Smart Systems For Road Safety

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Abstract: Road accident is most unwanted thing to happen to a road user, though they happen quite often. The most unfortunate thing is that we don’t learn from our mistakes on road. Most of the road users are quite well aware of the general rules and safety measures while using roads but it is only the laxity on part of road users, which cause accidents and crashes. Main cause of accidents and crashes are due to human errors. While rash driving, drunken driving are main causes for accidents caused by drivers, on the other hand carelessness of pedestrians and crossing at wrong places are equally responsible. This note gives an idea on Smart systems for road safety.

Keywords: Road Accident; Smart Systems; Road Safety; Rash Driving; Pedestrian

I. INTRODUCTION

Road safety is an issue with rising concern in the modern-day world. While most of the developed countries have properly planned roadways and road traffic management systems, the developing and under developed countries have to deal with Road safety measures mainly because of lack of proper infrastructure and implementation of roadways in the country. In a country like India, most of the metropolitan cities are a hub of IT Industry and house major industrial areas. As a result, the metropolitan cities record large number of vehicles on road. Statistical analysis show a drastic increase in the number of accidents that take place every year and the number of deaths caused by road accidents. Engineers are always working on newer and better technologies for the betterment of Road Traffic management systems. Intelligent and Smart systems aid Traffic Management and makes it easier to track traffic movements in the cities. City traffic includes cars, two wheelers which are classified as LMV-Light Motor Vehicles and Local Buses for public transit, trucks, lorries, canters, tankers and goods carrier vehicles which are classified as HMV-Heavy Motor Vehicles. The major cause of road accidents is the negligence of drivers and over speeding. Road Signal systems must be obeyed, which alone can reduce the amount of accidents that take place. Distracted or Ignorant drivers are the major cause for road accidents. To implement the best road safety management, technology interfacing plays a major role. Adopting and Implementing the latest technologies to control signals, heavy motor vehicle transits in the city and toll inspections can increase the efficiency of the management system. Any technological system involving sensing, actuation and decision making in order to describe and analyze a situation and make decisions with available data in a predictive manner, thereby performing a smart action is called a Smart System. Smartness of a system is basically its ability to execute an autonomous operation based on looped controls and perform networking.

II. SURVEILLANCE AND WARNING SYSTEMS

Deployment of Surveillance and Warning systems can help track traffic violations and warn the citizens about strict laws regarding the violations.

A. Surveillance Systems

Surveillance systems are broadly classified into two types, namely Intrusive and Non-Intensive. Systems. Intrusive technologies are those which require direct installations onto pavements, standing poles or require under earth tunneling. The drawbacks of this technology are traffic disruption for installations and failures due to poor road conditions. Reinstallations must be carried out in case of road repairs or resurfacing. One of the evolving technologies includes the Inductive Sensing loop systems. It is recognized as an Industrial standard because of its high detection accuracy. The inductive loop wires are installed below the roads which sense traffic motion on the road. During its operation, the inductive coil is supplied with a signal of frequency varying from 10Hz to 50kHz. The basic arrangement of a inductive loop system is shown in below diagram.

![Diagram of Inductive Loop System](image-url)

When a vehicle (or a metal) passes over or stops by it, a change in the inductance of the inductive loop takes place which results in change in oscillation frequency. If the change in frequency exceeds a
defined value, called the threshold value, the controller will be signaled indicating vehicle detection. The speed is estimated by using a loop pair or by a single loop with some deduced statistical algorithms. Over speeding vehicles can thus be detected and warned for violating traffic rules and over-speeding. The biggest disadvantage of this system is that it leads to serious traffic disruption for its installation and maintenance activities. The installation and maintenance cost becomes expensive. Apart from these, the inductive wires are subjected to traffic stresses and temperature variations which increases the failure rates of these loops. Advance methods have to be adopted to detect bad or false detectors without disturbing traffic flow on the roads. Nevertheless, bad or false detectors have to be manually replaced as this is an intrusive system.

Further research on alternate sensors or detectors is being carried out that can be easily implemented without much traffic disruption. Other alternatives include the Piezo-electric sensor systems and Weigh-In-Motion systems. These systems also have similar drawbacks as the inductive loop system.

Any intrusive system employs disruption of vehicular traffic for its installments, repairs and maintenance activities. Therefore, Non-intrusive systems have better performance efficiencies compared to the intrusive ones. They can be implemented in more economically feasible ways.

On the contrary, Non-intrusive systems do not need installations onto pavements or below earth tunneling. They can be installed without disrupting the traffic. Devices are installed at overhead positions usually on Signal Poles or any upright poles. Microwave Radars, Infrared Devices or Closed Circuit Cameras usually known as CC Cameras are non-intrusive systems for surveillance. The most efficient system of non-intrusive surveillance is using Closed Circuit cameras and carry out Video Image processing. This process includes processing of captured images and videos of several cameras and analyzing them. The video and photos captured by the CC Cameras are communicated with the surveillance centers and they are processed in advanced softwares by techniques like edge detection and pixel density analysis. Below is a flow diagram of various processes involved in Image processing.

III. SMART SPEED CONTROL SYSTEMS

Smart speed systems can assist drivers to stick to speed limits and avoid over-speeding on roads.

B. Intelligent speed adaptations

This involves GPS systems linked with speed zone database. A mobile application using GPS can assist the driver with optimum speed and speed limit. The mobile application shall give visual and auditory assistance to the driver in-case he/she exceeds the speed limit. Serious and fatal vehicle crashes can be avoided, especially on expressways where vehicles travel at high speeds compared to city speed limits. The application shall provide with accurate speed zone information for users ensuring safety on roads against over speeding.

C. Proximity Sensors

Sensors fitted at various parts of the vehicle’s body provide information about immediate surrounding obstacles. These sensors are able to sense vehicles, road users, cyclists or any other obstacle in the proximity of the vehicle which can possibly cause the vehicle to crash. Audio and Video alerts to the drivers can help avoid potential crashes if the vehicle is moving with a crashing speed. Some of the latest collision avoidance systems take smart and intelligent decisions and control the vehicle during crashes. Autonomous emergency braking system, which can operate the brakes independent of the driver is the latest available technology. All of these employ smart systems which are capable of decision making during emergencies.

D. Cooperative smart systems

Cooperative smart systems are those which are able to communicate with other vehicles and the surrounding roadside environment. This employs both Vehicle to vehicle and Vehicle to infrastructure communications which can reduce the risk of accidents to a large extent. The reliability of the information available to the drivers about the immediate environment, road users and other vehicles increases. These are basically short-range wireless systems that share information about vehicle positions and directions. Based on this, driver receives safety alerts helping them avoid crashes by controlling the speed of their vehicle.

E. Speed Interceptors

Speed interceptors are devices that are installed on traffic police vans that can help the police catch over-speeding vehicles on roads. The speed interceptor device can display date, time, speed-limit, actual speed, location, and Vehicle registration number. This device automatically generates a Speeding Ticket if it detects a vehicle over-speeding. The added feature of this device is that it captures a photograph of the vehicle as a valid proof for
violation. This system has already been implemented in New Delhi and Bengaluru cities of India. The interceptors are normally placed at road curves or empty stretches where people cannot stick to unrealistic speed limits.

IV. SMART STREET LIGHTING SYSTEMS

Lighting systems are an integral part of urban infrastructure. Poor road visibility at night is also a main reason for road accidents. Therefore, proper street lighting systems are necessary as a part of Road safety systems. In times of constantly rising energy crisis, the cost factor has to be given a lot of thought. The conventional street lighting systems are not efficient in their operations due to failures and lack of constant checks and maintenance. Therefore, there is a requirement of smart lighting systems that automatically adjust to the lighting requirements.

The present road lighting systems can be modernized. Only the necessary parts of the system can be renewed which gives increased energy efficiency at reasonable cost. Latest software’s can be easily integrated into the existing system. The lighting control system adjusts itself automatically to actual traffic levels and makes use of many of the telematic components already installed in the city. Traffic intensity is taken into account and even the current road conditions. An individual lighting program can be installed on the controllers for any kind of traffic situation and for each lighting group. If communication between the controller and the light is interrupted, an emergency program automatically activates the lighting level for heavy traffic.

Energy meters in control rooms continuously record the energy consumed by the lighting system. Statistics already confirm that the lighting level only needs to be raised every twentieth nighttime hour in response to critical traffic situations. The reduction in the remaining 95 percent of the time allows savings between 60 and 90 percent. A smart street lighting system model is proposed by the technological pioneer and giant Siemens. Their intelligent street lighting systems provide inductive loops, but information coming directly from connected cars will offer more precise information, in real time, and across a wider catchment. Data flows into the connected car for a better driving experience. Someday road blocks and hassles will become a thing of the past as the next generation of connected car services leverages dynamic data to provide intelligence that can avoid real-time traffic snarls, quickly find open parking spaces, as well as provide the already familiar GPS and search experiences to find charging stations or compare prices on nearby fuel sources.

V. THE IOT SAFETY SYSTEMS

The Internet of Things (IoT) is unlike the traditional Internet. It replaces the main source of data input (which are humans) with computers, machines and sensors. This development easily ensures the physical world is intimately connected to the Internet without the need for any human intervention.

Application of the IoT will extend to all aspects of the car. The mechanics of the vehicle, external infrastructure supporting traffic flow, and the comfort and entertainment of the occupants would all be connected. The connected car will be able to benefit from smart transport systems combining vehicular communication, smart traffic control, electronic toll collection, vehicle control, as well as safety and road assistance, among the other vehicles.

Cars connected to the IoT will be able to supply information about location, speed and direction, allowing powerful servers to analyze traffic flow, predicts bottlenecks, and manages congestion when jams do occur. Inside the car, drivers will be warned about impending problems and advised of alternative clear routes. Outside the vehicle, congestion-easing techniques directed by these computers will include variable speed limits, smart traffic lights and signage, tidal road flow, and variable toll pricing.

Some of these systems already exist. They measure traffic flow using roadside monitoring or buried-inductive loops, but information coming directly from connected cars will offer more precise information, in real time, and across a wider catchment. Data flows into the connected car for a better driving experience. Someday road blocks and hassles will become a thing of the past as the next generation of connected car services leverages dynamic data to provide intelligence that can avoid real-time traffic snarls, quickly find open parking spaces, as well as provide the already familiar GPS and search experiences to find charging stations or compare prices on nearby fuel sources.

INRIX, a Seattle-based company, creates tools for the connected car, including one that helps drivers find on- and off-street parking, as well as providing real-time and predictive traffic data from as many as 2 billion data points per day, applied to in-car traffic services. Computational power and intelligence of the systems must be really high to carry out these autonomous operations. The challenge of the hour is to design and deduce algorithms that help the smart systems perform with highest intelligence and
decision making capabilities. Computer science engineers today are working on artificial neural networks and artificial intelligent systems that can bring about a revolution in smart system engineering.

VI. ROAD HEALTH MONITORING SYSTEMS

Road health monitoring is a process of damage detection and characterization strategy for roadways and bridges. Damaged roads due to mismanagement in construction or poor maintenance are the main reasons for road accidents today.

Road management falls under the category of Structural Health Monitoring which has the following steps:

(i) Operational Condition evaluation
(ii) Data Acquisition
(iii) Data analysis
(iv) Improved structural Modelling

Sensors like piezo-electric, piezo-resistive, optical, acoustic and measurement sensors must be used to collect data from structural members. Integrated electronic circuits must be used for data communication from structural members. Microprocessors and Microcontrollers are used to analyse the acquired data and process it. Data analysis must be done with the available data on the structural health. Smart system and intelligent system engineering concepts must be applied to build a statistical model to improve the structural health.

The latest advancements in this area include implementation of Self-Healing Structures. This employs smart sensors, smart particles which are capable of self-assembly. The Micro-Electro-Mechanical Systems known as MEMS is a revolutionary technology in the field of Structural Health Monitoring. The have miniaturized sizes and have very less power consumptions. It has improved linearity and provides three-dimensional detection.

Road health monitoring includes investigation of deformation and deflection of bridges and roads. It becomes a lot easier to identify, quantify and locate structural deformations using smart systems. The idea is to replace the traditional Schedule-Driven maintenance with Condition-Based maintenance. All this is possible with the Nano-engineering and smart structure technology. PH3T is a conductive polymer that has many electro-chemical sensing abilities. It is a smart particle technology employed in health monitoring of structures. Bad highway design and conditions are a factor in more than half the fatal crashes in the United States, contributing to more deaths than speeding, drunken driving or failure to use seat belts, according to Ted R. Miller, who co-wrote a 18-month study. Road-related conditions were a factor in 22,000 fatalities and cost $217.5 billion each year, the study concludes. By comparison, similar crashes where alcohol was a factor cost $130 billion, speeding cost $97 billion and failure to wear a seat belt caused losses of $60 billion. Almost 42,000 people die in traffic accidents per year. The report was commissioned by the Transportation Construction Coalition, which represents trade groups and unions with a vested interest in funding for road construction.

VII. CONCLUSION

Road accident is most unwanted thing to happen to a road user, though they happen quite often. The most unfortunate thing is that we don’t learn from our mistakes on road. Most of the road users are quite well aware of the general rules and safety measures while using roads but it is only the laxity on part of road users, which cause accidents and crashes. Main cause of accidents and crashes are due to human errors. While rash driving, drunken driving are main causes for accidents caused by drivers, on the other hand carelessness of pedestrians and crossing at wrong places are equally responsible. Passengers, vehicle and road conditions on the whole contribute to road accidents. Smart engineering and intelligent systems thus reduce human interference in managing road safety systems and provide with more efficient safety systems. Education and awareness about road safety and strict enforcement of laws and regulations must be done apart from Vehicle-design and road infrastructure engineering. Distracted driving, drunken driving and driver negligence must be avoided as any safety system cannot offer complete safety against all human errors and negligence.

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IX. REFERENCES

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