaving the map in vertical direction.

5. maxVelocity- The max velocity a vehicle can attain after it has left the junction.

6. Acceleration- The rate at which the velocity increases once vehicle starts moving.

7. Delay Time- Delay time is the time difference between the phases of adjacent crossings. Delay time zero means that there is no time difference between the phases.

8. Time- It denotes the total time of simulation.

9. Start- Denoted the start of simulation.

10. Reset- Start the simulation again by setting delay = 0 , and setting green, yellow and red time, maximum velocity and acceleration again to a predefined value in the program.

Working:

The current program is dynamic as the time of the traffic lights can be set during the simulaton period seeing the traffic conditions.

The window ar the top shows N1/N2/Flow1 & n1/n2/Flow2.

Flow- It is the no. of vehicles passing passing a specific point during the specific period of time.

Flow1= (N1 + N2/2)/T

Flow2=(n1+n2/2)/t

T – it's the total time of simulation

t – it's the time which resets after every 60 seconds.

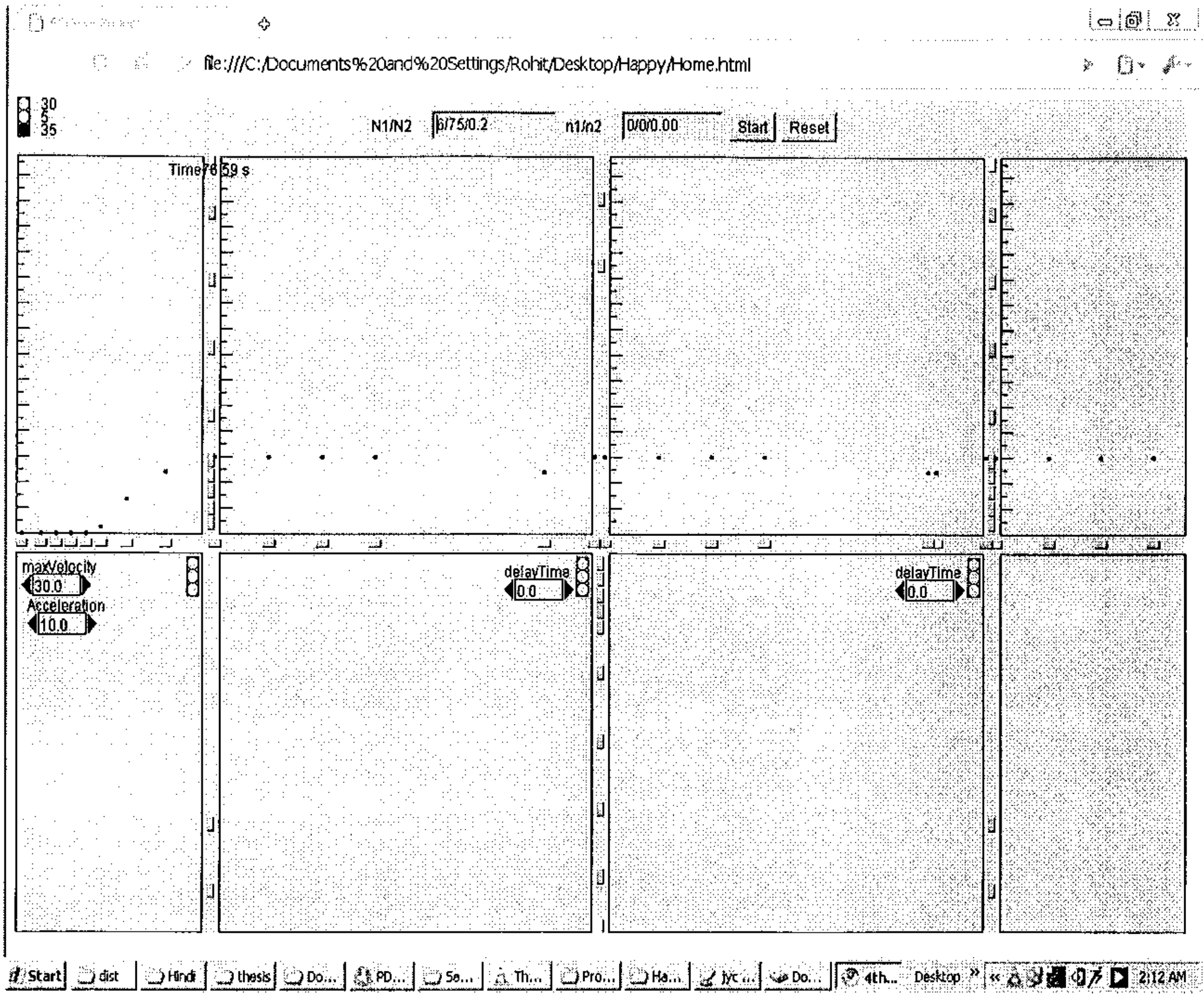

Figure 7.4 Simulation at time=76.

Here, Delay Time=0, Max Velocity= 30, Acceleration=10m/s

Green Phase=30s, Yellow Phase=5s, Red Phase=35s

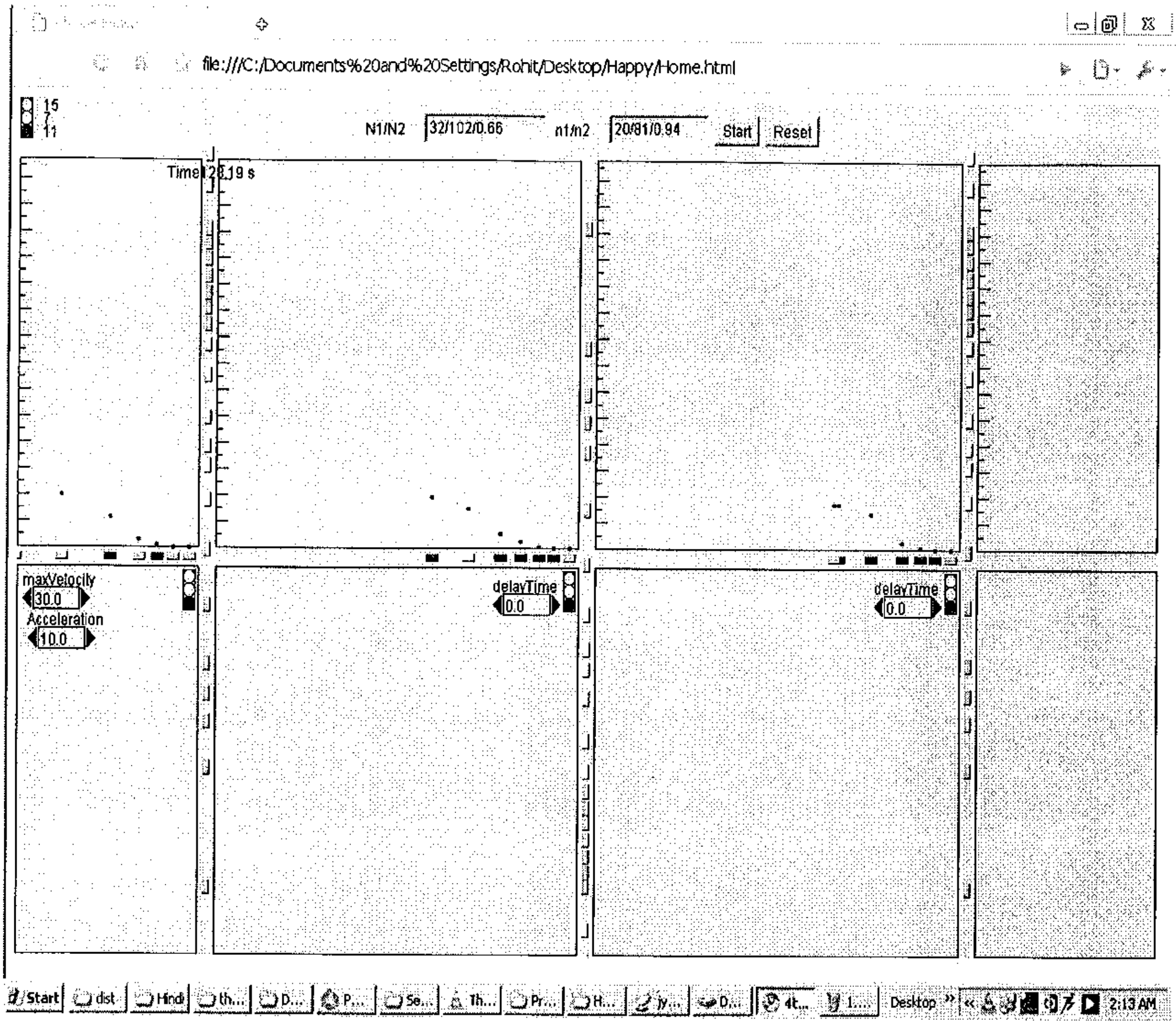

Figure 7.5 Simulation at time=128.

Here, Delay Time=0, Max Velocity= 30, Acceleration=10m/s

Green Phase=15s, Yellow Phase=7s, Red Phase=11s

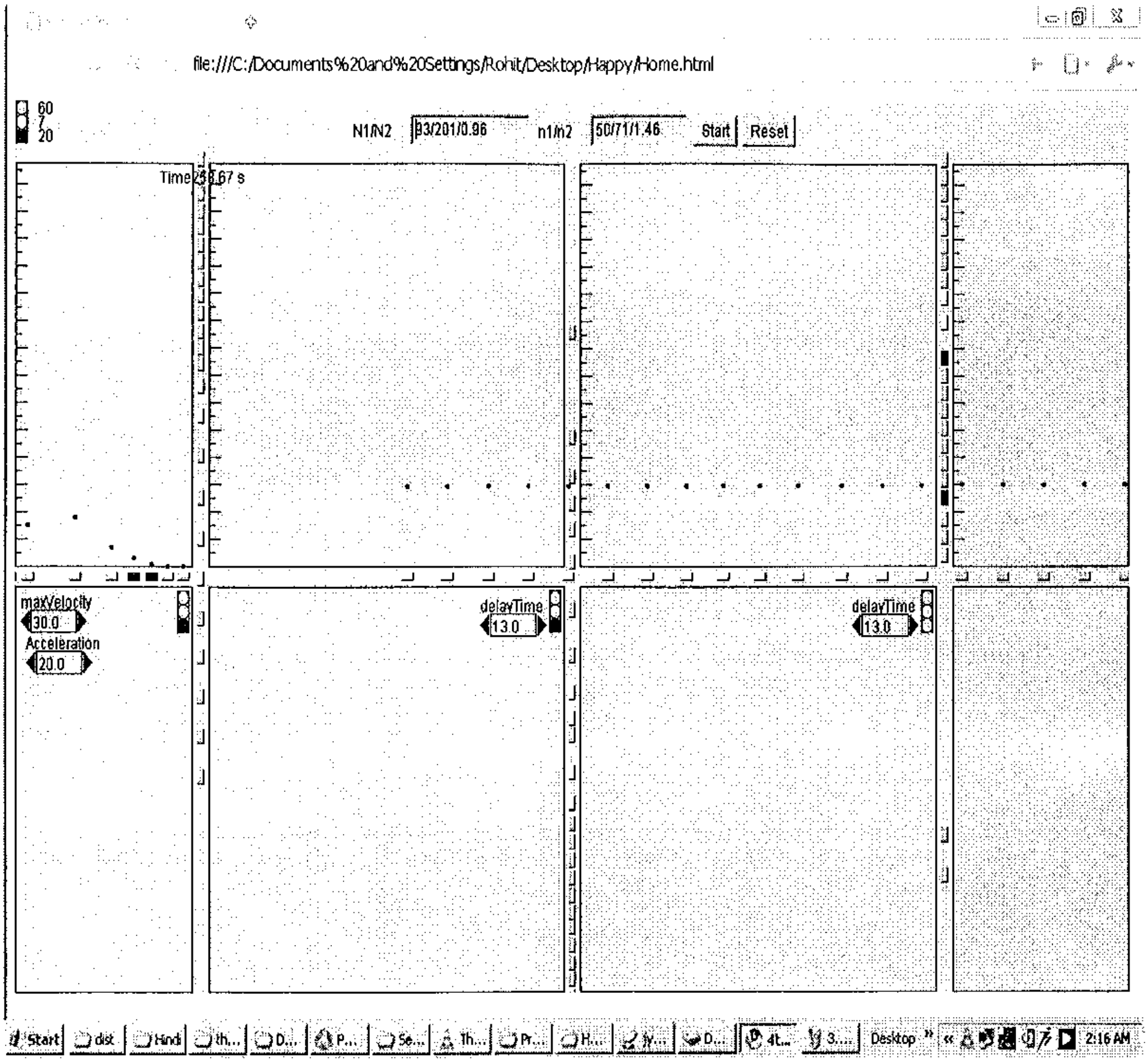

Figure 7.6 Simulation at time=256.

Here, Delay Time=13, Max Velocity= 30, Acceleration=20m/s

Green Phase=60s, Yellow Phase=7s, Red Phase=20s

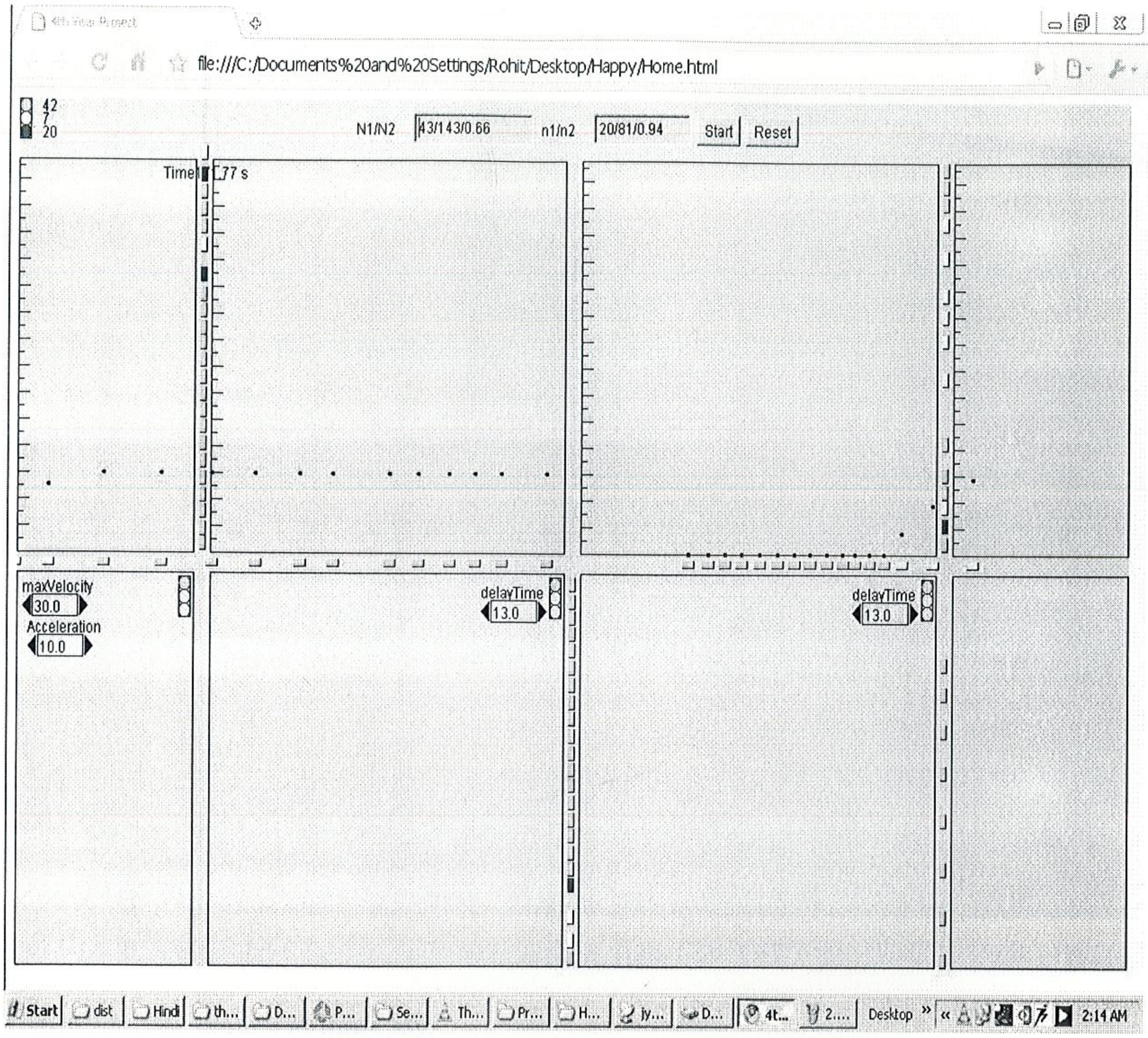

Figure 7.7 Simulation at time=277.

Here, Delay Time=13, Max Velocity= 30, Acceleration=10m/s

Green Phase=42s, Yellow Phase=7s, Red Phase=20s

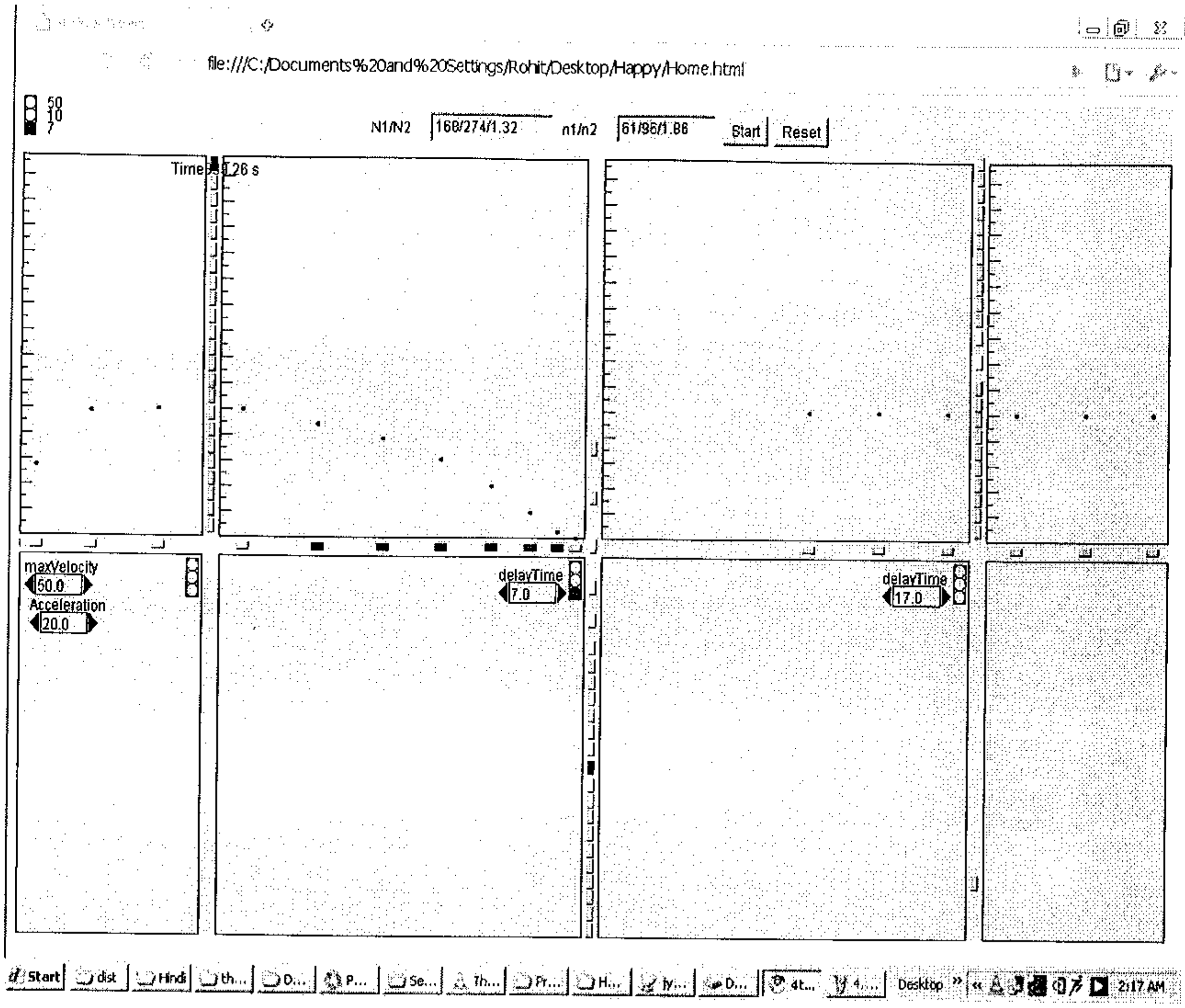

Figure 7.8 Simulation at time=359.

Here, Delay Time=7, Max Velocity= 50, Acceleration=20m/s

Green Phase=50s, Yellow Phase=10s, Red Phase=7s

Conclusions

From the simulation we can conclude that the road crossings have been successfully simulated.

The traffic light timings can be set seeing the prevailing traffic conditions. This hence justifies the dynamicity of the program.

Future Prospects

More words can be done on this simulation taking into account the flow of the traffic.

Traffic light timings can be made dependent on flow of traffic.

Also road signs need to be taken into consideration.

Diversion techniques can be used where the congestion crosses a threshold.

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