International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-8 Issue-7S2, May 2019

Mobile Crowdsensing for Traffic Congestion Control

Kuldeep Jha, Niranjan Ray

***Abstract*: Traffic Congestion Control is a major challenge for many urban transportation systems. The variations of volume and speed of vehicles during peak/normal hours severely affects the traffic monitoring activities. Also, due to increase in vehicular density and presence of other physical constraints resulting into traffic congestion. The existing traffic control mechanisms are not that much of efficient to tackle the congestions. In this paper, a mobile crowd sensing based approach is used to monitor and control the traffic congestions. To effectively control congestion and balance the traffic load, we have proposed a mechanism that reduces the congestion and provides better solution to handle this. The proposed approach uses Mobile Crowdsensing and Cloud computing technology to achieve better execution.**

***Index Terms*: Congestion control, Cloud Computing, Traffic load balancing.**

I. INTRODUCTION

In the present time, Internet of Things (IoT) based applications are omnipresent. IoT has become the centre of attention for many applications [1]. Consumer centric, mobile sensing and computing devices that are connected to the Internet are helpful in the evolution of IoT [2]. Few examples are: smart phones, music players, vehicles with different types of sensors etc. These devices use various sensors and wireless technology that helps them to communicate with other networks. There are numerous IoT applications that can run on these devices. Based on the applications they may be divided into (i) Personal detecting, and (ii) Community detecting. In the former approach monitoring is limited to an individual, where in the latter approach it is applications monitor phenomena that cannot be estimated by single person. Mobile Crowdsensing (MCS) is used to refer the broad range of community sensing. Crowdsensing permits a requestor to enroll smart device clients to give sensor information to be utilized towards a particular objective or as a component of a social or specialized analysis. Crowdsensing is not the same as Crowdsourcing because Crowdsourcing is a method for obtaining administrations, thoughts, and important information from a gathering of individuals. Crowdsensing is a similar standard just that the information is obtained by devices and not from human input. MCS utilizes blend of human and machine intelligence [3]. It lies at the intersection between the IoT and the crowd-based scheme [4]. There are numerous problems that can be solved using MCS. Traffic congestion is one of them. Streets and vehicular activity are a key piece of the everyday existences of individuals. Street and movement conditions in the creating scene have a tendency to be more shifted due to different socio-economic reasons. Street quality has a tendency to be variable, with uneven streets and potholes being ordinary even in the core of urban communities. Watching such moved road and development conditions is testing, yet it holds the assurance of engaging new and important functionalities. Traffic administration is changing into completely certifiable stress in the context of the fast rate of increment of vehicles. Watching their conditions have gotten a lot of thought. To screen this data, Intelligent Transportation System (ITS) has been made. ITS is a joining of computer, electronics and correspondence advancements to enhance thriving and gainfulness of transportation structure through transmitting real-time data. ITS deals with the current and also the consequent necessities of broadening improvement success, capacity, and solace. Traffic congestion is a situation on-street structure that happens as the utilization increments and is portrayed by coordinate velocities, long trek timings and high vehicular covering. This is likewise alluded as an automobile overload. As a result of Congestion which decreases profitability of transportation and assembles travel time, air sullying, and fuel usage. Congestion postures challenge for transporting lifesaving medications and gear, patients, mischance casualties, resistance hardware, cash chest and so forth. Traffic congestion happens when a volume of action or then again particular split produces enthusiasm for space more significant than the open road confine; this point is for the most part known as saturation. There are various clarifications behind traffic congestion. Some of them are the augmentation in the number of vehicles, poor street structure, poor development association, particular reasons like unevenly appropriated vehicles, negligence of traffic rules. There are numerous approaches to conquer traffic congestion. A growing variety of framework advancements and structure information styles are delivered to form transportation cleaner, safer and more viable. A few governments endeavor to enhance the street arrange through endeavors to manufacture new streets, flyovers, and underpasses but these endeavors are constrained to urban zones. Moreover, individuals some of the time develops illicit speed breakers on open streets to back off activity close to their homes and organizations.

The rest of the paper is organized as follows. Related works on traffic congestion control is discussed in section 2, in section 3 proposed work is discussed, simulation results

Revised Manuscript Received on May 28, 2019.

First Author name, CS&E, KIIT Deemed to be University, Bhubaneswar, India.

Second Author name, CS&E, KIIT Deemed to be University, Bhubaneswar, India.

Third Author name, His Department Name, University/ College/ Organization Name, City Name, Country Name.

are presented in section 4 and concluding remark is made in section 5.

II. RELEATED WORK

Numerous methodologies have been used to manage the traffic congestions. A vehicular correspondence framework for identifying congested driving conditions through data assembled utilizing between vehicles correspondence was proposed by Anand Bihade et al. [5]. The technique comprises of incorporating both the least congested itinemry algorithm and the SOP in the solution. Congestion inside a given region shown by a ZOR. All the vehicles in that ZOR react showing the traffic congestion level each in its relating area. Another framework based on traffic signal controllers and machine-learning techniques was proposed in [6]. The traffic signal sensor controllers take care of the issue by assessing what extent it would take for a vehicle based on traffic light. A wireless sensor network-based response for regular Indian city traffic was proposed in [7]. The approach here is to redesign flexibility of vehicles by gathering those courses which are next in line of clearance. A project called Nericell was proposed in [8]. The project concentrated on activity in growing areas. It focus on the set on the location of potholes in streets, in view of specific examples of increasing speed perceptions, and movement clog, where microphones were utilized to recognize sounding. The errand introduced activated detecting, in which an impression of a less essentialness eating up sensor is used to institute a more anxious for control yet exact sensor. ParkNet: An application that recognizes accessible parking spaces in urban areas utilizing advanced cells joined with ultrasonic detecting gadgets introduced on vehicles was presented in [9]. Project Cartel was proposed by Bret Hull et al. [10]. The CarTel framework can assess street travel times utilizing a blend of historical and constant data. These assessments are utilized as a part of location of congested street portions and progressively course wanting to limit expected travel times. An Intelligent Transportation System for Detection and Control of Congested Roads in Urban Centers was proposed by Celso A. R. L. Brennand [11]. This paper introduces an intelligent transportation framework that gathers continuous movement of data and can recognize the activity blockage based on this data. The proposed framework contains an arrangement of RSUs circulated through the guide keeping in mind the end goal to give full coverage. Each RSU is in charge of overseeing vehicles and distinguishing clog just inside the scope zone of its correspondence span. VANET empowered Eco accommodating Road Characteristics mindful Routing for Vehicular Traffic was proposed by Ronan Doolan [12]. This paper presents EcoTrec, a novel eco-obliging guiding count for vehicular action which considers road characteristics, for instance, surface conditions and edges, and moreover existing development conditions to improve the fuel assets of vehicles and decrease gas transmissions. EcoTrec makes usage of the Vehicular Ad-hoc NETworks (VANET) both for social event data from flowed vehicles and to dissipate information in help of the guiding computation. Congestion Avoidance Algorithm using Extended Kalman Filter was proposed by Sung-Soo Kim et al. [13]. This paper presents another activity forecast calculation on the premise of the joined information of both the historical and the real-time traffic information. In view of this activity forecast result, this paper introduces a novel steering strategy fit for giving canny course benefits totally sufficient to dynamic course direction frameworks. Road Traffic Congestion Management Using Vanet was proposed by Cynthia Jayapal et al. [14]. This paper presents an appropriated, community activity blockage discovery and dispersal framework that utilizations VANET where every one of the driver's advanced cells is outfitted with a Traffic App which is fit for area identification through Geographic Position based System (GPS). Mobile Crowd Sensing for Traffic Prediction in Internet of Vehicles was proposed by Jiafu Wan et al. [15]. Rerouting is done through dynamic shortest path algorithm.

III. PROPOSED WORK

In this section we propose a framework to mitigate traffic congestion using the concept of Mobile Crowdsensing. This model has benefits of both Crowdsensing as well as cloud computing. We try to overcome the limitation of most commonly used path selection approach. The major advantage of the proposed approach is given below.

A. Advantages

1. All the sensed data will be transmitted to the cloud and all the processing will be done in the cloud. Therefore, it circles each dealt with information online for the utilization of all client. All clients having internet connection can access the data.
2. The proposed system can be extended to other applications with minimal hardware support. It uses smart phones, which is nowadays most common handheld device. The user with the help of smart phone can connected to the proposed framework at anytime and anywhere.
3. All the necessary sensors are present in one place that is on the smart phone. This framework does not require any other hardware support.
4. The entire framework is user centric. The process from the data accumulation to data consumption revolves around user.

B. Working Method

As demonstrated by the Internet and Mobile Association of India (IAMAI) and Mobile Millennium ventures suggests that a 2%-3% utilization of cell phones by the drivers is adequate to evaluate the exact activity conditions. The road paths consist of different junctions. The smart phones of users will act as nodes. Smart phones conveyed by driver can occasionally forward information (e.g., mobile Id, area, speed, and course) to the cloud. To exchange and get information, the driver will utilize the cell Internet. The driver can rapidly get traffic congestion by smart phones. The service flow diagram is shown in Fig 1. The proposed framework uses the concept of Mobile Crowdsensing, each detecting and information transmission undertaking will be completed by the users. We additionally think about the calculation to acknowledge traffic congestion with MCS innovation.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

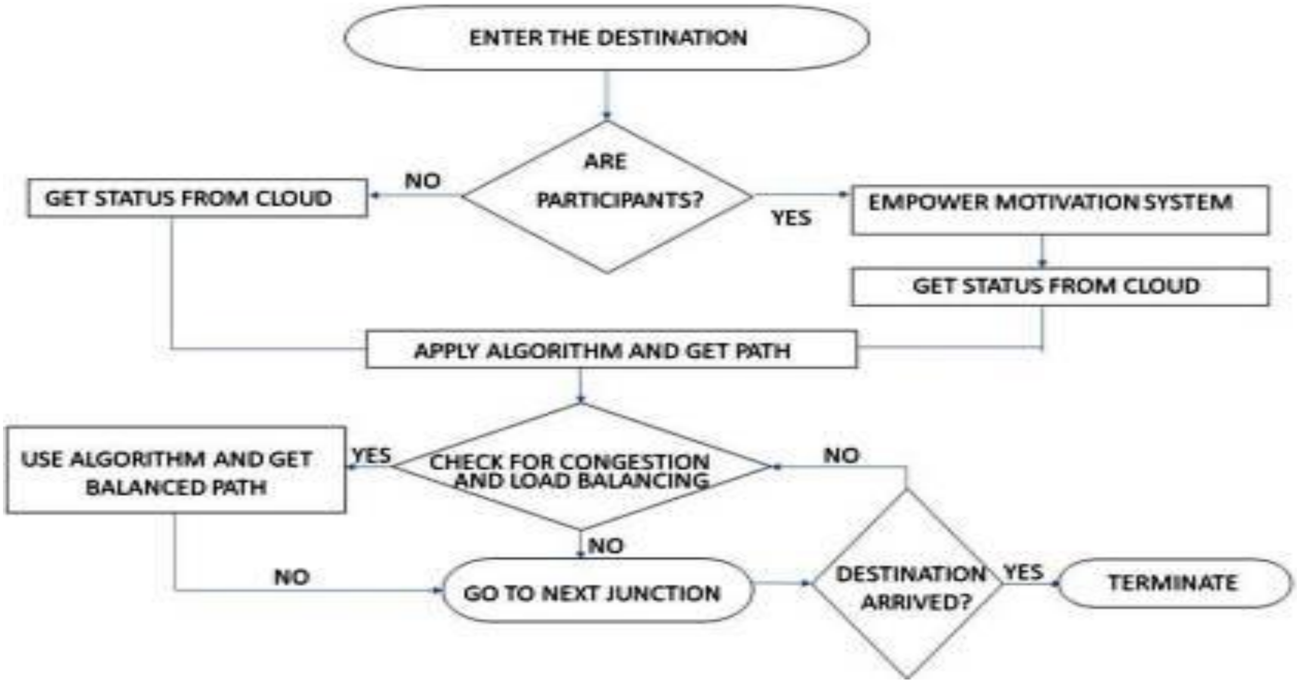

Fig. 1. Flowchart of Traffic Congestion Control.

Algorithm 1: Algorithm for Traffic Congestion Control
1: des: destination station
2: cloc: current location
3: procedure CONGESTIONCONTROL (des, cloc)
4: Construct the values of $r_{i,j}$,$d_{i,j}$ *and* $q_{i,j}$.
5: Using equation (3) and (4), construct the weight $w_{i,j}$.
6: Implement Yen's algorithm and get all possible paths.
7: check for the congestion.
8: if congestion found then
9: update weight $w_{i,j}$.
10: find new congestion free path and check congestion level.
11: if congestion level is high then
12: Choose smaller path with less congestion.
13: Go to the next node.
14: if destination arrived then
15: terminate
16: else
17: Repeat above steps.

The path is partitioned into various intersections. The information of every intersection will be placed in the cloud. In the proposed work, the cloud will have the separations between the distinctive junctions. The separation between various junction stays consistent. Congestion is caused by a few occasions, r i,j demonstrates the occasion that causes congestion. Congestion can be caused by numerous occasions. These sorts of events are called antagonistic occasion. The estimation of r i,j lies in [0,1]. The value of r i,j is provided as follows:

$$\left\{ \begin{array}{l} 1, \text{ if congestion;} \\ 0, \text{ normal events.} \end{array} \right\} \quad (1)$$

The nature of path will likewise be put away in the cloud. The nature of the path is ordered into 2 classifications: Road is of good quality and road which can't be utilized. The street quality has two values: -1 and 0. The street condition is spoken to as $p_{i,j}$. The estimations of $p_{i,j}$ are:

$$\left\{ \begin{array}{l} 0, \text{ if the street is in good condition;} \\ -1, \text{ if it cannot be used.} \end{array} \right\} \quad (1)$$

As this framework follows dynamic approach, hence to calculate the path we will use the weight matrix whose value will keep updating dynamically. The value of weight matrix will depend upon the values of distance between two nodes $d_{i,j}$, the road quality $p_{i,j}$and congestion $r_{i,j}$.:

$$w_{i,j}= r_{i,j}+ p_{i,j} + d_{i,j} \quad (2)$$

The value of $w_{i,j}$varies as follows:

$$\left\{ \begin{array}{l} d_{i,j}, \text{ if } p_{i,j}=0 \text{ and } r_{i,j}=0; \\ \infty, \text{ if } p_{i,j}= -1 \text{ or } r_{i,j}=1. \end{array} \right\} \quad (4)$$

Equation (3) and (4) shows how the weight of a path will vary. As shown in eq. (3), weight is dependent on three factors: distance $d_{i,j}$, road quality $p_{i,j}$ and congestion $r_{i,j}$. Weight will be equal to the distance $d_{i,j}$ if there will be no congestion and road can be used. Weight of the path will be set to ∞ if there is congestion or path cannot be used. If there should be an occurrence of congestion, the client will be rerouted on the various course based on their congestion level. On the off chance that rerouting is managed without checking the congestion level, it will simply move the congestion starting with one way then onto the next way. Subsequently, it is imperative to adjust the heap. The maximum number of vehicle can be calculated by dividing path length between two junctions (di,j) to the sum of average length of vehicle (Lavg) and minimum gap between the vehicles(Lgap). It is denoted by β.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

$$\beta = d_{i,j} / (L_{avg} + L_{gap}) \quad (5)$$

The congestion level is the proportion of current no of vehicles in a way (V(cur)) to the maximum number of vehicles that can proceed onward that way(V(max)). The congestion level is meant by α.

$$\alpha = V(cur)/V(max) \quad (6)$$

The value of α lies in the range of [0,1]. In case of congestion rerouting will be done on the basis of α.In case of congestion, N paths will be calculated. The vehicle will be routed on that path on which congestion is low. If two paths have same congestion level then the shortest path will be chosen. For load balancing rerouting can be done on the basis of congestion level. If the value of $\alpha < 0.6$, then there is no need toreroute, but if the value of $\alpha > 0.6$ then the system will start rerouting vehicle for load balancing.

The threshold value for rerouting is taken as 0.6. The density of vehicles along a path changes very rapidly. It is very necessary to maintain the load along all the path to prevent congestion. The value of αvaries between o to 1. Upto 0.6 there is no need to reroute the vehicles as the load along all paths are balanced. When the value of αbecomes greater than 0.6, vehicles will be rerouted on the path having value of αless than 0.6. As the vehicles density changes very rapidly, therefore it is possible to maintain the load by rerouting when αbecomes greater than 0.6.

But at a point we will get no path having congestion level < 0.6. In this case we will choose path on the basis of less congestion level. The priority of this system is to choose less congested paths. This approach will prevent congestion. The calculation utilizes any most limited way calculation to locate the best way, at that point continues to discover K − 1 deviations of the best way.The time complexity of Yen's calculation is subject to the briefest way calculation utilized as a part of the calculation of the ways, therefore, Dijkstra calculation has been expected.

IV. SIMULATION RESULTS

We utilized MATLAB/ Simulink as the simulation condition.We develop a weighted directedgraph G = (V, E, w) as takes after. Let V = (s1, s2, … ,sN), and E = {(si, sj)| there exists an immediate way amongst si and sj} as appeared in Fig. 2.

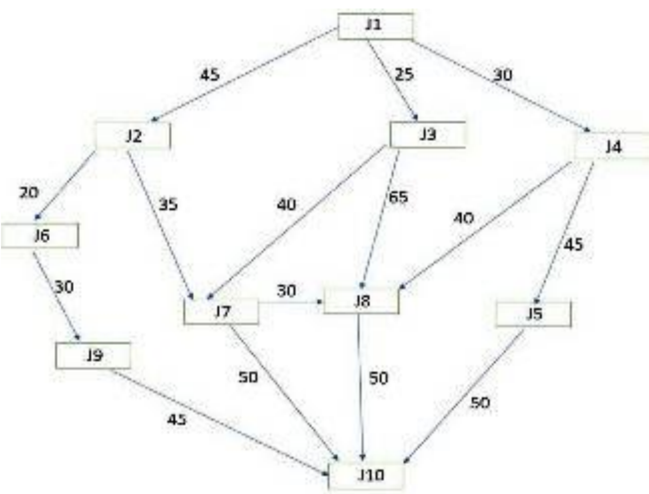

Fig. 2. The distance between different junctions (in km).

With a specific end goal to give a quantitative examination for the proposed approaches, we make a couple of assumptions: (1) The separation starting with one intersection then onto the next is thought to be known precisely. (2) The starting point and destination is known. (3) Maximum number of vehicles that can be available in a way is known. (4) The present number of vehicles is known. (5) The vehicles move with steady speed. We'll do simulation using different cases. After that we will compare the results of different cases with other approaches.

According to the algorithm, in case of congestion the weight of that path becomes infinite. Taking the congestion along path (3, 7) and (7, 10), the weight of both the paths becomes infinite according to the equation (3) and (4) as shown in the table I. Now, the different cases will be generated and optimum path selection for each case will be shown in table II. The selected cases will vary on the basis of the occurrence of congestion as well as congestion level.

Table I. Weight in case of congestion along (3, 7) and (7, 10)

0	45	25	30	0	0	0	0	0	0
0	0	0	0	0	20	35	0	0	0
0	0	0	0	0	0	∞	65	0	0
0	0	0	0	45	0	0	40	0	0
0	0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	20	0	30	0
0	0	0	0	0	0	0	30	0	∞
0	0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	0	0	0	45
0	0	0	0	0	0	0	0	0	0

Table II. Optimum Path Selection For Different Cases.

No.	R(i,j)	C_Level	Cost	Path
1	No Congestion	< 0.6	115	1-3-7-10
2	(3,7)	< 0.6	120	1-4-8-10
3	(3,7),(7,10),(4,8),(8,10)	< 0.6	125	1-4-5-10
4	No Congestion	(3,7)=0.9 (7,8)=0.8	120	1-4-8-10
5.	(3,7) (7,10)	(8,10)=0.8 (4,5)=0.7	140	1-2-6-9-10

In table II, from case 1 and case 4, it is clear that even if there is no congestion but if the load is unbalanced then the rerouting will be done to balance the load which will be helpful to prevent traffic congestion. Now the traffic congestion control algorithm will be compared with classical rerouting strategy which is Dynamic Shortest Path (DSP) strategy. It simply uses Dijkstra algorithm to find best shortest path.

Table III. Different cases compared with DSP.

Case	R(i,j)	C_level	DSP	MCS
1.	Nil	< 0.6	1-3-7-10	1-3-7-10
2.	(3,7)	(4,8)=0.7	1-4-8-10	1-4-5-10
3.	(4,8)(3,7)	(4,5)=0.9	1-4-5-10	1-2-7-10

From table III, it is clear that Dynamic Shortest Path approach picks way just based on briefest way. It doesn't consider clog level of the considerable number of ways. This approach is inefficient as it will simply move the clog

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

starting with one way then onto the next way. As though the chosen way has high clog and this approach will continue sending vehicles on the exceptionally congested way, after some time there will be blockage along that way.

V. CONCLUSION

Traffic Congestion is a noteworthy issue all around the globe. Only technology has the power to solve it up to some extent. In this paper, we have proposed Mobile Crowdsensing based framework to control the traffic congestion. The proposed framework provides the alternate path to the user in case of any occurrence of congestion. Along with providing alternate route choices, it balances the load along the street. Rerouting is done is such a way that it does not shift congestion from one place to another. Simulation demonstrates that the proposed framework works productively under various cases. Future work focuses on the execution of proposed work in more realistic situation.

REFERENCES

1. Jian, A., Xiaolin, G., Jianwei, Y., Yu, S., Xin, H.: Mobile crowd sensing for internet of things: A credible crowdsourcing model in mobile-sense service. In: 2015 IEEE International Conference on Multimedia Big Data, pp. 92-99 (2015). DOI 10.1109/BIGMM. 2015.62.
2. Ganti, R.K.,Ye, F.,Lei, H.: Mobile crowdsensing: current state and future challenges.IEEE Communications Magazine 49(11), 32-39 (2011). DOI 10.1109/MCOM.2011.6069707.
3. Guo, B., Yu, Z., Zhou, X., Zhang, D.: From participatory sensing to mobile crowd-sensing. In:2014 IEEE International conference on Pervasive Computing and Communication Workshops PERCOM WORKSHOPS), pp. 593-598 (2014). DOI 10.1109 / PerComW.2014.6815273.
4. Liu, J.,Shen, H., Zhang, X.: A survey of mobile crowdsensing techniques:A critical component for the internet of things. In: 2016 25th International Conference on Computer Communication and Networks (ICCCN), pp. 1-6 (2016). DOI 10.1109/ ICCCN.2016.7568484
5. Bihade, A.,Talmale, R.: Detection and avoidance of road traffic congestion using vanet. In: Proceedings of IRAJ International Conference,(21st July 2013), Pune, India (2013)
6. Sundarakumar, M.: Development of Cloud based adaptive Congestion control smart traffic management systems Development 5(4) (2017)
7. C, A., Kumar, M., Kumar, P.:City trafficcongestion control in Indian scenario using wireless sensors network. In: 2009Fifth International Conference on Wireless Communication and Sensor Networks (WCSN), pp. 1-6 (2009). DOI 10. 1109 / WCSN.2009.5434809
8. Mohan, P., Padmanabhan, V.N., Ramjee, R.: Nericell: rich Monitoring of road and traffic conditions using mobile smart phones. In: Proceedings of the 6th ACM conference on Embedded network sensor systems, pp. 323-336. ACM (2008)
9. Mathur, S.,Jin, T.,Kasturirangan, N., Chandrasekaran, J., Xue, W., Gruteser, M., Trappe, W. : Parknet: drive - by sensing of road-side parking statistics. In : Proceedings of the 8th international conference on Mobile systems, applications, and services, pp. 123-136. ACM (2010).
10. Hull, B.,Bychkovsky, V., Zhang, Y., Chen, K., Goraczko, M., Miu, A., Shih, E., Balakrishnan, H., Madden, S.: Cartel: a distributed mobile sensor computing system. In: Proceedings of the 4th international conference on Embedded networked sensor systems, pp. 125-138. ACM (2006)
11. Brennand, C.A.R.L., de Souza, A.M., Maia, G., Boukerche, A., Ramos, H., Loureiro, A.A.F., Villas, L. A.: An intelligent transportation system for detection and control of congested roads in urban centers. In: 2015 IEEE Symposium on Computers and Communication (ISCC), pp. 663-668 (2015). DOI 10. 1109/ ISCC. 2015.7405590
12. Doolan, R., Muntean, G.M.: Vanet-enabled eco-friendly road characteristics-aware routing for vehicular traffic. In: 2013 IEEE 77th Vehicular Technology Conference (VTC Spring), pp. 1-5 (2013). DOI 10.1109/VTCSpring.2013.6692807
13. Kim, S.S., Kang, Y.B.: Congestion avoidance algorithm using extended kalman filter. In: 2007 International Conference on Convergence Information Technology (ICCIT 2007), pp.913-918 (2007). DOI 10.1109/ICCIT.2007.147
14. Jayapal, C., Roy, S.S.: Road traffic congestion management using vanet. In: 2016 International Conference on Advances in Human Machine Interaction (HMI), pp.1-7 (2016). DOI 10.1109/HMI.2016.7449188
15. Wang, S., Liu, J., Shao, Z., Vasilakos, A.V., Imran, M., Zhou, K.: Mobile crowd sensing for traffic prediction in internet of vehicles. In: Sensors (2016)

AUTHORS PROFILE

Kuldeep Jha completed his Bachelor of Technology and Master of Technology from Kalinga Institute of Industrial Technology (KIIT) Deemed to be University, Bhubaneswar. During M.Tech , I worked on MOBILE CROWDSENSING.

Dr. Niranjan Ray is working as Associate Professor in KITS University, Bhubaneswar. His Research interest includes MANET, LAN, WAN etc.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication