Traffic Management using Intelligence in Transportation Systems

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Abstract— Road traffic congestion is a recurring problem worldwide. In India, a fast growing economy, the problem is acutely felt in almost all major cities. This is primarily because infrastructure growth is slow compared to growth in number of vehicles, due to space and cost constraints. Building new roads to meet the demand is now not a feasible solution. In this paper, we present a comprehensive study of all available Intelligent Transportation Systems, including both research prototypes and deployed systems. National Expressway N.E-1 is considered as a case study and the implementations of these technologies on N.E-1 have been discussed.

Key words: Traffic Management, Transportation Systems

I. INTRODUCTION

India, the second most populous country in the world, and a fast growing economy, is seeing terrible road congestion problems in its cities. With the development of the Golden Quadrilateral, India is seeing an increasing use of automated technologies in the transport sector. Intelligent Transport Systems can be broadly defined as the use of modern day technology for an efficient management of the transportation systems. I.T.S. employs modern communication, computer and sensor technology directly and are also enabled indirectly by developments in materials technology and operations research including network analysis and risk assessment.

There are a few metropolitan cities such as New Delhi, Bangalore and Pune that have standalone ITS applications like automated parking systems, electronic toll collection, automated traveller information systems (ATIS) and intelligent signal control. Passenger information systems (PIS) have been implemented in some bus rapid transit (BRT) systems in India.

Intelligent Transportation Systems is a global phenomenon, attracting worldwide interest from transportation professionals, automotive industry and political decision makers. I.T.S. applies advanced communication, information and electronics technology to solve transportation problems such as, traffic congestion, safety, transport efficiency and environmental conservation. We can say that the purpose of I.T.S. is to take advantage of the appropriate technologies to create "more intelligent" roads, vehicles and users.

II. SYSTEMS OF I.T.S

Looking at the Indian scenario of the traffic problems, the various applications of I.T.S. that can be incorporated are as:

A. Advanced Traffic Management Systems (ATMS):

ATMS integrates various sub-systems (such as CCTV, vehicle detection, communications, variable message systems, etc.) into a coherent single interface that provides real time data on traffic status and predicts traffic conditions for more efficient planning and operations.

B. Advanced Traveler Information System (ATIS):

ATIS provide to users of transportation systems, travel-related information to assist decision making on route choices, estimate travel times, and avoid congestion.

C. Advanced Vehicle Control Systems (AVCS):

AVCS are tools and concepts that enhance the driver's control of the vehicle to make travel safer and more efficient. In more advanced AVCS applications, the vehicle could automatically break or steer away from a collision, based on input from sensors on the vehicle.

D. Commercial Vehicle Operations (CVO):

CVO comprises a system of satellite navigation system, a small computer and a digital radio, which can be used in commercial vehicles such as trucks, vans, and taxis. This system affords constant monitoring of truck operations by the central office and provides traceability and safety.

E. Advanced Public Transportation Systems (APTS):

APTS applies state-of-art transportation management and information technologies to public transit systems to enhance efficiency of operation and improve safety. It includes real-time passenger information systems, automatic vehicle location systems, bus arrival notification systems, and systems providing priority of passage to buses at signalized intersections (transit signal priority). In APTS are also included the automatic payment systems, through the use of multiple usage smart cards which provide functions such as stored credit or automatic capture of passenger information and journey profile.

F. Advanced Rural Transportation System (ARTS):

ARTS provide information about remote road and other transportation systems. This type of information is valuable to motorists travelling to remote or rural areas.

G. Intersection Control:

At intersections, deciding the total signal cycle and the split of green times among different flows, is one of the most basic traffic management applications (2) Incident detection - Pinpointing locations of accidents or vehicle breakdown is important to handle the emergency situations. (3) Vehicle classification - Knowing

III. TECHNOLOGIES OF I.T.S

Intelligent Transport Systems again consist of state-of-the art Technologies. Some of them used in Indian cities are as follows:

A. Electronic Toll Collection (ETC):

ETC aims to eliminate the delay on toll roads by collecting tolls electronically. It is thus a technological

implementation of a road pricing concept. It determines whether the cars passing are enrolled in the program, alerts enforcers for those that are not, and electronically debits the accounts of registered car owners without requiring them to stop.

System assists in the management of toll operations by providing valuable data such as traffic volume, vehicle classification, and fare expected / collected.

With ETC, these transactions can be performed while vehicles travel at near highway cruising speed. ETC is fast becoming a globally accepted method of toll collection, a trend greatly aided by the growth of interoperable ETC technologies.

B. Weigh In Motion (WIM):

A WIM system is defined as a device that measures the dynamic axle mass of a moving vehicle to estimate the corresponding static axle mass. WIM systems should not be confused with on-board vehicle weighing systems. On-board weighing systems are mounted or attached to the vehicle, while WIM systems are independent of the vehicle being weighed.

One of the purposes behind the development of WIM technology was the ability to measure the actual loads being applied to a roadway by a moving truck. It was felt that this would more accurately represent what the pavement is subjected to than a static weight. . As a vehicle travels, the dynamic load applied to the road varies significantly due to the vehicle bouncing, acceleration or deceleration, and shifting of the load either physically or just in its distribution through the suspension system. The combination of all these loading factors is what is actually measured by a WIM system. Fig shows the application of WIM.

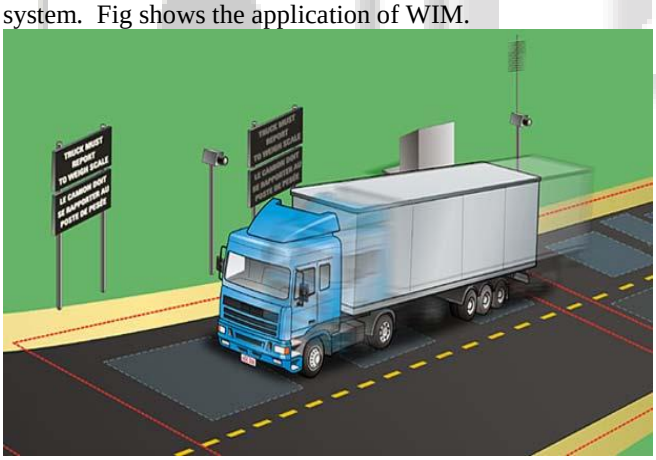

Fig. 1: WIM application

C. Emergency Call Box (ECB):

Emergency Call boxes also exist at regular intervals along the sides of many highways and rapid transit lines around the world, where drivers or passengers can use them to contact a control centre in case of an accident or other emergency. Such call boxes are often marked by a blue strobe light which flashes briefly every few seconds. Boxes in remote areas often now have solar cells to power them.

Call boxes have the advantage that their location is immediately known, while mobile phone users in trouble do not necessarily know where they are.

Fig. 2: Emergency call Boxes

These telephones are almost always marked by a placard or sign indicating a unique serial number or identifier which allows the authorities to know exactly where the caller is - even if the caller does not know - by having the caller read the short identifier from the placard over the telephone. Some phones are equipped with the equivalent of caller id and the agent receiving the call can identify the location even if the caller cannot.

Emergency phones can also be found at the ends of bridges or near cliffs which have a history of suicides. They are also occasionally found along the coastline where members of the public may wish to report swimmers or boats in danger at sea. In some countries, they are also found in places where people may feel vulnerable or unsafe at night due to theft incidents occurring in the area.

D. Other Technologies:

The other important technologies of Intelligent Transport System include, Emergency Vehicle Notification System, Automatic Road Enforcement, Variable Speed Limits, Collision Avoidance System, Dynamic Traffic Light Sequence, Video Vehicle Detection etc.

It is beyond the scope for the present study to explain every technology in detail, so only the important ones are been explained.

IV. CASE STUDY OF I.T.S

National Expressway 1 (N.E.1), a part of the Golden Quadrilateral project in India has been considered for the case study. N.E.1 is the first project of its kind connecting Ahmedabad and Vadodara cities of Gujarat. It is a 93 km long highway having exits at intermediate cities of Nadiad and Anand. With almost a decade of its successful run, N.E.1 is at its saturation level as the number of vehicles are increasing. Construction of new highway is no more an effective solution. Hence the use of I.T.S was the only economic option in front of the engineers.

N.E.1 adopted some of the important technologies of I.T.S and they are working tremendously well in effective management of traffic on N.E.1. Some of them are as follows:

A. Closed Circuit Television Surveillance (CCTV):

CCTV cameras were already in use on N.E.1, but previously they were only used to observe the toll collection. Now, they are installed on every 5-6 km. on either sides of the lanes to monitor the traffic. If there is any emergency or accident on the highway, it is detected in the CCTV's and the

emergency response team is dispatched quickly. Also if there is any over speeding on the highway or any unwanted elements are acquiring the road than it can also be easily detected. Fig. 3 shows the CCTV cameras on N.E.1.

Fig. 3: CCTV on N.E.1

B. Emergency Call Boxes:

Installation of ECB's was done simultaneously along with the installation of CCTV cameras. In some stretches on N.E.1, there is a poor network connectivity for a majority of mobile network providers and an emergency in this stretches of the highway is a night-mare. To overcome this problem ECB's are also installed at important locations on N.E.1. All the emergency services are directly connected with ECB's and the response is in within minutes. Fig 4 shows ECB on N.E.1

Fig. 4: ECB on N.E.1

C. Electronic Toll Collection (ETC):

As discussed earlier, N.E.1 is a major highway connecting two important cities of Gujarat. A number of people use this highway on a daily basis. With the increase in number of users, a problem of long queues has taken place. Result of which daily commuters had to face a lot of problems. But the use of ETC has solved this problem considerably. A special dedicated lane has been started as a part of ETC system. All the daily users have to just register themselves and they can use this special lane dedicated to them so that they don't have to wait in long queues and a lot of time is saved.

Fig 5 shows the ETC system and lane on N.E.1.

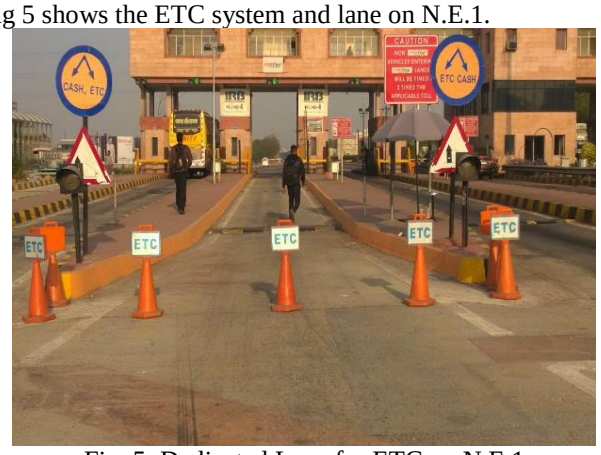

Fig. 5: Dedicated Lane for ETC on N.E.1

D. Weigh In Motion (WIM):

A major chunk of users on N.E.1 are truck drivers. The trucks are sometimes heavily loaded and as discussed in the previous sections, this may affect the road in a very serious manner. Cracks and breaking of the pavements are few of them. So WIM has been used to resolve the issue of over loaded trucks. With the help of this sensors, the weight of the truck is determined and if it is found over loaded then an extra charge is collected from them. This is one of the major technologies used on N.E.1 so that the riding quality can be maintained for the users. Fig 6 shows the WIM sensors on N.E.1.

Fig. 6: WIM on N.E.1

D. Variable Message Signs (VMS):

This system comprises of using a single sign board that can change the instructions as the authorities want. It solves the issue of using multiple sign board. VMS has been propped on N.E.1 so that the users can obtain multiple information from a single sign board.

V. CONCLUSION

In a developing country like India, the problem of traffic congestion is a very important issue to deal with. Construction of new roads is not the only and feasible solution to that. This paper presents a concept of Intelligent Transport Systems that can be used to solve these kind of problems effectively. Further research can be done and new technologies can be developed that can be used in Indian cities. Also some changes in the current traffic system can also be made to resolve the issues. There is a lot of scope for

I.T.S. in India and sooner or later, India will be also one of the nations, using fully developed I.T.S. systems.

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