Intelligent Transportation System and Its Application Modules - A Literature Review

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Abstract

Objectives
This paper aims to build a structured literature review in the area of Intelligent Transportation Systems (ITS) and its different application modules. In this literature review an attempt made to critically evaluate the previous research work and methodologies related with Intelligent Transportation System's different modules. The recently published research articles related to ITS are considered for the study.

Prior work
This paper is making an effort to discover the information and knowledge in the area of ITS by reviewing the related previous publications in the field of application modules of ITS.

Approach
The paper take up the narrative review to critically review the published literature in the ITS area.

Results
The literature review carried out in this paper primarily studies the different types of ITS application modules such as Advanced Traveler Information System (ATIS), Advanced Public Transportation System, Advanced Traffic Management System (ATMS), (APTS) and Emergency Management System (EMS) etc. The literature review focuses on different devices and modules used in the implementation of ITS. The available technology gives a liberty to make ITS more efficient and economical from the raising requirements of road transportations. After analysis it is observed that the use of these modules requires to undertake all relevant factors of individual region requirements.

Implications
This study will give a narrative information which results into benefits for entrepreneurs, policy makers, researchers, and educators as giving information about the different ITS modules and their suitability for the effective implementation of ITS.

Value
This paper will lead to the addition of knowledge to the field by illustrating and studying a narrative review of the earlier published work in the field of ITS and its application modules. Depending on this review, scholars and researchers in the field of ITS can have more clear view to fix their pathway towards future research work leading to contribution in the related field of body of knowledge.

Keywords: Intelligent Transportation System (ITS), ITS application modules, ITS tools

1. Introduction
The applications of advanced technologies to help in the management of traffic density and flow has been general for over 70 – 80 years with initial attempts at traffic signal control of flow at intersections as well as railway crossings in the Europe and USA. Today’s Vehicles are manufactured with advanced technologies to build vehicles safer, less stressful driving with more comfort and convenience. The advancement in the vehicular technology leads the origin of intelligent transport system (ITS). The suitability of the available technologies with more safer and secure transport system is prerequisite.

2. Research Problem and Questions
The basic problem motivating this research is to understand various angles of the researchers in the ITS and its application modules and also critically evaluate the development in the technology related to ITS Modules. Based on available modules identification of suitability for the different environment can leads to future research scope in the same field.

3. Research Objectives
The main objective of this research is to: develop a clear understanding about the different research points related to studies of ITS published. To study and analyze the different methodologies implemented by the researchers in the field of ITS and its tools.
Consequently, the objectives of this research are as follows:-

• To understand the ITS and its various tool/modules used for managing the road traffic.
• To study and understand the possible adaptation of ITS modules with respect to local environment.
To study the latest development in the field of ITS application modules.

4. Methodology

4.1 Sample and Procedures
The author reviewed the literature related to ITS and its application modules and new technology related to it. The literature reviewed covers the scope of the research study.

4.2 Classification Method
The research articles considered for the review are qualitatively classified and exploratory as well as review research articles are undertaken for this study.

5. Intelligent Transportation System (ITS) and its application modules:

Bhupendra Singh; Ankit Gupta in their study addresses the issue of increasing problems in the traffic management with the help of new technologies used in ITS. Particularly in developing countries like India, Brazil, South Africa etc ITS is still new concept. This study addresses primarily four major elements of ITS i.e., Advanced Traveler Information System (ATIS), Advanced Public Transportation System, Advanced Traffic Management System (ATMS), (APTS) and Emergency Management System (EMS). The objective of this study is to understand different models and architectures used in ITS developed over the period by different researchers. The use of GIS and WWW platforms in ITS system have their own advantages which are explored by developed countries. The GPS technology have high analysis capability while WWW platform operates on real time information processing. The synchronization of these two technology can be highly useful. By these technology use travel time and response time can get decreased considerably. In developing countries while implementing ITS mixed traffic conditions are required to be considered. The installation and operating cost of ITS implementation is crucial factor in the developing countries. The new technology like Zigbee and RFID can also be useful in future. The mobile phone penetration is high which can also be useful gazette in implantation of ITS.

P.Vijayakumar, V.Vijayalakshmi, Aakash Nigam, Anubhav Jain, Somprakash Bandopadhyaya discussed in their research about different ITS technologies which can combine with Bus Rapid Transit (BRT) to enhance network performance focusing on reliability, travel time, operational efficiency, convenience, security and safety. The research objective majorly concentrates on use of Radio Frequency Identification (RFID) for BRT. The Real Time Locating Systems (RTLS) uses technology like RFID and IEEE 802.15.4 wireless communication standard. In this paper advanced technology use in BRT is discussed in first section, second part addresses the conventional technology used in BRT and third part focuses upon use of RTLS in BRT architecture and Section four discusses ITS implementation using RTLS. The signal synchronization of different vehicles requires high attention for improvement. This paper proposes a prototype for ITS using RFID and IEEE 802.15.4 based wireless communication.

Geetanjali Singh, Neelima Chakrabarty, Kamini Gupta discussed the burning issue of traffic in India, due to poor road infrastructure and behavior of road users in India. Vehicular Ad-hoc Network (VANET) system applied worldwide to manage traffic congestion due to less expensive, distributive and collaborative nature. Overall cost of project reduces drastically by this system. The average speed of Indian traffic movement in cities raging from 16 km/hr to 20 km/hr. The VANET system can be used to detect traffic density and address the parking problems faced in most of the cities. The VANET architecture takes into account wireless connectivity of two vehicles to enhance communication. A case of Delhi demonstrates that the VANET system adaptation with Non Lane based traffic system. The VANET have a technical challenges such as security, congestion and collision control, environmental impact and infrastructure support. The other issue of Parking can also effectively addressed by VANET system. Development of parking clusters probably addresses the major issue of parking of vehicles in the city in general.

Vipin Kumar Nitin Rastogi and Sachin Malhotra presented in their research paper role of wireless sensor network (WSN) in the ITS with special emphasis of the Indian context. The utilization of WSN with in-vehicle and road infrastructure becomes more convenient and useful as WSN provides benefits in the form of tiny sensing devices, less equipment cost, small sensing devices etc. WSN based ITS enhances safety, security, traffic, reliability, mobility and parking management through electronic toll collected works, accident avoidance systems, in-vehicle direction finding system and parking management system. The challenges identified in implementation of WSN in ITS are traffic congestion, traffic incidents, reliability, freeway traffic management etc. Traffic safety management, emergency vehicle preemption, highway data collection, automatic road enforcement, parking management etc are the areas where the application
of the WSN provides promising impact, but it is requires to be customized with the local environment.

M. R. Friesen & R. D. McLeod presented in their research increasing use of Bluetooth devices can also be used in the ITS for effective management of traffic through accurate traffic analysis, measuring density and flow effectively. The installed Bluetooth device can connect with onboard vehicle Bluetooth device and transmit information related to the traffic which leads assistance to the driver. The Bluetooth devices which can be installed on the field should have following attributes like cost effective, solar powered, online/offline data processing, remote control, bidirectional, cross validation/calibration etc. The architecture design focuses on the most of the attributes to get incorporated in and each probe sensor equipped with GPS/GPRS so as any disturbance in the lines of communication can be overcome. The increased cost may overcome by the reliability and low maintenance.

Dr. Mrs. R. D. Raut, Abhishek D. Raut, Aakanksha G. Ambulkar presented in their work that financial problems are the core issues in the enforcement of Intelligent Public Transport System (IPTS) in developing countries. Wireless Sensor Network (WSN) have high potential in remote traffic monitoring and target tracking etc, but it is difficult to select suitable WSN for good performance for developing countries. Researcher illustrated sensors techniques and factors affecting selection of sensors. A case study approach with emphasis on estimation of cost of IPTS with various WSNs in reference with Rajasthan State has carried out. The on board sensor cost ranges from $ 100 to 7000 per vehicle, similarly real-time information providing cost varies from $ 100,000 of 156-bus system to $ 46.5 million of system having 5,700. The sensors techniques used in ITPS are as follows, 1) Static Sensor Based WSN which incorporates Multi Media based WSN, Magnetic and acoustic based WSN, Inductive loop based WSN. 2) Mobility sensor based WSN covering RFID based WSN, RF based WSN, GPRS/GSM based WSN. Selection of sensors affected by cost, latency and precision, energy utilization, synchronization, scalability. Study carried out in Rajasthan state reveals that for RSRTC’s 1350 bus stands and 4476 buses the total investment in GPS WSN approximated as 1,11,90,000 INR, in GSM WSN is calculated as 87,39,000 INR, for GSM/GPRS WSN will be 1,99,29,000 INR and in case of RF Tx/Rx WSN it costs 35,91,600 INR in 2010-11. Hence it is observed that the initial investment in the WSN technology varies with the different available options. Researcher observed that this study will facilitate in selection of appropriate sensor suitable for IPTS requirements and constraints based on performance in developing countries.

D. Kandar, S.N. Sur, D. Bhaskar, A. Guichhait, R. Bera and C. K. Sarkar explained in their study that the ITS designed with target of achieving aim of safety and non-safety applications. The combination of communication and remote sensing technology will yields into effective and robust system. The RADAR location technology combined with sensing technology is considered in this study. The moving target tracked on RADAR receiver, this signal information processed by RAKE receiver. The MATLAB simulation model able to calculate BER (Bit error rate) and PER (Packet error rate) also finds the target. As in DSRC system SS technology is used which results into no extra channel requirement for RADAR operation. The physical size of RADAR plays crucial role in commercial application of it in the vehicles.

Emad Felemban, Adil A. Sheikh in their research work primarily addressed the challenges which can be solved by ITS such as traffic congestion, emission and environmental pollution, accidents and emergency conditions, parking space, planning of route. By reviewing other researchers work different technologies in the mobile an sensor networks are discussed. The innovation in the ITS technology like WSN-based transportation, VANET, GPS used in public transit system, WSN and Bluetooth etc discussed in this research. According to the market requirement these technologies provides ITS solution to the above mentioned challenges such as Masarak project provides real time traffic information management, Hawa’ak platform addresses issue of air quality and environment issues, Labeeb platform for collection of information which address the need of users, Dash project combines Smartphone interface with car, SFpark to address parking, SARTRE for safe transportation with support from Volvo, Park4U to address parking system and BMW’s park assistant.

Voichita Popescu, Sergiu Nedevschi, Radu Danescu & Tiberiu Marita propose a solution for the identification of current lane number in which vehicle is travelling through objects assessment of surrounding traffic objects, detection by stereovision perception system. The advanced driving assistance system comprises of two stages, first to identify the position of the relevant objects and in second stage as interpretation this identified objects are correlated with traffic environment elements and speed of the traffic. The Bayesian
Network are used for modeling of human like decision making, under uncertainty. Dynamic nature of the traffic conditions leads to observations of multiple states rather than specific moments in time, hence dynamic Bayesian model is used in this study. The results of experiment show that efficiency of this proposed method.

Kashif Naseer Qureshi and Abdul Hanan Abdullah reviewed the work of the different researchers to integrate and combine several areas and applications. The different elements of ITS such as Intelligent Transportation System Freight Management, Arterial and Freeway Management, Transit Management Systems (TMS), Regional Multimodal and Traveler Information Systems, Incident and Emergency Management Systems, Information Management (IM) Systems; few of the other areas of ITS are Highway Data Collection (HDC), Electronic Toll Collection (ETC), Traffic Management Systems, Transit Signal Priority (TSP), Vehicle Data Collection (VDC), Emergency Vehicle Preemption (EVP) etc area discussed and studied. To address the challenges in the form of accident rate, air pollution, traffic congestion, passage time etc different above ITS applications shows promising way ahead.

Prashant Trivedi, Kavita Deshmukh, Manish Shrivastava undertaken the study of paradigm of traffic management system over the period of time. The latest approach in the form of Cloud i.e. Intelligent transportation clouds gives services like mobility, autonomy, standard development environment and mobility etc. Mobile agent technology for managing the urban traffic based on Agent Based Distributed and Adaptive Platform (Adapts) and Agent Based Distributed platforms are feasible and effective. The proposed prototype of urban traffic management system using multi agent based intelligent traffic clouds addresses the issue of emergence of complex and powerful organization layer which requires very high computing and power resources.

Shunsuke Kamijo & Kaichi Fujimura studied in their research video surveillance system of different types used in tunnels for detection of incidents from heavy traffic and identified that the accidents in tunnels can cause more accidents or fires which results in to disaster fatal in nature. The problem identified in detection of these incidents in tunnel due to low position of camera settings which results into high occlusion. Researcher developed a tracking algorithm for vehicle segmentation and evaluating accurate trajectories of vehicles against high occlusions. The algorithm hierarchy for image understanding semantic hierarchy used for the construction of cognitive systems. Low angle of installed camera increase the occlusions and results into distracted images. By using morphology layer algorithms can segment the vehicles in horizontal edge pattern resulting into rich edges of vehicles and clear distinction of vehicle patterns like sedan, buses, trucks and wagon etc. By experimenting for 6 months with 32 cameras researcher identified the usefulness of their interlayer feedback algorithm.

Dr Praveen Kumar, Dhanunjaya Reddy & Varun Singh undertaken the work of development of advanced traveler information system (ATIS) using Geographic Information System (GIS) environment. With ATIS drivers can arrange their travel route and can also estimate travel time. The optimal route or path based upon the travel distance, time can be planed based upon ATIS. The different places, landmarks, areas of the city in the form of information can be uploaded in the system in which can be use be used in the ATIS for route planning. The city bus service with all the details of origin and destinations, their timings, distance, traveling time etc can be provided to the traveler to plan for their journey. This package has multiple applications in the form of overall geographic information combined with transportation modes and aligned information for the selection of shortest route and give other information about city. To develop a model, Hyderabad city is undertaken for study and accordingly ATIS using GIS environment is prepared.

Bahar Namaki Araghi, Jonas Hammershoj Olesen, Rajesh Krishnan, Lars Torholm Christensen & Harry Lahrmann carried out controlled field experiments to evaluate the relation of size of Bluetooth sensor detection zones and procedure of discovery of Bluetooth devices based upon impact on reliability and accuracy of estimated travel time. The collected data of 1000 trips for Bluetooth and global positioning system (GPS) on the reliability criteria on an average 80% of time Bluetooth devices are detected while passing through sensor location. As regards to the size of detection zone in the range of 100 m around the sensor more than 80% of detection events are captured. In case of short range antennas detection of Bluetooth devices are more accurate when they are near to the sensor which results in to precise estimation of travel time. The size of detection zone also have major impact upon penetration rate affecting the accuracy. The factors like Location of sensor installed, antenna configuration and mount design are having major impact upon the travel time estimation in terms of accuracy and reliability.

Panos Papadimitratos, Arnaud de La Fortelle, Knut Evenssen, Roberto Brignolo and Stefano Cosenza surveyed different approaches,
technologies and solutions in the field of vehicular communication systems projects. There are different types of Vehicular Communication VC systems applications which can be categorized in three ways i.e. transportation safety, efficiency of transportation and user services delivered to vehicle. The information on communication, messaging type, message period, Critical latency etc are the elements of the Vehicular communications and this fulfills the drivers requirements from decision making.

6. Conclusion:
In the growing need of the transportation systems the use of technology plays very crucial role to make it more affordable and efficient. The developments in the ITS modules using advanced tools made it more practical and adaptable in this environments.

The new developments in sensor technology and communication technology boosted the growth in ITS implementation. The use of these ITS tools according to the need of the environment and regional factors is a crucial decision making factor. Particularly in developing countries where ITS has different challenges to be faced in executing it.

There will be future scope of study to explore the most appropriate ITS modules which may lead to effective tackling for traffic related issues in developing countries.

References: