Intelligent transportation system using IOT: A Review

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Abstract: **This paper presents review on intelligent transportation system (ITS) model with Advanced Traveller Information System (ATIS) and Advanced Traffic Management Systems (ATMS) for smart Transportation. GIS and IOT technology used in intelligent transportation system with sensors and detection algorithms over the world. Advanced Traveller Information System (ATIS) display all regional travel-related information so that travellers can make informed decisions about the best transportation mode, route, time, and costs for each trip. Advanced Traffic Management Systems (ATMS) consist real time traffic data information, vehicle detection and tracking, communications, variable message systems, predicts traffic conditions, Dynamic traffic control systems, freeway operations management systems, incident response systems, automatic configuration in traffic lights, smart parking .ATIS model explain with some well-known studies path computation algorithm to find out shortest path of ATIS application ATMS explain with IOT technology. real time traffic information can get by using different hardware components like Closed-Circuit Television (CCTV) cameras, inductive loop, and magnetometer, active and passive infrared sensors, acoustic sensors, ultrasonic, radar etc and Global Positioning System (GPS).**

Keywords: **Intelligent Transportation System (ITS), Advanced Traffic Management Systems (ATMS), Internet of things (IOT), Advanced Traveller Information System (ATIS).**

Introduction

Today's day to day life we face lots of transportation related problems. to improve solution of this problems there are lots of issues and challenges which are directly and indirectly related to transportation system like Managing traffic congestion, improving safety, providing equal access, Protecting the environment, incorporating new technology, securing financial resources, Developing adequate institutional arrangements. Intelligent transportation system (ITS) is the application of advanced sensor, computer, electronics, and communications technologies and management strategies in an integrated manner to providing traveller information to increase the safety and efficient of the surface transportation system [1]. Intelligent transportation system (ITS) aims to provide innovative services relating to different modes of transport and traffic management which helps in resource allocation and route decision [2]. Benefits of ITS are Traveller Information Systems, improving traffic safety, reducing infrastructure damage, Traffic control, parking management, gathering traffic data ATMS and ATIS are the recent trends in intelligent transportation systems [3][4].

Literature Survey

This chapter includes the existing studies of ITS system used by different countries, path computation algorithm for Advanced Traveller Information System (ATIS) and vehicle detection using IOT for Advanced Traffic Management System (ATMS). Following are some countries case studies which uses ITS

ITS in Japan

ITS in Japan is developed in four phases. In first phase vehicle navigation systems and electronic toll collection are done. The second phase developed in 2005 with transportation development. The ongoing third phase 2005-2010 involves improvement of infrastructure and in-vehicle equipment, and organization of legal and social systems pertinent to travel and transport. The future Fourth Phase (after 2010) would integrate all technology and concepts developed in the previous phases and apply them in synergy for a fully functional ITS. The ITS in Japan focus on Advances in Navigation Systems, Electronic Toll Collection, Assistance for Safe Driving, Optimization of Traffic Management, Increasing Efficiency in Road Management, Support for Public Transport, Increasing Efficiency in Commercial Vehicles, Support for Pedestrians, Support for Emergency Operations [5].

Research and Innovative Technology Administration (RITA)

United States of America developed its system known as RITA. The main aims of RITA include as Coordinating, facilitating and reviewing research and development programs and activities , academic and industrial partnerships, traffic management through academic and small business innovative research (SBIR) programs , transportation statistics research, analysis and reporting; and Educating special groups and general public in transportation and transportation-related fields .RITA focus on Telephonic Data Dissemination, Next Generation 9-1-1, Cooperative Intersection Collision Avoidance Systems, Congestion Initiative, Integrated Corridor Management Systems, and Emergency Transportation [6].

Border Information Flow Architecture (BIFA)

It is the first ITS system introduced by Canada in 1999. BIFA for Canada are organized into 8 User Services like Traveller Information Services, Traffic Management Services, Public Transport Services, Electronic Payment Services , Commercial Vehicle Operations, Emergency Management Services, Vehicle Safety and Control Systems, Information Warehousing Services[7].

Road Transport Informatics (RTI)
The Intelligent Transport Systems of Europe is known as Road Transport Informatics (RTI). RTI consist approaches Road Infrastructures for Vehicle safety and Program approaches for European Traffic. It detects the driving environment using of laser, radar, sensors and video image processing, and communicating the information to road users. For active safety, RTI done automatic detection of barriers. Traffic congestion is done by regulation of speed and maintenance of safe distance and detection of potential obstacles [8].

Transport for London
This ITS developed by London for personal and commercial use. For traffic congestions and controlling traffic using motorway traffic viewer (MTV) and the web-based online MTV, cameras are installed on roads across the country and information centres across town. Electronic toll collected using Toll collection and management system [9].

Previous work on ATIS
Following are some existing studies of ATIS application with path computation algorithm to find out shortest path.

Seyed Morsal Ghavami (2019) developed web based ATIS system for multimodal network. He proposes a modified version of the shortest path solution for the fuzzy bi-criteria multimodal network. In this system user can get heterogeneous and distributed data of the different organizations are combined together using open geospatial consortium (OGC) web services. for each mode of transportation, a web feature services (WFS) was assigned and then the related data gathered and converted to a standard data format such as geographic markup language (GML). Fuzzy bi-criteria k -shortest-path analysis was done by using a web processing service (WPS). The shortest routes between two locations are display on a digital map by using a web map service with the help of fuzzy set theory and fuzzy decision tables. OGC standards sometimes break down while faced with large data sets because of sequential data conversions and available restrictions in the communication's infrastructures for transferring large data sets. Author suggest to overcome that issue by gathering the data from the data sources, transferring them to the central server, and then periodically updating the data of the central server at timely intervals. The second suggestion is to use an XML data set to store different urban data sources to have a faster system in data retrieval, query and transfer [10].

Ceder and Yu Jiang (2019) had addressed the work on route guidance methodology for public transport with the use of smartphone apps to acquire real time and readily available journey planning information. The k-weighted shortest path algorithm is used to find not only the shortest path, but also subsequent shortest paths The proposed k-shortest path guidance methodology is based on computing a weighted travel cost for the consideration of multiple public transport attributes. The results of the case study show that the average reduction of the value of the most important PT traveller's attribute is 12.3% for the k-weighted shortest path method and 13.4% for the lexicographical JND based shortest path method in comparison with the classical shortest path method [11].

The equilibrium model was proposed by Paolo Delle Site [2018] was derived from the fixed-point states of a day-to-day assignment process. The steps of MUE beyond the state of the art include the simultaneous consideration of predictive and static ATIS, and the presence of inertia effects in route choice. This research offers the first application of this comprehensive equilibrium model to a realistic network, albeit small-scale, to appraise the impacts of ATIS market penetration and inertia. Depending upon sources of traffic information three classes is studied: users with predictive information, users with static information and compliant and users not equipped with ATIS or noncompliant. In this research heuristic approach was used to compute the traffic and routes flows and travel. The algorithm generates a sequence of feasible route flows, i.e., satisfying both the demand and non-negativity constraints. The model and applications in the paper have considered, for simplicity, a linear-in-the-inaccuracy compliance rate function. Calibration of the compliance rate function and exploration of the impacts on MUE of other compliance rate parameters and functions are left for future research [12].

Mariagrazia Dotoli [2018] focused on the work of ATIS for Optimal Trip Planning in a Co-Modal Framework. He proposed a novel Advanced Traveller Information System (ATIS) for co-modal passengers' transportation based on multi-agent system architecture to answer multi-criteria user requests. The multi-agent systems framework is selected due to its distributed feature that allows decomposing the trip planning problem into multiple simpler tasks. while making use of a co-modal optimization, allowing for instance the use of a private service such as carpooling together with the use of a public service such as for instance the subway, leads to a service penetration that single service use do not allow. In this work, a shortest path involves the minimum number of vertices between points. To find the shortest path between these points, the weight or length of a path is calculated as the sum of the weights of the edges in the path. So, a path is a shortest path if there is no path from the two points with lower weight. The shortest path is considered as a small size optimization problem, so used directly an exact method such as Dijkstra's algorithm to optimize locally criteria as the travel time, total travel cost, etc. some operators are reticent and are not yet prepared to share their data within the same information system because of legal and political reasons. These limitations may prevent the massive use of an ATIS and the data update can be considered as another limit of the ATIS [13].

The author Mohammad Hossein [2017] developed ATIS architecture known as Interactive Traveller Information System (ITIS). This architecture consists two-way communication between uses and ITS system. Smartphone Application of this architecture collects related information from vehicles, with the help of tools such as acceleration sensors, GPS, and cameras. Via cellular communication networks ITIS sends vehicle position and driver behaviour parameters. After that information, server gives latest best path to user. This architecture is very good in scalability including both in utilization and performance. This means that all the drivers can use the system and all drivers can benefit from the use of this system. the current architecture has some problem like large calculation required on server side, all drivers must need to have Smartphone. Then another major limitation is that no traffic assignment algorithms developed [14].

Dib Omar et al [2017] delivered the techniques for a multimodal transportation network for compute best paths. He had developed a routing algorithm to compute best paths over the described modelling approach. He used routing algorithm in presented approach.

That approach applied on different transport modes like Railway, Bus Tram and Metro. A multicriteria routing algorithm has been proposed for solving the emerging problem over the proposed modelling approach. in that paper author discussed on only public transportation modes, private modes such as Bike and Car Sharing are not focused. Another limitation of current approach is that it needs to make more realistic [15].

The developer Chaturvedi (2017) design an ATIS that uses the real time speed estimations generated using the COCOMO or ECOMO. This paper elaborates the design of an Advanced Traveller Information System (ATIS) using traffic information generated by the COCOMO (Congestion Coverage Model) and ECOMO (Edge Coverage Model). The simulation results show that the ATIS improves average trip duration and congestion in the road network, and the performance is comparable to the full deployment of ITS infrastructure. The Dijkstra's shortest path algorithm is used to compute the shortest path with respect to travel time from vehicle's current position to its destination. However, the generated traffic information has the following properties: (i) it has a certain amount of error, and (ii) speed estimation may not be available for some fraction of edges or for some congestion levels due to limited infrastructure deployment. The ATIS considers the above properties in its design. The simulation results show that the traffic information generated by the COCOMO and ECOMO is useful and the ATIS improves average trip duration and congestion in the road network [16].

Abdelfattah IDRI (2017), proposed own time-dependent shortest path algorithm for finding out shortest path. It depends on the basis of "closeness" node using heuristic approach toward its destination node. Algorithm uses the virtual path as a conductor of the search space and the parameter. The optimality of the algorithm is principally based on computing a virtual path which is basically a Euclidean distance from the source to the target aiming at a restriction of the search space [17].

In this article author Liao, Chun-Hsiung, and Chun-Wei Chen (2015) had addressed the basic concepts of possible ways of applying to route choice. Some well-known examples of such approaches include advanced vehicle control systems (AVCS), advanced traffic management systems (ATMS), vehicle routing problems (VRP), network assignments, and the route choice model. The route choice problem is helpful to construct an efficient traffic system through individual-foundation problem solving. An important factor that has been introduced to related work over the past few years is traffic information and its effect on travellers' route choice. This study applies the concept of a Bayesian to the route choice problem when travellers are maximizing their degree of satisfaction by choosing routes. A Bayesian model is used in this work to analyse the impact of this heterogeneity on travellers' route choices. He fined that the use of ATIS exposes certain heterogeneities in traveller types and beliefs [18].

Authors Xipeng Zhang, Gang Xiong, Liang Xiao (2015), presented the work on an Intelligent Route Guidance System (IRGS) that additionally recommends the shortest path. Authors divided the IRGS system into four parts Road Network Data Collection System: These are simple sensors responsible for collecting the road network data like no. of vehicles currently on a particular route. Vehicle Mounted Terminal System: This component is fitted in user's vehicle which is composed of both GPS and GIS module. The user provides the desired destination from this component only. Data Communication Subsystem for traffic guidance: This component is responsible for establishing communication between Vehicle Mounted Terminal System and Road Network Data Collection System. All these communications made through a wireless medium. Route Optimizing Subsystem: This component receives data from Vehicle Mounted Terminal System and Road Network Data Collection System with the help of Data Communication Subsystem. It also contains an algorithm for recommending shortest path. This system uses Bellman-Ford algorithm to suggest a single source shortest path to the user. Suggested shortest path algorithm fulfils the guidance task for drivers. The application of IRGS can reasonably mitigate traffic congestion, utilize insufficient road infrastructure and achieve better network performance [19].

Jianqiang Wang' (2014), presented novel approach applied on two-route systems under ATIS basis on graded information feedback for getting accuracy and the time delay of information feedback. Presented approach consist the fuzzy C-means clustering algorithm to classify road traffic conditions based on flux mean velocity and density. Real time traffic on the road was finding by using the preceding cluster centres and depending on that result the best route choices decision taken. On the basis of fuzzy best route choice also dependent on velocity-dependent randomization (VDR) model and a two-route scenario. this approach helps to find out best path with minimize travel time. Author gives more focus on study of graded method of traffic information and performance analysis of the graded-information feedback strategy (GIFS) in two-route scenario [20].

This paper discusses the methodology used in the development of advanced traveller information system (ATIS) by Praveen Kumar [2014]. This system is designed as a part of web geographical information system (GIS). This system is designed as a part of web geographical information system (GIS) based advanced public transport systems. Web GIS-based ATIS system includes spatial data for the designed functionalities and provides GIS capabilities to the users through the internet. In addition to these functionalities, a route planning algorithm to plan the shortest route between the selected bus transit points is also designed using ant system algorithm and is integrated with web GIS. This study presents the ant system algorithm adopted for the shortest route finding with the methodology developed for the web GIS-based ATIS system for the study area of the city Chandigarh in India using open-source software Map Server as web map server. This study also discusses the three-tier logical architecture used in the methodology for providing GIS capabilities to the user over the internet. The ant system algorithm with pheromone intensity used for the shortest route finding was coded in the C# programming language and integrated with the ATIS web page functionalities. Current system uses mathematical approach of pheromone intensity; use of Artificial intelligent can increase more smart effectiveness [21].

The authors Jincheng [2014], proposed two new dynamic shortest path algorithms based on the re-optimization method for Vehicle Navigation. a) Weight of single arc changes b) The weight of multiple arcs changes. Real-time route conditions can be handled effectively and computational time is less than Dijkstra's algorithm. Experimental results demonstrate that the proposed algorithms can be applied to vehicle navigation in the transportation network with dynamic variation of the travel times on arcs and runs much faster than the traditional Dijkstra's algorithm [22].

A conceptual Multimodal Advanced Traveller Information System (MATIS) [2011] was focused on the work on a Sun SPARC workstation using the ARC/INFO GIS software platform by Kyriacos C. Mouskos. The primary components of the MATIS are the databases, the data-processing algorithms, and the user interface. The data-processing algorithms include route planning for private automobile, transit, and ride sharing. These algorithms are executed independently of each other in the present version of the system. The user interface allows the users to enter the input through customized menus that were developed using the ARC/INFO capabilities. The system can accept both Subscribers, who have their individual profile in the system containing their travel characteristics for one or more of each subsystem, and nonsubscribers, who can enter at any time into the system and receive travel information from any of the subsystems. Any user can subscribe or unsubscribe to/from the system at any time. The design and the required input/output of MATIS are outlined, and future enhancements of the model are suggested. Data processing may include some or all of the following algorithms and processes: data reduction from the traffic surveillance system, data fusion, travel-time estimation, travel-time prediction, traffic assignment, route planning, automatic vehicle location/identification, ride-sharing algorithm, incident detection algorithm. The present prototype cannot be used for real-time operations due to the rather slow execution of the algorithms of the three subsystems. Implementation of MATIS into real-time operations also will require the development of the interfaces with the traffic surveillance system and the communications system and the development of fast travel-time algorithms, route-planning algorithms, and an efficient design of a traffic operations center which will be able to handle a large volume of users at the same time [23].
This multimodal transport networks developed by Jianwei Zhanga(2011) , the networks categorize into private and public. The algorithm consists of three steps: 1) initialize individual networks 2) compile each individual network and 3) integrate the individual networks into a single multimodal transport network. In the compilation step, there are two compilers corresponding to two kinds of abstract networks – private and public. When a full multimodal transport network has been constructed in this way, then routing algorithms used to check the consistency of the model. Commonly used algorithms include the Dijkstra’s algorithm and A *The test results indicate that even the basic Dijkstra’s algorithm could be used to find high quality routes in short computation time for realistic [24].
This system is developed for Vilnius City by Jakimavièius (2010), this research work focus on mechanism for a rational choice of the route and designed vector database are published on the general GIS for public use with the help of ESRI technologies. Also, GIS database and a mechanism of updating the road network database could be successfully adapted in other Internet information systems. Dijkstra’s algorithm has been applied to make calculations finding the optimal driving route. Street sections have been given weights in the database: street segment length, driving time necessary to pass street edge and historical driving time needed to go through the street segment when performing a route calculation task for the nearest future. An automatic traffic light management system arranged in the corridors and determined priority for traffic flow [25].
Kumar et al. (2005) developed ATIS system for Hyderabad city. This application has the capabilities to finding the shortest path based on distance and drive time, closest facility, city bus routes using Dijkstra’s algorithm. The developed package can be used in multiple areas like Bus stands, Railway stations, Airports, Tourist information center etc to give information to the travellers. This ATIS system does not use real time traffic information, but the extension is feasible [26].
In this paper some Path Computation Algorithms had applied on ATIS by Shashi Shekhar . He has carried out algebraic and implementation-based evaluations of the performance of three algorithms for computing the shortest path between a pair of points (source. destination). A* outperforms the Iterative algorithm if the path [source. destination] is much smaller than the diameter of the graph, or if the edge-cost distribution is skewed. Be iterative algorithm outperforms A* and Dijkstra's algorithms if the path [source, destination] is comparable to the diagonal of the graph with non-skewed edge-cost distributions. Estimator functions can reduce the number, for nodes explored to provide satisfactory performance on graphs with hundreds of nodes. Algorithms such as A*, with the Manhattan distance estimator function are not guaranteed to be optimal. These algorithms were able to find a good path very quickly. In real applications such as the ATIS with speeds the processing [27].

A Traffic Monitoring System Using IOT
A traffic monitoring system have many applications like traffic congestion, accident detection, vehicle identification/detection, automatic vehicle guidance, smart signalling, forensics, traffic density, safe pedestrian movement, emergency vehicles transit, etc. the system can design by using - In situ traffic detector technologies, Vehicular sensor networks or probe vehicles (like taxis and Buses) and Image or video processing [28]. The number of devices which connect to the Internet is – seemingly exponentially – increasing. Because of low-cost processors and wireless sensor networks; it becomes easy to turn anything into IoT. IoT can add some level of digital intelligence to devices, enabling them to communicate and also to merge the digital and physical world. IoT has massive possibilities for developing new sensible applications in almost every discipline [29]. A traffic monitoring system is the one of the applications of IoT.
In Situ Technologies
In situ traffic detector technologies consist two technologies Intrusive technology and non-intrusive technology. In intrusive technologies includes detectors like embed magnetometers, pneumatic tube detectors, inductive detector loops, and Weigh-in-Motion (WIM) systems. In these technologies’ detectors are mounted or on the road surface. Nonintrusive technologies include manual methods, video data collection, passive or active infrared detectors, microwave radar detectors, ultrasonic detectors, passive acoustic detectors, laser detectors, and aerial photography [30].
Vehicular Sensor Networks
This technology uses moving vehicles (with sensing device and GPS) continuously gathering the traffic information over the selected area [31].

Image and Video Processing

Video monitoring and image processing have been widely used in traffic management for solving number of traffic issues. Video monitoring systems uses camera for detecting traffic conditions [32].

Some traffic sensing technologies are used in existing studies, listed below with merits, demerits and principles

Magnetometer:

Magnetometer's sensors base on Intrusive technology that sense the horizontal and vertical components of the Earth's magnetic field. Magnetometer transmit data over wireless RF link, another merit of magnetometer is that it's not effected by bad whether such as snow, rain, and fog. Some demerits of this sensor like Installation requires pavement cut or boring under roadway and it cannot detect stopped vehicles unless special sensor layouts and signal processing software are used [33].

RFID (Radio-frequency identification)

In this technology radio waves are used for tracking vehicles. radio waves are passed between radar and electronic tag for the purpose of data passing. It consists Antenna (transmitter and receiver), Transponder, tag reader system. Though the merits of RFID are economical and without disturbing traffic but have demerits that it senses only equipped vehicles [34].

VIP (Video image processor)

This technology camera are used to detect traffic condition. Some transformations and processing are done on capture images of traffic. This technology is widely used cause of easy and simple installation, monitors multiple lanes, portability, etc. but having some demerits like effected by bad weather, lots of maintenance required like lens cleaning continuously camera is need to mountain over 30- to 50-ft and cost effective [35].

Ultrasonic

Ultrasonic sensor an Ultrasonic sensor transmits ultrasonic waves and again collects the echoed waves from an object. It uses the time lapse between the transmitted and reflected sonic wave to identify the location of the object. Merits of the ultrasonic sensors is that it can capture Multiple Lane with capability of over height vehicle detection. But it's effected by environmental changes and large pulse repetition periods may degrade occupancy measurement on freeways with vehicles travelling at moderate to high speeds [36].

Inductive loop

In this technology vehicle detection are done by using sensing the loop inductance, which is dropped by inducing currents in the object. These loops are not affected by environmental changes like rain, fog, snow etc. Accuracy is good with High-frequency excitation models. Installation requires pavement cut more care taking c if installation is not proper then it decreases pavement life. Detection accuracy may decrease when design requires detection of a large variety of vehicle classes [37].

Microwave radar

The Microwave radar transmits signals in the recognition regions and captures the echoed signals from vehicles. The reflected signal is processed to find the speed and direction of the vehicle. Radar is used because of its merits like that it is not affected by bad weather, direct measurement of speed and Multiple Lane operation available. But one demerit is that Continuous wave (CW) Doppler sensors cannot detect stopped vehicles [38]. Following table 1.1 shows some Existing work using IoT.

Table 1.1 Existing work using IoT

Author	Paper Name	Technology used	comments
JinLi,YuXiang,Jiancheng Fang, Wenyong Wan and Yiming Pi [2019] [39]	Research on Multiple Sensors Vehicle Detection with EMD-Based Denoising	Using radar-based Internet of Things (IoT)	Developed Vehicle detection scheme known as vehicle detector based on EMD-HT (empirical mode decomposition- null-hypothesis interval threshold) and multi-channel GLRT (multi-channel generalized likelihood ratio test) detector. Data acquisition and processing method done.
Mahesh A. Rakhonde (2018) [40]	Vehicle Collision Detection and Avoidance with Pollution Monitoring System Using IoT	GPS and GSM module with flex sensor, raspberry pie and MCU.MQ7	System focuses on four modules - Accident Detection Unit, Accident-Avoidance Unit, Vehicle Pollution Monitoring Unit, Communication Unit proposed system can be improved by adding pressure sensors for detecting accidents, instead of ultrasonic sensor, RADAR can be used to increase range and accuracy.
Jason Kurniawan (2018) [41]	Traffic Congestion Detection: Learning from CCTV Monitoring Images using Convolutional Neural Network	CCTV cameras are used for traffic detection.	Used intelligent neural network approach for traffic detection. On the basis of users request for traffic information of particular area, system captured the images of required area and applying CNN model. Depending output o model system decides that wheatear is traffic jam or not.

Yifan Wang (2018) [42]	In-Road Microwave Sensor for Electronic Vehicle Identification and Tracking: Link Budget Analysis and Antenna Prototype	Microwave sensor is used and tested in a real road environment.	Has used the approach of embed the interrogator in the road and read license plate tags exclusively. a prototype antenna in the shape of modified low profile dicone is designed to meet the in-road reader requirements.
Mohammad Ahmar Khan (2018) [43]	IoT based framework for Vehicle Over speed detection	The system contains GPS module, Radar, Google maps and IoT module. The safe regions are identified automatically using GPS and IoT technologies.	The system sends the data wirelessly. If the over speeding vehicle is detected, then the sensor alerts by sounding an alarm. The purpose of the proposed sensor is to decrease high death rates because of accidents
Wynita M. (2018) [44]	Localising Missing Entities using Parked Vehicles: An RFID-Based System	Using RFID-based techniques.	utilizing networked vehicles that are parked for extended periods of time, in dense, urban areas, to detect and localise moving, missing entities using RFID technology
Xue Yuan(2017) [45]	A Graph-Based Vehicle Proposal Location and Detection Algorithm	novel graph-based algorithm	A novel graph-based algorithm was proposed to estimate the possibility of containing a vehicle. Limitation of the algorithm is accuracy issue due to the incorrect segmentation and two adjacent vehicles with the same Color are difficult to find out.
Hon Fong Chong, [2016] [46]	Development of IoT device for traffic management system	used Internet of Things (IoT) device for traffic management system	In his research an Intel Edison collects real-time traffic data and communicates with Microsoft Azure IoT cloud server. System consists two parts, in first part system gathering real time information by inductive loop detector and in second part traffic congestion algorithm was used.
KristófCsorba (2016) [47]	Visual Traffic Load Sensor for Emission Estimation	embedded system with CCTV camera	Author used embedded system for traffic counting with the help of CCTV camera for the purpose of Visual Traffic Load Sensor for Emission Estimation. on the basis that information again he developed architecture traffic transmission.
Vahedha (2016) [48]	Smart Traffic Control System Using ATMEGA328 Micro Controller and Arduino Software	ATMEGA 328 micro controller and RFID and GSM module	Three applications are studied in this work including Automatic vehicular signal control, Detection of stolen vehicle and Clearance to emergency vehicle/fire car.
Patole S M, Torlak M, Wang D, et al [2015] [49]	Automotive radars: A review of signal processing techniques	use radar sensors	use radar sensors because of offering long distance capturing capacity and detecting blind spot
A Mukhtar, L Xia, T B Tang (2015) [50]	Vehicle detection techniques for collision avoidance systems	IoT with sensors	proposed approach for-road vision-based vehicle detection and tracking systems for collision avoidance systems. This system used radar-based sensors for road conditions and can be classified into two active and passive groups. System gives detail scenarios for vehicle detection at day, night, rain, fog etc. condition.

Conclusions

This paper includes study of two different sections. First section has been discussed some well-known studies path computation algorithm to find out best path of ATIS application. Second section describes IoT technology used in intelligent transportation system with sensors and detection algorithms over the world. ITS system was developed by using advanced sensor, computer, electronics, and communications technologies and management strategies in an integrated manner to providing traveller information to increase the safety and efficient of the surface transportation system. Many authors use fuzzy logic, Dijkstra's algorithm and A* algorithm, bellman ford, **k -shortest-path algorithm, heuristic approach** for finding shortest path. Most of studies proposed Dijkstra's and A* algorithm that means these algorithms are more popular and high performance, less time-consuming solutions for finding best route. In second part of literature survey focus on IoT technology used for vehicles detection and tracking. Sensors, such as radars, LIDAS and cameras, RFID are critical components in vehicle detection. Some popular sensors like flux microwave were used in many researches. Some authors used graph-based algorithm and fuzzy logic for vehicles detection. Vehicle detection is an important part on smart vehicles with limited or full driver automation. It is also an essential basis for adaptive cruise control, blind spot detection, objects tracking and prediction, parking assistance and more. Vehicle's detection tracking and authentication are done by different studies using different algorithms. most of studies as, used algorithms of artificial neural network, fuzzy logic, machine learning algorithms.

References

[1] ITS Xu, Xiujuan, et al. "ITS-Frame: A Framework for Multi-Aspect Analysis in the Field of Intelligent Transportation Systems." IEEE Transactions on Intelligent Transportation
Systems (2018).

[2] Broggi, Alberto, et al. "Intelligent vehicles." Springer Handbook of Robotics. Springer, Cham, 2016. 1627-1656.

[3] Bhokarkar, Renuka P., Sandeep V. Gaikwad, and K. V. Kale. "Development of ATIS-web based system for Aurangabad city." (2018).

[4] Bhokarkar, Renuka P. et al. "Advanced Traveler Information System for Aurangabad City." (2018).).

[5] M.Tsuzawa, H.Okamoto; Advanced Mobile Traffic Information and Communication System - CH2789-6/89/0000-0475 IEEE, pp.475-483, 1989

[6] https://webcache.googleusercontent.com/search?q=cache:CIJLC7uUv_kJ:https://local.iteris.com/cvria/docs/CVRIA_Webinar_220131113b.pdf+&cd=1&hl=en&ct=clnk&gl=in&client=firefox-b-ab

[7] ITS Canada Website: http://www.itscanada.ca

[8] ITS-U. K Website: http://www.its-uk.org.uk

[9] B. McQueen, I. Catling; The Development of IVHS in Europe. In SAE Technical Paper Series (SAE No. 911675) Ed. Warrendale, PA: Society of Automotive Engineers, pp. 31- 42, 1991.

[10] Ghavami, Seyed Morsal. "A Web Service Based Advanced Traveler Information System for Itinerary Planning in an Uncertain Multimodal Network." Geocarto International just-accepted (2019): 1-16.

[11] Ceder, Avishai Avi, and Yu Jiang. "Personalized public transport mobility service: a journey ranking approach for route guidance." Transportation Research Procedia 38 (2019): 935-955

[12] Delle Site, Paolo. "A mixed-behaviour equilibrium model under predictive and static Advanced Traveller Information Systems (ATIS) and state-dependent route choice." Transportation Research Part C: Emerging Technologies 86 (2018): 549-562

[13] Dotoli, Mariagrazia, et al. "A multi-agent advanced traveler information system for optimal trip planning in a co-modal framework." IEEE Transactions on Intelligent Transportation Systems 18.9 (2018): 2397-2412.

[14] Noranian, Mohammad Hossein, and Ahmad Reza Tahsiri. "Developing architecture of a traveler information system for dynamic equilibrium in traffic networks." Journal of Modern Transportation 25.2 (2017): 106-115.

[15] Dib, Omar, et al. "A multimodal transport network model and efficient algorithms for building advanced traveler information systems." Transportation research procedia 22 (2017): 134-143.

[16] Chaturvedi, Manish, and Sanjay Srivastava. "Advanced traveler information system using COCOMO and ECOMO." 2017 IEEE Region 10 Symposium (TENSYMP). IEEE, 2017.

[17] Idri, Abdelfattah, et al. "A new time-dependent shortest path algorithm for multimodal transportation network." Procedia Computer Science 109 (2017): 692-697.

[18] Liao, Chun-Hsiung, and Chun-Wei Chen. "Use of advanced traveler information systems for route choice: Interpretation based on a Bayesian model." Journal of Intelligent Transportation Systems 19.3 (2015): 316-325.

[19] Xipeng Zhang, Gang Xiong, Liang Xiao 2015, Fenghua Zhu, XiongguangYang and Timo R. Nyberg, "A Design of Intelligent Route GuidanceSystem Based on Shortest path algorithm", IEEE Int. Conf. on Service Operations And Logistics, And Informatics (SOLI), pp. 12-17, 2015.

[20] Wang, Jian-qiang, and Hui-min Niu. "A Graded-Information Feedback Strategy in Two-Route Systems under ATIS." CICTP 2014: Safe, Smart, and Sustainable Multimodal Transportation Systems. 2014. 1775-1787.

[21] Kumar, Praveen, Sanjeev Suman, and Shambhavi Mishra. "Shortest route finding by ant system algorithm in web geographical information system-based advanced traveller information system." The Journal of Engineering 2014.10 (2014): 563-573.

[22] Jiang, Jincheng, and Lixin Wu. "A re-optimization dynamic shortest path algorithm for vehicle navigation." 2014 IEEE Geoscience and Remote Sensing Symposium. IEEE, 2014

[23] Mouskos, Kyriacos C., and Joshua Greenfeld. "A GIS-Based Multimodal Advanced Traveler Information System." Computer-Aided Civil and Infrastructure Engineering 14.4 (1999): 267-279.

[24] Zhang, Jianwei, et al. "A multimodal transport network model for advanced traveler information systems." Procedia-Social and Behavioral Sciences 20 (2011): 313-322.
[25] Jakimavièius , Marius, and Marija Burinskienë. "Route planning methodology of an advanced traveller information system in Vilnius city." Transport 25.2 (2010): 171-177.
[26] Kumar, Praveen, Varun Singh, and Dhanunjaya Reddy. "Advanced traveler information system for Hyderabad City." IEEE Transactions on Intelligent Transportation Systems 6.1 (2005)
[27] Shekhar, S., A. Kohli, and M. Coyle. "Path computation algorithms for advanced traveller information system (ATIS)." Proceedings of IEEE 9th International Conference on Data Engineering. IEEE.
[28] Prasad, Anupriya, and Pradeep Chawda. "Power management factors and techniques for IoT design devices." 2018 19th International Symposium on Quality Electronic Design (ISQED). IEEE, 2018.
[29] Ray, Partha Pratim. "A survey on Internet of Things architectures." Journal of King Saud University-Computer and Information Sciences 30.3 (2018): 291-319.
[30] Conti, Mauro, et al. "Internet of Things security and forensics: Challenges and opportunities." (2018): 544-546.
[31] Baldini, Gianmarco, et al. "Ethical design in the internet of things." Science and engineering ethics 24.3 (2018): 905-925.
[32] Ding, Wenxiu, et al. "A survey on data fusion in internet of things: Towards secure and privacy-preserving fusion." Information Fusion 51 (2019): 129-144.
[33] https://nptel.ac.in/course.html
[34] Pasku, Valter, et al. "Magnetic field-based positioning systems." IEEE Communications Surveys & Tutorials 19.3 (2017): 2003-2017.
[35] Pedraza, Cesar, Felix Vega, and Gabriel Manana. "PCIV, an RFID-based platform for intelligent vehicle monitoring." IEEE Intelligent Transportation Systems Magazine 10.2 (2018): 28-35.
[36] Jain, Neeraj Kumar, R. K. Saini, and Preeti Mittal. "A Review on Traffic Monitoring System Techniques." Soft Computing: Theories and Applications. Springer, Singapore, 2019. 569-577.
[37] Dong, Honghui, et al. "Improved robust vehicle detection and identification based on single magnetic sensor." Ieee Access 6 (2018): 5247-5255.
[38] Peng, Zhengyu, et al. "A portable FMCW interferometry radar with programmable low-IF architecture for localization, ISAR imaging, and vital sign tracking." IEEE transactions on microwave theory and techniques 65.4 (2016): 1334-1344
[39] Li, Jin, et al. "Research on Multiple Sensors Vehicle Detection with EMD-Based Denoising." IEEE Internet of Things Journal (2019).
[40] Rakhonde, Mahesh A., S. A. Khoje, and R. D. Komati. "Vehicle Collision Detection and Avoidance with Pollution Monitoring System Using IoT." 2018 IEEE Global Conference on Wireless Computing and Networking (GCWCN). IEEE, 2018.Kurniawan, Jason, Sensa GS Syahra, and Chandra K. Dewa. "Traffic Congestion Detection: Learning from
[41] CCTV Monitoring Images using Convolutional Neural Network." Procedia computer science 144 (2018): 291-297.
[42] Wang, Yifan, et al. "In-road microwave sensor for electronic vehicle identification and tracking: Link budget analysis and antenna prototype." IEEE Transactions on Intelligent Transportation Systems 19.1 (2018): 123-128
[43] Khan, Mohammad Ahmar, and Sarfraz Fayaz Khan. "IoT based framework for Vehicle Over-speed detection." 2018 1st International Conference on Computer Applications & Information Security (ICCAIS). IEEE, 2018.
[44] Griggs, Wynita M., et al. "Localizing missing entities using parked vehicles: An RFID-based system." IEEE Internet of Things Journal 5.5 (2018): 4018-4030.
[45] Yuan, Xue, Shuai Su, and Houjin Chen. "A graph-based vehicle proposal location and detection algorithm." IEEE Transactions on Intelligent Transportation Systems 18.12 (2017): 3282-3289.
[46] Chong, Hon Fong, and Danny Wee Kiat Ng. "Development of IoT device for traffic management system." 2016 IEEE Student Conference on Research and Development (SCOReD). IEEE, 2016.
[47] Csorba, Kristóf, Lilla Barancsuk, and László Blázovics. "Visual Traffic Load Sensor for Emission Estimation." Procedia Engineering 168 (2016): 47-50.
[48] Jyothi, B. Naga. "Smart traffic control system using ATMEGA328 micro controller and arduino software." 2016 International Conference on Signal Processing, Communication, Power and Embedded System (SCOPES). IEEE, 2016.
[49] Patole, Sujeet Milind, et al. "Automotive radars: A review of signal processing techniques." IEEE Signal Processing Magazine 34.2 (2017): 22-35.
[50] Mukhtar, Amir, Likun Xia, and Tong Boon Tang. "Vehicle detection techniques for collision avoidance systems: A review." IEEE Transactions on Intelligent Transportation Systems 16.5 (2015): 2318-2338.