[Samanta* *et al.*, 5(7): July, 2016]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

FUTURE VEHICLE TRACKING SYSTEM BASED ON WMSN

Sunny Samanta*, Sandip Roy
[*] Department of Computer Science & Engineering, SDET-Brainware Group of Institutions, India

DOI: 10.5281/zenodo.58557

ABSTRACT

Wireless Multimedia Sensor Network (WMSN) has recently attained the importance in several applications based on Multimedia Surveillance Sensor Network and Environment monitoring. The rapid accretion of mobile and sensor nodes open up a new path way for Internet of Things (IoT) to capacitate a new breed of future Internet based applications. In this paper we have proposed a fog based vehicle tracking system results in attenuated network traffic and diminished latency which incorporates an energy saving surveillance mechanism.

KEYWORDS: Cloud computing, Fog computing, IoT, RFID, WMSN.

INTRODUCTION

All Over the last few decades, Integration of Radio Frequency Identification (RFID) and Wireless Sensor Network (WSN) have drawn the attention of the research community for advancing different fields in vehicle tracking over the world. RFID is a versatile tool within vehicle capable of harvesting information from the external environment and processed on the extracted data to transmit it to the remote servers. More recently, RFID embedded in cloud computing have got a great demand on the technology market for future roadside computing. However cloud computing applications are developed for cloud provider's platform and processed data in different datacenter apart from the users' current location.

Therefore cisco proposed a new computing paradigm called fog computing where applications run on network edge devices such as set-top-boxes or access points. This new distributed computing architecture allows applications to run as close as users' access point [1, 2, 3].

Both Cloud and Fog provide computation, storage and application services to their users. Although Fog can be differentiates from cloud due to its location based fast processing service. With the advent of fog computing and Internet of Things (IoT) we proposed Fog-based Vehicle Tracking System (FVTS) for future Transport infrastructure as a service.

LITERATURE SURVEY

In this portion of the manuscript we have tried to articulate the background study of our proposed framework. The authors in [4] proposed a distributed solution based on node collaboration to select the optimal subset of camera sensors that participate in the target location process. SensEye [5] is the first solution that introduces the concept of heterogeneous network. In [6], authors proposed a low-cost new solution for tracking a mobile target called Energy Aware Object Tracking (EAOT). It consists of a distributed cooperative algorithm that runs in heterogeneous Wireless Sensor Networks composed of both scalar and multimedia sensors. The scalar sensors (SS) are equipped with a motion detector; their role is to detect the target and then activate the camera sensors (CS) through message exchanges. Here the authors considered the camera sensors are static i.e. they can't rotate. We have tried to improve the performance of incorporated WMSN in both target detection capability and energy consumption by considering rotational motion of IP camera sensor in FVTS [6].

Edge devices like sensor nodes or mobile nodes should reach out the cloud data centers in order to achieve high scalability for web-scale applications. Satyanarayan et al. [7], enunciates WAN latencies can be that much high to interfere with the interactive applications. Thus we can infer that cloud is too far from edge devices for latency-sensitive applications. Bonomi et al. in their manuscript [1] enlisted the fundamental characteristics of fog computing and also depict the importance of fog computing in order to implement the applications related to connecting smart vehicles in smart cities. The manuscript of Kirak Hong et al. [8] depicts the requirement of fog computing to the application required attenuated network traffic and diminished latency.

SYSTEM MODEL

Network Architecture

In this proposed system we have considered multi-tier cluster based architecture to overcome the shortcomings of conventional vehicle tracking system. The ground tier consists of RFID tags and scalar sensor nodes with RFID reader capable of sensing unique RFID tag number and transmits it to the parent fog server. RFID tags are associated with each vehicle number plate to identify the vehicle uniquely [9]. The middle tier consists of rotational IP camera sensor nodes that performs more complex tasks of identifying object and video capturing and sends the information to the parent fog server. These camera sensors are wireless multimedia sensor equipped with both motion detector and camera. The upper tier consists of the legitimate cloud server. The fog servers are placed at central hub or gateway of each tier for data processing and communication. The fog servers placed at the gateway of ground tier are referred as SS-fog-server. The fog servers placed at the gateway of middle tier is referred as CS-fog-server. The network architecture is depicted in the following Fig. 1.

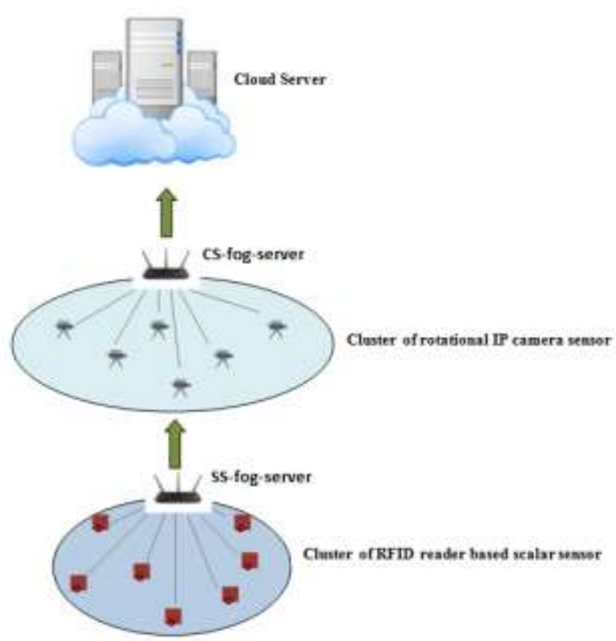


Figure 1: Proposed Network Architecture

,

Cluster Formation

In this framework the clusters are formed statically at the time of network deployment. Thus, all the member nodes and their corresponding parent nodes are defined before the tracking algorithm takes place. Thus this cluster ready infrastructure simplifies the monitoring system.

Kinematic Model of Rotational Camera

In our proposed system rotational camera sensor nodes are considered. The terms FoD and FoV are defined as follows in Fig. 2.

Definition 1 Each vehicle located in the Field of Detection (FoD) of CS can be detected by the corresponding camera sensor node. FoD is represented by a circle with radius D.

Definition 2 Each vehicle located in CS's Field of View (FoV) can be visually detected. FoV is a CS's directional view and it is assumed to be a cone with angle α and radius D.

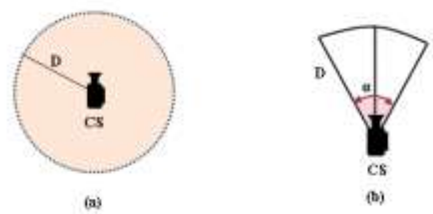


Figure2 (a): FoD of CS; (b) FoV of CS

Communication Model Using Wireless IP Camera Module

IP Network Cameras are designed to work over the Internet. IP cameras can send the captured images and stream live video via digital packets across the Internet. This means multimedia contents of surveillance environment can be accessed remotely and stored remotely giving legitimate users increased flexibility.

Capability of SS-fog-server

SS-fog-server maintains a storage containing list of interested vehicles such as **B**e **O**n **L**ook **O**ut (Bolo) vehicles. It also controls the camera sensor to tune them in active mode from sleep mode.

Capability of CS -fog-server

CS-fog-server also maintains storage to store the captured video of interested vehicle by the rotational IP camera sensor.

Energy Model for Packet Exchange

Heinzelman et al. [12] proposed a mechanism for power aware transmission in wireless networks based on a transceiver model in which the power consumed to transmit (E_{tk}) and receive (E_{rk}) k-bit message over a distance d is given by Equation (1) and Equation (2) respectively [12].

$$E_{tk} = k * (E_{elec} + \varepsilon_{amp} * d^{pl}) \quad (1)$$
$$E_{rk} = k * E_{elec} \quad (2)$$

Where E_{elec} amount of energy dissipates to run the transmitter or receiver circuitry per bit, ε_{amp} is the energy used by the transmit amplifier per bit and pl is the path loss exponent.

Capabilities of Cloud Server

A cloud server is maintained for storing multimedia contents of surveillance environment providing legitimate users increased flexibility.

VEHICLE TRACKING MECHANISM

The main objectives of our proposition are:

- To track the target vehicle behaviour properly with such a mechanism that saves the energy consumption of overall network.
- To enable the remote legitimate authority to observe the target vehicle behaviour with attenuated network traffic and diminished latency.

Our proposed mechanism integrates three emerging technologies i.e. WMSN, Fog computing and Cloud computing. Here our main objective is not only to improve the vehicle tracking capacity of sensor nodes equipped with rotating IP camera instead of using static camera sensor nodes but also to keep our eyes open for managing whole mechanism in an energy efficient way. So the main aim is not only appropriate vehicle tracking but also energy efficiency and information sharing with legitimate authorities are given same importance in our proposition [6]. Here we have assumed that the target vehicle moves with rectilinear motion. When a target vehicle enters in the area of interest, scalar sensors in cluster sense the corresponding RFID tags with the help of RFID readers and determine the vehicle number. Each of the scalar sensors sends a DETECTION message for each detected vehicle number to the parent SS-fog-server. The SS-fog-Server then determines whether the vehicle is a target vehicle or not, when 2 DETECTION messages that is set as threshold are received for a particular vehicle. If the detected vehicle is an interested one, the SS-fog-server sends an ACTIVATION message to activate the corresponding camera sensor CS_1.Then CS_1activates and starts rotating horizontally as the target vehicle moves. As the target vehicle is about to leave FoD of CS1, it sends a CONTROL message to activate the next CS (i.e.CS_2), according to the target vehicle movement path. When the target vehicle moves out of FoD ofCS_1, it goes to sleep mode. Now CS_2 rotates with the moving target vehicle. When the target is about to leave FoD of CS_2, it activates another CS (i.e.CS_3) by passing one CONTROL message and when target moves out of FoD of CS_2, it goes to sleep mode. The fog server checks for the target vehicle "only after receiving a threshold number of DETECTION message". Any CS is activated "only after receiving ACTIVATION messages from SS-fog-server" or "only after receiving 1 CONTROL message from another CS". After a certain time interval the SS-fog-server delivers the captured video records to the designated cloud server. Legitimate users can access these records and process them accordingly after proper synchronization. The overall process is depicted in the following Fig. 2 labeled with different activity order number and the following Table 1 enlists all the activities.

Table 1. List of different activities to be performed

Activity Order Number	Actors	Activity
1	RFID tags implemented in vehicle, scalar sensor with RFID reader	RFID tags are sensed and corresponding vehicle number is detected by scalar sensor.
2	Scalar sensor with RFID reader	A DETECTION Message with detected vehicle number is transmitted to SS-fog-server
3	SS-fog-server	Identifies whether the detected vehicle is target vehicle or not. Send an activation message to the corresponding rotating IP camera sensor
4	Rotating IP camera sensor	Zoom to the target vehicle and to record the target vehicle movement it rotates horizontally as the target moves. Sends CONTROL message to the next camera sensor according to the target vehicle movement path. The initiator camera sensor goes to sleep mode and initiated camera sensor moves to active mode.
5	Rotating IP camera sensor	Delivers the recorded video data to the parent CS-fog - server
6	CS-fog-server	After a time interval recorded video data are transmitted to designated cloud server

ISSN: 2277-9655
Impact Factor: 4.116

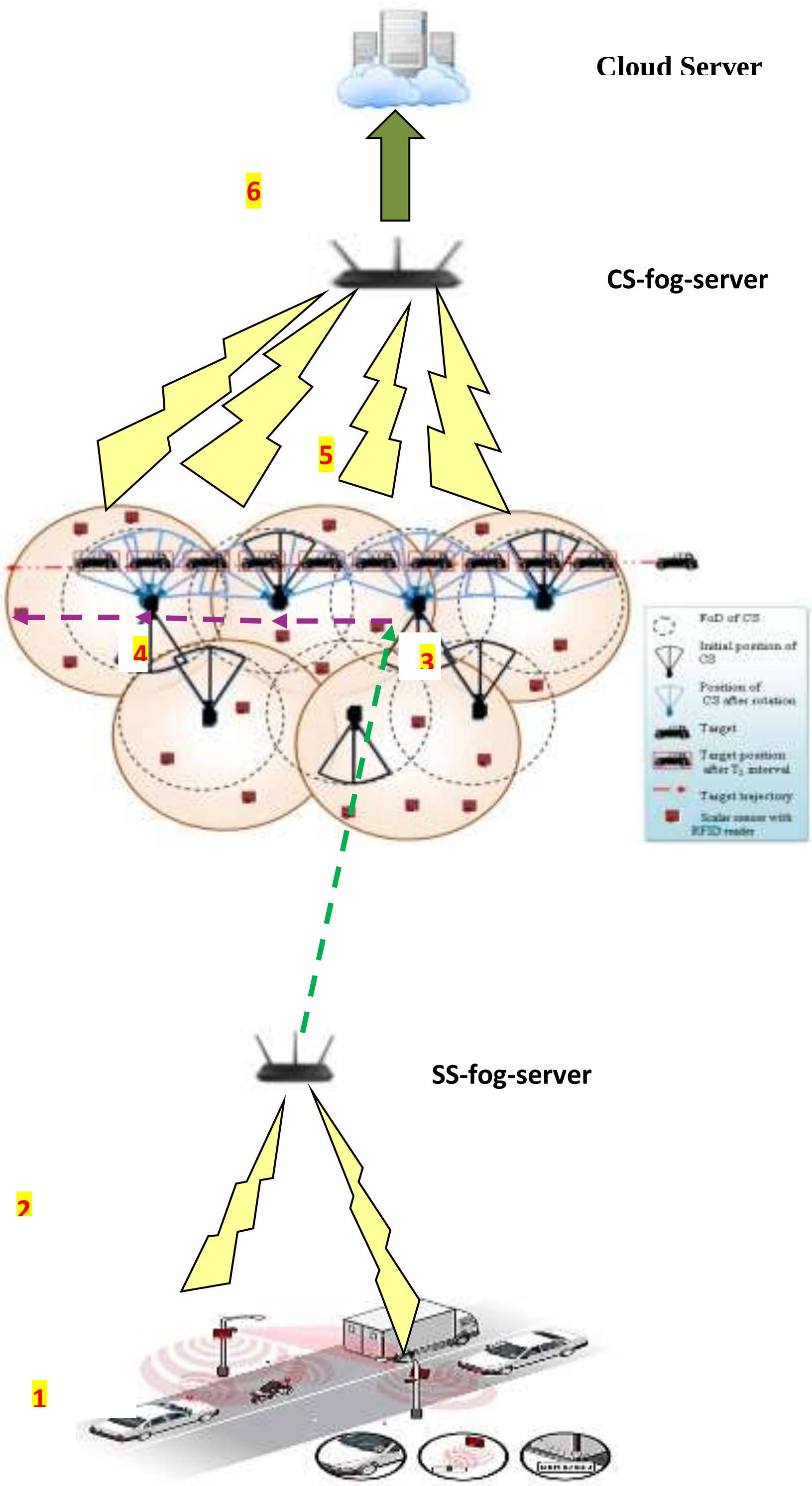


Figure3: Proposed vehicle tracking system model with different activities

The energy consumption for rotational motion of camera and for passing messages within the network is considered here. The energy expenditure for rotational motion of CS is calculated using the following Equation. (3).

$$E_r = 0.5 * I_d * \omega^2 \quad (3)$$

Where, I_d = Moment of Inertia of camera module, ω = angular velocity
Thus the energy expenditure for CS_1's activation is calculated using Equation. (4).

$$E_{mc1} = E_r + E_{act} + 2E_{tx} + 3E_r \quad (4)$$

For activating other camera sensor nodes (CS_i for i = 1, 2, 3 … n) each time the energy consumption is calculated using Equation. (5).

$$E_{mcother} = E_r + E_{act} + E_{tx} + E_{rx} \quad (5)$$

Where, E_{act} = Activation energy of CS, E_{tx} = Energy of packet transmission, E_{rx} = Energy of packet receive

EVALUATION

The efficiency of proposed scheme can be measured by crossing two stepping stones. The deployment of proposed WMSN in FVTS could lead up not only to proper target vehicle monitoring but also perform with energy efficient way. Incorporating fog-servers in between the sensor networks and cloud servers leads to attenuated traffic network and diminished latency.

Target vehicle tracking and energy consumption in FVTS

We have used Matlab R2012b simulator to simulate the WMSN incorporated in FVTS. We have used 1.3 Mega Pixel TOP3803 CMOS IP Camera Module interfaced with RS485 and Hi3512 camera chip. The two metrics are used to compare our proposed Fog-based Vehicle Tracking System (FVTS) with EAOT: Target detection by CS and energy consumption. All the parameters value for simulation is summarized below.

Table 2. Simulation parameter for WMSN

Parameter	Value
Target speed (v)	1.38m/s [6]
Transmission range (d)	30 m
Depth of view (R) of CS	20 m [6]
Angle of view of CS (α)	60° [6]
Size of message (k)	64 Kb [6]
Mass of IP Camera module	0.06 Kg
Length of IP Camera module	38 mm
Width of IP Camera module	38 mm
Energy used by circuit/bit (ε_c)	50nJ/bit/m^2 [10]
Energy used by amplifier/bit (ε_{amp})	0.1nJ/bit/m^2 [10]
Path Loss (pl)	2 [10]

We have considered a defined target trajectory. In Fig. 4, if the target is detected by CS then the phenomenon is represented by 1 otherwise 0 i.e. in case of not detection. Our new solution FVTS performs better than EAOT as shown in Fig. 4. Initially in both scenario target is detected by CS. After some time span when the target moved out of detection range of fixed CS, target is not detected by fixed CS but is detected by Rotating CS either in still image mode or video mode as it rotates with the moving target. Again when the target comes within the detection range of fixed CS, target is detected by fixed camera. The detection line of our proposed FVTS takes constantly the value 1 because the target is always detected by rotational CSs as CSs rotate with target movement.

ISSN: 2277-9655
Impact Factor: 4.116

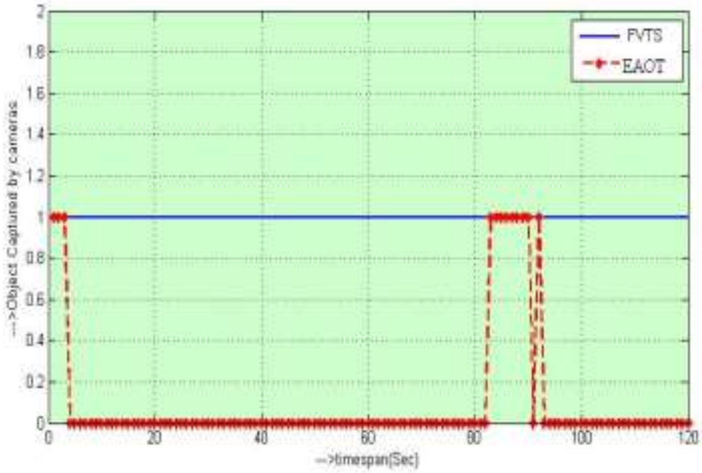
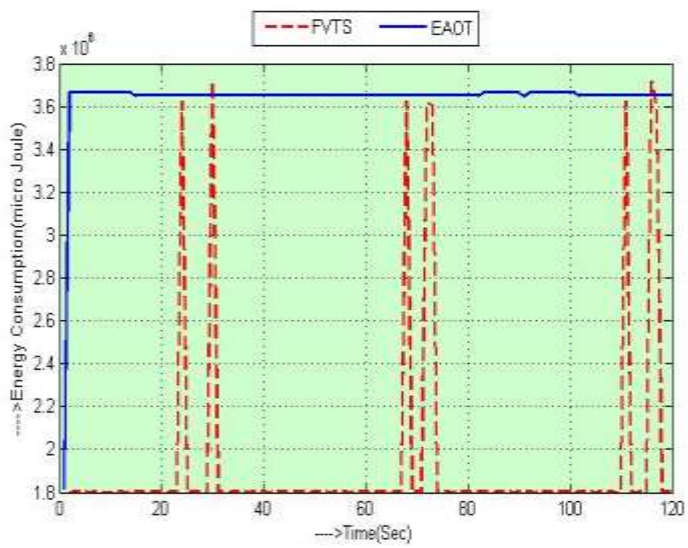


Figure4(a): Target detection capability



Figure(b): Energy consumption (micro Joule) Vs Time (sec)

Energy consumption

The energy consumption is much less in FVTS than EAOT as shown in Figure. 4. We have considered here that the target is within the area of interest throughout whole time span. As per EAOT if the target is in area of interest, DETECTION massages are broadcasted by SSs each time CS is activated and if target is within FoV of CS, CS sends LOCALIZATION Massage.

In FVTS, when target vehicle enters in the area of interest, to activate the first CS only, DETECTION massages are sent by scalar sensors to parent SS-fog-server. When target is about to move out of FoD of CS then CS passes a control massage to the next CS to activate it. The Mobile Sink also receives this control message and moves towards the next CS accordingly. The energy consumption of network in FVTS is calculated using Equation. (3), Equation. (4) and Equation. (5).

Rotation of camera sensor nodes

Rotation of Camera sensor nodes is shown in Figure. 5. Here we have considered only 4 CSs' rotation. Initially we have considered that CS_1 is at 90º, CS_2 is at 270º, CS_3 is at again 90º and CS_4 is at again 270 º angles with positive X-axis. It can be seen from Figure. 5 that CS_1 starts rotating as the target enter into the FOD and thus graph of CS_1

increases. In the mean while when target stays CS_1 stops rotating as the video mode is activated and the graph of CS_1 becomes straight line for short while. Then again CS_1 starts rotating when target moves, so the graph of CS_1 again starts increasing as its rotational angle increases with respect to positive X-axis. Now when displacement of target is about 40 m then it exits from FOD of CS_1 and enters the FOD of CS_2. So CS_1 stops rotating and CS_2 starts and accordingly the graph of CS_1 becomes stable and that of CS_2 starts increasing. This process is followed by CS_3 and CS_4 which is also shown in Fig. 5.

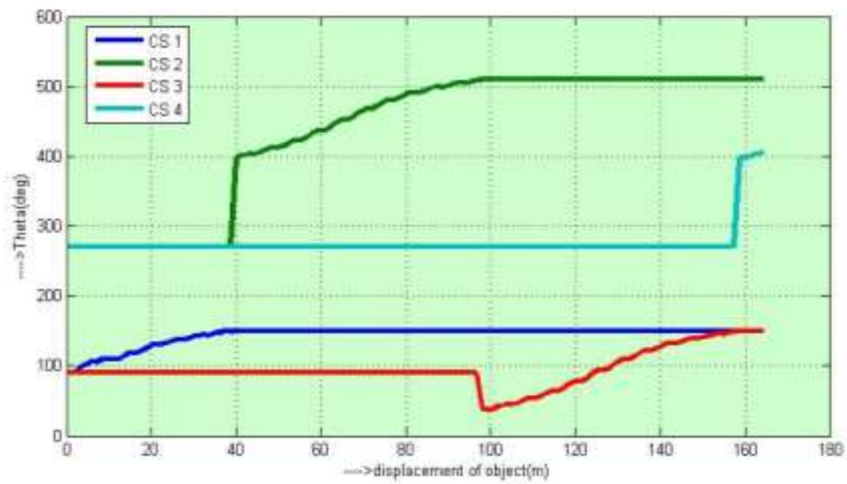


Figure5: Rotation of CS Vs Displacement of Target Object

Achieved attenuated network traffic and diminished latency

We have considered a simulation environment as stated at [6], where thousand randomly moving vehicles over an interval of fifteen minutes on the route network of (7.7 × 3.5 km) urban area is simulated. The entire region is wrapped by a Quadtree communication structure: a cloud server as root node, four CS-fog-servers as core fog servers, sixteen SS-fog–servers as edge fog servers that directly communicate with the scalar sensors. The network latency between each pair of nodes is also taken as 20 milliseconds. The said manuscript shows the graph that deploys the achievement of attenuated network traffic and diminished latency as the effect of using fog servers.

CONCLUSION AND FUTURE PLAN

In this paper we discussed a fog based simulation environment incorporating WMSN for tracking vehicle. Here we have used two fog servers, one for detected vehicle is target vehicle or not and another fog server stores the recorded video of the target vehicle to the designated fog server for evidentiary purpose. Hence our problem is current research issue for tracking BOLO vehicle. Our research methodology can be implemented future vehicular network. We have also planned to develop a distributed runtime system where our FVTS can be incorporated for better performance.

ACKNOWLEDGEMENTS

Authors gratefully acknowledge to the Department of Computer Science and Engineering of SDET- Brainware Group of Institutions, Kolkata, West Bengal, India for providing lab and related facilities for do the research.

REFERENCES

[1] F. Bonomi, R. Milito, J. Zhu, and S. Addepalli, "Fog computing and its role in the internet of things" in Proc of MCC'12, 2012, pp. 13-16.
[2] S. Roy, R. Bose, and D. Sarddar, "A fog-based DSS model for driving rule violation monitoring framework on the Internet of things" IJAST, 2015, pp. 23-32.
[3] S. Roy, A. Sen, T. Roy, and D. Sarddar, "Energy Efficient WMSN for Virtual Sensor-Based Global Information Sharing using Mobile Cloud" IJSER, Vol. 6, No. 6, 2015, pp. 1127-1133.

[4] L. Liu, X. Zhang, and H. Ma, " Optimal Node Selection for Target Localization in Wireless Camera Sensor Networks" IEEE Trans. On Vehicular Technology, Vol. 59, 2010, pp. 3562-3576.
[5] P. Kulkarni, D. Ganesan, P. Shenoy, and Q. Lu, "SensEye: a multi-tier camera sensor network" 13th annual ACM International Conference on Multimedia, 2005, pp. 229-238.
[6] I. Boulanouar, A. Rachedi, S. Lohier, and G. Roussel, " Energy-aware object tracking algorithm using heterogeneous wireless sensor networks" Wireless Days, 2011, pp. 1-6.
[7] M. Satyanarayanan, P. Bahl, R. Caceres, and N. Davies, "The case for VM-based cloudlets in mobile computing."IEEE Pervasive Computing, Vol. 8, 2009, pp. 14-23.
[8] K. Hong, and B. Ottenwalder, "Mobile Fog: A Programming Model for Large-Scale Applications on the Internet of Things" MCC'13, 2013, pp. 15-20.
[9] C. Sungur, H. Gokgunduz, and A. Altun, "ROAD VEHICLES IDENTIFICATION AND POSITIONING SYSTEM."in Proc. Federated Conf. on Com. Sci. and Info. Sys., 2014, pp. 1353-1359.
[10] S. Misra, M. Reisslein, and G. Xue, " A survey of multimedia streaming in wireless sensor networks" IEEE Communications Surveys & Tutorials, Vol. 10, 2008, pp. 18-39.
[11] H. Wu, and A. Abouzeid, "Power aware image transmission in energy constrained wireless networks" in Proc. 9th International Symposium on Computers and Communications, Vol. 1, 2004, pp. 202–207.
[12] WR. Heinzelman, A. Chandrakasan, H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks" in Proc. 33rd Annual Hawaii International Conf. on Sys. Sci., 2000.