International Journal of Engineering & Technology, 7 (3.34) (2018) 15-20

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

A Study on Sensor Networks and its Research in Recent Application Developments

[1]K. Immanuvel Arokia James,[2]R.Prabu,[3]A.Mary Judith,[4]L.Gladis Flower

Assistant Professor (s),Department of Information Technology,
Vel Tech Multitech Dr.Rangarajan Dr.Sakunthala Engineering College, Chennai, India.
**Corresponding author E-mail: immanuel_james@yahoo.com, dprpit@gmail.com*

Abstract

In recent days Wireless Sensor Networks and Internet of Things have become a growing and challenging research area. Those are used in various hard and sophisticated real time environments. A lot of challenges have to be faced by the researchers in these areas to meet the features like the quality level of sensed data, nodes autonomy, less energy utilization, battery storage, cluster range with cluster head selection and size of nodes…etc. In this paper, We did an extensive analysis on their recent developments in various application areas such as intelligent buildings, smart homes, Smart city developments, healthcare and smart hospital, transport and traffic management, Horticulture, water resources and quality monitoring, smart grid, space research…etc. This analysis will be helpful for the fresh researchers for doing research in WSN and IoT. The researchers have to look in identifying better solutions to the above said challenges must meet.

Keywords: *Research applications; challenges; wireless sensor networks; IoT; Smart city; horticulture; smart grid*.

1. Introduction

A WSN is a collection of sensor nodes where each node is having sensors to detect physical quantities like smoke, light, heat, water level pressure...etc. By comparing the WSN with the wired sensor network, the features of WSN are easier deployment and better flexibility of devices. During this fast technological development of wireless sensors, the WSNs concept will become the key technology for Internet of Things [1]. The overview of WSN and application areas of WSN is shown in Figure 1 and Figure 2.

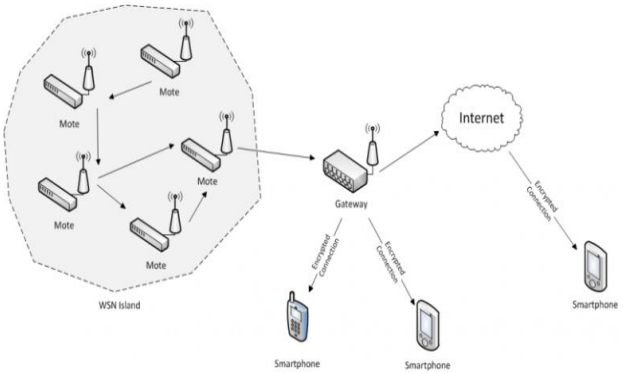

Fig. 1: Overview of WSN

In other words, A WSN formed by a collection of sensor nodes, each sensor units are designed with a microprocessor, radio interface, sensor unit, ADC with signal conditioning unit, memory unit and power supply unit.

The processor does controlling and managing functions and performs data processing. The sensors interfaced are having the capability of sensing temperature, pressure, humidity, light, smoke, etc. The given issues will be taken up for further research and developments. The Various applications areas of WSNs are Terrestrial, Underground, Underwater, Mobile and Multimedia WSN.

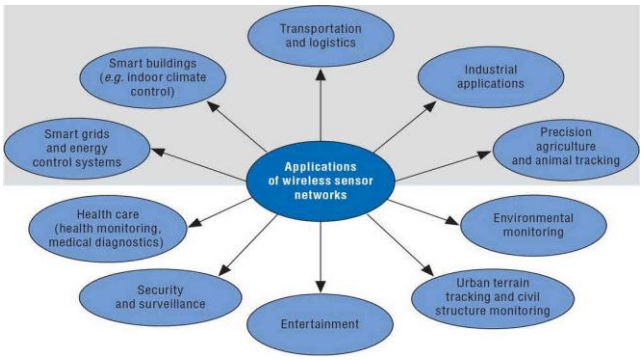

Fig. 2: Application areas of WSN

1.1. Terrestrial WSN

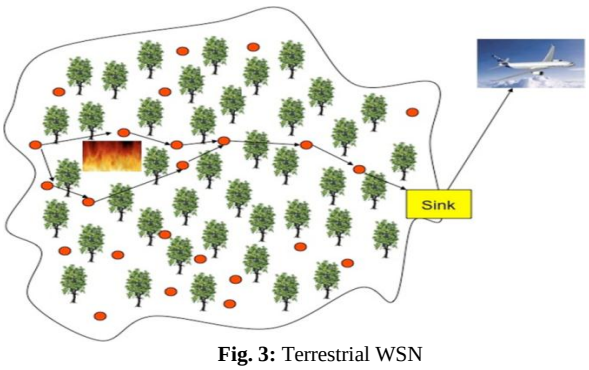

Fig. 3: Terrestrial WSN

In Terrestrial sensor networks solar cells are used. The energy can be conserved by reducing delays etc. The Figure 3 shows the Terrestrial WSN.

1.2. Underground WSN

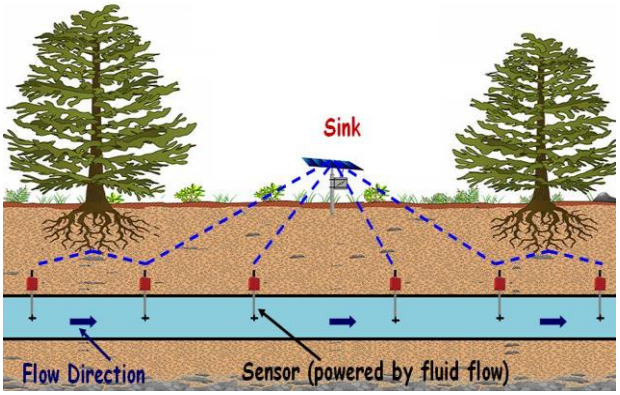

Fig. 4: Underground WSN

These are more costly than terrestrial networks. Very expensive equipments are used and properly maintained. Problems are faced while recharging the batteries, Loss of signal will be occurred due to high attenuation level. Examples are Water pipelines, Drainage. The Figure 4 shows the underground WSN.

1.3. Underwater WSN

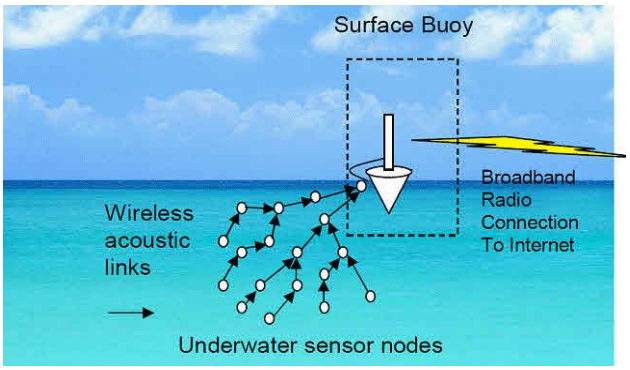

Fig. 5: Underwater WSN

The major issues and challenges of the underwater communication are long propagation delay and sensor failures. The battery of the sensor unit cannot be charged therefore so we must follow some other methods have to follow to solve this issue. Examples are Tsunami finder, Submarine and others. The Figure 5 shows the underwater WSN.

1.4. Multimedia WSN

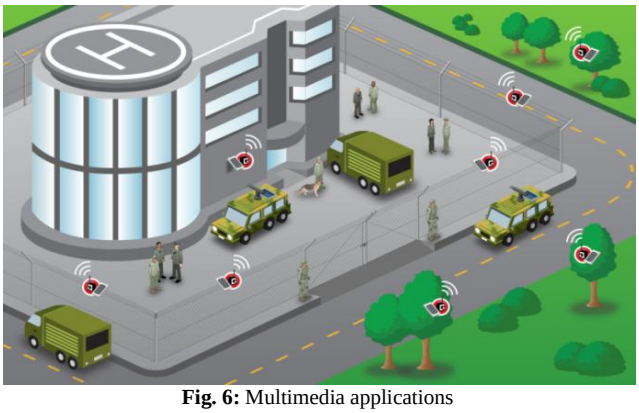

Fig. 6: Multimedia applications

In this application data will be in the form of audio, video and imaging. The sensor nodes are interfaced with cameras and microphones. These sensor units required high power consumption and wide bandwidth. Some advanced methods of data processing and compression techniques are used in it. Examples are various government organizations, banking sector and other secure areas. The Figure 6 shows the Multimedia WSN.

1.5. Mobile WSN

It is not a fixed environment; rather the portable sensor nodes can move anywhere. And this network can be easily interfaced with the existing network places. Their main advantages are they provide good in coverage, high channel capacity.

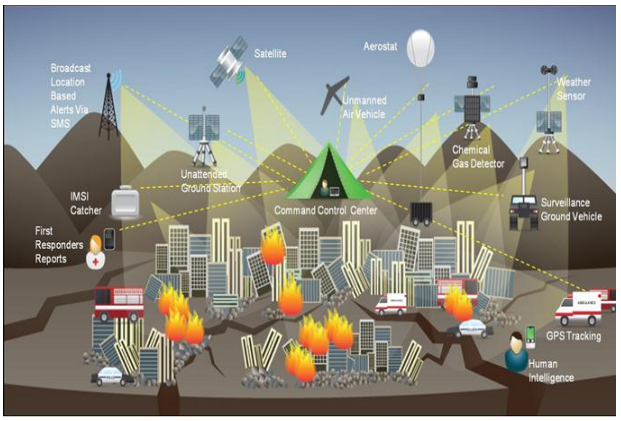

Fig. 7: Mobile WSN

Examples are Tsunami, earth quake, flood affected areas….etc. The Figure 7 shows the mobile WSN.

2. Traffic Patterns in Wsn

In Local Communication pattern anode data is to be shared among its neighbours and be used to transmit the information between the two nodes in straight. In point to point routing the data packet is transmitting through a randomly selected node to another node. In Convergence method, several no of node's data packets will be shared to a single base node. It finds the application for data collection in the WSNs. various traffic Patterns of the WSN is shown in Figure 8,

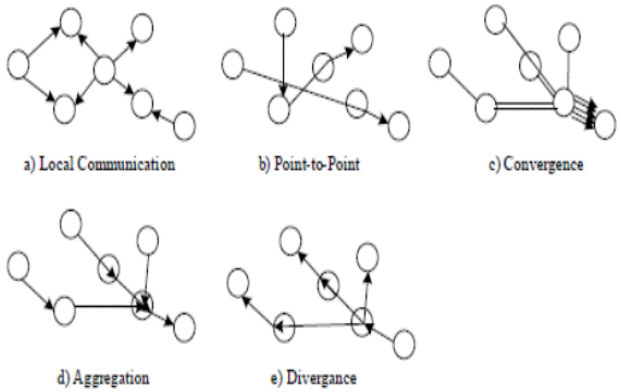

Fig. 8: Traffic Patterns in WSN

2.1. Topologies of WSN

Cluster based topology and Fusion centre based topologies are compared on the basis of the two most important factors for a WSN like Energy Efficiency and Lifetime of the sensor units.
It results Fusion centre based topology is more energy efficient in case of uniform distribution of sensors. Accordingly, when the

sensors are distributed randomly with cluster based topology proves that will be more efficient.

2.2. Protocol Stack for WSNs

The WSN protocol stack consists of five network layers namely physical, data link, network, transport and application layers and three new elements are power management plane, mobility management plane and task management plane. The WSN protocol stack is shown in Figure 9.

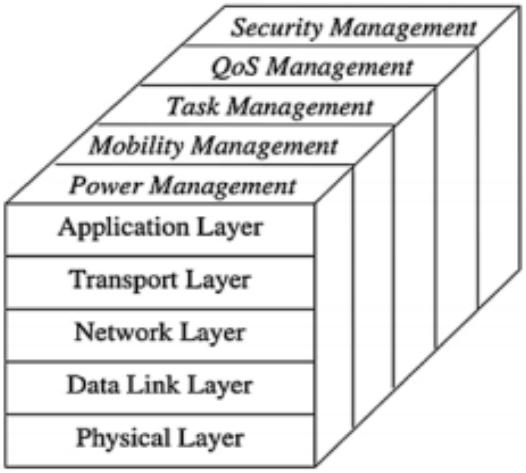

Fig. 9: Protocol Stack for WSNs

- The application layer - have various sensor network applications.
- The transport layer is used for reliable data transmission.
- The network layer is mainly taking responsibility of routing schemes between the sender and the receiver.
- The data link layer is dependable for data frame transmission / reception, data stream multiplexing, medium access control, and error control.
- The physical layer is dependable for line encoding, frequency generation; signal encoding, transmission / reception.

The comparison of OSI versus WSN protocol stack shown in Figure 10.

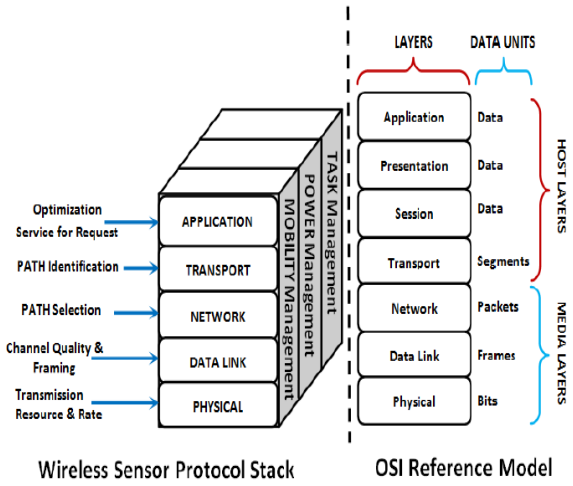

Fig. 10: WSN vs. OSI

2.3. Market Status

IDTechEx research has analyzed and found that the WSN market will grow up to 1.8 billion USD in next ten years. This analysis refers that the WSN defined as wireless mesh networks with self healing, self adapting and self organizing. The WSN ultimately have the capability of automatic monitoring of water or oil pipe line systems, flood, hospitals, storm, hurricanes, forest fire, military surveillance, transportation, navigation and other wide areas. The wireless sensor network trade is set to turn out to be a multibillion dollar boom. This WSN market report focuses the developers and manufacturers and came across closely at the hurdle to rollout and finding the possibilities to overcome those issues [2]. The Figure 1 shows the future market status of WSN.

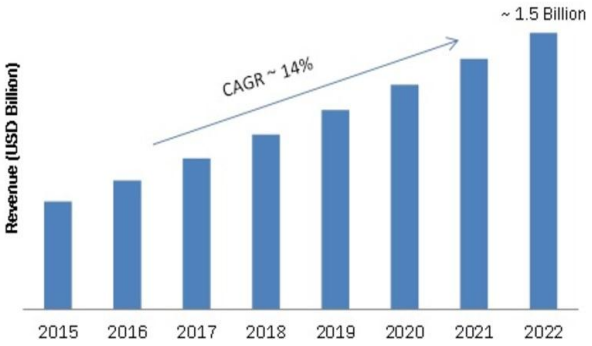

Fig. 11: Global WSN Market Status 2016-22

Now globally the growth of WSN market is expected at the rate of more than ~14% in the years 2016 to 2022. And major aspect that obliges the growth of the WSN market is because of huge demand in robotics, automation, Gas, Oil, automobile industries [11].

3. Recent Application Developments of Wsn

The recent application areas of WSN areas as follows Smart City, Smart Buildings, Transportation and logistics, Industrial applications, Agricultural, Animal tracking, Environment monitoring, Urban terrain tracking, Civil structure monitoring, Entertainment, Security surveillance, Health care monitoring, medical diagnostics, Smart Grids, Energy control systems…etc

3.1. Predictive Maintenance

Now days the range of the sensors has developed in fast with low cost sensor units. This has led to a speedy development in sensor based monitoring systems. This analysis demonstrates the wireless sensor technology for monitoring the railways, structures, automobiles and machinery [3].

3.2. Intelligent Buildings and Smart Homes

The real time monitoring of the electrical and electronics appliances can be complied through internet from anywhere. This device can be upgraded to monitor the whole smart building environments. This setup will be helpful to ensure the areas of more electricity usage level and to solve this issue by which we can minimize the power consumption and to enhance the usage of alternate resources during peak hours [4].

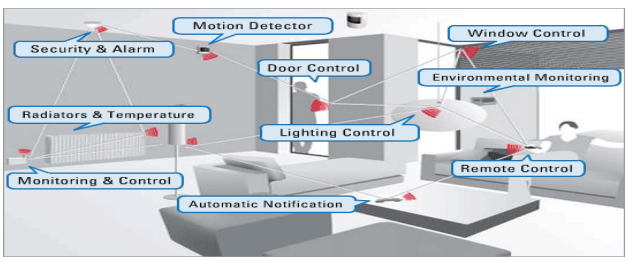

Fig. 12: Smart Home using sensors

Everywhere tiny sensors and rapid research developments in the wireless network technology have transformed of revolution in home, office buildings monitoring system and security surveillance systems. The installation setup and configuration of these sensor devices for an elderly persons and bed ridden patient's house will become a smart home in the making of small cities. The overall system is used for machine learning to analyze the data generated by the sensor nodes [6]. The Figure 12 shows the smart home applications using various sensors.

3.3. Healthcare and Smart Hospitals

In future there will be a binding between the existing medical systems with wireless networks. They are coexisting with the installed network environment. Examples of areas in which present and future medical fields will be benefited highly from IoT like smart nursing home for patient care, clinical trial and research growth.

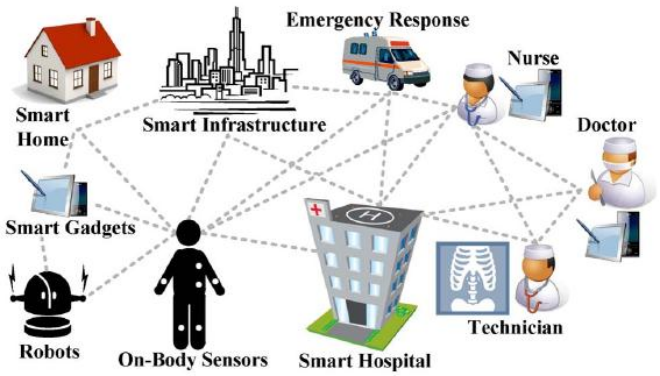

Fig. 13(a): WSN in Healthcare

Therefore, many researchers have getting idea for doing research in biological and medical applications [5].

Fig. 13(b): Human body diagnose

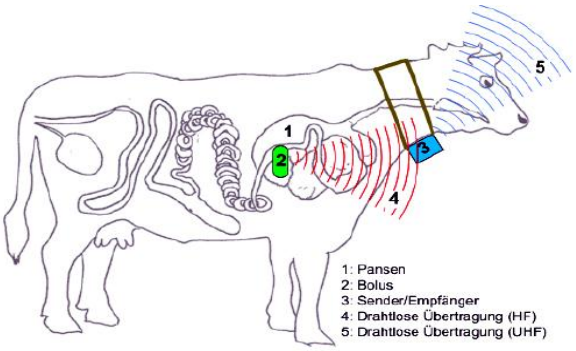

Fig. 13(c): Animal's stomach diagnose

Not only for human, by using the WSN system we can determine the pH level and the temperature level of animals by sending sensors inside the animal's stomach. The above Figures 13(a), 13(b) and 13(c) show the use of WSN in Human and animal health care domain.

3.4. Smart City

The applications of WSN in Smart cities include power generation and distribution, pollution monitoring, traffic management, water pipeline, waste management and utilization, domestic pipelined gas maintenance. The Figure 14(a) shows the various smart city applications and the Figure 14(b) shows the waste management system using WSN and the Figure 14(c) shows the smart pollution detection system using WSN.

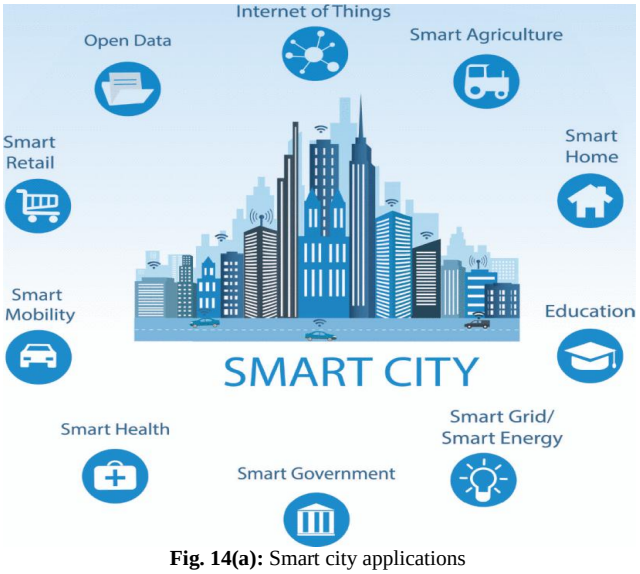

Fig. 14(a): Smart city applications

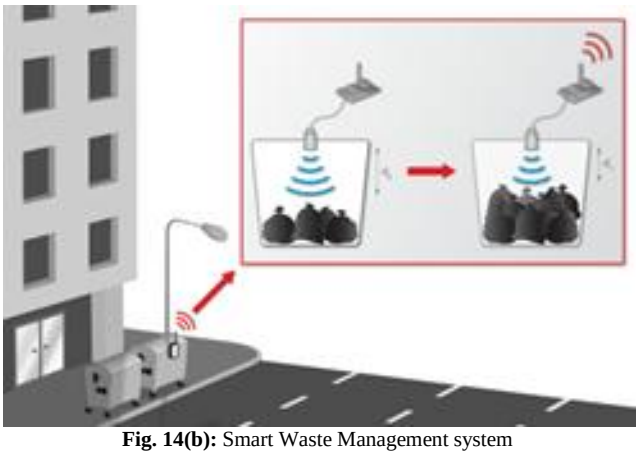

Fig. 14(b): Smart Waste Management system

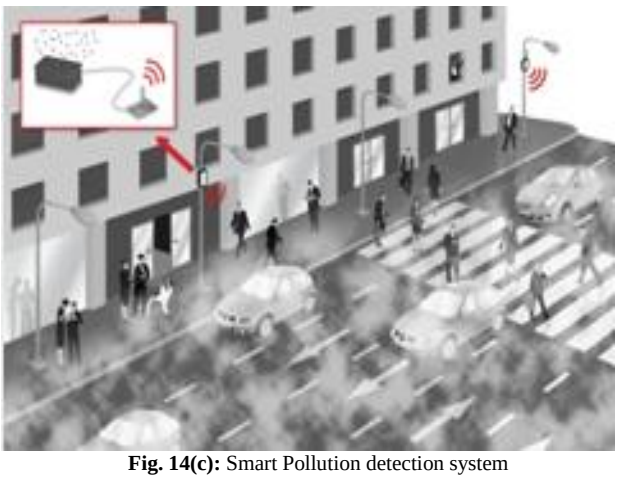

Fig. 14(c): Smart Pollution detection system

3.5. Transport and Traffic Management

Now days constantly increasing of vehicular traffic are a headache and the presently using traffic management systems are not satisfactory. In future, this system should be modified to solve continual traffic congestion and increasing more accidents. The WSN based intelligent transportation systems have huge possibilities to overcome those troubles.

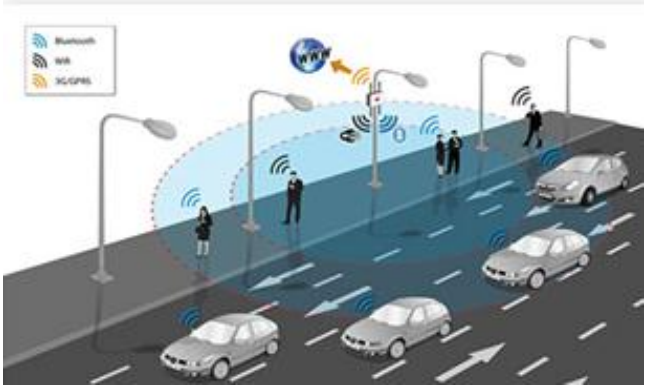

Fig. 15(a): Smart Road Transport Management system

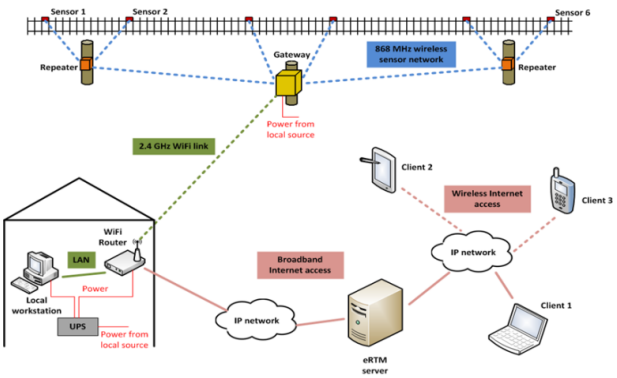

Fig. 15(b): Smart Railway Management system

Intelligent Transportation Systems are takes important part on smart city formation in traffic congestion control, traffic safety, road and track monitoring, vehicular warning services, and parking management system [8]. The Figure 15(a) and Figure 15(b) show the smart traffic management system using WSN.

3.6. Horticulture

In General WSN architecture used for monitoring the agricultural crops. Berkeley Medium Access Control is useful to guarantee the power autonomy of sensor node with high degree.

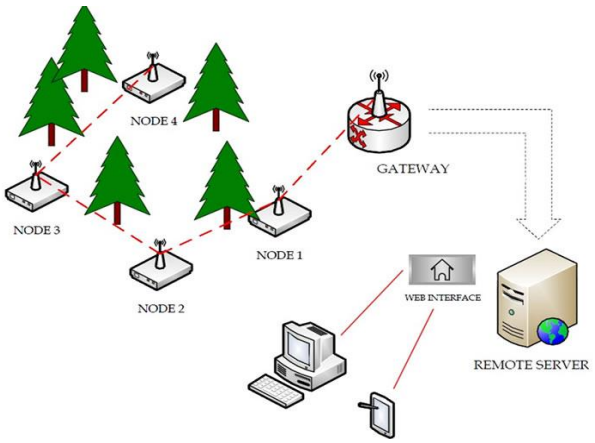

Fig. 15: WSN in Agriculture

This has the topology to arrange network using four types of nodes like Soil Mote, Gateway Mote, Water Mote and Environmental Mote. These networks have been designed along with a gateway interconnecting them with the central office [7].

3.7. Water Resources and Quality Monitoring

Wireless sensor networks plays significant role in real time monitoring of water pipeline network. This application is considered to be one of the most important challenges. And it is expected to magnify over time, given the shortage of available traditional water resources and the immense costs of providing fresh water from non-traditional water sources such as water treatment plants like desalination etc. Hence, a robust and reliable Wireless sensor networks technology is required to monitor leakages, bursts and other anomalies in the water pipelines. It gives clarity and combined analysis on WSN for water resource monitoring applications [9]. This application is a very big challenge in WSN like to solve implementation issues.

3.8. Energy Saving Smart Grid

The major issues in the power distribution networks of effective monitoring are fault diagnostics, automation and data communication can boost the possibility of system failures. To solve the above problems, smart grid concepts have to be developed. And the Smart grid concepts are based on recent electric power grid environments, which provide effective integration of all other renewable energy sources in order to the sensing technology, communication and automated control platforms [10]. The desired applications of smart grids are huge and they can be listed as follows,

- Higher reliability and safety,
- More energy efficiency,
- Easy integration of plug-in electric vehicles,
- And high physical, operational security and flexibility against attackers and disasters,

The main technical challenges for realization of WSN based smart grid applications can be summarize as follows,

- Security.
- Packet Errors and Variable-Link Capacity.
- QoS Requirements of Smart Grid Applications.
- Harsh Environmental Conditions and Dynamic Topologies.
- Resource Limitations of Sensor Nodes.

The major challenges of WSN development are as follows,

- ❑ To maintain network energy efficiency, reliable data delivery with timely and the Size, Memory space and Bandwidth.
- ❑ To increase the lifetime of each sensor node,
- ❑ To reduce the power usage,

4. Routing Protocols in Wsn

In Location-based Protocols locations are sensed by the sensor nodes. For the sensor networks, sensing locations are one of the most important task. Using these nodes, the distance between two particular nodes can be calculated and from this distance energy consumption can be estimated. These types of protocols use location to guide routing discovery.

Through Data centric protocols data is sent from source to sink. When the source sensors send their data to sink intermediate sensor perform data collection from multiple sensor nodes and send the collected data and forward to the sink. By using this protocol energy is saved because of less transmission required to send the data from the source to sink Hierarchical clustering is an important aspect in WSN.

Hierarchical protocol is used by the sensors to report their sensed

data to the sink. It is a energy efficient communication protocol. In this layered protocols a network is composed of several cluster of sensors. All the clusters present in the network range are managed by a special node called cluster head (CH). This CH will be the responsible for all data coordination and data transmission activities of all sensors within the clusters. The Figure 16 shows the various routing protocols in WSN. In addition to that the routing protocols for dynamic spectrum networks should exploit the flexibility and power of cognitive radios while addressing unique challenges not present in traditional networks. And the challenges on routing in dynamic spectrum networks are considered by the feasibility of applying approaches previously proposed for conventional networks [13].

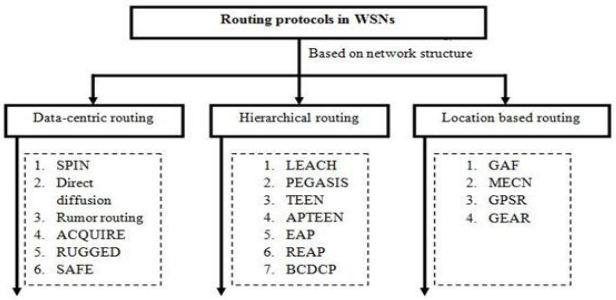

Fig. 16: Various Routing protocols in WSN

The landmark based centric routing protocol, which employs the geographical information of landmark to predict the mobility of nodes having strong social relationships with the landmark. And we can also use social interaction utilities and the content based multicast scheme such that their positive effects on protocol performance can be preserved in our protocol [12]. The main advantages are flexible, efficient, secure packet delivery and high energy.

5. Research Scope

By following the below steps, we can make the WSN as energy efficient,

- Comparing different routing methods, a new algorithm can be designed, developed, tested.
- Can try a variety of sensor batteries, and test under different conditions such as humidity and pressure and see their effect on the battery lifecycle.
- Dead node identification mechanism can be done on different scenario can be considered; from this a new algorithm can be developed to vary the recharging cycle of the battery.
- A new energy efficient power saving algorithm can be developed.

6. Conclusion

Wireless sensor networks (WSN) make the modern life, focus better quality life by linking many intelligent and smart devices. Everything around us can be get automated by using WSN. This article provides an overview of WSN concept, its applications and the latest studies demanding situations. Also offer an awesome groundwork for researchers who are showing interest to know-how within the region of WSN. And a portion of problems, issues and difficulties that relate to the deployment of WSN implementation were discussed. The future developments in these WSN and IoT applications must have many challenges such as routing protocols, energy consumption, data security, data aggregation and minimal cost devices. The researchers have to look in to overcome the above mentioned issues and have to give high priority to solve those problems.

References

[1] Internet of Things: Wireless Sensor Networks International Electro technical Commission IEC WP IoT: WSN:2014-11(en)

[2] http://www.idtechex.com/research/reports/ wireless-sensor-networks-wsn-2014-2024-forecasts-technologies-players-000382.asp

[3] V. J. Hodge, S. O'Keefe, M. Weeks and A. Moulds, "Wireless Sensor Networks for Condition Monitoring in the Railway Industry: A Survey," in IEEE Transactions on Intelligent Transportation Systems, vol. 16, no. 3, pp. 1088-1106, June 2015.

[4] K. Suryadevara, S. C. Mukhopadhyay, S. D. T. Kelly and S. P. S. Gill, "WSN-Based Smart Sensors and Actuator for Power Management in Intelligent Buildings," in IEEE/ASME Transactions on Mechatronics, vol. 20, no. 2, pp. 564-571, April 2015.

[5] J. A. Stankovic, Q. Cao, T. Doan, L. Fang, Z. He, R. Kiran, S. Lin, S. Son, R. Stoleru, A. Wood "Wireless Sensor Networks for In-Home Healthcare: Potential and Challenges"

[6] D. Basu, G. Moretti, G. Sen Gupta and S. Marsland, "Wireless sensor network based smart home: Sensor selection, deployment and monitoring," Sensors Applications Symposium (SAS), 2013 IEEE, Galveston, TX, 2013, pp. 49-54.

[7] Juan A. López, AntonioJavier GarciaSanchez, F. Soto, A. Iborra, Felipe Garcia-Sanchez, Joan Garcia-Haro, "Design and validation of a wireless sensor network architecture for precision horticulture applications", Springer Precision Agriculture, April 2011, Volume 12, Issue 2, pp 280–295

[8] Mohamed Amine Kafi, Yacine Challal, Djamel Djenouri, Messaoud Doudou, Abdelmadjid Bouabdallah, Nadjib Badache, "A Study of Wireless Sensor Networks for Urban Traffic Monitoring: Applications and Architectures", ANT 2013, Elsevier - Procedia Computer Science 19 (2013) 617 – 626.

[9] M. S. BenSaleh, S. M. Qasim, A. M. Obeid and A. Garcia-Ortiz, "A review on wireless sensor network for water pipeline monitoring applications," Collaboration Technologies and Systems (CTS), 2013 International Conference on, San Diego, CA, 2013, pp. 128-131.

[10] Gurkan Tuna, V. Cagri Gungor, Kayhan Gulez, "Wireless Sensor Networks for Smart Grid Applications: A Case Study on Link Reliability and Node Lifetime Evaluations in Power Distribution Systems", International Journal of Distributed Sensor Networks February 2013 vol. 9 no. 2 796248.

[11] https://www.marketresearchfuture.com/re ports/wireless-sensor-network-market-1805

[12] K.Immanuvel Arokia James, R.Prabakaran, "Analysis of Landmark Based Wireless Sensor Routing protocols", IJCTA, 9(9), 2016, pp. 3679-3689

[13] A.Sri Janani, K.Immanuvel Arokia James., Analysis Of Decentralized On Demand Cross Layer In Cognitive Radio Ad Hoc Network. Advances in Natural and Applied Sciences. 10(5); Pages: 1-5