EasyChair Preprint

№ 1846

A Various Surveillance and Detection Techniques Based on Wireless Sensor Networks

Rakesh Kalshetty and Asma Parveen

November 5, 2019

A various surveillance and detection techniques based on wireless sensor networks

Rakesh Kalshetty and Dr. Asma Parveen
Department of Computer Science & Engineering
Khaja Banda Nawaz College of Engineering
Gulbarga, India 585104
Email: {rakeshk.work, dr.asma.cse}@gmail.com

***Abstract*—In this paper we describe various methods used for surveillance and detection of various abnormalities (e.g. Human Interventions, natural calamities, and disasters, etc.) in the areas of interest. Although entities (Intruders, thief, temperature, humidity changes and fire accidents) surveillance has projected many challenges. But whereas, advances in technologies from time to time, many techniques were developed to identify the entities. In this survey paper, we describe and compare various techniques of surveillance and detection through a table and bar graph..**

Keywords—IoT, Real-Time, Context-Aware, Surveillance, Motion-detection, Face-recognition, Wireless Sensor Networks (WSN).

I. Introduction

In recent years there's been a rapid growth in the field of Internet of Things because of advances in technologies like cloud computing, context-aware computing, wireless sensors networks, etc. Whereas the IoT platform has made everyday devices smarter by processing an enormous amount of data generated by interactions between humans and devices. Context is any information that is used to distinguish between the entities, where an entity can either be a person, place, animal, object or an instance of time is considered relevant for interaction. Implementing context-aware computing into IoT is emerging as the future of smart computing, in which services offered by IoT devices will be available anywhere, anytime, anyway and anything is practically possible in true sense [1].

Intruder detection is one of the most important aspects of many critical areas, where no person is allowed to enter without authorized permission. These key areas may include banks, airports, government buildings, courts, hospitals, special laboratories like nuclear or chemical labs or even some parts of the planet (e.g. military base, U.S area 51, air force base station), which kept isolated from common people for national security. Intruding such places may cause critical problems for both intruder and even administrative authority of key areas. In addition, deploying guards at these places to safeguard is highly impractical and therefore, a hidden real-time surveillance system has to be deployed to monitor abnormalities in these places. Hereby, deploying a wireless sensor network system to understanding data collected and analyzing relationships between types of context information generated by these sensors which adapt to altering situations will justify the need for smart surveillance. Therefore, these sensors have to deal with context sensed from different entities (e.g. person, place, sound, time, etc.) for decision making.

As the Internet of Things generates a huge amount of data it's important to process and analyze sensed data into meaningful information. Therefore classification, modeling, and reasoning of context information to a specific situation is a challenging task.

The challenges that are faced while real-time surveillance system is as follows:

1. Whenever the sensors are placed in the area of interest, the location must be well illuminated so that the detection of an entity isn't shadowed.
2. The identification of an entity is highly complicated as sensors are placed at a distant location.
3. Power failure causes an interruption in the surveillance and detection of an entity.
4. Weak wireless connectivity between the admin module and sensors causes a delay in decision making and even loss of data.
5. For identifying various entities (e.g. humans, motion, temperature, humidity, etc.) variety of sensors are required for the identification of the entity.

To solve this above surveillance and detections complications, we combine various simple methods but powerful perceptual cues in a very probabilistic manner, to obtain precise surveillance and detection of an entity.

All of the potential entities belong to either area of interest or the surrounding of the surveillance location are segmented. Here segmented entities are identified and the sensors required for detection of any specific entity are deployed and data is obtained.

Following methods are implemented to increase robustness and accuracy:

1. With background subtraction method and with motion sensors abnormality in the surveillance area is detected, with PIR (Passive Infrared Sensors) dark areas are illuminated so that detection isn't shadowed.
2. By implementing the Viola-Jones algorithm face of an intruder is identified.
3. Verity of sensors such as temperature sensor, light sensor, smoke detector, humidity sensor, cameras, motion sensors are deployed and data obtained from these sensors are evaluated for proper decision making.

4. High-speed internet connectivity with power backup is utilized so that problems like data latency can be avoided caused due to week connectivity and power failures.
We analyze segmented sensors data which defines the processing of data. The second phase is to identify the entity in a particular surveillance location using internal contours in the processed images and data. And finally identifying an entity at any instance of time.

The organization of the paper is as follows. II section reviews Literature and briefly describes some related works and section III concludes the paper.

II. Literature Survey

IoT is constituted by part of sensor network which is deployed for detecting the motion of intruder in such restricted areas, the authors [2] have proposed a motion context which gives fair and high data extraction from each sensor node. The proposed system is capable of extracting sensor data in intruder detection applications of IoT.

This paper [3] presents a solution to the visual tracking mechanism which lacks in identifying objects or entities, a novel solution is developed to overcome the flaws whereas the objects or the entity is classified into multiple groups based on quadtree colour segmentation and furthermore item mining is performed to obtain collaborative tracking.

In this paper[4], the author proposes a face reorganization approach that is robust and efficient in matching faces using simple image filters and illumination invariance methods, which further need to be fed into an offline based algorithm were computation and learning of images take place

A vision-based human interaction system [5] is proposed, which deals with visual data to extract features of human face for an intelligent decision.

For the safety of food stored in the warehouse an online monitoring and control system [6] was developed. Where entities such as temperature and humidity are considered to protect food from spoilage. Also, a video surveillance system was deployed for monitoring and safeguarding storage area from external threats (e.g., Intruders, thieves). Furthermore, the system transmits sensed sensor data to the controller to take up an immediate measure.

A sensor-based system [7] was demonstrated for the efficient monitoring of grain stored in a warehouse. Here, the physical systems (e.g., air-conditioning system, humidity controller, light source) are connected to the cluster of sensors deployed all over the facility. Whenever storage condition varies and crosses threshold level the sensors sense abnormalities and turn on the physical systems so that conditions inside the warehouse is brought back to normal that is convenient for stored grains.

In this framework [8] fuzzy-based logics are used to predict the amount of time packed food is stored in a particular warehouse beyond which packed food will prone to germination and gets expired. To avoid such a situation fuzzy-based variable selection method was introduced.

An inventory information management system [9] for food warehouses integrated with a notification mechanism, which facilities stock picking and allocation system. This mechanism helps staff by informing about variations of the storage environment. The decision-making mechanism help minimize loss mainly caused due to deterioration, contamination, and expiry.

An RFID (Radio Frequency Identification) based system [10] monitors the amount of time perishable food items stored on smart pallets in the warehouse and these pallets triggers an alert before the maximum storage-time is reached. Such a way that losses of perishable food stored in a warehouse is minimized.

This paper [11] focuses on the design and development of an electronic nose integrated with temperature and humidity sensors, which is placed in a food warehouse to anticipate the rotting of food.

A MATLAB simulated controller based on fuzzy logic is developed [12], which is mainly used to control the temperature automatically when placed with air conditioning systems in a post-harvest storage facility.

The use of the Internet Smart Card [13] is demonstrated in the cold supply chain of perishable food for tracking and to continuously monitor physical conditions (e.g., temperature, humidity, and light source) in food warehouse and thereby, reducing the loss of perishable food items and enhancing quality when it is sold.

Here in [14], authors use mathematical modeling to demonstrate Markov_chain mechanism for estimating time spent by wheat stored in warehouses, considering physical entities (e.g., climatic conditions, temperature, humidity, germination factor, habitation, etc.) so that wheat can be kept fresh and edible which is stored for a longer duration.

This paper [15] presents the study of variations in the CO2 level for the determination of germination conditions of grains in the large food grain warehouses. Here, the CO2 sensor along with humidity and temperature sensors are used to obtain detailed information about the indoor conditions of the warehouse. Further, when each sensor node transmits acquired data wirelessly to a remote base station. Facilitates easy maintenance of depositories.

An Intruder detection system was developed [16] to monitor irregular activities in sensitive areas such as airports, govt. buildings etc. The developed system is a real-time surveillance system capable of identifying motion using wireless sensor networks which utilize radio frequency as the mode of contact between sensors, whenever the point of contact between sensors breaks and alarm is triggered to take necessary action.

The authors [17] have formulated the tracking of multiple objects. The sensors that are deployed for tracking objects consume lots of energy hence to conserve energy wireless sensors are put into sleep mode for a set amount of period but during inactive period sensors tend to produce tracking errors. Hence the Markov decision algorithm is utilized to overcome these errors.

The [18] surveillance equipment that is to be deployed in the forest or wildlife environment, here the instruments/devices are checked for their functionality, behavior, and maintenance so that devices can withstand the harsh environments and continue to monitor wildlife what so ever.

This paper [19] presents a dense sensor surveillance system based on generic, domain-independent approaches that are deployed around a large area, where multiple sensors send data to the central unit and by implementing the various algorithms results are obtained.

The work [20] demonstrates knight a surveillance system that is automated and implemented in real-world scenarios. The system is capable of tracking and identifying humans and objects, where the data is collected from multiple cameras gets processed using various techniques and the required result is obtained.

A model [21] was developed to simulate optimized power consumption by wireless sensor networks, here the system is capable of transferring data by eliminating redundancy between source and nodes with less consumption of energy during data transmission.

In the paper, [22]authors present a novel approach to identify the important parts of the video data produced by the cameras during the surveillance. Hence authors developed a context-aware summarization system that implements motion detection, spatio-temporal algorithm to fetch most informative parts, analyze data and triggers an alarm to take immediate action within time.

This paper reviews [23] developments in surveillance systems that occurred in recent years which utilizes technologies like motion detection, background subtraction, face detection, object identification, pattern recognization, multi-camera tracking, etc. Here combining all these techniques an

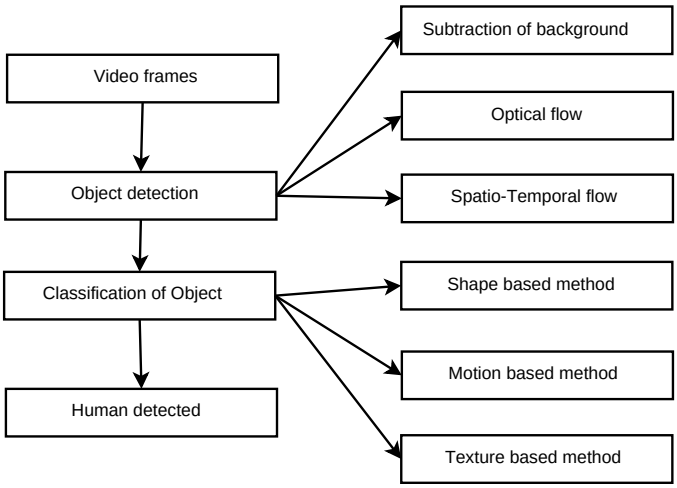

Fig. 2: FLOW CHART OF HUMAN DETECTION

and take necessary action to safeguard the house from external threats and intruders.

However, the above methods depicted only parts of faces as input for intruder detection without considering another context like the person, motion, time, place, etc. for surveillance which is more reliable and efficient in intruder detection and tracking. The

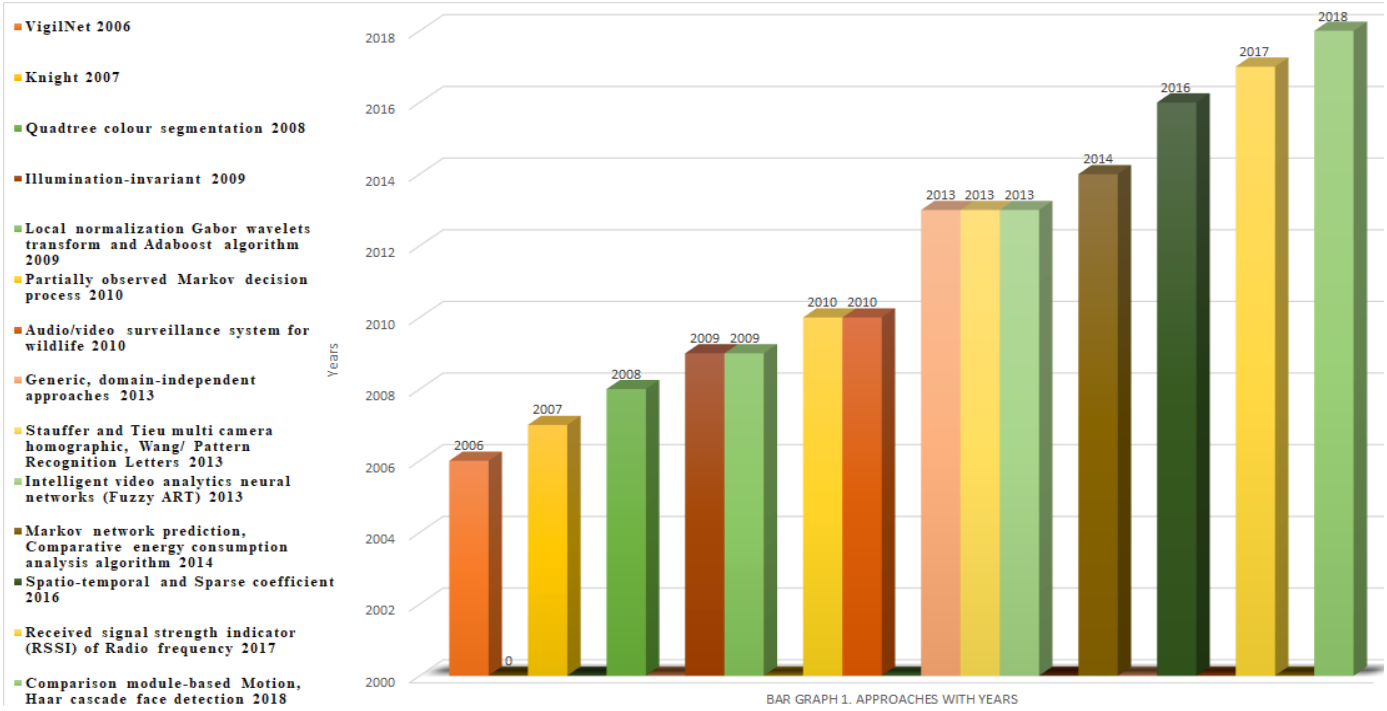

Fig. 1: APPROACHES WITH YEARS

The article [24] describe an approach for home security using the Internet of things, real-time monitoring system and wireless sensor networks utilizing data obtained from multiple sensors, a system is developed to process all the sensed data

TABLE I: COMPARISION TABLE

Author	Year	Approach	Description	Advances	Drawbacks
Tian He, Pascal Vicaire, etc. all	2006	VigilNet based on deadline partition method	The authors demonstrate real-time target tracking using wireless sensor networks by implementing VigilNet based on the deadline partition method.	Target tracking is implemented in a large area with 10,000 nodes as well as a small area such as 200 nodes which makes a flexible deployment of target tracking.	The accuracy percentage provided is 95% and the author hasn't provided the worst case of node failure with which target couldn't be tracked.
Mubarak Shah, Omar Javed etc, all	2007	Knight surveillance system	The work Knight demonstrates real-world scenarios to detect, classify targets and track them across multiple cameras.	The Efficient detection of entities in real-world scenarios is developed whereas lots of detection systems lack the identification of entities.	This system lacks in identifying camouflaged entities in extreme weather conditions and situations such as crowded places.
Ming Yang, Ying Wu, Gang Hua	2008	Quadtree colour segmentation	The Experiment implementing Quadtree colour segmentation exhibits exciting performance even in challenging real-world cases.	Based on context, target entities are tracked for long-duration which develops co-relation among multiple entities during tracking lost.	Here the system needs to track for long durations for relation build up. The short time interval for tracking isn't efficient.
Ognjen Arandjelovic, Roberto Cipolla	2009	Rapid illumination-invariant face recognition	In this paper, the author brings out a novel face recognition from low-resolution images by implementing rapid illumination-invariant using image processing filters.	Results excellent large, real-world face identification results from low-resolution images	The system doesn't implement robust image processing filters which could eventually reduce the loss of computational efficiency.
Yun Tie, Ling Guan	2009	Local normalization Gabor wavelets transform and Adaboost algorithm	In this paper, the author proposes face detection in video sequences using local normalization and other correlation techniques.	By implementing coarse to fine strategy and LN technique problems such as illumination variation in face detection are eliminated and even time consumption for processing is reduced.	The overall processing time for each frame in a video sequence is about 0.6 sec, which is a lot slower when compared to today's displays which range from 60-120 frames per second.
Jason A. Venu gopal	2010	Partially observed Markov decision process	The authors have formulated the tracking of multiple objects using a sensor network by implementing (POMDP) and dynamic programming methods.	Sensors are capable of tracking multiple objects without consuming much energy as the sensor goes to a sleep state when no objects are detected for a long period of time.	Sensors are capable of tracking multiple objects without consuming much energy as the sensor goes to a sleep state then no objects are detected for a long time.
Roman Gula, Jörn etc. all	2010	Audio/ video surveillance system for wildlife	The audio/video surveillance over a long period of time using relatively inexpensive components and which are easy to assemble.	Here animals and birds are observed 24x7 to find abnormality in behaviour, livelihood etc.,	There exist very large surveillance data even when there isn't any activity. Hence on-board storage gets wasted and processing such footage is time-consuming.

Author	Year	Approach	Description	Advances	Drawbacks
Jorge, Lorena Calavia, etc. all	2013	Generic, domain-independent approaches	This paper presents a dense sensor surveillance platform based on generic, domain-independent approaches that are deployed in large metropolitan areas.	Here video surveillance is achieved over a large area such as complete cities and facilities with inexpensive sensors that trigger an alarm when abnormalities are detected.	The complete surveillance area has to be installed with cameras without leaving any dead spot. Sensors such as motion, temperature sensors are not utilized which could come in handy inside congested areas.
Xiao gang Wang	2013	Stauffer and Tieu multi camera homogrraphic, Wang/ Pattern Recognition Letters	The authors in this paper review technologies like Stauffer and Tieu homographic and Wang/ Pattern Recognition Letters to solve problems in multi-camera video surveillance.	A Multi-camera setup has been implemented to monitor a specific area of interest, here tracking is possible even when an entity moves from one area to another without loss of data of an entity.	Human help is needed to continuously monitor an area of interest as the data from cameras are continuously transmitted on to the screen.
Marius, Grama, Rusu.	2014	Markov network prediction, Comparative energy consumption analysis algorithm	This paper goal an optimized energy consumption based wireless sensor networks for efficient communication and redundancy elimination.	An artificially generated results show, the developed protocol is capable of saving more energy when compared to other a protocol using wireless sensor networks that don't implement time and space data correlation.	The results are artificially generated and aren't compared with performances of other protocols that hold the same objective and could be more energy efficient.
Shu, Zhu, and Amit K.	2016	Spatio-temporal and Sparse coefficient	The author presents context-aware surveillance on video summarization where part of the video is distinguished and informative parts are retrieved.	The system is capable of identifying context and based on the type of content obtained the most important video is summarized.	Here the system is capable of identifying entities and their context but based on that it doesn't trigger any kind of alarm so that any mis happening couldn't be avoided in time.
Muhannad Quwaider	2017	Received signal strength indicator (RSSI) of Radio frequency	The proposed mechanism adopts the Received signal strength indicator (RSSI) of radiofrequency and measures signal strength between deployed sensors.	A pair of wireless motion sensors are deployed so that any motion in the area of interest can be detected and necessary action can be taken when needed.	By implementing motion sensors, all sorts of motions are detected and an alarm is triggered so besides behaviour identification cameras must be used to avoid unnecessary warnings.
S. Pandya, etc, all.	2018	Comparison module-based Motion, Haar cascade face detection	An approach to providing real-time monitoring of houses based on various sensors and large video data handling.	Here an intelligent house intruder detection system is developed where only human intruder is identified and a notification is sent to the administrator for necessary action.	The deployment of the system is limited to small places like houses but whereas in larges areas like factories, warehouses, etc, the intrusion is done not only by humans but also by animals, birds, etc, were it's necessary to identify intruders whatever might be.

III. Conclusion

In this paper, we specify the various methods of surveillance, motion-detection, object-tracking, classification, identification of entities that have been studied. And literature review of steps carried out for specific instances of an entity in a real-time environment using a variety of different approaches. This paper aims to identify an entity by using different methods and many approaches to get the best results.

References

[1] P. P. Ray, "A survey on Internet of Things architectures", Elsevier. 1319-1578, Journal of King Saud University – Computer and Information Sciences. Vol. 30, Issue 3, pp. 291-319, July 2018.

[2] Muhannad Quwaider, "Real-time Intruder Surveillance using low-cost Remote Wireless Sensors", 8th International Conference on Information and Communication Systems (ICICS), 2017.

[3] Ming Yang, Ying Wu, Gang Hua, "Context-Aware Visual Tracking", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 31, no. 7, pp. 1195-1209, may 2008.

[4] Ognjen Arandjelovic, Roberto Cipolla, "A methodology for rapid illumination-invariant face recognition using image processing filters", Elsevier. 1077-3142, Computer Vision and Image Understanding, Vol. 113, Issue 2, pp. 159-171, 2009.

[5] Yun Tie, Ling Guan, "Automatic face detection in video sequences using local normalization and optimal adaptive correlation techniques", Elsevier. 0031-3203, Pattern Recognition, Vol. 42, Issue 9, pp. 1859-1868, September 2009.

[6] Li Lijuan and Minchai Hao, "The mathematical model of food storage safety monitoring and control system", IEEE International Conference on Computer Application and System Modelling (ICCASM), vol. 13, pp. 591-594, 2010.

[7] Sazia Parvin, Amjad Gawanmeh, Sitalakshmi Venkatraman etc. all, "Optimised Sensor Based Smart System for Efficient Monitoring of Grain Storage", IEEE International Conference on Communications Workshops (ICC Workshops), pp. 1-6, 2018.

[8] Yasmin Y.Y. Hui, K.L. Choy, G.T.S. Ho, etc. all, "A fuzzy association Rule Mining framework for variables selection concerning the storage time of packaged food", IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), pp. 671-677, 2018.

[9] S. I. Lao, K. L. Choy, Y. C. Tsim etc. all, "An Integrative Food Handling System for Managing Inventory Information in Food Warehouses", IEEE PICMET 2010 Technology Management For Global Economic Growth, pp. 1-7, 2010.

[10] Faouzi Kamoun, Omar Alfandi, Sami Miniaoui, "An RFID Solution for the Monitoring of Storage Time and Localization of Perishable Food in a Distribution Center", IEEE Global Summit on Computer & Information Technology (GSCIT), pp. 1-6, 2015.

[11] Nihad Benabdellah, Mohammed Bourhaleb, M'barek Nasri, "Design of temperature and humiditysensors for an electronic nose used in rotten food", IEEE International Conference on Electrical and Information Technologies (ICEIT), pp. 505 – 509, 2016

[12] Adeyinka Oluwo, Md Raissuddin Khan, Momoh Jimoh E. Salami, "Intelligent Temperature Control of a Tropical Post-harvest Storage System", IEEE 10th Asian Control Conference (ASCC), pp. 1-6, 2015

[13] Pascal Urien, Selwyn Piramuthu, "Internet Smart Card for Perishable Food Cold Supply Chain", IEEE Eighth International Conference on Intelligent Sensors, Sensor Networks and Information Processing, pp. 83-88, 2013.

[14] Ge Wang, Qin Li, Jane You, "On wheat storage period estimation using Markov chain Analysis", 6th IEEE International Conference on Industrial Informatics, pp. 882-887, 2008.

[15] Neha R. Deshpande ; A.D. Shaligram, "Determination of Germination Status of Food Grains In Warehouses Using CO2 Sensor Data Acquisition System", IEEE 1st International Symposium on Physics and Technology of Sensors (ISPTS-1), pp. 33-35, 2012.

[16] Tian He, Pascal Vicaire, Ting Yan, Liqian Luo, Lin Gu, etc. all, "Achieving Real-Time Target Tracking Using Wireless Sensor Networks", 12th IEEE Real-Time and Embedded Technology and Applications Symposium, 2006.

[17] Jason A. Fuemmeler, Venugopal V. Veeravalli, "Energy Efficient Multi-Object Tracking in Sensor Networks", IEEE Transactions on Signal Processing, Vol. 58, No. 7, pp. 3742-3750, July 2010.

[18] Roman Gula, Jörn Theuerkauf, Sophie Rouys, Andrew Legault, "An audio/video surveillance system for wildlife", Springer Verlag, European Journal of Wildlife Research 2010, Vol. 56, Issue 5, pp 803–807, 2010.

[19] Jorge Fernández, Lorena Calavia, Carlos Baladrón, etc. all, "An Intelligent Surveillance Platform for Large Metropolitan Areas with Dense Sensor Deployment", Article, Sensors, pp. 7415-7442, 2013.

[20] Mubarak Shah, Omar Javed and Khurram Shafique, "Automated Visual Surveillance in Realistic Scenarios", IEEE MultiMedia, Vol. 14, Issue 1, pp. 30-39. 2007.

[21] Marius Popescu, Lăcrimioara Grama, Corneliu Rusu, Marius Sîrbu, "Communication Protocol for Wireless Sensor Networks for Energy Consumption Optimization", ResearchGate, The Institute of Electronics, Information and Communication Engineers, 2014.

[22] Shu Zhang, Yingying Zhu, and Amit K. Roy-Chowdhury, "Context-Aware Surveillance Video Summarization", IEEE Transactions on Image Processing, Vol. 25, No. 11, pp. 5469-5478, November 2016.

[23] Xiaogang Wang, "Intelligent multi-camera video surveillance: A review", Elsevier. 0167-8655, Pattern Recognition Letters, Vol. 34, Issue 1, pp. 3-19, January 2013.

[24] S. Pandya, H. Ghayvat, K. Kotecha, M. H. Yep and P. Gope, "Smart Home Anti-Theft System: A Novel Approach for Near Real-Time Monitoring, Smart Home Security and Large Video Data Handling for Wellness Protocol", Article, pp. 1-22, 2018.

[25] Honghai Liu, Shengyong Chen, Naoyuki Kubota, "Intelligent Video Systems and Analytics: A Survey", IEEE Transactions on Industrial Informatics, Vol. 9, No. 3, pp. 1222-1233, August 2013.