International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 10 | Oct 2022 www.irjet.net p-ISSN: 2395-0072

STUDY OF AUTOMATED HIGHWAY SYSTEMS AT AMRAVATI

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Abstract - *The Automated Highway System (AHS) idea establishes a new bond between moving objects and the road system. AHS designates a group of lanes on a restricted access road where specially equipped cars are driven entirely automatically. AHS employs vehicle and roadway control technologies that delegate control of the vehicle from the operator to the driver. To ensure safer and more convenient transportation, throttle, steering, and brakes are automatically regulated. AHS also makes use of communication, sensor, and obstacle detection technology to identify and respond to changes in the outside infrastructure. In order to coordinate vehicle movement, avoid impediments, and optimise traffic flow, the highway and the vehicles work together to increase safety and decrease congestion. In conclusion, the AHS idea blends communication technologies that link automobiles to highway infrastructure with a variety of intelligent technologies deployed on existing highway infrastructure.*

Key Words*: Entrance/Exit, Deployment, Automated Highways, and Roadway Interfaces.*

INTRODUCTION

The automated highway system is a long-term transportation system with several potential advantages in the future. AHS technology creates a new connection between roads and transportation networks. It is a driverless approach that operates automobiles through an automatic control system. For the design of an automated highway system, a variety of techniques connected to computing concepts, microelectronics, numerous sensors, and advanced civil engineering techniques are applied. In an automated highway system, the essential parts of any mechanically propelled vehicle—the throttle, steering, and braking—are automatically operated. An automated highway system may readily satisfy the primary requirements of any traffic facility, such as coordinated vehicle flow, the removal of obstructions, an improvised traffic system, and safety. The recently developed intelligence algorithms are extensively used to link highway networks and the moving traffic on those networks.

Radio controls and mechanical mechanisms are used to manage the operation of this scientific apparatus. The primary idea behind the creation of an automated highway system is the increase in vehicle capacity on a road with fully managed traffic. The creative idea of an automated highway system has been significant in managing the transportation network in developed cities when compared to the behaviour of human drivers. The Intermodal Surface Transport Efficiency Act of 1991 was enacted (ISTEA), An effort was made to design and test early prototypes for completely automated automobiles and highways. With the intention of creating standards for a fully automated highway system concept that would support and encourage the advancement of vehicle and roadway technologies, this legislation inspired the US DOT to create the National Automated Highway System Research Programme (NAHSRP). Highway Automation Systems Amravati Page No. 2, Dr. Rajendra Gode Institute of Technology and Research The National Highway System Consortium was established by the US Department of Transportation in 1994. (NAHSC). The consortium included members from nine key organisational categories, including academia, local, state, regional, and federal governments, as well as the transportation, electronics, and communications industries. The consortium supported boosting the program's knowledge and resources and insisted that the stakeholders' cooperation would be essential in fostering the shared enthusiasm needed for the early design and implementation of fully automated highway systems. Despite the fact that the US Department of Transportation stopped funding the National Automated Highway Systems Research Programme (NAHSRP) in 1997, research is still being done today, albeit in a sparse manner. With a greater emphasis on a shorter time horizon, many research undertaken by the National Automated Highway Systems Consortium (NAHSC) continue in part with a few federal programmes like the Intelligent Vehicle Initiative (IVI).

1.2 Objectives

• Develop new tools for controlling urban transportation. Automated highway systems will create resources that can assist cities in overcoming obstacles that are keeping them from implementing cutting-edge technology.

• Studies will be conducted to demonstrate that an automated transportation system is not only doable but will also help find a long-term solution to the city's mobility issues.

• To research how factors including traffic volume, capacity, road characteristics, and surface characteristics affect accident rates on highway roads. Highway Automation Systems Amravati

• To analyse the annual, monthly, and per-mile accident statistics for the chosen highway road.

• To survey and record automated highway systems with driver and passenger safety features on the highways. There is still a long way to go before viable intelligent driver assistance systems and safety warning systems are available.

2. LITERATURE REVIEW

Many studies on the subject of automated highway systems have been conducted by a variety of researchers and vehicle developers. These studies show the advantages of using an automated highway system.

Anthony Nuzzoloa Give some examples of the Advanced Traveler Advisory Tool's theoretical and practical applications (ATAT) It need to be able to support users using multimodal networks by recommending the optimal routes in accordance with their individual preferences. Such routes are distinguished based on an assessment of the perceived path utility codified in the Random Utility Theory. It demonstrates user requirements, TVPTA's logical and functional design, as well as the framework for transit modelling, which provides tailored pre-trip information, and the learning process, which identifies user preferences. The second section outlines a metropolitan area implementation example of TVPTA concepts. The researcher's findings were given by the author in an effort to create an ATAT that could provide real-time data-based tailored information to the user. Its foundation is a path choice modelling framework that may present different paths based on individual travel preferences that are determined through a learning process. The theoretical foundation is built on individual path choice models that can offer other transport routes depending on the user's own travel preferences as recorded by a learning process of user behaviours. The authors' current analyses, which follow the decisions made by a sample of students travelling in a major city, demonstrate the advantages of giving personalised information as well as the limitations of using aggregate models to provide travel advise. The initialization and updating of model parameters are among the other achievements of this research that experimental evidence also supports. In reality, even while the use of Stated Preferences interviews created on 2-alternative scenarios with a minimum of 10 observations enables us to estimate initial model parameters for an acceptable individual Highway Automation Systems Rajendra gode, D.O. Page No. 6 Travel advise from the Institute of Technology and Research, Amravati: To generate statistically meaningful findings, a large number of observations are required, and the updating procedure of individual model parameters is relatively slow. Such a finding points to the need for future research into parameter updating methods, path choice modelling (e.g., examination of additional O/D pairs, user preferences, and model forms), and TVPTA implementation. They create a controller that directs a desired velocity at each part of the highway using a macroscopic traffic model similar to that in so that the density of the entire highway corresponds to a designated density profile. Their model is based on how real drivers behave. Although designing control laws for automated vehicles to make them act like those piloted by people is a possibility, this is not the only strategy. The created control law is based on the inversion of the dynamics of traffic flow, which necessitates a specific controllability requirement for the flow of traffic. When the density in any area of the highway gets exceedingly low, this condition is broken. The information from the entire highway is needed for the control action at a particular spot in the roadway. A dynamic version of the control rule that solves the matrix inversion dynamically helps to fix this issue. This work does not take into account commands for changing lanes or numerous lanes.

METHODOLOGY AND DATA

- Similar to current high-occupancy-vehicle (HOV) or carpooling lanes, a driver choosing to use such an automated highway may first pass through a validation lane. The system would then set the car's location, decide whether it will operate properly in automated mode, and deduct any tolls from the driver's credit account. Vehicles that are operating incorrectly will be directed to manual lanes.

- The vehicle would next be directed through a gate and onto an automated lane when the driver steered into a merging area. Newly entering traffic would be coordinated with existing traffic using an automatic control system. The driver may unwind till the turnoff once they were in autonomous mode. The operation in reverse would remove the car from the road. The system would next need to determine whether the driver could regain control and decide what to do if they were unconscious, ill, or even dead.

- A mixed traffic system, in which automated and non-automated cars use the road, is an alternative to this type of dedicated lane system. This strategy would yield the greatest benefits but would require more extensive adjustments to the transportation infrastructure.

- In fact, a range of strategies that vary in the level of autonomy for each vehicle can be imagined for highway automation systems. Fully independent or "free-agent" vehicles with their own proximity sensors would be on one end of the spectrum, allowing other vehicles to safely stop even if the vehicle in front applied the brakes suddenly.

- Vehicles in the middle would be able to adapt to different levels of cooperation with other vehicles (platooning). Systems that depend less or more heavily on the highway infrastructure for automated support would be at the opposite end. However, the majority of the technology would typically be installed in the vehicle.

3.1 Informattion of study area Amravati to Talegaon National Highway.

The high-speed, access-controlled toll road from Amravati to Talegaon is India's national highway number 6 (NH 6 has been renumbered NH 53 after renumbering all national roads by National Highway Authority of India in 2010 year). It links Talegaon with Amravati across a stretch of 55.1 kilometres. The road is a section of the major East-West national highway NH-6, often known as the G.E. (Great Eastern Road). India's NH-6 travels across the states of Gujarat, Maharashtra, Chhattisgarh, Orissa, Jharkhand, and West Bengal. The cities of Surat, Dhule, Amravati, Nagpur, Raipur, Sambalpur, and Kolkata are all along the route of the highway. From Hazira to Kolkata, NH 6 travels over 1,949 kilometres, establishing crucial east-west connection for the entire region. The NH-6 study segment serves a variety of traffic, including regional, suburban, and urban traffic. The construction next to the highway suggests a combination of land uses, including residential, commercial, and small- and medium-sized industrial facilities producing textiles, woollen blankets, ropes, timepieces, and other items, as well as agricultural and arid lands on both sides of the road. Future development along the roadway and in the influence region has considerable potential for the corridor as a whole, as is further detailed in this Report. Agriculture is the primary land use on both sides of the project corridor. This section of the Great Eastern Highway, which connects Kolkata and Hazira, two of the country's largest ports, sees a sizable volume of commercial bulk transportation activity.

Fig 1 - Satellite view Study Area

The Amravati district is traversed by the project highway corridor, which is located in the state of Maharashtra. Before reaching the conclusion of the project stretch at Talegaon, it goes through a number of large and minor urban centres, including Nandgaon Peth, Mozri, Tivsa, and Ramdara, among others, along its length.

Also known as the Amravati-Nagpur Highway, the corridor. The highway has a central divider, two carriageways with each two lanes, paved shoulders, side drains on both sides, and flyovers at significant crossings.

The study area's quiet features are listed below;

55.1 km is equal to four carriageway lanes.

There are 1 major bridges.

25 Numbers for Minor Bridges

2 flyovers total.

Bridge Over Rail: 1 No.

Culverts: 86 total no.

11 pedestrian underpasses are allowed.

11 vehicle underpasses are required.

36 numbers at major intersection.

Service Road: 26.50 kilometres.

15 bus bays total.

Complex at Toll Plaza = 1 Nos.

3.2 Data Processing

For analysis, almost all of the data was downloaded onto spreadsheets. The data was examined to identify issues and shortcomings in the corridor. Because reducing accidents is AHS's primary goal, the project study focused on accident analysis. A floating referencing system was used to calculate accident rates for each segment measuring half a mile. Rates were specifically set on a half-mile basis, moving forward every tenth of a mile along the route. Additionally, severity rates were calculated for every half-mile length of floating water. These rates were used to determine probable anomalous accident sites for future investigation. Trend-exhibiting segments were considered to have the most potential for realising the advantages of AHS applications.

3.3 Traffic Characteristics

The amount of traffic on the route does not entirely determine its toll revenue. The potential impact of certain traffic features on toll income is considerable. Some of these characteristics of traffic include a portion of local traffic, a portion of passenger and commercial traffic, a portion of traffic on repeat trips, and a portion of traffic on monthly passes.

Fig 2 - Toll Plaza Location as TP1

3.4 Classified Traffic Volume Count

Understanding the modal split and traffic flow pattern on a roadway is the goal of a Classified Traffic Volume Count. The concessionaire of the project highway delivered the Classified Traffic Volume Count survey based on actual traffic data collected at toll plaza sites based on monthly data. The vehicles can be roughly divided into two categories: those that move quickly and are propelled by motors and those that move slowly and are propelled by human power. Toll-exempt vehicles are counted separately and the vehicle groups are further divided to capture the toll-able vehicle classifications. Table lists the specific vehicle categorization system according to IRC: 64- 1990.

Vehicle Type	
Auto Rickshaw	
Passenger Car	Car, Jeep, Taxi & Van (Old / newtechnology)
Bus	Mini Bus
	Standard Bus
Truck	Light Goods Vehicle (LCV)
	2 – Axle Truck
	3 Axle Truck (HCV)
	Multi Axle Truck (4-6 Axle)
	Oversized Vehicles (7 or more axles)
Other Vehicles	Agriculture Tractor, Tractor & Trailer

Fig 3 – Vehical Classification System

3.5 Speed Limit Control

This study describes a device that may spot reckless highway driving and notify the traffic authorities of any violations. There have been many gadgets created in the past to catch reckless highway driving. The majority of the methods demand a lot of human work and concentration, which makes them challenging to put into practise. In this study, we propose to develop a system for the early detection and warning of rash driving-related risky vehicle driving behaviours. A buzzer, a control circuit, an IR transmitter, and an IR receiver are needed for the full implementation. The police employ a system to determine the speed limit based on the volume of traffic in the area. The control circuit calculates the distance travelled by the vehicle between two predetermined points and shows that information on seven segment displays. Additionally, if the car exceeds the speed limit, a buzzer alerts the police.

PROPOSED SECTION

In this section, we've created a circuit for a highway speed checker that uses timers, counters, logic gates, seven-segment displays, and other electronic devices to identify reckless driving. It displays the conventional block diagram of a speed checker that uses a Timer and a Timer's sensor module, logical module, power supply, sound detector, and display module to detect reckless driving on roads. A further logical module includes decade counters, clocks, and NAND gates.

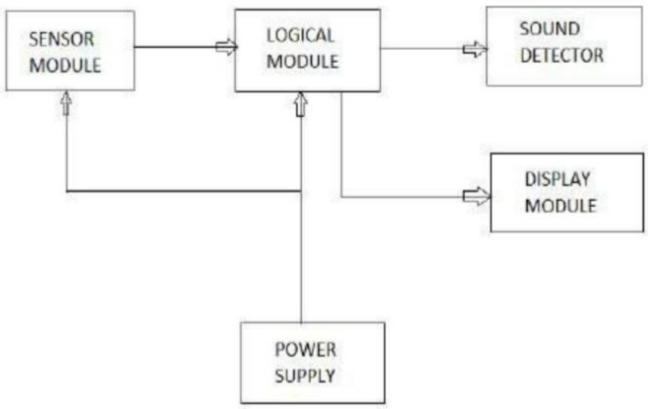

Fig 4 – Block diagram of Vehical speed detector using Timer

Depending on the operation mode. The only difference between photodiodes and conventional semiconductor diodes is that the sensitive portion of the device may be uncovered (to detect vacuum UV or X-rays) or packed with a window or optical fibre connection to let light in. PIN junctions, as opposed to the more conventional PN junction, are also utilised by many diodes made expressly for use as photodiodes. An electron is excited when a photon with enough energy contacts a diode, producing a mobile electron and a positively charged electron hole. These carriers are swept away from the junction by the depletion region's built-in field if the absorption takes place there or one diffusion length distant from it. As a result, electrons flow toward the cathode and holes toward the anode, producing a photocurrent that travels to the timer. The 555 Timer IC, an integrated circuit (chip) that implements a number of timer and multi-vibrator applications, is used in this instance. The 555 can operate in one of three ways: Monostable mode: The 555 performs as a "one-shot" in this mode. Timer, missing pulse detection, bounce-free switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM), and other applications are examples of applications.

The 555 chip can run in the astable, unrestricted mode, acting as an oscillator. Uses for pulse generation, logic clocks, tone creation, security alarms, LED and light flashers, pulse position modulation, etc. If the DIS pin is not connected and no capacitor is utilised, the 555 can function as a flip-flop in bistable mode or Schmitt trigger. Bounce free latched switches are among their uses.

Different types of lane systems on automated highways:

Depending on the number of lanes, the automated highway system uses one of three basic types of road networks. Here is a list of them:

A single-lane road :

The longitudinal pace of traffic is controlled on this sort of highway, which has a single automatic lane.

Solitary-lane highway:

A discrete number of automated lanes make up this kind of road network, and longitudinal velocities are controlled in a manner that is proportional to the frequency of lane changes.

Discrete-lane motorway with a number of stops:

This kind of road networks also have a number of distinct lanes, but the control over the lanes is determined by the cars' end destination.

3. RESULT

4.1 Accident rate

Accordingly, the number of accidents of all categories per km of each highway and street classification is used to indicate the total accident hazard. R=A/L Where L is the length of the control section in kilometres, A is the total number of accidents that occurred during the year, and R is the overall accident rate per km. Accident rate from April 2017 to April 2020, all accidents included (Fatal, Grievous, Minor)

Years	Lenth (km)	Total No. of accident	Accident rate per km
Apr -2017 to Dec - 2017	55	93	1.70
Jan-2018 to Dec - 2018	55	106	1.93
Jan- 2019 to Dec - 2019	55	64	1.16
Jan- 2020 to Dec - 2020	55	35	0.64

Fig 5 – Total Accident Rate Amravati to Talegaon

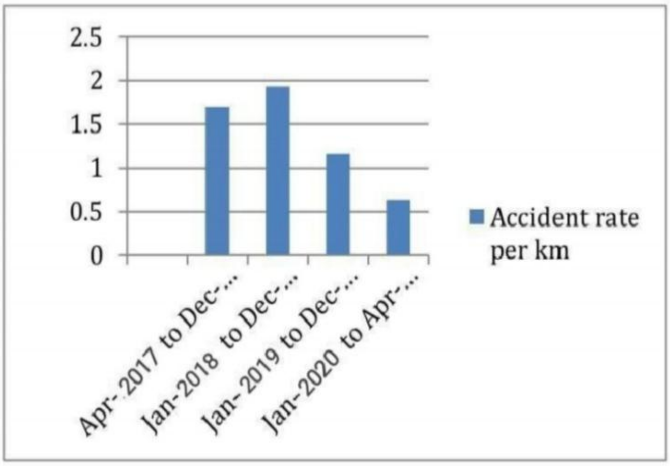

Fig 6 – Total Accident Rate per km

Accident Rate April 2017 to April 2020 for Fatal

Years	Lenth (km)	No. of accident	Accident rate per km	%Accident rate per km
Apr-2017 to Dec 2017	55	7	0.13	13%
Jan-2018 to Dec-2018	55	20	0.36	36%
Jan-2019 to Dec-2019	55	17	0.31	31%
Jan-2020 to Apr-2020	55	4	0.07	7%

Fig 7 – Accident Rate of Fatal Amravati to Talegaon

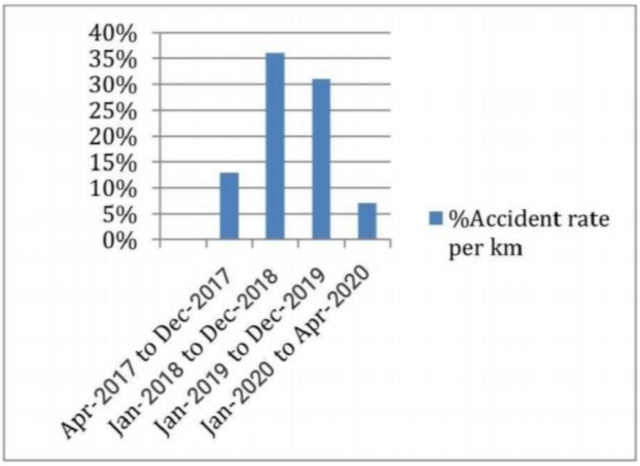

Fig 8 – Percentage of accident rate of fatal

3.2 Accident rate for animal

Accordingly, the number of accidents of all categories per km of each highway and street classification is used to indicate the total accident hazard.

R=A/L

Where,

R is the annualised total accident rate per km,

A is the total number of accidents that occurred in a given year, and

L is the control section's length in kilometres.

Months	Lenth (km)	No. of accident	Accident rate per km
Jun-17	55	65	1.81
Jan-18	55	23	0.42
Mar-19	55	52	0.95
Apr-20	55	52	0.95

Fig 9 – Accident Rate of Animals Amravati to Talegaon

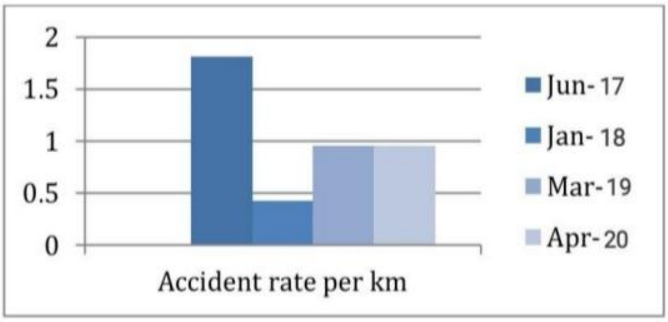

Fig 10 – Accident Rate of Animals

5. CONCLUSION

In order to fulfil its development objectives, Automated Highway Systems offers significant transportation benefits in terms of safety, efficiency, affordability and usability, as well as the environment.

- The division of the various control functions into discrete layers with well defined interfaces is a crucial component of the control design architecture. Each layer is then built with its own model that is appropriate for the functions for which it is accountable.
- The models at the different layers differ from one another not just in terms of the formal structure (which might range from differential equations to state machines to static graphs), but also in terms of the entities that play a part in them.
- The AHS is a sophisticated large-scale control system that requires advancements in communication, actuator, and sensor technology during its creation.
- The fact that these techniques have developed to the point where they might be successfully applied in the AHS project is an indication of the advanced state of the art.
- Despite what has been said, the failure of numerous federal programmes, like the National Automated Highway System Research Program (NAHSRP), can be attributed to the program's entanglement in technological optimism.
- Numerous examples from AHS demonstrate the lack of both technical and non-technical showstoppers. However, cultural, institutional, and legal problems are equally important to address as technical ones. Furthermore, because they are so closely related to people's perceptions, behaviours, consensus, and social changes based on those, these institutional and societal concerns cannot be resolved in a single day.

SCOPE OF FUTURE WORK

- Creating cutting-edge concepts for futuristic passenger and cargo vehicles. While the majority of preceding projects focused on discrete areas of cities' mobility issues, AUTOMATED HIGHWAY SYSTEM focuses on the larger issue of urban transportation.

- Disseminating new instruments for controlling urban transportation. AUTOMATED HIGHWAY SYSTEM will create tools that can assist cities in overcoming barriers that are keeping them from implementing cutting-edge technology. Examples include the lack of certification processes and the lack of viable business models.

- Eliminating obstacles that prevent the widespread adoption of automated technologies. Some of these restrictions are technological, while others are legal or administrative in nature. For instance, one such regulation practically forbids driverless cars from utilising public roads since it mandates that the driver be in control of the vehicle at all times.

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