International Journal of Scientific Research & Engineering Trends
Volume 9, Issue 5, Sept-Oct-2023, ISSN (Online): 2395-566X

Cost Efficient And Higher Accurate Intelligence Automated Highway System Using Artificial Intelligence

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Abstract- Automated highway system (AHS) is an intelligent transportation system, which removes human drivers from the operation of vehicles during driving. AHS includes control problems from the vehicle level to the highway network and its challenging opportunities for intelligent mechatronics. This technology requires extreme accuracy in vehicle location within the least times. AHS refers to a set of designed lanes on a limitedaccess roadway where specially equipped vehicles are operated under completely automatic control. It can help reduce fuel consumption and individual vehicle discharge. The AHS designed requires advanced sensors, actuators, and communication technologies. It managed transportation systems for traffic problems in big cities, congestions, accidents, delays. This technique can change the driving & safety scenario of India.

Keywords - Mechatronics, Actuator, Congestions, Scenario

I. INTRODUCTION

The Automated Highway System (AHS) concept defines a new relationship between vehicles and the highway infrastructure. AHS refers to a set of designated lanes on a limited access roadway where specially equipped vehicles are operated under completely automatic control.8 AHS uses vehicle and highway control technologies that shift driving functions from the driver/operator to the vehicle (Figure 1). Throttle, steering, and braking are automatically controlled to provide safer and more convenient travel. AHS also uses communication, sensor and obstacle-detection technologies to recognize and react to external infrastructure conditions. The vehicles and highway cooperate to coordinate vehicle movement, avoid obstacles and improve traffic flow, improving safety and reducing congestion. In sum, the AHS concept combines on-board vehicle intelligence with a range of intelligent technologies installed onto existing highway infrastructure and communication technologies that connect vehicles to highway infrastructure.

A consequent application of the headway warning system is the automatic headway control. Adaptive cruise control systems are currently designed by many automobile manufacturers. The market introduction of the first vehicle with adaptive cruise control is expected in 1997. This will enable the drivers to hold their desired speed as well as the desired headway distance. Although the drivers defined as “creepers” will be cut-of by more aggressive drivers (“hunters”), the ability to set the desired headway may be desirable to many users. Also, the issues such as sensor types, curve handling, merging vehicles, changing lanes, integration of steering and braking all have to be addressed

to obtain a complete system design. Applications in advanced traffic management, traveler information and public transportation systems (ATMS, ATIS, APTS) will require more sophisticated vehicle location capabilities.

1.Safer Highway Transportation High Accuracy

A vehicle that can “predict” the actions of neighboring vehicles is an important step for safer highway transportation. Locating the position of all the vehicles in close proximity to the automated vehicle with high accuracy is essential. This can be accomplished through multi-sensor systems for adjacent vehicles and possibly inter-vehicle communications to give an idea of what to expect beyond adjacent vehicles. Alternatively, the “roadside control” may have knowledge of the positions of the vehicles relative to fixed reference points. This knowledge is obtained by either vehicle based or roadside based detection, and/or by communicating with the vehicle. Therefore automation on arterials will lag significantly behind automated highways. However, many safety measures can be taken on arterials using the equipment already designed for the highway.

II. AHS BENEFITS

Research has proven that the benefits of AHS on the performance of the existing U.S. transportation system will, over time, be enormous and far-reaching. Over the long term, traffic congestion will be reduced; safety will be enhanced to produce a virtually collision-free environment; driving will be predictable and reliable. More specifically, the advantages of AHS implementation include the following.

- **More vehicles can be accommodated on the highway.** The number of vehicles per hour per lane can be significantly increased as traffic speeds are standardized and increased and headway distances are decreased.

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- **Driving safety will be significantly greater than at present.** The human error factor will be removed.
- **High-performance driving can be conducted without regard to weather and environmental conditions**. Fog, haze, blowing dirt, low sun angle, rain, snow, darkness, and other conditions affecting driver visibility (and thus, safety and traffic flow) will no longer impede progress. (1)
- **All drivers using AHS can be safe, efficient drivers.** AHS offers enhanced mobility for people with disabilities, the elderly, and less experienced drivers. (1)
- **Fuel consumption and emissions can be reduced.** In the short term, these reductions will be accomplished because start-and-stop driving will be minimized and because on-board sensors will be monitored to ensure that the vehicle is operating at top performance. (1) In the long term, the AHS can support future vehicle propulsion/fuel designs. (2)
- **Land can be used more efficiently.** Roads will not need to take up as much room, since AHS facilities should allow for more effective use of the right of way. (1)
- **More efficient commercial operations.** Commercial trucking can realize better trip reliability to support "just-in-time" delivery.
- **More efficient transit operations.** Transit operations can be automated, extending the flexibility and convenience of the transit option to increase ridership and service.

III. AHS TECHNOLOGIES

What will the automated highway system actually be? Will it be very different from what we have now? Will our roads hover in mid-air as futuristic cars whiz along?
Not really--or at least not yet. An AHS facility will probably be a normal lane or two on an existing freeway.
Initially, AHS will probably be deployed and operated on high-priority routes in high-demand major urban and intercity freeway corridors. (2) And an AHS car will look like a normal car.

But both facility and road will be outfitted with sophisticated control and communication devices that will essentially put the vehicle in communication with the roadside. The car will "know" what roadway conditions are like. The road will "offer" each vehicle options, navigation, and advisories based on its conditions. While on the AHS facility, the vehicle will be operated under automated control--similar to the autopilot control in aircraft. (2) The products, technologies, and concepts underlying AHS do, for the most part, currently exist. For example, products now on the market or under development include sensors that detect obstacles in vehicle blind spots, collision warning systems, and infrared vision enhancement systems. Also, intelligent cruise control systems (systems that accelerate and decelerate in response to the speed of the vehicle immediately ahead) are under development by automobile manufacturers. (3) In addition, concepts and products from the defense industry--advanced computing systems, sensors, advanced command and control, etc.--are being applied. "The automated highway program is perfectly positioned to harness these military technologies and convert them for civilian use." (4) Thus, over the next few years, an integrated system that uses all these existing or developing technologies will be developed, and that system will be tested in more realistic environments.

IV. RESEARCH MOTIVATION AND PROGRAM PROGRESS

Between July and September of 1993, 15 "precursor systems analysis" contracts totaling $14.1 million were let by FHWA to an array of impressive project teams. The purpose of the one-year contracts is to investigate the issues and risks related to AHS design, development, and implementation. Collectively, the contracts aim at surfacing, researching, analyzing, and debating a broad spectrum of AHS-related issues.

The structure of these precursor systems analysis contracts is innovative. Rather than assign a single topic to an individual contractor, the precursor systems analysis contracts comprise a matrix of 16 activity areas investigated by multidisciplinary, multi-organizational teams. Many teams are investigating one of more of these areas; two teams are addressing all 16 areas--one team from a broad systems analysis perspective and the other from the perspective of the vehicle industry.

The project teams individually and collectively represent a wide variety of perspectives, from state transportation departments (including New York, Massachusetts, and California), academia (including the Massachuetts Institute of Technology, Princeton, Tufts, and others), the aerospace and automotive industries (such as Hughes Aircraft, Daimler Benz, and Ford), and defense and high-tech research organizations (including Battelle, Honeywell, Martin Marietta, Rockwell, TRW, and Lawrence Livermore National Laboratory).
The specific AHS activity areas these contractors are investigating are: (5)

- AHS in urban and rural operational environments.
- Certification of proper vehicle functioning for automated operation (automated check-in).
- Certification of proper vehicle and driver functioning for manual operation (automated check-out).
- Lateral and longitudinal control of an automated vehicle.
- Malfunction management.
- Unique AHS-related needs of commercial and transit vehicles.
- Lessons learned from deployment of comparable systems.
- Deployment of possible AHS configurations within existing freeway networks.
- Impact of AHS on nearby non-AHS roadways.
- AHS entry/exit implementation.

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- Ongoing AHS operation.
- AHS vehicle operation, including vehicle retrofitting.
- Impact of alternative propulsion systems on AHS deployment and operation.
- AHS safety issues.
- Institutional and societal aspects of AHS deployment.
- Assessment of AHS preliminary cost/benefit factors.

The Need For An Ahs

Today's vehicle-highway system functions surprisingly well with its more than 6 million kilometers of streets, roads, and highways and its 190 million vehicles. However, it cannot keep pace with society's increasing transportation needs. Driven by population growth, the demand for mobility as a fundamental economic need is in direct conflict with our ability to fund new conventional highways and maintain a clean environment. The total vehicle kilometers traveled in the nation is predicted to nearly double by the year 2020, and our population will grow 50 percent by the middle of the twenty-first century. We will need to make more efficient use of existing transportation facilities. Although traffic fatalities have decreased significantly in recent years, there are still more than 40,000 lives lost annually on the nation's highways, and there are more than 1,700,000 serious disabling injuries.

The annual cost to the nation in dollars is estimated at more than $156 billion. Traffic volume has increased anywhere from 38 and 54 percent for each of the last three decades. Because system capacity has not kept pace with peak demand, 70 percent of all urban interstate peak-hour traffic is congested, and this figure is predicted to grow to 80 percent by the year 2000. A large portion of this congestion is caused by incidents on our highways (e.g., crashes, breakdowns, obstacles in the lane). Congestion is projected to worsen by 300 to 400 percent over the next 15 years unless significant changes are made in the surface transportation system.6 In many areas, the traditional solution of building more lanes is becoming less viable because of limited rights-of-way, cost, citizens' concerns about the impact on the quality oflife in their communities, and environmental requirements.

Today, congestion alone costs the nation an estimated $100 billion in lost productivity annually.? It also increases driver frustration and discomfort as congestion becomes worse and travel times become less predictable. Also, some drivers, including the elderly, are intimidated or frightened by highway travel. Moreover, fuel consumption will rise as trip times increase due to either length of the trip or time delays. In addition, predictability of delivery times will become less reliable, thereby increasing the frustration of customers of the shipping industry. As traffic volume and congestion continue to increase, methods to reduce exhaust emissions will be necessary to maintain air quality.

V. LITERATURE REVIEW

[1] Base Paper- Kore Lakkappasubhash, Automated Highway Systems-An Intelligent Transportation System: Automated highway system (AHS) is an intelligent transportation system, which removes human drivers from the operation of vehicles during driving. This talk is focused on activities on AHS at the California Partners of Advanced Transit and Highways (PATH). AHS includes control problems from the vehicle level to the highway network level and offers a number of challenging opportunities for intelligent mechatronics. The Automated Highway System (AHS) concept defines a new relationship between vehicles and the highway infrastructure. AHS refers to a set of designated lanes on a limited access roadway where specially equipped vehicles are operated under completely automatic control. AHS uses vehicle and highway control technologies that shift driving functions from the driver/operator to the vehicle. Throttle, steering, and braking are automatically controlled to provide safer and more convenient travel. AHS also uses communication, sensor and obstacle-detection technologies to recognize and react to external infrastructure conditions.

[2] Lakshmi DheviBaskar, Optimal routing for automated highway systems: We present a routing guidance approach that can be used in Automated Highway Systems (AHS). We consider automated highway systems in which intelligent vehicles organised in platoons drive to their destination, controlled by a hierarchical control framework. In this framework there are roadside controllers that provide speed and lane allocation instructions to the platoons. These roadside controllers typically manage single stretches of highways.

A collection of highways is then supervised by so-called area controllers that mainly take care of the route guidance instructions for the platoons and that also coordinate the various roadside controllers in their area. In this paper we focus on the optimal route choice control problem for the area controllers. In general, this problem is a non-linear integer optimisation problem with high computational requirements, which makes the problem intractable in practice. Therefore, we first propose a simplified but fast simulation model to describe the flows of platoons in the network. Next, we show that the optimal route choice control problem can be approximated by a mixed-integer linear problem. Later, we describe a new METANET-like model to describe the flow of platoons in the AHS. With a simple case study we illustrate that both approaches result in a balanced trade-off between optimality and computational efficiency.

[3] RuiHou, Cyber-physical system architecture for automating the mapping of truck loads to bridge behavior using computer vision in connected highway corridors: Bridges are critical components of highways

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ensuring traffic can efficiently travel over obstructions such as bodies of water, valleys, and other roads. Ensuring bridges are in sound structural condition is essential for safe and efficient highway operations. Structural health monitoring (SHM) systems designed to measure bridge responses have been developed to quantitatively track the health of bridges. More recently, SHM systems have also begun to integrate measurement of vehicular loads that create the responses measured. However, precise correlation of traffic loads to bridge responses remains a costly and technically difficult strategy.

[4] Yi-Shao Huang, Decentralized adaptive fuzzy control for a class of large-scale MIMO nonlinear systems with strong interconnection and its application to automated highway systems: In the previous work of Huang et al., a decentralized adaptive fuzzy controller of large-scale multiple-input multiple-output nonlinear systems is obtained predicated upon the assumption that the interconnections between subsystems can be bounded by first-order polynomials. In this note, we focus in the absence of the conservative assumption upon developing a novel decentralized adaptive fuzzy control scheme. In virtue of fuzzy systems and a regularized inverse matrix, the developed control scheme not only addresses controller singularity under an overall design framework but also copes with interconnections with arbitrary nonlinear bounds.

[5] P.V. Manivannan, Vision Based Intelligent Vehicle Steering Control Using Single Camera for Automated Highway System: Generally, stereoscope vision is used for guiding autonomous intelligent road vehicles, as image depth can be calculated easily. However, when one of the camera fails, it will advantages to have suitable guidance algorithm that can detect the lane marking using single camera. The primary objective of this work is to develop and implement control algorithms for identifying and guiding the intelligent road vehicle in the assigned lane using image-processing techniques, using single camera. It deals with dividing the video being taken by the camera, into several number of frames. Then, the obtained frames are processed using Image acquisition techniques in Matlab. It detects the lane to be followed through image processing, calculates the angle of movement required for the robot to stay in the assigned path and commands the steering system with appropriate control algorithms.

[6] Jason Carbaugh, Safety and capacity analysis of automated and manual highway systems: This paper compares safety of automated and manual highway systems with respect to resulting rear-end collision frequency and severity. Safety is related to driver, vehicle and highway operating characteristics. Our safety analysis method maps the variation in these operating characteristics, modeled by probability distributions, to the probability and severity of the first rear-end crash due to a hard braking disturbance on the highway.

[7] Luis Alvarez, Multi-destination traffic flow control in automated highway systems: Traffic flow control in automated highway systems (AHS) is addressed. A link layer controller for a hierarchical AHS architecture is presented. The controller proposed in this paper stabilizes the vehicular density and flow around predetermined profiles in a stretch of highway using speed and lane changes as control signals. Multiple lane highways in which vehicles have different destinations and types are considered. The control laws are derived from a model based on a principle of vehicle conservation and Lyapunov stability techniques. The implementation requires only local information. Simulation results are presented.

[8] Han-Shue Tan, Lane changing with look-down reference systems on automated highways: Automated lane changing is a vital component of the steering control system for automated vehicles. The most important requirements of such maneuvers are smoothness and robustness. Look-down sensing systems face the challenge of having to bridge the gap whenever reference lines of the respective lanes are not measurable.

[9] Meihua Tai, FEEDFORWARD COMPENSATION FOR LATERAL CONTROL OF HEAVY VEHICLES FOR AUTOMATED HIGHWAY SYSTEM (AHS): In this paper, we propose a feedforward compensation method to enhance the performance of the lateral guidance system of heavy vehicles on automated highway systems (AHS). The feedforward controller blends well with the linear robust feedback controller. The proposed feedforward compensation is motivated by the analogy between a vehicle lateral control system on curved roads and a mechanical system with Coulomb friction.

[10] William B. Stevens, The Automated Highway System Program: A Progress Report: This paper reports status of the National Automated Highway System Consortium (NAHSC) and its progress in conducting the Automated Highway System (AHS) program in partnership with the U.S. Department of Transportation. Research has indicated that automated vehicle control technology might offer major improvements in safety and efficiency of existing highways. Congress directed the demonstration of a fully automated vehicle-highway system by 1997. NAHSC goals are to demonstrate AHS technical feasibility by 1997; conduct research of critical enabling technologies; and select and prototype an AHS design for operational test.

VI. RESEARCH HYPOTHESIS

The following research methodology has been followed to achieve the primary objectives.

1. First, a study is performed to understand the concept, types, challenges and applications of AHS in traffic management system. Study of the complexity of road

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transportation and its network, consequently exploring the key factors affecting transportation mode.
2. A study is undertaken to discover key gaps and challenges persisting in the predictions of traffic information.
3. Study of traffic information prediction on road transportation for by exploring multifaceted techniques used to predict various macroscopic characteristics and its applications related to traffic.
4. Understanding the popularity of DL techniques and DL hybrid methods from the study carried out, a review is done to explore potential work done by the researchers in the field of road transportation for predicting traffic information. Also, depicted the challenges to explore.
5. Investigated accuracy gaps in traffic information prediction for related methods that considers irregular, inadequate, missing, uncertain, non-linear and abnormal situations of traffic data caused by environmental and contextual factors.
6. A hybrid DL model with ANN algorithm is proposed to address optimization and accuracy issues caused by the abnormal traffic situations considering one of the important dynamic traffic characteristics called speed. Experiment is done to find the performance with respect to the existing system.
7. To address the accuracy problem due to the irregularity of traffic data, a hybrid DL method is developed using the flow strength indicators as features with the input traffic data considering the spatiotemporal information.
8. Finally, an effective augmented DL-based transfer-learning model is constructed to address the problem of poor prediction in data-strapped regions by utilizing data-rich regions.

RESEARCH CONTRIBUTION

In this thesis, we have analysed and compared multifaceted techniques used to predict macroscopic traffic stream parameters for road transportation. Identifying the key technology, trend and opportunities, to further improve prediction accuracy for traffic considering contextual factors and complex environment. Based on the popularity of DL and hybrid techniques we mined various DL algorithms and its capability to infer useful features from the huge set of traffic data. Stated major challenges yet to be explored further and solved specific objectives using DL and hybrid techniques. For the technical solution to the objective defined, We proposed Fuzzy Optimized Long Short-Term Memory (FOLSTM) neural network using bio-inspired optimization methods for TSP addressing aberrant factors, environmental affects and parameters causing abnormal situations for traffic on road leading to inaccurate prediction.

VII. CONCLUSION

Automated highway are one of the most promiding technologies to reduce traffic accident and urban traffic congestion. New technology engineer and policy maker have some important decision to make that will effect the future of transportation. The potential to save lives is what makes this technology so exciting automated highway can also eliminate all accidents and also reduce delays, congestion, high density in urban areas. Automated highway system allows more benefits in terms of saafety, efficiency, affordability, and usability as compared to traditional transportation system in any city.

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