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Automated Highway System (Pune to Mumbai) In India

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ABSTRACT: A combination of market forces, cost constraints, and other factors necessitate incremental evolution of a fully automated highway system (AHS) rather than instantaneous deployment. Thus, an understanding of the interdependencies among required AHS functional capabilities is essential for planning. This paper proposes a set of three AHS functional evolution reference models that include essential as well as supplemental functions. The reference models include lateral motion handling, longitudinal motion handling, obstacle handling, and selected infrastructure support functions. This family of three models is used to present the needs of baseline autonomous tactical vehicle operation, the benefits of adding inter-vehicle communications, and the benefits of adding infrastructure support. The reference models reveal a critical need for vehicle motion prediction capability, and suggest that both communications and infrastructure support are beneficial but not mandatory for achieving an AHS. Furthermore, there appear to be a number of safety and efficiency benefits that can be realized with only partial automation and in some cases no automation. These results could help set priorities and guide strategies for incremental introduction of AHS technology into vehicles and roadways.

KEYWORDS: AHS functional evolution; incremental deployment.

I. INTRODUCTION

For many years, scientists and engineers have envisioned building an automated highway system (AHS) to increase both the safety and efficiency of the nation's highways. In such a system, the vehicles become driving robots, capable of sensing and reacting to the surrounding environment while the driver is free to do other tasks. Automating the vehicle has significant potential advantages: it can reduce accidents caused by driver error and can potentially increase traffic-carrying capacity and fuel economy by eliminating human driver inefficiencies.

1.1 INTRODUCTION

Automating the vehicle also presents difficulties: shifts in legal liability, issues of technical feasibility, and questions of political and social acceptance make the design of an AHS highly constrained, and often subject to heated debate. There is not yet consensus on exactly what policies and configurations will be used in the operation of a fully deployed AHS. However, it is clear that an automated system will require a number of common functions such as the ability to stay in a traffic lane and to avoid collisions. Furthermore, a number of cost, technical, social, and customer constraints make it seem likely that any deployment of AHS will need to be an incremental one, as opposed to a fielding of a completely automated system from the beginning (National Automated Highway System Consortium Stakeholder Workshop #3, Minneapolis Minnesota, September 18-20, 1996, unpublished). This paper addresses the technical evolution of the AHS by asking the following questions: what common functions are all automated vehicles required to have? and what are the evolutionary dependencies among these functions? The answers to these questions form a proposed family of three reference models for AHS evolutionary development. In this context, the reference models

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Vol. 7, Issue 5, May 2018

illustrate a reasonably straightforward way to implement the incremental introduction of technology into the vehicle-highway system. It is not necessarily the only possible way, but rather a general representation that encompasses essential issues. These reference models may be useful for both planning and for providing common ground for detailed discussions about technological dependencies and Bayouth & Koopman 3 tradeoffs. These models do not include control policies (e.g., whether vehicles follow each other at short distances in “platoons”), but rather focus on the common underlying technical functions (such as maintaining safe headway spacing among a group of vehicles).

1.2 PROBLEM STATEMENT

There are many different causes of road defects. Some of the causes on the Indian roads are.

1. POOR DESIGN AND CONSTRUCTION.

Failures like cracking in rigid pavement are caused by inadequate curing of concrete, settlement, movement or restraint at joints may also lead to the development of cracks and subsequent failure. Most of the roads in the country are designed in the ministries or by consultants some of who are not within the environment of the road work. This leads to a situation where preliminary studies of the environment that will help the design and construction decisions are not done. This leads to poor understanding of the road environment which subsequently leads to poor road design and construction. Oguara (2010), then said that to save the road network from total collapse, requires good and efficient management which had to be done in a pragmatic and organized frame work.

2. HEAVY TRAFFIC

All road surfaces wear under the action of traffic, particularly during the very early life of the road. But within a short time the micro texture reaches an equilibrium level and thereafter the low speed skidding resistance remains reasonably constant. However, the action of traffic continues to wear the macro surface texture and thus gradually reduces the high speed skidding resistance. Oguara(2010) stated that with the increase of traffic loads both in terms of numbers and axle loads due to increased economic and developmental activities in the country, the road network was experiencing a systematic deterioration equivalent to an asset loss of about N80 billion due to road deterioration and vehicle operating cost of N53.8billion per annum. One of the defects caused by heavy traffic on the road is the deformation of the road way which is the change in a road surface from the intended profile. This results due to the application of overload that is beyond what the roadway is designed and constructed for.

3. POOR MAINTENANCE CULTURE.

Even if the roads are well built they need adequate maintenance for sustainability. One of the main problems of highway development in India is maintenance. The roads are rarely maintained and whenever maintenance is attempted it is done haphazardly. According to Oguara (2010), the financing of the maintenance, rehabilitation and conservation of the roads network in India had always been left to the government at the India, state and local government levels who because of their lack of maintenance culture do not release funds for road maintenance at the appropriate time.

4. POOR HIGHWAY FACILITIES.

Highway facilities like drainages when not in use or lacking in performance result in some of the environmental related defects like roadway deformations and pot holes. As at 2011, virtually all roads in the country have become hubs of intractable snarl-ups and ghastly motor accidents, as unsuspecting motorists speed into deadly craters and monstrous potholes (Igomu 2011). Every part of India’s main roads is not spared the onslaught of deadly potholes that have inflicted both physical and emotional torture on motorists. The situation degenerates by the day aided by the rains and failed drainages filled with silts.

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Vol. 7, Issue 5, May 2018

5. POOR LABORATORY AND INSITU TESTS ON SOIL.

There is the need for the adequate test of the soil and the materials used for road construction. Unfortunately this is not always done. This is due to lack adequate laboratory facilities and trained laboratory manpower for the job. Since most of the construction companies in the country could not afford adequate laboratory facilities they should make use of the laboratories in the universities and polytechnics that have better facilities in the country for the test of their construction materials. Even the road research institute in Ogun state can help if the facilities are adequate.

6. USE OF LOW QUALITY MATERIALS.

Use of low quality aggregate adversely affects the quality of the roads in India. This sometimes occurs in the form of the improper grading of aggregates for sub base and poor sub grade soil. The use of extreme cohesive and expansive soil as sub grade soil results in prolonged consolidation and unnecessary settlement of the roadway. The use of soil of low bearing capacity leads to the failure of the sub grade soil.

7. POOR WORKMANSHIP.

Most of the workmen in construction sites in India are not well trained. This is especially among the artisans and the craftsmen. Some times the technicians, the technologists and even the engineers are not given adequate practical training. Inappropriate application of materials by the workmen is mostly due to low knowledge of the works by the workmen. Operations like soil compaction and stabilization are inadequately done due to low knowledge of the workers.

8. POOR SUPERVISION.

In India most of the supervisions of construction work are done by the engineers and other middle level supervisors like the foremen. Some of these supervisors who have low knowledge of the work find it difficult to deliver adequate supervision at the site. Some of the faults on the roadway like depressions, cracks and even pothole can occur due to improper workmanship that resulted from wrong supervision. Wrong supervision could result to improper application of the material and operation of the works. Operations like the application of bituminous material, compaction of the soil etc could be messed up because of improper supervision.

9. LOW KNOWLEDGE BASE.

Lack of modern method of road construction on the part of the old engineers and low curriculum standards on the part of the young engineers are some of the problem of road construction in the country. Even the multinational construction companies in the country their workers display inadequate knowledge of the process of road construction. There are modern methods and standards of road design and construction available today. Our road contractors have to avail themselves of the used of these available new and modern methods of road construction and maintenance.

10. NO LOCAL STANDARD OF PRACTICE.

There is the need for adequate monitoring and control in the local construction process. This can be done by the provision of a standard method of practice which will be strictly followed, monitored and maintained. The professional bodies in the country will play a very important role at this stage. They should be able to provide a local standard of practice for the country, maintain it and monitor compliance to the use of the standard. This is because a local standard will take cognisance of the local peculiarities that will affect the environment where road works are located.

International Journal of Innovative Research in Science, Engineering and Technology

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Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

11. INADEQUATE SANCTIONS FOR HIGHWAY FAILURES.

There have been records of failures on Indian highways. No body or agency has ever been held responsible. Even the roads constructed by the multinational companies some of them start failing before the construction work are completed. Even when accident occurs it is generally blamed on the behaviour of the driver without looking at the effects of the nature of the road. The main factors that contribute to the cause of accident are driver behaviour, nature of vehicle and the nature of the road. In this country whenever accident occur we emphasise the first factor while deemphasising the effects of the other two factors which make tremendous contribution to the cause of accidents.

12. NOT CO-OPTING LOCAL PROFESSIONAL BODIES IN HIGHWAY DESIGN, CONSTRUCTION AND MAINTENANCE.

As earlier mentioned, the professional bodies have a lot of contribution to make to the construction of highways in this country. At present in the India the professional bodies have not been given adequate chance to contribute to road construction and maintenance in the country. The whole work of road construction and maintenance in the country is left at the mercy of expatriate companies that need to understand the local terrain and situation of our roads to enable them construct appropriately. These information can be provided by the local professional bodies that have more knowledge of the local environment. The professional bodies can even act as checks and monitors to the construction firm on road work in the country.

1.3 OBJECTIVES

Automated highway system's ambitious goals can be achieved by: Developing advanced concepts for advanced road vehicles for passengers and goods. Most of the earlier projects addressed isolated aspects of the mobility problems of cities, whereas automated highway system focuses on the overall urban transportation problem. Introducing new tools for managing urban transport. automated highway system will develop tools that can help cities to cross the thresholds that are preventing them from introducing innovative systems. For instance, the absence of certification procedures and the lack of suitable business models will be addressed. Taking away barriers that are in the way of large-scale introduction of automated systems. Some of these barriers are of a technological nature, some are of a legal or administrative nature: for example, the legal requirement for vehicles using public roads where the driver is responsible for the vehicle at all times, which effectively prohibits driverless vehicles from using public roads. Validating and demonstrating the concepts, methods and tools developed in automated highway system in European cities. In a number of other cities, studies will be carried out to show that an automated transport system is not only feasible, but will also contribute to a sustainable solution for the city's mobility problems, now and in the future. To survey and document automated highway system with pedestrian safety systems on roads. These systems include crossing control arms, video cameras, radar and acoustic detection systems, skirts, and collision avoidance systems.

1.4 SCOPE

The reliable intelligent driver assistance systems and safety warning systems is still a long way to go. However, as computing power, sensing capacity, and wireless connectivity for vehicles rapidly increase, the concept of assisted driving and proactive safety warning is speeding towards reality. As technology improves, a vehicle will become just a computer with tires. Driving on roads will be just like surfing the Web: there will be traffic congestion but no injuries or fatalities. Advanced driver assistant systems and new sensing technologies can be highly beneficial, along with largebody of work on automated vehicles. These findings suggest that the research into autonomous vehicles within the ITS field is a short term reality and a promising research area and these results constitute the starting point for future developments. Some of the 169 suggestions towards extension and/or future related works are identified and are summarized below: New sensory systems and sensory fusion is to be explored to plug additional information to the control system. This work can be extended to include different maneuvers to make the driving system capable of dealing with all driving environments. Future issues may also include an algorithm for autonomous formation of the

International Journal of Innovative Research in Science, Engineering and Technology

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Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

cooperative driving. Thus, with the current and growing awareness of the importance of security, trustworthy vehicle autonomous systems can be deployed in few years.

II. LITERATURE SURVEY

In order to deploy AHS capabilities, the uncertainties in the research and development of new technology must be managed well. Additionally, it is impractical to introduce fully automated vehicles on all highways instantaneously. Incremental deployment, then, is a significant issue, and several alternative strategies have been proposed. One strategy advocates the deployment of fully automated vehicles on dedicated lanes, but restricts the deployment to heavily used roadway segments equipped with special-purpose AHS guidance infrastructure.⁽¹⁾ Another strategy is to introduce AHS capabilities onto mass transit vehicles for use on existing High Occupancy Vehicle (HOV) lanes, subject to the supervision of a safety driver. A third general strategy involves gradually increasing the degree of automation of new and refitted vehicles over time, with both AHS vehicles and manually driven vehicles sharing essentially all interstate highways. This paper does not assume that any one of the above deployment strategies will be implemented. Rather, it presents the set of functions and sequencing constraints that are likely to be involved in deploying an AHS. Whichever deployment strategy is used, the system will need to contain some subset of the reference models' functionality to be considered a partial AHS. And, no matter the deployment strategy selected, substantially all of the functions will need to be implemented to achieve a complete AHS. This paper begins by presenting the baseline functional evolution reference model of an autonomous robotic vehicle, assuming that inter-vehicle communications are not universally available. An expanded reference model is then presented that includes the use of inter-vehicle communications, and is used to illustrate functions that are enhanced or enabled for the first time. Finally, a fully elaborated reference model is presented that adds Communications with roadside intelligence (highway infrastructure support), enhancing and enabling even more functions. These three reference models illustrate important technical dependencies, highlight the effects of communication and infrastructure support on the deployment of autonomous vehicle systems, and can be used as a roadmap for tracing the development and potential usage of the functions inherent to an AHS.

1. Information of Mumbai Pune Express Way. (Length, Lane, Places etc)

The **Mumbai-Pune Expressway** is India's first six-lane concrete, high-speed, access controlled tolled expressway.^[1] It spans a distance of 94.5 km connecting Mumbai, the administrative capital of Maharashtra state and the financial capital of India, with Pune, an industrial and educational hub.^[2] The expressway, which was fully operationalized in 2002, introduced new levels of speed and safety in automobile transportation to Indian roads.^[3] It is one of India's busiest roads.^[4]

The expressway has reduced the travel time from Mankhurd where Mumbai city ends to Pune to about two hours. It has supplemented the older Mumbai-Pune National Highway (old NH 4) which had become extremely congested and accident-prone. (NH 4 has been renumbered NH 48 after renumbering of all national highways by National Highway Authority of India in 2010 year.) The expressway starts at Kalamboli (just before Panvel) and ends at Dehu Road (just before Pune). It cleaves through the scenic Sahyadri mountain ranges through passes and tunnels. It has six interchanges: Shedung, Chowk, Khalapur, Lonavala, Kusgaon and Talegaon.

The expressway has two carriageways, each with three concrete lanes, separated by a central divider and a tarmac or concrete shoulder on either side. Vehicles with fewer than four wheels and agricultural tractors are not permitted, although tractor-trailers (semi-trailer rigs) are permitted. The expressway handles about 43,000 PCUs daily,^[4] and is designed to handle up to 1,000,000 PCUs. This road has improved transport between these two metro cities.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018



The Government of Maharashtra appointed RITES and Scott Wilson Kirkpatrick in 1990 to carry out feasibility studies for the new expressway to be operated on toll basis. RITES submitted its report in 1994 with the estimated cost of project at ₹11.46 billion (US\$180 million).

The government of Maharashtra entrusted the work of the construction of Mumbai-Pune expressway to MSRDC in March 1997 on Build-Operate-Transfer basis with permission to collect toll for 30 years. The Ministry of Environment and Forests, Government of India gave environmental clearance on 13 October 1997 and forest clearance on 11 November 1997.

The tender notice was published in leading newspapers all over India and also on the Internet. Due to the wide publicity, 133 tenders were sold and 55 tenders were received on 18 December 1997. After technical and financial evaluation, work orders were given on 1 January 1998 to four contractors. Thereafter tenders for widening of Khandala and Lonavala-Khandalabypass works were invited. The tenders were received on 24 August 1998 and orders were issued on 4 September 1998.

2. Previous 1 Year data of Accidents on highway, date rate and Reasons?

DISTRIBUTION OF ACCIDENTS BY TIME OF OCCURRENCE

The 155 accidents were plotted against time durations of 6 hours (figure 7) to identify times of Occurrence. The data shows highest percentage of accidents (34%, 54 accidents by count) Occurred between 06:00 to 11:59 hrs. The highest percentages of accidents resulting in fatal/serious injury occurred during the time periods of 00:00 to 05:59 hrs and 06:00 to 11:59 hrs (31.5%, 31 accidents by count).

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

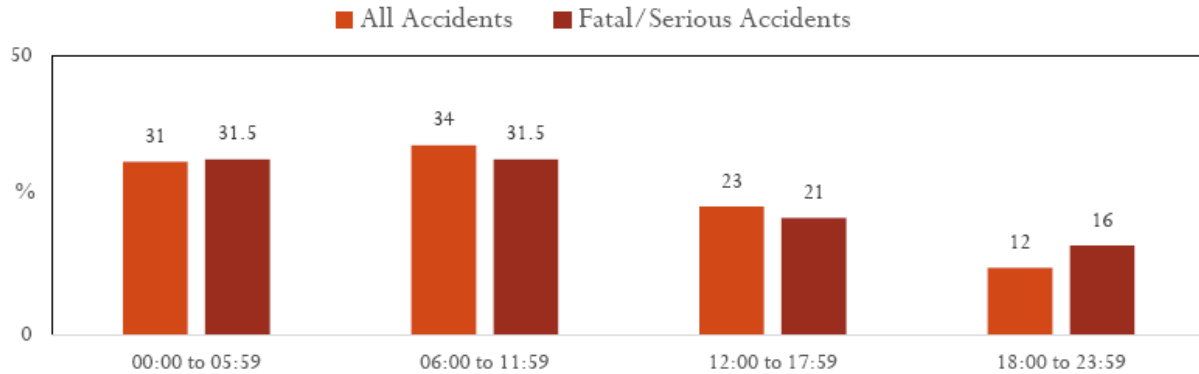


FIGURE 1: PERCENTAGE DISTRIBUTION OF ACCIDENTS BY TIME OF OCCURRENCE

Please note that in the above figure, “Fatal/Serious Accidents” refers to crash counts and not the numbers of injury victims or vehicles involved.

VEHICLES/ROAD USERS INVOLVED

A total of 256 vehicles/road users (240 vehicles and 16 pedestrians) were involved in the 155 expressway crashes examined in the year 2016. Figure 2 shows the percentage distribution of the types of vehicles/road users involved in these accidents.

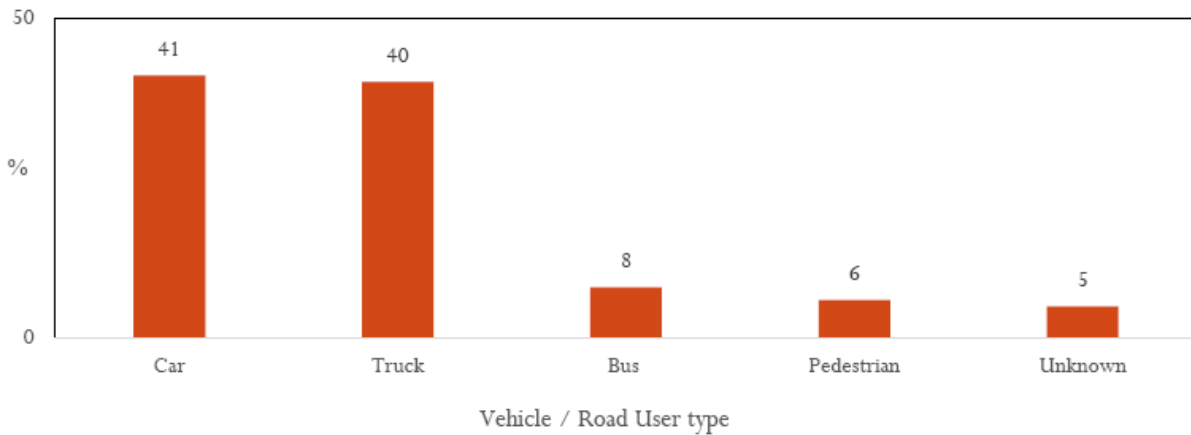


FIGURE 2: PERCENTAGE DISTRIBUTION OF VEHICLE/ROAD USER TYPE INVOLVED.

Please note that the figure is based on a count of the vehicles and pedestrians involved in the accidents analyzed and not the number of occupants or accidents. In the case of pedestrians, each pedestrian is a single count. For purposes of this report, all persons injured on the expressway outside of a vehicle are considered as pedestrians.

Accidents in a Year on Pune Mumbai Express way-

| Sr No | Vehicle Type | Accident |
|-------|---------------|----------|
| 1 | Bus | 1142 |
| 2 | Heavy / Truck | 854 |

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

| | | |
|---|--------------------------|-------------|
| 3 | Passenger Vehicle | 8547 |
| 4 | Two Wheeler | 9578 |
| 5 | Car | 8547 |
| 6 | Other | 6658 |

3. Case Study of Japan Automated Highway?

Japan, with a population density almost 12 times greater than the United States, has an abiding interest in developing intelligent transportation systems (ITS) to resolve its traffic congestion and other transportation problems. Indeed, the Japanese Comprehensive Automobile Traffic Control System (CACCS) program from 1973 to 1979 was the first public-private partnership effort in Japan -- perhaps in the world -- to test in urban areas an interactive route guidance system with an in-vehicle display unit.

But recently, Japanese officials have started looking at ITS from a much greater perspective. ITS is an essential element in creating a global advanced information and telecommunications society. This advanced society will realize the free generation, circulation, and sharing of information and knowledge that are the products of all human intellectually creative activities, thus leading to a new socioeconomic system that can forge a balance between living/culture, industry/business, and nature/environment. As a result, it is expected that there will be an expansion of economic frontiers, balanced national land development, and the creation of a standard of living for the people such that they can realize a truly comfortable and affluent lifestyle.

To put this in context, let's briefly review the history of ITS before taking a look at the Japanese approach to ITS and the status of development efforts in Japan.

ITS History

I see three stages in the history of ITS to date.

Stage 1 is the beginning of ITS research in the 1960s and 1970s. This early research was characterized by Japan's CACS, the Electronic Route Guidance System (ERGS) in the United States, and a similar system in Germany. All of these systems shared a common emphasis on route guidance and were based on central processing systems with huge central computers and communications systems. Due to limitations, these systems never resulted in practical application.

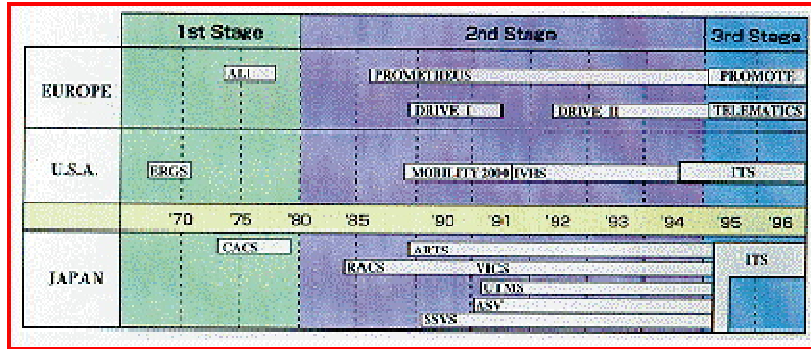
The next period from 1980 through about 1995 could be called stage 2. Conditions for ITS development had improved by the 1980s. Technological reforms, such as the advent of mass memory, made processing cheaper. New research and development efforts directed at practical use got under way. In Japan, work on the Road/Automobile Communication System (RACS) project, which formed the basis for our current car navigation system, began in 1984. Two projects were going on in Europe at the same time: the Program for a European Traffic System with Higher Efficiency and Unprecedented Safety (PROMETHEUS), which was mainly set up by auto manufacturers, and the Dedicated Road Infrastructure for Vehicle Safety in Europe (DRIVE), set up by the European Community. The U.S. Intelligent Vehicle-Highway Systems (IVHS) project was also progressing.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018



History of ITS Development.

It seems to me that we have now entered a new stage -- Stage 3. Several trends support this view. First, we are beginning to see practical application of earlier programs. Second, we are at last beginning to understand the full potential of ITS, and intelligent transportation systems are being thought of in intermodal terms rather than simply in terms of automobile traffic. Third, intelligent transportation systems have started to gain recognition as critical elements in the national and international overall information technology hierarchy.

Basic Guidelines for ITS

4. Accident rate before and After Automation in japan in a year?

Before Automation-

| Sr No | Vehicle Type | Accident |
|-------|-------------------|----------|
| 1 | Bus | 545 |
| 2 | Heavy / Truck | 85 |
| 3 | Passenger Vehicle | 654 |
| 4 | Two Wheeler | 850 |
| 5 | Car | 541 |
| 6 | Other | 658 |

After Automation-

| Sr No | Vehicle Type | Accident |
|-------|-------------------|----------|
| 1 | Bus | 246 |
| 2 | Heavy / Truck | 32 |
| 3 | Passenger Vehicle | 342 |
| 4 | Two Wheeler | 352 |
| 5 | Car | 152 |
| 6 | Other | 354 |

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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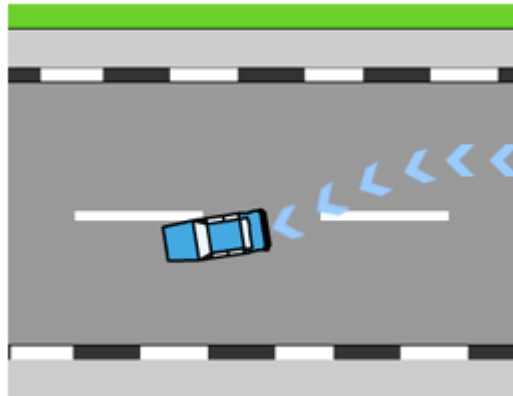
Vol. 7, Issue 5, May 2018

III. METHODOLOGY

1. LANE CHANGING MECHANISM

You might need to change lanes on roads with more than one lane in the same direction. You may want to change lanes to overtake another vehicle, to avoid a parked vehicle or when the vehicle ahead slows to turn at an intersection.

Always give proper signal before changing lanes and ensure the move can be made safely.



Steps for changing lanes-

1. Check for a space in traffic where you can enter safely.
2. Check your blind spot by looking over your shoulder in the direction of the lane change. Give an indicator in the direction you want to move.
3. Recheck to ensure the way is clear and that no one is coming at a fast speed from behind.
4. Turn steadily into the new lane.

Methodology Used-

The system consists of four subsystems: the sensor (videocamera), image processing, the controller and the vehicle as shown.

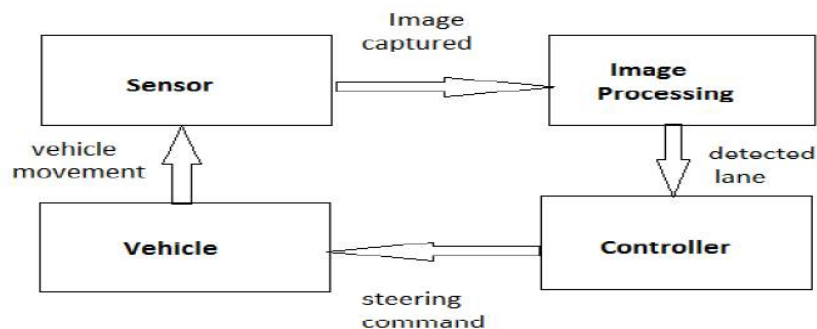


Fig.1.The four subsystems of a vision-based autonomous vehicle driving control system.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

1. Sensor

The sensor is the key element of an autonomous vehicle system, because it provides the information about a driving scenario. The system discussed here uses a single video camera as a sensor. To get the input data from the image, the video image sequences must be captured. The input data of this system is provided by colour image sequences taken from a moving vehicle. A single colour video camera is mounted inside the vehicle behind the wind shield along the central line. This records the images of the environment in front of the vehicle, including the road, the vehicles on the road, traffic signs on the roadside and, sometimes, incidents on the road. The video camera saves the video images in AVI file format, then the video file is transferred to the computer. The image processing subsystem takes an image from the memory and starts processing it in order to detect the desired lane.

2. Image Processing and Analysis for Predicting and Detecting the vehicle lane

The goal of the image processing is to extract information about the position of the vehicle with respect to the road from the video image. Two major processes are implemented: the preprocessing process and then the lane detection process. The goal of pre-processing is to remove image noise and make the images sharper. The goal of lane detection is to detect the desired lane of the vehicle in order to obtain the look-ahead distance and the lane angle. This process is based on the real-time data of video sequences taken from a vehicle driving on the road. The four processing steps of the lane detection algorithm are image segmentation, edge detection, Hough Transform, and lane tracking.

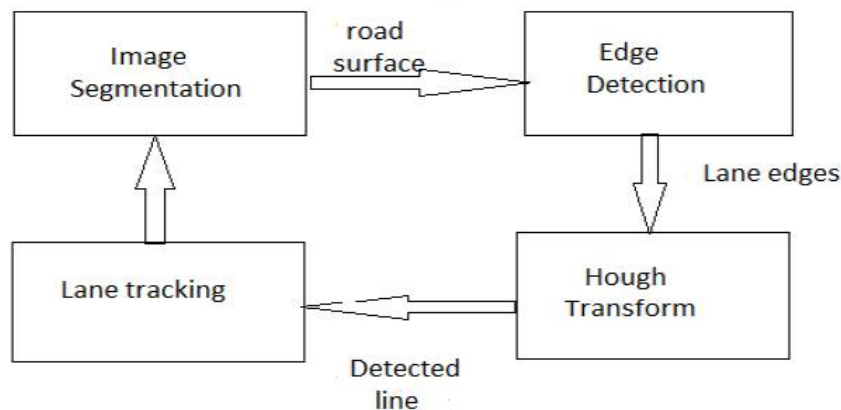


Fig. 2. Image processing steps of the lane detection algorithm.

3. Regions of interest measurement and features extraction using Color Cue Segmentation

Segmentation of the images is crucial for the analysis of the driving environment. Parts of the traffic scenes can be recovered by extracting geometric features in order to infer and verify the existence of certain categories of objects. Another relevant method of segmentation is based on region growing and clustering. The effectiveness of such a method crucially depends upon the capability of measuring similarity, such as in texture and pixel color information.

Cost Sheet-

1. Sensor (video-camera)- Rs 15000
2. Image processing Module- Rs 18000
3. Controller(Raspberry Pi 3) – Rs 3500

Total- 36500

International Journal of Innovative Research in Science, Engineering and Technology

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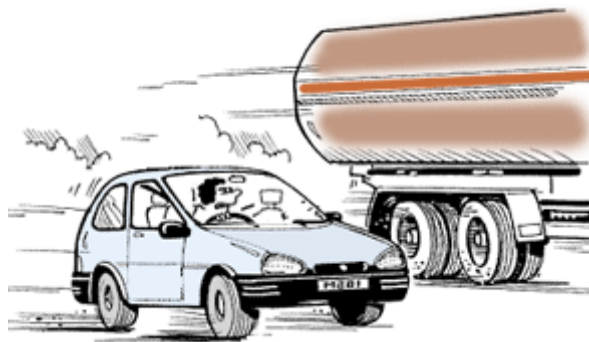
Vol. 7, Issue 5, May 2018

Benefit-

1. Safe Driving
2. Avoid Accident

2. OVERTAKING

- 1) Overtaking is changing lanes to move past a slower vehicle.
- 2) Never overtake other vehicle unless you are absolutely sure you can do so without danger to yourself or others.
- 3) Points to consider while overtaking a vehicle:



1. Use your right-turn indicator to show that you want to overtake. Check the way ahead and behind is clear before overtaking.
2. Watch out for scooters or motor cycles that may be hidden from view in front of the vehicle you are about to overtake. Watch for vehicles that may be turning right in front of you.
3. After overtaking, give indicator that you want to get back into the lane you started from. Change lane when you can see all the front of the vehicle you are passing in your rear view mirror. Never cut off a vehicle by suddenly moving in front of it.
4. Do not race if the vehicle you are passing speeds up. Get back into your original lane.

Do not overtake within 30 metres of a pedestrian crossing. When another vehicle wants to overtake you, move to the left and let it pass. Be prepared to slow down to allow the overtaking vehicle get into your lane ahead of you. The other driver may not have anticipated the speed of the oncoming vehicle.

Cost Sheet- Zero Cost

3. OVERTAKING AT NIGHT

Be very careful when you overtake other vehicles at night.

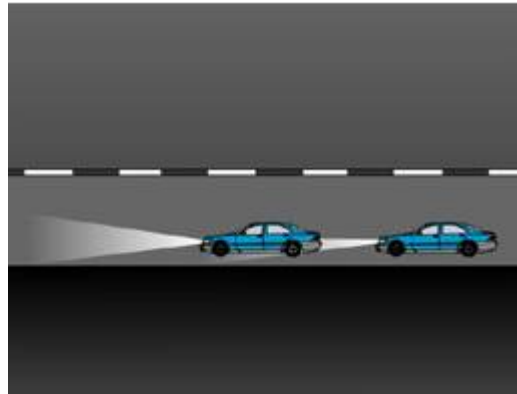
1. Switch your headlights to low beams as you approach a vehicle from behind.
2. Switch your high beams on and off quickly to warn the driver ahead that you are going to overtake.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018



3. Check your mirrors and blind spot, and pull out to overtake. As you move besides the vehicle you are overtaking, switch on your high beams so that you can see more of the road ahead of the vehicle you are about to overtake. Watch for vehicles that may be turning right in front of you.

4. When you can see all of the front of the vehicle you are overtaking in your rear view mirror, pull back into the left lane. Give indicator so the other driver knows you are getting back into the lane.

Cost Sheet- Zero Cost

4. ETC MECHANISM

What is ETC System?

The Electronic Toll Collection (ETC) System is a new toll system designed to enhance convenience for drivers by enabling cashless toll collection and thus Reducing congestion at High-way tollgates.



Objectives-

Avoid the fuel loss.

Saving of time in collecting toll.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 5, May 2018

- Avoid financial loss.
- Reduce longer waiting time in a toll queue
- Provide traveler ease of toll payment
- Reduce illegal toll gate entry

Problems in bar Code

- Transmission of data is performed optically- hence, clear line of sight is required
- Information storage is limited (upto 1 Mb)
- Read only one tag at a time
- Read capability can be affected by dirt, water and scuffing
- Reduced security

RFID Need-

Communicates through radio waves, line of sight not required

- RFID tags store significantly more information (upto 2 Mb)
- RFID is dynamic and information can be added or deleted at every step in the supply chain
- Increased functionality: covert and difficult to counterfeit
- Read multiple tags at once

RFID mechanism-

RFID is a technology to identify and authenticate tags that are attached on vehicles.

- Each user holds a unique id for his vehicle, when user scans his ID, some amount is charged from his account depending upon his vehicle category.
- This system depends on three devices
- Tag: Transponder
- RF Reader: Antenna
- In-Lane Computer

RFID Tags

An RFID tag, or transponder, consists of a chip and an antenna.

- The microchip contains memory and logic circuits to receive and send data back to the reader.
- Each tag contains an identification number, data identifying the issuing agency, tag type, a description of the vehicle, and other agency-specific data.
- The RFID Tag is mounted on windshield of vehicle.

Reader-

A reader contains an antenna to transmit and receive data from the tag.

- The reader also contains a decoder and an RF module. It could be mounted or built as a portable handheld device

In Line Computer-

The In Lane Computer checks the data against a database of valid tags and active accounts, deducts the appropriate toll from the customer's account, and approves passage or raises a tollgate to allow the vehicle to pass through the toll plaza

Working

As a vehicle approaches a toll plaza, the radiofrequency (RF) field emitted from the antenna activates the transponder.

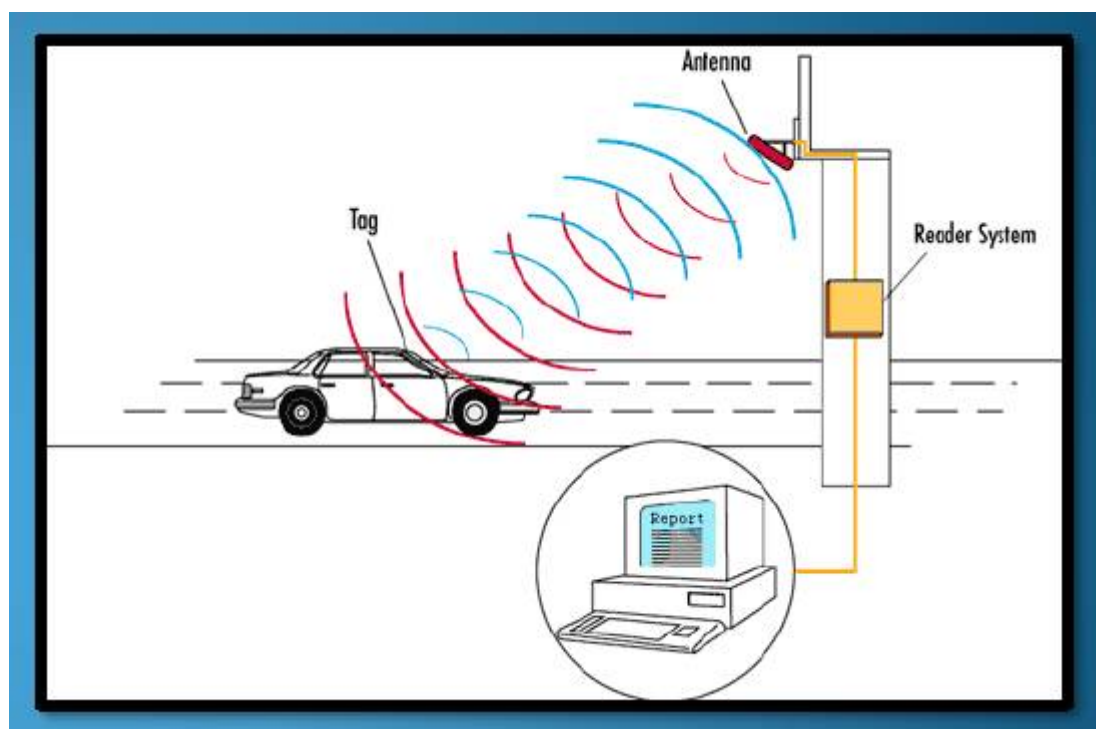
- The transponder broadcasts a signal back to the lane antenna with some basic information.
- That information is transferred from the lane antenna to the central database

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 7, Issue 5, May 2018



If the account is in good standing, a toll is deducted from the driver's prepaid account.

- If the toll lane has a gate, the gate opens.
- A green light indicates that the driver can proceed

Advantages-

- Entire process takes a matter of seconds to complete.
- Electronic system records transaction, including the time, date, plaza and toll charge of each vehicle.
- Safe Transaction (Less chances of Corruption)

Cost Sheet-

1. Tag: Transponder- Rs 25400
2. RF Reader: Antenna Rs 26000
3. In-Lane Computer- Rs 55000

Total- 1,06, 400

4. SPEED LIMIT CONTROL

This paper presents a device to detect rash driving on highways and to alert the traffic authorities in case of any violation. In past, lot of devices to detect rash driving on highways has been made. Most of the approaches require human concentration and involve a lot of effort, which is difficult to implement. In this paper we intend to design a system aimed at early detection and alert of dangerous vehicle driving patterns related to rash driving. The entire implementation requires an IR transmitter, an IR receiver, a control circuit and a buzzer. The speed limit is set by the police who use the system depending upon the traffic at the very location. The time taken by the vehicle to travel from one set point to the other is calculated by control circuit and displays that on seven segment displays. Moreover, if the vehicle crosses the speed limit, a buzzer sounds alerting the police.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

PROPOSED MODEL

In this section, we have designed a highway speed checker circuit to detect the rash driving using different electronic components such as timer, counter, logic gates, seven segment display and all other components. It shows the typical block diagram of speed checker to detect rash driving on highways using a Timer which consists of sensor module, logical module, power supply, sound detector and display module. Further logical module comprises timers, NAND gates and decade counters.

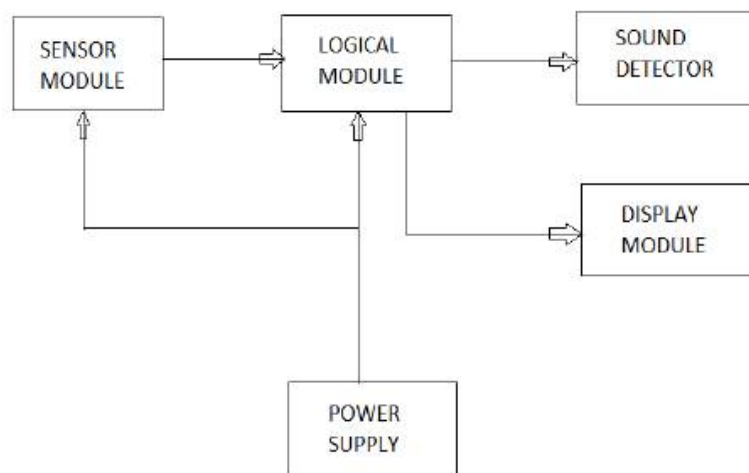


Figure 2. Block diagram of Vehicle speed detector using Timer

A photodiode used as sensor is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation. Photodiodes are similar to regular semiconductor diodes except that they may be either exposed (to detect vacuum UV or X-rays) or packaged with a window or optical fibre connection to allow light to reach the sensitive part of the device. Many diodes designed for use specifically as a photodiode will also use a PIN junction rather than the typical PN junction. When a photon of sufficient energy strikes the diode, it excites an electron, thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region. Thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced which goes to the Timer. In this case, we use 555 Timer IC which is an integrated circuit (chip) implementing a variety of timer and multi-vibrator applications. The 555 has three operating modes: Monostable mode: in this mode, the 555 functions as a "one-shot". Applications include timers, missing pulse detection, bounce free switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) etc. Astable - free running mode: the 555 can operate as an oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, pulse position modulation, etc. Bistable mode or Schmitt trigger: the 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bounce free latched switches, etc.

The circuit uses standard power supply comprising of a step-down transformer from 230v to 12v and four diodes forming a bridge rectifier that delivers pulsating dc which is then filtered by an electrolytic capacitor of 1000 μ f. The filtered dc being unregulated IC LM7812 is used to get 12v constant output at its pin no 3 irrespective of input dc varying from 9v to 14v. The input dc shall be varying in the event of input ac at 230volts section varies in the ratio of $v_1/v_2=n_1/n_2$. The regulated 12volts dc is further filtered by a small electrolytic capacitor of 0.1 μ f for any noise so

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 5, May 2018

generated by the circuit. This is used as the supply for different ICs in the circuit. A buzzer or beeper is an audio signaling device, which may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep. Here, piezo-buzzer sounds an alarm if the vehicle crosses the distance between the IR Diode set-ups at more than the selected speed. Fig. 3 shows the theory of buzzer so as to emit the sound. Simultaneously, the time taken by the vehicle to cross both the IR Diode beams is displayed on the 7-segment display.

IV. METHODOLOGY

This system has been designed assuming that the maximum permissible speed for highways is either 40 kmph or 60 kmph as per the traffic rule. Before operation, using a multimeter we have to check whether the power supply output is correct. If yes, apply power supply to the circuit by flipping switch to 'on.' In the circuit, we use long wires for connecting the two PHOTO DIODEs, so that we can take them out of the PCB and install on one side of the highway, 100 meters apart. We have installed two IR Diode transmitters (such as IR Diode torches) on the other side of the highway exactly opposite to the PHOTO DIODEs such that IR Diode light falls directly on the PHOTO DIODEs. Reset the circuit by pressing RESET switch, so the display shows '0000.' Using switch S1, select the speed limit (say, 60 kmph) for the highway. When any vehicle crosses the first IR Diode light, PHOTO DIODE1 will trigger IC1. The output of IC1 goes high for the time set to cross 100 meters with the selected speed (60 kmph) and LED1 glows during for period. When the vehicle crosses the second IR Diode light, the output of IC2 goes high and LED2 glows for this period. Piezo-buzzer sounds an alarm if the vehicle crosses the distance between the IR Diode set-ups at more than the selected speed (lesser period than preset-period). The counter starts counting when the first IR Diode beam is intercepted and stops when the second IR Diode beam is intercepted. The time taken by the vehicle to cross both the IR Diode beams is displayed on the 7-segment display. For 60kmph speed setting, with timer frequency set at 100 Hz, if the display count is less than '600' it means that the vehicle has crossed the speed limit (and simultaneously the buzzer sounds). Reset the circuit for monitoring the speed of the next vehicle.

Since the system comprises two laser transmitters- LDR sensor pairs, which are installed on the highway 100 meters apart, with the transmitter and the LDR sensor of each pair on the opposite sides of the road. The installation of lasers and LDRs is shown in fig 3 below. The system displays the time taken by the vehicle in crossing this 100m distance from one pair to the other with a resolution of 0.01 second from which the speed of the vehicle can be calculated as follows:

$$\begin{aligned} \text{Speed (kmph)} &= \text{Distance/ Time} \\ &= \frac{0.1 \text{ km}}{(\text{Reading} \times 0.01) / 3600} \end{aligned}$$

As per the above equation for a speed of 40 kmph the display will read 900 (or 9 second), and for a speed 60 kmph the display will read 600 (or 6 seconds). Note that the LSB of the display equals 0.01 second and each succeeding digit is ten times the preceding digit. You can similarly calculate the other readings (or time).

- Step 1- Apply the power supply by flipping the switch to ON.
- Step 2- Reset the circuit so that display shows '0000'.
- Step 3- Select the speed limit to 60 kmph.
- Step 4- When any vehicle crosses the first IR Diode light, PHOTO DIODE1 will trigger IC1 hence LED 1 glow during for period.
- Step 5- When the vehicle crosses the second IR Diode light, the output of IC2 goes high and LED2 glows for

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

this period.

Step 6- If the vehicle crosses the distance between the IR Diode set-ups at more than 60 kmph, the piezo-buzzer sounds an alarm.

Step 7- The counter starts counting when the first IR Diode beam is intercepted and stops when the second IR Diode beam is intercepted.

Step 8- The time taken by the vehicle to cross both the IR Diode beams is displayed on the 7 segment display

Table 1. Depicting final results of Over Speeding Detection on National Highway No. 1

| Vehicle | Speed1 40 Km/h | Speed2 60 Km/h | T1 (s) | T2 (s) | Buzzer Sound |
|---------|----------------------|----------------------|-----------|-----------|-----------------|
| Car | ---- | 70 | --- | 5.14 | Yes |
| Bus | 35 | --- | 10.3 | --- | No |
| Van | ---- | 54 | --- | 6.67 | No |
| Truck | 77 | ---- | 4.68 | --- | Yes |
| SUV | ----- | 90 | --- | 4.00 | Yes |
| Tempo | 40 | ---- | 9.00 | --- | No |

Cost Sheet-

1. Sensor Module- Rs 12500
2. Logical Moodle- Rs 17000
3. Power Supply Rs 15000
4. Sound Module- Rs 3500
5. Display Module Rs 15000

Total- Rs 63000

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 5, May 2018

4. Narrow/No Shoulder

| | | |
|---|-----------------------|---------------------------------|
| EXPECTED BENEFIT | INR 23.52 crores | |
| Number of fatal victims: 19 ; Number of serious victims: 66 | | |
| COST OF SAFETY MEASURE | INR 87.24 crores | |
| Safety measure: Widening of shoulders (where possible) | | |
| BCR | 1st year: 0.12 | Subsequent Year(s): 2.16 |

The “shoulder” is an area at the side of a road that provides vehicles with space for emergency stopping without affecting the traffic. The expressway has long sections of road with no shoulders (ghat section), while in other sections the shoulders are wide only on the left side of the road way and are narrow on the median side of the roadway.



On wide highways, it is preferable to have shoulders on both sides of the roadway (in the median as well as at roadside) for additional safety. At places where wide median is available on the expressway, it can be converted to a shoulder. To prevent misuse of the shoulders by drivers who may use them as travel lanes, longitudinal rumble strips can be installed throughout the edge of the roadway on the shoulders.



Figure 4: shoulders provided on both sides of the roadway (road side and median side) with continuous rumble strips, to prevent use of shoulders as regular travel lanesSS

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 5, May 2018

5. Roadside/median concrete structure

Details of all the roadside/median concrete structure locations are provided in Appendix A, page 117.

| | | |
|--|-----------------------|---------------------------------|
| EXPECTED BENEFIT | INR 9.96 crores | |
| Number of fatal victims: 9 ; Number of serious victims: 24 | | |
| COST OF SAFETY MEASURE | INR 13.75 crores | |
| Safety Measure: Install impact attenuators (water/sand filled drums) | | |
| BCR | 1st year: 0.33 | Subsequent Year(s): 5.79 |

At many locations on expressway, concrete structures have been constructed in the median and at road sides. These concrete structures might be serving some dedicated purpose but when vehicles go off the road and impact them, these rigid structures cause high deceleration rates resulting in intensive damage to vehicles and fatal or serious injuries to the occupants.

At many locations on expressway, concrete structures have been constructed in the median and at road sides. These concrete structures might be serving some dedicated purpose but when vehicles go off the road and impact them, these rigid structures cause high deceleration rates resulting in intensive damage to vehicles and fatal or serious injuries to the occupants.



Figure 5: expressway crashes with concrete structures

Safety measures that can mitigate accidents and injuries Impact attenuators placed in front of the concrete structures can reduce the crash severity by decreasing the rate of deceleration of the vehicle. They can be made of metal structures or can be engineered barrels of water or sand that can withstand an impact with a vehicle and minimize the injury to the vehicle occupants.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018



Figure 6: pictures of impact attenuators – metal (left) and sand/water- filled barrels (right).

6. Roadside steep slope/drop- offs

Details of all the roadside steep slope/drop-off locations are provided in Appendix A, page 245.

| | | |
|---|-----------------------|---------------------------------|
| EXPECTED BENEFIT | INR 7.27 crores | |
| Number of fatal victims: 5 ; Number of serious victims: 24 | | |
| COST OF SAFETY MEASURE | INR 27.70 crores | |
| Safety measure: Install guardrail/wire rope safety barriers | | |
| BCR | 1st year: 0.17 | Subsequent Year(s): 2.92 |



Figure 7: a car that rolled down a steep drop-off in the ghat section of the expressway.

The expressway has continuous stretches of downhill slopes and uphill mountain walls throughout the length. Lack of adequate barriers cause vehicles to go off road into the steep slope which increases the injury severity of the accident. Safety measures that can mitigate accidents and injuries
Accidents involving steep slopes/drop-offs can be reduced by installing roadside barriers along that will prevent both passenger cars and heavy vehicles from going off the road.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

7. Poor/ineffective road signage

Details of all poor/ineffective road signage locations are provided in Appendix A, page 377.

| | | |
|--|------------------------|-----------------------------------|
| EXPECTED BENEFIT | INR 6.80 crores | |
| Number of fatal victims: 6 ; Number of serious victims: 17 | | |
| COST OF SAFETY MEASURE | INR 12,60,000 | |
| Safety measure: Install effective road signage | | |
| BCR | 1st year: 24.54 | Subsequent Year(s): 431.83 |

Road markings and signage are important means to communicate with driver and help them take decisions in time. The common road signage problems on the expressway include incorrect placement of the signage, visibility of the signage in both light and dark conditions and difficulty in understanding signage because of small text or lack of multilingual messages.



Figure 9 examples of poor/ineffective road signage on the expressway

Safety measures that can mitigate accidents and injuries

Design and placement of road signage is a science that can help in reducing accidents and injuries initiated due to poor/late driver reaction or decision making. Hence, design and placement of signage and their effectiveness in informing drivers should be assessed. Signage should be placed at least a kilometer in advance of the critical situation that the driver needs to react to. The signage must also be quickly readable and easily understood by the driver. Symbolic/pictorial signage should replace the text signage wherever possible. In case, text signage has to be used, then the information must be displayed in – Marathi (state language), Hindi (national language) and English. It is important to repeat the signage, at least three times, to ensure that the driver gets the message even if he/she missed one sign due to any reason.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 5, May 2018

V. RESULT AND DISSCUSSION

1. If Camera Used Then (Range, Location, Specification, Span, Cost, Size, Image Processing Time, Exact Location on Highway)?

| | |
|------------------------------|---|
| Specifications of the camera | |
| ANPR camera | Wide VGA digital infra camera Resolution: 752 X 480 |
| Lens | Varifocal motoric zoom and iris Effective range 3-20m IR pass filter included |
| High performing illumination | High power IR leds - ideal for ANPR Strong sunlight/shadow correction Software adjustable intensity |
| Extras | Auto focus Auto brightness control |
| Specifications of the radar | |
| Measurement principle | Doppler-Radar |
| Radar frequency | 24.165 GHz, K-Band |
| Type of detection | Movement, selectable uni- or bidirectional |
| Installation angle | For counting 45° For tracking < 11° |
| Installation height | Over head: 5m typ. Lateral: 2m typ. |
| Operating modes | Counting (signed) speed, profile, gap One value per vehicle |
| Specifications of the PC | |
| CPU | 1.6 GHz Intel Atom CPU 32 bit |
| Memory | 2GB SSD memory At least 1GB free memory for user data |
| Network | Gigabit ethernet card Web-server for smooth communication |
| Operating system | Linux, Fedora11 32 bit |
| Other specifications | |
| Trigger | Serial RS232 port, GPI port |
| Power consumption | Isolated 24-28V AC or 30-36V DC input (50-60Hz)F 18-48W (28V AC) depending on heating ON/OFF Automatic internal heating with thermostat |
| Operation temperature | -10 °C to +50 °C Extra heating: optional |

2. For Highway Management (Control Room and Its Size, Police Stations)?

In the early days, general perception of term control room is for NASA, Mission control Space programs, or Military command center. A control center is one of the most important and complex working environment in any organization

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 5, May 2018

whether government or enterprise. For over a decade, Intertech Vision is a pioneer in creating and implementation of Central Control Room which would satisfy Human factors and Ergonomics.

At present, Intertech Vision has designed and implemented central control rooms in Transportation, Traffic management, Media and broadcasting, Manufacturing, oil and gas, energy power generation, surveillance and security, telecommunication.

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No of Control Rooms on Mumbai Pune Express Highway- 25

Size- 16*16 sqft

Police Stations- 23 (is on / near Highway)

3. Steep slope in Highway?

The Mumbai-Pune Expressway is marred by fatal accidents due to over-speeding, lane indiscipline, design faults, rash driving and drunk driving. Between May-July 2011, 74 accidents on the expressway have been reported, of which 21 resulted in deaths. DNA finds out how this grave problem can be resolved.

Vehicles find it difficult to manoeuvre on the steep slope near Amrutanjan Bridge Compared to NH4 Mumbai-Pune Expressway, the Baroda-Ahmedabad NH1 Expressway is not accident-prone. The stretch near Amrutanjan Bridge must be widened and two additional lanes should be constructed. Also, there are no road safety markers on the whole stretch of the expressway. Heavy vehicles, especially in the night, don't follow lane discipline and cars have to dangerously make their way through these heavy vehicles. Over 90% of accidents happen between the stretch of Lonavla entry point and Khalapur toll naka. Vehicles find it very difficult to manoeuvre on the steep slope near Amrutanjan Bridge. Overall, there is no attempt by the concerned authorities to control vehicle speeds. Nobody is maintaining the expressway as per the requirement with IRB Infrastructure Developers and Maharashtra State Road Development Corporation (MSRDC) putting the responsibility on one another.

According to the data received from highway police, between April-July 2011, 74 accidents have been reported on the expressway out of which 18 were fatal, 31 serious and 48 minor accidents, resulting in 21 deaths, 51 serious injuries and 47 minor injuries. — Chandmal Parmar, social activist

The speed limit should not exceed 80 km on expressway, but very few follow the norm We try our best to maintain the international standards of the Mumbai-Pune Expressway. My observation is that 90% of the road accidents take place due to over-speeding and mistake of drivers. With our patrolling unit, we are trying to keep such incidents under control, but our authority is limited. It is the responsibility of regional transport office (RTO) and highway police to ensure road safety. The speed limit should not exceed 80 km on the expressway, but very few follow the norm. We have widened the highway route in the ghat section from four-lane to six-lane, which has resulted in better traffic movement. VR Naik, chief engineer, MSRDC, Pune Division

We suggest converting the total stretch of expressway into an eight-lane road We are following the expressway issues through our Railway, Road Traffic Management Committee and have submitted letters in this regard to the concerned government departments.

The design change that we proposed between Lonavla exit and Amrutanjan point has been accepted.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 5, May 2018

This stretch of road has some serious issues, which need to be attended quickly. In fact, we have suggested converting the total stretch of Mumbai-Pune Expressway into an eight-lane road from the present six-lane. The Lonavla Ghat section, which is incomplete and is common for both expressway and Mumbai-Pune highway users, needs to be separated.

4. Location of Foggy area , High traffic congestion area, Lane Cutting Area, Accident Area?

Location of Foggy area- Lonavala Valley , Talegaon Ambi

High traffic congestion area- Katraj to Talegaon Ambi, Lonavala.

Lane Cutting Area- Bhujbal Chowk, Bhumkar Chowk, Balewadi Chwok, Chandni Chowk.

Accident Area- Lonavala valley, Chandni Chowk, Talegaon Corner.

5. Places in India where this system can be used?

This automations technique we will used in following highways-

| National Highways | Connectivity |
|-------------------|---|
| NH -1 | Delhi to Amritsar (via Ambala and Jalandhar) |
| NH-1 A | Jalandhar to Uri (via Madhavpur, Jammu, Srinagar and Baramula) |
| NH-2 | Delhi to Kolkata (via Mathura and Varanasi) |
| NH-3 | Agra to Mumbai (via Gwalior, Indore and Nasik) |
| NH-4 | Thane (Mumbai) to Chennai (via Pune, Belgaun, Hubli, Bangaloru and Ranipet) |
| NH- 5 | Behragoda (Near Kolkata) to Chennai (via Cuttack, Visakhapatanam and Vijaywada) |
| NH-6 | Hazira to Kolkata (via Nagpur, Raipur and Sambalpur, Dhule) |
| NH-7 | Varanasi to Kanyakumari (via Nagpur, Bangalloru and Madhurai) |
| NH-8 | Delhi to Mumbai (Jaipur, Ahmadabad and Vadodara) |
| NH-9 | Pune to Machilipatnam (via Sholapur and Hyderabad, Vijaywada) |
| NH-10 | Delhi to Fazika proceeding to Indo-Pak border |
| NH-14 | Beawar to Radhanpur (Sirohi) |
| NH-15 | Pathankot to Kandla (Near Thar Desert) |
| NH-24 | Delhi to Lucknow |
| NH-39 | Numaligarh to Indo-Myanmar Border |

VI. CONCLUSIONS

Transportation systems are an indispensable part of human activities. Estimation shows that an average of 40% of the population spends at least one hour on the road each day. People have become much more dependent on transportation systems in recent years; transportation systems themselves face not only several opportunities but several challenges as well. The competitiveness of a country, its economic strength and productivity heavily depend on the performance of

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(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 5, May 2018

its transportation systems. Three successively more comprehensive reference models have been presented to depict how an AHS might evolve using incremental introduction of functionality. These models indicate precedence constraints on the introduction of capabilities and depict how the introduction of inter-vehicle communication and infrastructure support can increase the efficacy of an AHS. The models also demonstrate that addition of additional capabilities in most cases does not supplant previously introduced in-vehicle functionality. The first reference model suggests that full tactical driving capability requires neither inter-vehicle communication nor roadside-to-vehicle communication. However, if robust communication mechanisms can be provided, communications might be used to significantly improve the quality of maneuvering and collision avoidance capabilities. With the exception of merging, adding communication capabilities does not obviate the need for any vehicle based functions when these vehicles are incrementally introduced onto an existing roadway system. The presence of non-AHS-equipped and older-but-equipped vehicles in an incremental deployment scheme necessitates the development of in-vehicle systems that can function effectively without relying on communication. Even though an end-state of full automation is desirable, the reality is that an incremental deployment will be necessary. As shown by the reference models, there appear to be a number of obtainable safety and efficiency benefits at intermediate deployment points utilizing partial automation and in some cases no automation. Using these models as a roadmap may help plan evolutionary approaches to creating an AHS that satisfy both technical constraints and a need to provide value before fully automated operation is achieved.

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