ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/327073557

Intelligent Road Traffic Control System for Traffic Congestion A Perspective

Article *in* INTERNATIONAL JOURNAL OF COMPUTER SCIENCES AND ENGINEERING · July 2018

DOI: 10.26438/ijcse/v6i7.908915

CITATIONS
14

READS
25,683

3 authors, including:

Pallavi Mandhare
Savitribai Phule Pune University
4 PUBLICATIONS **14** CITATIONS
SEE PROFILE

Vilas Kharat
Savitribai Phule Pune University
69 PUBLICATIONS **202** CITATIONS
SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Semantic Web View project

ARTIFICIAL-INTELLIGENCE-AI-GLOBAL-PORTAL View project

All content following this page was uploaded by Vilas Kharat on 10 October 2018.

The user has requested enhancement of the downloaded file.

International Journal of Computer Sciences and Engineering Open Access
Review Paper Vol.-6, Issue-7, July 2018 E-ISSN: 2347-2693

Intelligent Road Traffic Control System for Traffic Congestion: A Perspective

Pallavi A. Mandhare [1*], Vilas Kharat [2], C.Y. Patil [3]

[1]Department of Computer Science, Savitribai Phule Pune University, Pune, India
[2] Savitribai Phule Pune University, Pune, India
[3] Instrumentation and Control Department, College of Engineering, Pune, India

[*]*Corresponding Author: mandharepa@gmail.com, Tel.: 9422512387*

Available online at: www.ijcseonline.org

Accepted: 13/Jul/2018, Published: 31/Jul/2018

***Abstract*—** An important measurement for the cost-effective growth of any nation is rapidly increasing vehicle count. The effect of raise in vehicle count grows the traffic congestion. It results in wastage of energy, time and environmental pollution. To meet the demands of an overgrowing city the traditional traffic lights deployed in cities are not sufficient since these traffic lights have specific predetermined time intervals for changing from a red phase to green phase. This major issue, that most of the cities is facing in spite of measures being taken to palliate and reduce it. In recent years traffic congestion has become apparent as one of the major challenges for engineers, planners, and policymakers, not in all urban setting, but worldwide. In this regard with the help of Intelligent Transportation Systems (ITS), several attempts were made to automate the traffic lights based on the density of vehicles on the road. Some researchers suggested the use of various distinctive sorts of strategies and computerized sensor frameworks to examine traffic density and to tackle the congestion issue depending on the traffic nature. This paper reviews different sensor frameworks by analyzing the pros and cons of each in cost, reliability, accuracy, efficiency, and maintenance overhead.

***Keywords*—**Intelligent Transportation Systems; Computer Vision; Machine Learning; Wireless Sensors; Traffic Control;

I. INTRODUCTION

The transportation system is important in everyone's life. Traffic congestion is a major issue in our daily life. There are several reasons for the sudden surge in the traffic, in many regions. The main reason can be defined as, to increase in the population which in turn has caused a rise in the number of vehicles on the road. Also, there are several other issues for traffic congestion like insufficient infrastructure, ineffective management of capacity (i.e. poor traffic timing), work zone, special events, emergencies, unconstraint demands etc. In the past few years, development in wireless communication technologies and the development of vehicular network standards tiled the way for the implementation of ITS. ITS is defined as the application of advanced sensors, computer, electronics and telecommunication technologies and management strategies in an integrated way to improve the safety and efficiency of the transportation system [1]. The major goal of ITS is to evaluate, develop, analyze and integrate the sensors, information communications technologies, and concept to make efficient traffic flow to improve environmental quality, save energy, conserve time such that enhance the comfort of drivers, pedestrian, and other traffic groups[2].

We can say that the purpose of ITS is to take advantage of the appropriate technologies to create "more intelligent" roads, vehicles and users. Several ITS technologies were developed and started to use in the 80s in many countries. The Zero-Sum Ltd. Japanese firm who expertise in ITS along with Ahmadabad Municipal Corporation launched its pilot project on real-time traffic information in the city of Ahmadabad. This was the first ITS Solution with the integrated commercial system in India. One of the big milestones for ITS measure was carried out during "2010 Asian Games" at China for parallel traffic control and management [3].

An ITS application must detect, control and reduce congestion based on online data that describes traffic patterns such as, density, speed, travel time, the geographic position of vehicles and the current time. To accomplish this goal, however, the main challenge is how to forecast congestion and re-route vehicles appropriately by considering the time impact on future traffic in an area of interest [4]. Inadequate capacity or density and unrestrained demand are interconnected but signal delays are hard coded and do not depend on the amount of traffic density. Therefore there is a need to optimize the traffic control system and make it more dynamic so as to accommodate the varying traffic density. This paper provides reviews of the various techniques are proposed by different authors to automate and optimize the traffic signal for traffic

© 2018, IJCSE All Rights Reserved

flow. The paper is organized into many sections, in which section II will give the historical perspective and an overview of the state of the art on worldwide ITS. Section III highlights a comparative study of all the existing methods used with advantages and disadvantages. Section IV describes the challenges and issues of worldwide and Indian ITS. Finally, section V concludes the study and some future work.

II. ITS BACKGROUND

Intelligent Transportation Systems is a global trend, attracting worldwide interest from transportation professionals, automotive industry, and political decision makers. ITS is related to advanced communication, information, and electronics technology to solve transportation problems such as traffic congestion, safety, transport efficiency and environmental conservation, characterized as:

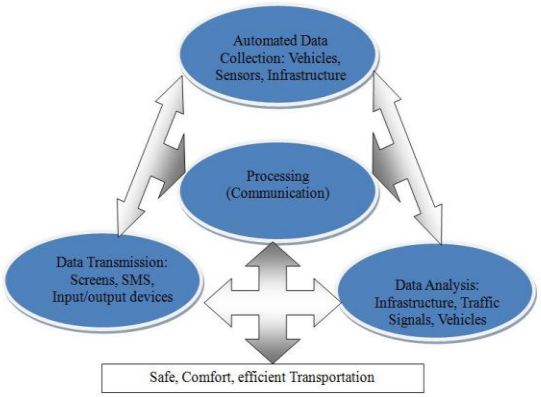

Figure1: Architecture / Overview Structure of ITS

As per the figure, 1 components of ITS can be defined as:

- Automated Data Collection: It needs extensive and precise strategic planning through hardware and competent software. Automatic vehicle identification, GPS based vehicle locator, cameras, sensors etc. are the some of the hardware used for data collection. With this large amount of data the analysis can be done like traffic count, surveillance, travel speed, time, location, delay etc.
- Data Transmission: It is a key aspect of rapid and real-time information communication in ITS implementation. Information can be communicated by a traffic-related announcement to the traveler through SMS, internet, on-board units of vehicles etc.
- Data Analysis: It contains adaptive logical analysis, error rectification, data cleaning, and data syntheses. The processed data analyzed further to forecast traffic scenario. Real-time information like travel time, delay, accidents on roads, change in route, work zone, diversions etc. is the gain after data analysis [4].

With respective above points ITS covers and improves almost all the aspects of transportation engineering. There are many auxiliaries of the ITS out of which most significant and extensively used all over the world to solve the traffic and transportation problem are as follows:

Figure 2: Subsidiaries of ITS

- Advanced Traveler Information System (ATIS): It implements a broad range of technologies, such as internet, telephones, cellular phones, television, radio, etc. to help travelers and drivers in making informed decisions regarding trip departures, optimum routes, and available modes of travel.
- Advanced Traffic Management System (ATMS): It is used by traffic police department and traffic regulation authorities as a tool to manage and control traffic by monitoring the flow of traffic and making appropriate decisions in a timely manner. Traffic management systems optimize the movement of vehicles, by using real-time information to interfere with and adjust controls such as traffic signals to improve traffic flow.
- Advanced Public Transportation System (APTS): It is concerned with increasing operational efficiency of all public transportation modes and increasing condition by making the transportation system more reliable. With the help of APTS the way public transportation systems functioning is transformed and the nature of the transportation services that can be offered by public transportation systems are changed.
- Emergency Management System (EMS): It is the newest research field in the intelligent transportation system. EMS is mainly concerned with the application of different intelligent transportation system technologies to develop a transport system which can provide help in the emergency conditions [5].

The architecture and different developed models over the years of four major branches of ITS have been considered by researchers in their studies using vehicle to infrastructure (V2I) or vehicle to vehicle (V2V) communications, for ease of life

© 2018, IJCSE All Rights Reserved

quality in metropolitan, urban areas complex management strategies with network-wide traffic control needed. As determined the goal of efficient traffic control using design process and investigation of algorithm and infrastructure with proper traffic planner is done in [10][57].

II-A. WORLDWIDE ITS

Now a day's many countries have accepted applications of this ITS not only for traffic congestion control but for road safety and proper utilization of infrastructure too. Many organizations are coming with multiple solutions related to the ITS issues. Because of ITS has become a multidisciplinary conjunctive field of work, between public, private and academic sectors.

In the U.S., Department of intelligent transportation system focuses on automation, connected vehicles, emerging capabilities, enterprise data, interoperability and accelerating deployment [18].

European ITS has taken a major step towards deployment and use of road transport since 2008. Other public-private partnership programs aim at safety applications of ITS like connected automated driving, deployment, and use of intelligent safety [43].

United Kingdom has done some remarkable executions of ITS as follows-electronic toll collection, cameras are installed to observe the traffic activities etc. Intelligent speed adaption is also implemented using GPS[48].

ITS features in Dubai are traffic jam alerts, parking, parking guidance, dynamic onboard navigation system for car users [53].

Canada is the first country that introduced ITS. ITS has traveler information system, public transport services consisting transit, management, real-time passenger information etc[49].

A few cities in India have implemented ITS projects such as automatic parking, highway toll collection, traffic signal management, and public transportation management. Chennai city authorities have initiated traffic management by installing surveillance cameras at intersections and supervise the traffic flow. Being a part of the project FM radio station played a very good role in transmitting traffic jam in Chennai. With the help of radar, accelerometer gun and smart cameras traffic control, as well as vehicle number detection, is implemented in Mumbai. A pilot project was implemented in Hyderabad and Delhi by initiating SMS based system for road users and BRT system implementation in Pune[50]. Also, because of inefficient management of traffic and increasing vehicle count creating inconsistencies reported [52].

III. STUDY OF EXISTING METHODS

The papers reviewed based on the following points:

- Approaches used to make traffic routing and a signal controlling decisions, i.e. adaptive (learning) versus non- adaptive, simulation versus real-time and hybrid strategies.
- Types of parameters (input and output) such as traffic quantity, waiting time, previous and current traffic data information/knowledge to make traffic routing.
- Traffic data collection methods used and communication methods applied/considered.
- Smart traffic control (STC) at a single intersection or multiple intersections or both.
- The way of improvement in the performance of traffic control to avoid congestion.

Video Analytics Deployed in traffic domain for traffic congestion control:

Generally, the problem of vehicle counting is mostly done using deploying inductive loops. These loops provide high accuracy but are very disturbing at the roadway, that's why it comes with high maintenance cost. Most of video analytics system on traffic congestion focuses on counting and doing classifications for more statistics. The vehicle identification is used with self-adaptive windows to estimate the mean travel time under traffic demand and supply uncertainty (i.e recurrent traffic congestion, bottleneck etc) [46]. In [8], demonstrated motion-based tracking with trajectory analysis method is to improve intersection behavior analysis for accurate turning movement count at the intersection. There is a major problem with mixed vehicle (e.g. cars, scooter, heavy vehicle etc) traffic flow that has been tackled in [5]. Image processing algorithm is used to estimate traffic density using cameras. Based on analysis of traffic images from live traffic evidence of congestion collapse which lasts for the extended time period shown in [9]. Many ITS applications rely on lane-level vehicle arrangement (positioning) that requires high accuracy, bandwidth, availability, and integrity. Lane-level positioning methods must reliably work in real time in a wide range of environments demonstrated in[16]. There are many lighting and weather conditions effects on vision-based systems. Such system must adopt all these lighting conditions. The different cues are given related to this kind of situation in [21][25][28]. Because of uncertainty in the traffic flows with the machine-vision algorithm an autonomous fuzzy control system also used in [39]. All representative of vision-based approaches that were analyzed in details are highlighted in Table 1:

Reference	Algorithm	Outcome
[5]	An optimization model for signaling time at intersection undermixed heavy traffic	The investigation provides queue length, queue clearance time
[8]	Vision-based Vehicle tracking system	Estimate turning movement count, speed profile and waiting time
[9]	Road traffic congestion system	Intelligent decision making for traffic controlling

© 2018, IJCSE All Rights Reserved

	with image mosaicking technique	
[16]	Computer vision and differential pseudo range Global Positioning System with Kalman filter	Inertial navigation
[21]	Vision-based automatic vehicle detection under lighting conditions	Vehicle detection
[25]	Night time traffic surveillance video	Vehicle detection, racking and speed estimator
[29]	Detecting and tracking of traffic shockwaves	Vehicle tracking
[37]	Traffic Signal Controlling using image processing	Automatically estimation of traffic density and duration of each traffic light
[39]	Machine vision algorithm and fuzzy expert system	Vehicle detection
[40]	The vision-based intelligent traffic management system	Vehicle detection, density estimation
[46]	Vehicle Reidentification System	Estimation of mean travel time

Table 1

Machine Learning Framework:

Machine learning and intelligence are being practical in numerous ways for tackling difficult confronts in many fields including transportation, energy etc. A good machine learning-based system requires all elements like sensors and data analytics capability to generate good results. A better understanding of the new technology is also important before system implementation to achieve high order performance for traffic monitoring and management. For a correct prediction of traffic information in real time such as flow, density, speed included intelligent traffic control systems to optimize the vehicle operations. Neural network, reinforcement learning techniques/frameworks used for efficient traffic signal policy, see [11][13][17][27][31][33]. For road network management the optimization techniques are given in [14]. All representatives of vision-based approaches that were analyzed in details are highlighted in Table 2 :

Reference	Algorithm	Outcome
[11]	Multi-agent system and reinforcement learning framework, a Q-learning algorithm with feedforward neural networks	Scheduling longest queue first at the intersection
[13]	Trip modeling system	Predict the traveling speed profile for the selected route based on the traffic information
[17]	Distributed unsupervised traffic-responsive signal control with hybrid computational intelligent techniques • fuzzy neural network • hybrid multi-agent system	Simulation on multi-agent system provide effective control of large-scale traffic network
[27]	Generalized Beta-Gaussian Bayesian Network	Predicated traffic variables like: • link travel time • link flow • link densities and their time evaluation in a real network
[30]	Discrete-Time Hidden Markov Model with classical Baum-Welch or Bayesian learning algorithm	Inferring the traffic signal phases from sequences of maneuvers
[33]	An intelligent decision-making system with • Artificial Neural Network (backpropagation) • Expert System (Fuzzy Expert system for decision making)	The integrated system gave an efficient performance for adaptable traffic control problem

Table 2

Smart Technologies for Traffic Control:

To improve safety and efficiency many research groups focus their attention on the emerging technologies as a feasible alternative to solve the traffic problem. The flexibility and increasing capacity of emerging technologies help to create cooperative automotive systems and reduce investment as well as operational cost and then making more well-organized transport system. Communication technologies are also helping to build a vehicular network to reduce traffic congestion given in [11]. In order to enable the deployment of the system, the vehicle must be equipped with wireless radios and communication devices must be placed at the roadsides. In this sense, the advanced technology, particularly in the area of mobile computing, wireless ad-hoc network (VANETs), is emerging and these vehicles can communicate with other

© 2018, IJCSE All Rights Reserved

vehicles and infrastructures, i.e. V2V, V2I as observed in [6][12][15][32]. Using inductive loop base traffic signals are analyzed in [36]. The traffic prediction is done with VANETs for traffic prediction [38].The historical traffic pattern is also a great asset in the maneuver of transportation management system [45]. Wireless Sensor Networks (WSNs) gain more attention in traffic detection. Taxonomy of different schemes for avoiding congestion with a number of sensors given in [41]. All representatives of smart technology approaches that were analyzed in detail are highlighted in Table 3 :

Reference	Algorithm	Outcome
[1]	Used vehicle to infrastructure communication and approximate dynamic programming with the simulation parameters like vehicle dimension, vehicle acceleration profile, vehicle braking profile, driving behavior	Travel time estimation and adaptive traffic signal control
[6]	Make use of mobile phone for accelerometer-based vehicular movement detection, map-matching for the traveled road segment, using cellular signal traffic congestion estimation of traveled road	Detection of road traffic congestion
[12]	Understanding of Internet of Things infrastructure in bus transportation system in Singapore	Predict arrival time of buses and crowded inside the bus
[15]	Using Taxi GPS tracing for the human mobility pattern in the city using two-phase approach for night bus route planning : • Phase I- cluster hot areas with dense passengers for identifying a location in the cluster as a candidate bus stop • Phase II-Given the bus route origin, destination, candidate bus stop, maximum total travel time and bus operation frequency builds bus route graph.	Automatic bus route generation
[31]	Using low-frequency data probe manuscript for pre-time traffic signals	Estimated collection of Signal Phase and Timing information
[34]	Smart traffic control system to make traffic routing decision • Fuzzy expert system • Artificial Neural Network • Wireless Sensor Networks	Traffic control and management
[36]	Inductive loop detection for traffic	Automation of traffic signal
[45]	Functional data analysis	Recognizing patterns of daily traffic profiles

Table 3

IV. ISSUES AND CHALLENGES

Several attempts were made for the traffic optimization by researchers. One of the challenges is to integrate the predictions for upcoming traffic conditions. Another challenge is to design flexible model to deal with objectives like time, financial cost, convenience and environmental pollution etc. From the technical point of view, correct detection of vehicle density on road by keeping high accuracy including improved algorithmic solutions for multiple cues, for statistical and learning methods, sensors and telematics (e.g. V2X communication, GPS). One of the key aspects in ITS is proper collection of dataset can carried out by employing more powerful sensors or developing sensor fusion to handle software and hardware issues coming at algorithmic level. In Asian nation like India, the National Development Policy Committee (NTDPC) was legitimate by the government of India in 2010 to formulate long run ITS policy. It identifies methodologies to unravel current ITS issues and targeted towards too long run vision on 2032 by introducing multi-model structures[26].

Because of people's demand and expectation of service quality has changed due to the availability of maps, GPS, etc. People plan their routes based on distance, time and cost. Therefore 'Information and Communication Technology' (ICT) enabled transport is stressed nowadays. This functionality will help to collect more efficient data and analytics will lead towards the better decision making in systematic execution of ITS applications [54].

For the ITS implementation the key aspects that India is facing are given by world bank study report : improper developed road networks, economical restriction observed in the government, uncontrolled population growth, lack of resources for function and maintenance of roads, less requirement for automation, less interest in decision making and lack of user awareness.

At the same time, the number of small scaled ITS pilot projects are being implemented that are given in the previous section. So far there is hardly any fully implemented ITS application present in India.

In India, ITS applications must focus on emergency management, congestion management, advanced traffic

© 2018, IJCSE All Rights Reserved

management system, advanced traveler information system, commercial vehicle operations, advanced vehicle control system etc. This probably can be achieved by implementing proper road network. Following are some specific challenges in the implementation:

- Evolving an ITS standard for its different essentials and applications
- To monitor, regulate and document the current and future ITS projects, the formation of ITS authority combined with Ministry of Road Transport and Highway and Ministry of Urban Development.
- Fully functional Traffic Management Center coordinating urban and regional ITS activities.
- Surfacing and applying the good methodologies for data collection techniques in Indian traffic conditions.
- Setting up national data records
- Promoting involvement or interaction between academia, industries, and government agencies developing ITS projects and decision making.
- To achieve all the above in ITS applications in wide area current infrastructure has been made proficient as much as necessary for its successful functioning.

V. CONCLUSION

Ever increasing population growth in urbanization because of migration from rural to urban and economic expansion has made an impact on the rapid increase in vehicle population. It puts a massive amount of pressure on transportation infrastructure and particularly on traffic management practices in cities and town of the urban area. Based on worldwide best practices observed in countries like the USA, Dubai, Canada, United Kingdom etc., the ITS application appears to be providing promising solutions for traffic control and management. In this paper, we have tried to explore the world of ITS and an efficient model can be designed by an integrated approach with a number of sensors and technologies. On another hand, each technology has its own limitations. As far as a country like India is concerned, there are many physical, social, economic challenges in front of ITS to grows efficiently. In India, under the "Smart City" project many government organizations have taken initiative for implementing a number of ITS projects. In order to avoid accidents on highways, a proposal has been initiated and communicated to the Maharashtra Government to install Intelligent Traffic Monitoring system [51]. India has started a big take off towards the journey of ITS.

REFERENCES

[1] Cai, Chen, Yang Wang, and Glenn Geers. "Vehicle-to-infrastructure communication-based adaptive traffic signal control."IET Intelligent Transport Systems 7.3, pp. 351-360, 2013.

[2] L. Vanajakshi, "Centre of Excellence in Urban Transport IIT Madras Synthesis Report on ITS Including Issues and Challenges in India," pp. 1-58 December 2010.

[3] G. Xiong, K. Wang, F. Zhu, C. Cheng, X. An, and Z. Xie, "Parallel traffic management for the 2010 Asian Games," IEEE Intell. Syst., vol. 25, no. 3, pp. 81–85, 2010.

[4] T. Roor, "Intelligent Transportation System in India - A Review," January, 2016.

[5] C. Lan and G. Chang, "A Traffic Signal Optimization Model for Intersections Experiencing Heavy Scooter – Vehicle Mixed Traffic Flows," vol. 16, no. 4, pp. 1771–1783, 2015.

[6] M. Lv, L. Chen, X. Wu, and G. Chen, "A road congestion detection system using undedicated mobile phones." IEEE Transactions on Intelligent Transportation Systems", vol. 16, no. 6, pp. 3060–3072, 2015.

[7] Ministry of Transport, Intelligent Transport Systems Technology Action Plan 2014-18, May. 2014.

[8] Shirazi, Mohammad Shokrolah, and Brendan Tran Morris. "Vision-based turning movement monitoring: count, speed & waiting time estimation." IEEE Intelligent Transportation Systems Magazine 8.1, pp. 23-34, 2016

[9] P. Y. P. Singh and U. P. Bijnor, "Analysis and Designing of Proposed Intelligent Road Traffic Congestion Control System with Image Mosaicking Technique," International Journal of IT, Engineering and Applied Sciences Research (IJIEASR) vol. 2, no. 4, pp. 27–31, 2013.

[10] Tettamanti, Tamás., "Advanced Methods for Measurement and Control in Urban Road Traffic Networks," 2013.

[11] I. Arel, C. Liu, T. Urbanik, and A. G. Kohls, "Reinforcement learning-based multi-agent system for network traffic signal control," IET Intell. Transp. Syst., vol. 4, no. 2, p. 128, 2010.

[12] A. Menon, R. Sinha, D. Ediga, I. Technology, and O. A. Road, "IMPLEMENTATION OF INTERNET OF THINGS IN BUS TRANSPORT SYSTEM OF SINGAPORE ", 2013.

[13] J. Park, Y. L. Murphey, R. McGee, J. G. Kristinsson, M. L. Kuang, and A. M. Phillips, "Intelligent trip modeling for the prediction of an origin-destination traveling speed profile," IEEE Trans. Intell. Transp. Syst., vol. 15, no. 3, pp. 1039–1053, 2014.

[14] S. K. Shukla and A. Agrawal, "Present and Future Perspective on Optimization of Road Network Management," vol. 22, no. 2, pp. 64–67, 2015.

[15] C. Chen, D. Zhang, N. Li, and Z. H. Zhou, "B-planner: Planning bidirectional night bus routes using large-scale taxi GPS traces," IEEE Trans. Intell. Transp. Syst., vol. 15, no. 4, pp. 1451–1465, 2014.

[16] A. Vu, S. Member, A. Ramanandan, A. Chen, J. A. Farrell, M. Barth, and S. Member, "Real-Time Computer Vision / DGPS-Aided Inertial Navigation System for Lane-Level Vehicle Navigation," vol. 13, no. 2, pp. 899–913, 2012.

[17] D. Srinivasan, M. C. Choy, and R. L. Cheu, "Neural networks for real-time traffic signal control," IEEE Trans. Intell. Transp. Syst., vol. 7, no. 3, pp. 261–272, 2006.

[18] I. Transportation, S. Its, J. Program, and O. Jpo, "Intelligent Transportation Systems (ITS) Strategic Plan 2015-2019," 2014.

[19] A. Geiger, M. Lauer, C. Wojek, C. Stiller, and R. Urtasun, "3D traffic scene understanding from movable platforms," IEEE Trans. Pattern Anal. Mach. Intell., vol. 36, no. 5, pp. 1012–1025, 2014.

[20] F. Zhang, "The current situation and development thinking of the intelligent transportation system in China," 2010 Int. Conf. Mech. Autom. Control Eng. MACE2010, vol. 717, pp. 2826–2829, 2010.

[21] Y. C. S. Huang and L. F. P. Hsiao, "Vehicle detection and tracking under various lighting conditions using a particle filter," no. May 2011, pp. 1–8, 2012.

[22] R. Jyothi Priya, S. M. Mansoor Roomi, B. Yogameena, V. Abhaikumar, and S. Raju, "People/vehicle classification by recurrent motion of skeleton features," IET Comput. Vis., vol. 6, no. 5, pp. 442–450, 2012.

[23] D.-Y. Chen, G.-R. Chen, and Y.-W. Wang, "Real-time dynamic

© 2018, IJCSE All Rights Reserved

vehicle detection on resource-limited mobile platform," IET Comput. Vis., vol. 7, no. 2, pp. 81–89, 2013.
[24] X. Liu, D. Tao, M. Song, L. Zhang, J. Bu, and C. Chen, "Learning to track multiple targets," IEEE Trans. Neural Networks Learn. Syst., vol. 26, no. 5, pp. 1060–1073, 2015.
[25] H. Hajimolahoseini, H. Soltanian-Zadeh, and R. Amirfattahi, "Robust vehicle tracking algorithm for nighttime videos captured by fixed cameras in highly reflective environments," IET Comput. Vis., vol. 8, no. 6, pp. 535–544, 2014.
[26] NTDPC, India Transport Report: Moving India to 2032, vol. II. 2014.
[27] E. Castillo, M. Nogal, J. M. Menéndez, S. Sánchez-Cambronero, and P. Jiménez, "Stochastic demand dynamic traffic models using generalized beta-gaussian bayesian networks," IEEE Trans. Intell. Transp. Syst., vol. 13, no. 2, pp. 565–581, 2012.
[28] V. Tyagi, S. Kalyanaraman, and R. Krishnapuram, "Vehicular Traffic Density State Estimation Based on Cumulative Road Acoustics," IEEE Trans. Intell. Transp. Syst., vol. 13, no. 3, pp. 1156–1166, 2012.
[29] Y. Chen, D. Yang, L. Xin, and Y. Zhang, "Real-time detecting and tracking of traffic shockwaves based on weighted consensus information fusion in distributed video network," IET Intell. Transp. Syst., vol. 8, no. 4, pp. 377–387, 2014.
[30] M. R. Gahrooei and D. B. Work, "Inferring Traffic Signal Phases From Turning Movement Counters Using Hidden Markov Models." IEEE Transactions on Intelligent Transportation Systems", vol. 16, no. 1, pp. 91–101, 2015.
[31] S. A. Fayazi and A. Vahidi, "Crowdsourcing Phase and Timing of Pre-Timed Traffic Signals in the Presence of Queues: Algorithms and Back-End System Architecture," IEEE Trans. Intell. Transp. Syst., vol. 17, no. 3, pp. 870–881, 2016.
[32] A. Guerrero-ibáñez, C. Flores-cortés, P. Damián-Reyes, and J. R. G. Pulido, "Emerging Technologies for Urban Traffic Management," Urban Development. InTech, 2012.
[33] M. Patel and N. Ranganathan, "IDUTC: An intelligent decision-making system for urban traffic-control applications," IEEE Trans. Veh. Technol., vol. 50, no. 3, pp. 816–829, 2001.
[34] R. Hawi, G. Okeyo, and M. Kimwele, "Techniques for Smart Traffic Control: An In-depth Review," vol. 4, no. 7, pp. 566–573, 2015.
[35] S. Hollborn, "Report Intelligent Transport Systems in Japan," 2002.
[36] I. Journal, O. F. Engineering, S. On, P. Of, and V. Routing, "International Journal of engineering sciences & research technology study on performance of vanet routing protocols and challenges," vol. 9655, no. 8, pp. 922–927, 2015.
[37] M. S. Uddin and A. K. Das, "Real-time Area Based Traffic Density Estimation by Image Processing for Traffic Signal Control System: Bangladesh Perspective," Electrical Engineering and Information Communication Technology (ICEEICT), 2015 International Conference on. IEEE, pp. 21–23, May 2015.
[38] S. Djahel, R. Doolan, G.-M. Muntean, and J. Murphy, "A Communications-Oriented Perspective on Traffic Management Systems for Smart Cities: Challenges and Innovative Approaches," IEEE Commun. Surv. Tutorials, vol. 17, no. 1, pp. 125–151, 2015.
[39] F. Espinosa, C. Gordillo, R. Jiménez, and O. Avilés, "Dynamic traffic light controller using machine vision and optimization algorithms," Engineering Applications (WEA), 2012 Workshop on. IEEE, pp. 1–6, 2012.
[40] M. H. Malhi, M. H. Aslam, F. Saeed, O. Javed, and M. Fraz, "Vision Based Intelligent Traffic Management System," Frontiers of Information Technology (FIT), pp. 137–141, 2011.
[41] K. Nellore and G. Hancke, "A Survey on Urban Traffic Management System Using Wireless Sensor Networks," Sensors, vol. 16, no. 2, p. 157, 2016.
[42] N. Buch, S. A. Velastin, and J. Orwell, "A review of computer vision techniques for the analysis of urban traffic," IEEE Trans. Intell. Transp. Syst., vol. 12, no. 3, pp. 920–939, 2011.
[43] J. Hopkin, "Study on ITS Directive , Priority Action A: The Provision of EU-wide Multimodal Travel Information Services D5 Final Report," no. May, 2016.
[44] D. S. N. Kheirabadi, D. N. M. Kulkarni, and D. A. D. Shaligram, "Wireless Sensor Network Based Traffic Monitoring; Overview and Threats To Its Security," J. Glob. Res. Comput. Sci., vol. 2, no. 8, p. 6, 2011.
[45] I. G. Guardiola, T. Leon, and F. Mallor, "A functional approach to monitor and recognize patterns of daily traffic profiles," Transp. Res. Part B Methodol., vol. 65, pp. 119–136, 2014.
[46] Jiankai Wang, N. Indra-Payoong, A. Sumalee, and S. Panwai, "Vehicle Reidentification With Self-Adaptive Time Windows for Real-Time Travel Time Estimation," IEEE Trans. Intell. Transp. Syst., vol. 15, no. 2, pp. 540–552, 2014.
[47] N. D. Agrawal and A. Sahu, "Intelligent Real Time Traffic Controller Using Image Processing – A Survey," vol. 4, no. 4, pp. 2980–2983, 2015.
[48] "http://www.its-uk.org.uk." .
[49] "http://www.Itscanada.Ca." .
[50] "http:// www.itsindia.org." .
[51] News from SakalNews- Today Section, Title- "To install Intelligent Traffic Monitoring system at Pune-Mumbai highway", pp 1, 1st December 2017.
[52] News from Maharashtra times of India , Title-"Vehicle strength increased about 50 lakhs", 8th September 2017.
[53] Chaudhry, G. A. "Evolution of the transportation system in Dubai." Network Industries Quarterly 14, pp. 7-11, 2012.
[54] http://eustandards.in, in the framework of project SESEI, Indo-European dialogues on ICT standards & Emerging Technologies, 07_dibyendu_sengupta_ebtc.pdf, 13th -14th March 2014.
[55] Xinlu, Ma, Liu Nanyun, and Li Bei. "The Date Collection and Analysis in Roundabouts with Traffic Signals."Measuring Technology and Mechatronics Automation (ICMTMA), 2016 Eighth International Conference on.IEEE, 2016.
[56] Li, Zhang, Lu Fei, and Zhao Yongyi. "Based on the Particle Swarm Optimization_NeuralNetwork integration algorithm in Internet of Vehicles application." Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC),Oct 3 (pp. 1973-1977) IEEE 2016.
[57] Singh, Bhupendra, and Ankit Gupta. "Recent trends in intelligent transportation systems: a review." Journal of Transport Literature 9.2 : 30-34 2015.

Authors Profile

Pallavi A.Mandhare, completed Master of Computer Sciencedegree from Savitribai Phule Pune University, formerly known asUniversity of Pune, India in 2006.Pallavi has qualified State Eligibility Test (S.E.T.) for Lectureship. She is Pursuing Ph.D. degree in Computer Science at Department of ComputerScience, Savitribai Phule Pune University. Currently, she is working as Assistant Professor in Computer Science Department,Savitribai Phule Pune University, Pune. Pallavi has more than 10 years of teaching experience for postgraduate programmes in Computer Science and Information Technology. Her research interest includes Computer Vision, Machine Learning, Artificial Intelligent.

© 2018, IJCSE All Rights Reserved

Prof. Vilas S Kharat, graduated with Physics, Chemistry and Mathematics, subsequently did his Master of Science from the Dr. B. A. Ambedkar Marathwada University, Aurangabad and Doctor of Philosophy from the University of Pune. During late Eighties he joined as a lecturer and in mid Nineties University of Pune, became full Professor in 2005. He is recipient of four consecutive best research papers awards by Indian Mathematical Society for the years 1998, 1999, 2000 and 2001. Professor Kharat has published number of research papers in different international journals. Five students have obtained their Ph.D. degrees and work of seven is in progress and importantly he has to his credit a partial solution to a very famous Frankl's Conjecture in collaboration with his research student. Kharat is also member of various learned societies including IEEE, American Mathematical Society member of various academic bodies which includes Board of studies, Research and Recognition Committee, Faculty of Science of various universities.

Prof. C.Y. Patil is the Head of Department at Department of Instrumentation and Control, College Of Engineering, Pune. He has more than 22 years teaching experiencers. A PhD in Instrumentation, he has international journal, national journal, international conferences and national conference papers to his name. He is a life member of Indian Society of Technical Education (ISTE), Instrument Society of India (ISOI) and Biomedical Society of India. Currently working on the above research, he has previously worked on Design and development of Wireless Sensor Network for Greenhouse Agriculture and Fuzzy based energy efficient & environment friendly Air conditioner.

© 2018, IJCSE All Rights Reserved

View publication stats