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INTELLIGENT TRANSPORT SYSTEM (ITS)

Dilip K. Shinde[1], Prof. Ashish P Waghmare[2]

[1]Student M.E. Structures, Dept of Civil Engineering Dr. D. Y. Patil School of Engineering and technology, Lohgoan, Pune, India
[2]Assistant Professor, Dept of Civil Engineering Dr. D. Y. Patil School of Engineering and technology, Lohgoan, Pune, India

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ABSTRACT:- An intelligent Highway is an innovative concept for smart roads of future smart cities. It is a program of innovation that links a different way of looking at things with innovative idea that apply the opportunities offers by new technologies in smart ways. Nowadays safety on road has become an important factor in our life because there is an increasing amount of accidents on the road and there are some places where accident occurs frequently such as crossings, turns. Also there is a big problem of traffic jams on road. Due to heavy rain fall, there is a possibility of water overflow on the bridges and accident may occur. In hilly area there is a possibility of landslide so, there came a need to design a system can detect these unexpected events. So we are designing a system that is "An Intelligent Highway System which is an innovative concept to maintain safety on road.

Intelligent Transport Systems or ITS, are increasingly being used globally to improve road safety, reduce travel times and help improve decision making by road users by providing relevant and timely data. Broadly, the ITS applications for road safety can be divided into three operational areas Data collection, Information exchange and emergency response & Enforcement.

As of now, use of ITS for improvement of road safety and traffic management in India is very limited. The scenario is beginning to unfurl as the government has now recognized road safety as a major issue and has resolved to reduce accidents. Therefore, the implementation of ITS along major urban corridors can resolve many traffic management safety issues, while creating a smart urban environment. And achieving the objectives with help of effective utilization of ITS.

***Keywords** – Intelligent Transport System (ITS)*

1. INTRODUCTION

Intelligent Transport Systems or ITS, are increasingly being used globally to improve road safety, reduce travel times and help improve decision making by road users by providing relevant and timely data. Broadly, the ITS applications for road safety can be divided into three operational areas:

1.1. Data Collection –

It involves implementation of sets of sensors to collect data relating to traffic environment. This data may include traffic data (flow, count, classification, speed, headway, gap, occupancy, etc), weather data (temperature, air quality, wind speed, wing direction, humidity, visibility, etc), accident and incident data (through manual or automatic means) and any other data relevant to the area or city or corridor under consideration. The collected data may be used for decision making in real time or for off-line use in planning for future infrastructure.

1.2 Information Exchange

The collected data is processed with the help of computers and software algorithms and presented in a meaningful and useful form. The data may be provided to the road users in real time through vehicle to infrastructure (V2I) devices like Variable Message Signs, FM Radio etc, or two way communications can happen using Emergency Call Boxes (ECB) and personal mobile phone or computers. The timely information exchange can be crucial for road safety, for example, a timely reporting of accident through an ECB can result in timely dispatch of emergency response team, hence saving lives.

1.3 Enforcement

While real time traffic data information interchange between various stakeholders is crucial in taking corrective action, strict enforcement of traffic rules can deter violators and pre-emotively reduce accidents. The violators not only risk their own life but also that of other road users. A large number of enforcement tools and systems are available like red light and stop line violation detection, over-speed detection, overload detection, video incident detection system (VIDS) etc. Most of these systems use cameras, which produce image proof admissible in court of law as evidence.

2. OBJECTIVS

Intelligent Transport Systems (ITS) are being developed and deployed across the world to improve the performance of transportation, providing improved social outcomes for communities and increased economic dividends for governments and markets. The benefits to community and business implicit in the use of ITS are being produced in tangible and measurable ways in the many locations where ITS systems have been deployed. ITS typically return a benefit/cost of 10:1. These gains provide the political justification for investing in or supporting such technologies. The National Strategy for Intelligent Transport Systems in Australia had ten strategic goals of e-transport which are shown below.

Following are the specific objectives Improved transport safety and security

- Improved transport efficiency, performance and quality for the movement of people (by public and personal transport) and goods, by covering all transport modes and their linkages.
- Reduced congestion and travel times, and improved travel demand management
- Improved effectiveness of use of transport infrastructure.
- Enhanced transport planning, policy-making and delivery.
- Improved transport contribution to sustainable development
- Improved transport accessibility and equity

3. DATA COLLECTION

3.1. Vehicle/Traffic information

Perhaps the most important traffic data is the class-wise traffic volume, i.e. how many vehicles of each class (car, bus, truck etc.) pass through a specific point. This gives valuable information to road designers and traffic planners to make and keep the road corridors safe. Other traffic data which is collected is headway, gap, occupancy, speed and vehicle weight. The traffic volume data along a corridor gives the level of service of traffic operations, which is an indication of traffic density. If the flow rate drops in a section of the corridor, and it shows significant unexplained difference between two points, it would mean traffic congestion due to a specific incident, like accident or vehicle break-down, and appropriate corrective measures shall be adopted for the corridor

3.2. Traffic data collection with intrusive sensors

Intrusive sensors are those which are embedded in the road and their maintenance and installation requires lane closure or traffic diversion. For traffic flow monitoring, the simplest system consists of sensors embedded in the road connected to a roadside electronic unit called the “data logger” which records the sensor readings. The back-end software analyses theses readings and notifies aberrations. The sensors commonly used are electromagnetic loop, piezo-sensor, and pneumatic road tubes. A loop sensor consists of a wire with multiple turns embedded in the road surface, generally concrete. A high frequency current is passed through this to generate an electromagnetic field and any metal body (the vehicle, in this case) passing over the loop disrupts this field and causes a change in current which is recorded by the loop detector in the data logger. As this loop behaves like an inductance, it is sometimes called and “inductive loop”.

The “piezo-sensor” is made of material which exhibits piezoelectric properties, i.e. it generates electric charge when subjected to pressure. The sensor generates a charge (or voltage) proportional to the speed and weight of the vehicle passing over it. Such sensors can be used not only for axle detection but also axle weight. A combination of loops and piezo-sensor can detect vehicle’s magnetic signature, vehicle presence, axle presence, and approximate weight, and a software algorithm then generates information on vehicle count, class, weight, speed, headway, gap and occupancy (traffic density).

3.3. Traffic data collection with non-intrusive sensors

Intrusive sensors require lane closure for installation as well as maintenance and to reduce this time, non-intrusive methods of data collection are superior. The commonly deployed non-intrusive technologies are based on (a) light beam: infra-red (IR) and LASER (Light Amplification by Stimulated Emission of Radiation), (b) camera: image and video capture and (c) radio beam: RADAR (Radio Detection and Ranging).

Infra-red (IR) sensors typically consist of infra-red transmitters and receivers installed on either side of the carriageway. As the vehicle passes between these sensors, it cuts the IR beam, which is called an “event”. The number of times the beam is disrupted generates a pattern which provides information on number of wheels; inter wheel spacing, vehicle profile and the tyre cord length. Each beam-cut event is time stamped and the data is then processed to calculate vehicle volume, class, speed and direction.

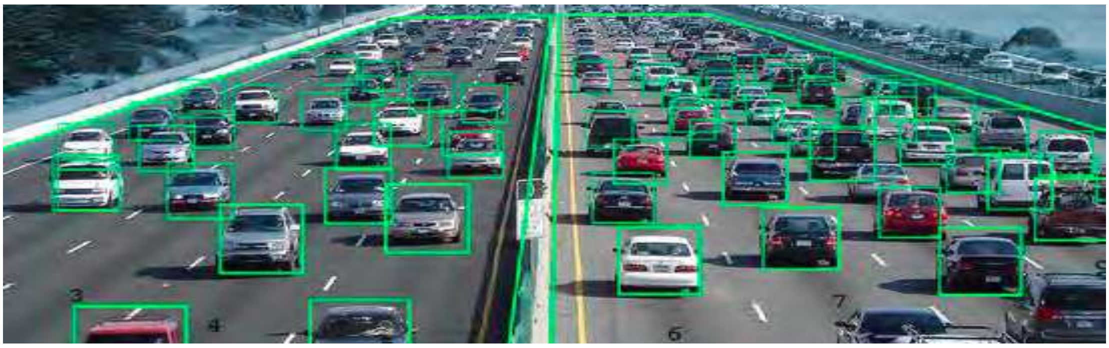

Image No. 01 Detection, Counting & Classification by Camera

Laser sensors are generally mounted overhead and consist of a laser scanner which emits highly focused light on the traffic and records the reflected light. This provides a three dimensional profile of the vehicle which is then used for count and classification.

Cameras can also provide information on detection and classification of vehicles. The video feed from the field cameras is fed to video analytic software which detects vehicle presence, analyses the vehicle shape in video frames and filters each vehicle according to its class.

3.4. Environment/Surroundings information

3.4.1. Weather

Weather sensors are installed at various locations in a city to provide data regarding temperature, humidity, wind, rain, visibility, pollution levels etc. Along with live data, weather forecast is very important for the road users to help plan journeys, especially long journeys. The weather data is disseminated to road users to take necessary safety precautions before or during the journey and plan their schedule accordingly. Along the major corridors of travel, these information are displayed on VMS (Variable Message Sign or electronic signs), as major share of travel will be through these major corridors.

3.4.2. Incidents

Video Incident Detection System or VIDS, provide automatic detection of incidents and alarm generation at the central control room. Such facilities are all the more important for major corridors/arterials of urban areas, which are critical links for urban transport network and required to be managed for smooth flow of traffic without any serious congestion or bottleneck. This is explained in detail in section on Enforcement.

4. INFORMATION EXCHANGE

Advanced Traveler Information System (ATIS) consists of various methods of disseminating useful and timely information to road users. Some information is unidirectional, i.e. the information is broadcast and any user can receive it, and some other can be bidirectional with user receiving and responding to it. Some common methods of information exchange are as follows.

4.1. Variable Message Sign (VMS)

The VMS, an LED (Light Emitting Diode) signboard, usually mounted on an overhead gantry. It displays real time information to the road users travelling along an urban corridor, which can help in taking appropriate en-route travel decisions. Portable VMSs are particularly useful when application is for a short duration, e.g. warning and advising road users of an ongoing nearby maintenance work activity or managing traffic during aftermath of an incident. Portable VMSs are towable or vehicle mounted and generally battery or solar powered.

4.2. Emergency Call Box (ECB)

The ECB is a fixed roadside telephone which has a microphone, speaker and a pushbutton. The road user presses the pushbutton and instantly gets connected to the control room where he can report an incident or accident or obtain relevant information related to the journey like weather, obtain directions regarding nearest hotel, fuel pump etc. ECBs are particularly useful for people in distress.

4.3. Internet

The road user is able to view road information on the internet on his mobile or computer (desktop, laptop, tablet, etc). This helps him in making a decision on which route to take for his journey based on shortest distance or time, etc. The information can be in the form of text or map or direct view of live streaming video of cameras installed in various locations on the road.

4.4. Highway Advisory Radio (HAR) or Traveler Information radio Station (TIS)

These are dedicated radio channels which broadcast specific information to road users on car radios. Static road signs display radio frequencies to be tuned in to. Rapidly deployable, solar powered and portable HAR is used to send messages to public during disaster or critical event or traffic management during peak hours and for safety at construction site. These are particularly useful where long messages or advisories are to be communicated to the user, which cannot be done using VMS.

4.5. Short Messaging Service (SMS)

Information is sent to registered road users on their cell phones via SMSs. Any road user, who registers for live update message service, shall get regular updates on traffic and road conditions. The number of messages should not be very high so as to cause driving inconvenience or safety issues. Also this information can be requested to a communication portal by sending an SMS to the pre-announced contact number.

4.6. Mobile Applications

The advent of smart phones and high speed mobile data a network has witnessed a growth of cell phone based applications (or "apps", as they are commonly called). One such application is use of cell phone to take pictures of incidents and accidents by citizens and instantly send them to the control room for emergency response. The users can also get traffic information, register complaints and provide feedback through such applications. One such example is the Public Eye initiative by Bangalore Traffic Police.

4.7. Dynamic Route Information Panels (DRIPs)

This is an in-vehicle panel which gives information about congestion on certain road segments at the individual vehicle level as the navigation systems, which give information about the route to a particular destination. It is to be expected that navigation systems will have a positive road safety effect because they prevent indecisive driving behavior and signpost searching. This also results in fewer kilometers driven. It is, of course, important that the information is offered in the appropriate and auditory way, and that the system is not manually operated while driving.

5. ENFORCEMENT

Use of ITS for enforcement is common in the developed countries and is now gaining acceptance in India. Several city administrations are in the process of implementing ITS for enforcement of traffic rules. Such systems perform the following functions:

- Detect violations automatically
- Record violations with proof admissible in court of law
- Store data for record and for future use
- Analyse stored data for planning and improvement of design or operations for reducing accidents, and for tracking and monitoring offenders and providing such data to relevant agencies (such as police, transport authorities and insurance companies), monitoring road user behavior, etc.

The following are some of the common applications of ITS used for enforcement. Generally such measures are deployed along major corridors of urban area, where there is higher rate of violations

5.1. Speed Enforcement:

High speed is a causation factor in around one third of fatal accidents, and an aggravating factor in the severity of all accidents. Research shows 5% increase in average speed leads to approximately 10% increase in all accidents and 20% increase in fatal accidents. Dangerous speeds can be either excessive or inappropriate.

- **Excessive speed -** driving above the speed limits
- **Inappropriate speed -** driving too fast for the prevailing conditions, but within the limits (e.g. during fog, driving on slopes with load, high speed driving in congestion)

ITS can help enforce excessive speeds and advise on inappropriate speeds to help reduce accidents.

Speed Enforcement - There are several methods of measuring and enforcing speed. The speed enforcement system consists of a speed measurement system and a camera. The measurement system accurately measures the vehicle speed and the camera records the vehicle license plate image for proof. The following systems are commonly deployed:

5.2. Spot speed measurement

In such systems, the instantaneous speed of a vehicle is measured. The speed measurement can be done through a LASER, microwave RADAR beam or camera. In case of LASER (or RADAR), a light beam is focused on a vehicle and the measurement of the reflected wave gives measurement of speed. In case of camera, the frame progress rate gives the vehicle speed. All these techniques measure the speed of the vehicle at a particular point on the road. The drawback of such system is that the road users tend to slow down at such places to avoid detection but over speed otherwise.

5.3. Average speed measurement

To overcome this measurement of instantaneous speed, sometimes average speed measurement is used where cameras are placed at intervals and average time for the vehicle to reach one camera location to the other is recorded and this is used to calculate average speed. The vehicle identification is done by license plate detection. Such system would work well if all cameras are synchronized, and it is required to be so for not being challenged in court of law. In India, though every state has laws for enforcement of over speeding, there are no specific laws on how the speed should be measured, equipment tolerance or calibration.

Variable speed limits - Recently some jurisdictions in the US have begun experimenting with variable speed limits that change with road congestion and other factors. Typically such speed limits only change to decline during poor conditions, rather than being improved in good ones. The speed limits may also vary with the lane, i.e. each lane on a carriageway may have a different speed limit. In this case each lane has a VMS to notify the road user of the speed and each lane has a separate enforcement sub-system.

5.4. Video Incident Detection System (VIDS)

The VIDS uses cameras to monitor a particular road section or "zone" for events defined as abnormal. These events are called "incidents" and can be selected from a list pre-defined by the manufacturer. The VIDS either uses ordinary cameras to record images, which are then sent to the control room for processing for incidents, or uses cameras with in-built intelligence to process incidents. The incidents generate audio/visual alarms at the control room on which the control room operator can take appropriate action

Typically the following are defined as incidents which can be detected by the VIDS:

- Traffic events - Stopped vehicle, inverse direction of travel, speed drop, traffic congestion, under speed, over speed, undesirable vehicle presence.
- Non traffic events - smoke and flame detection, pedestrian, fallen objects/debris, traffic data, flow speed., zone occupancy, volume count, gap time, density per lane, vehicle classification, etc.

5.5. Red Light Violation Detection (RLVD):

The RLVD system detects red light violations and captures image for proof. A typical RLVD system consists of an overview camera to capture the entire violation scenario and traffic signal status, an Automatic Number Plate Recognition (ANPR) camera to capture the license plate of the violating vehicle and processing software. The cameras are connected to the traffic signal and start recording as soon as it turns red. The overview camera captures the status of the traffic light as seen by the user. In some configurations two cameras may be used. Sometimes, in-road loop sensors are used to detect vehicle presence and trigger the cameras if a vehicle crosses the stop line while the light is red. The ANPR camera captures the license plate automatically and sends the image to the processing software. The software consists of an Optical Character Recognition (OCR) engine which converts the number plate image to text which is then used to search vehicle owner details including address (from vehicle registration database), to which the violation ticket is sent to.

5.6. Stop line violation detection (SLVD) System

The SLVD works in a fashion similar to the RLVD. However the objective is to detect vehicles which cross the stop line and stop while the traffic signal is red. These vehicles do not jump the red light and hence are a less safety hazard but do provide hindrance to pedestrians crossing the road. As special case, both RLVD and SLVD can be done by a single system. As shown below, cameras are used to define virtual zones which are monitored continuously for violation of pre-defined rules or change in status of the zone being monitored. This is called an “event”. The events are analyzed, filtered and audited for violations.

5.7. Dedicated Lane Enforcement:

This is a special application of VIDS and includes bus lane cameras that identify vehicles traveling in lanes reserved for buses, which are penalized for their violations.

5.8. Weight Enforcement or Overload Prevention

Overloaded vehicles not only cause damage to roads but also cause a serious concern to road safety. As of now, the police stop the goods carriers and manually check the documents related to weight which not only is time consuming but also slows down the city traffic on major arterials or corridors. A special application of Weigh-in-Motion called “Virtual WIM” can be used. A WIM consists of an in-road weighing scale which measures the weight of the axles and gross vehicle weight of a moving vehicle. In addition, such system has vehicle classification sensors, either in-road or non-intrusive, which provide vehicle class and hence allowed corresponding weight. In a normal WIM system, the vehicle detected as overloaded is stopped and penalized manually. In virtual WIM, a camera takes the image of the vehicle and transmits the information to the control room. The vehicle can be stopped later and penalized.

6. CONCLUSSIONS

This explains the various ITS technologies being put to use for safety of traffic operations in urban corridor of travel. It includes applications for providing information to road users as well as enforcement of traffic regulations. The technologies discussed cover established global techniques which may be used for Indian urban conditions

Intelligent Transport Systems (ITS) is a revolution or phenomenon which is sweeping the world, developed and developing, alike. The traditional TSM techniques which were popular in post 1980s have been replaced largely with ITS concepts and their implementations. It has been seen that the developed world had best of the transport infrastructures, and therefore, ITS could provide significant benefit to that system. Therefore, it is believed that ITS will generate multi-fold benefits in the developing world where transport systems are otherwise not fully developed. Thus, ITS is more beneficial to the poorer countries which are not able to afford transport intensive land uses and their transport implications.

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