

Wireless Network Sensors Applications and Challenges in a Real-Life Environment

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Abstract

Wireless sensor network is authentic, cheap, reliable and suitable way to monitor and observe different and divergent types of physical domains. Now a days, a demand for scalable communication networks is increasing so the entities can be observed based on physical nature and environmental condition. Wireless sensor networks are very promoting in nature because of its precise sensing, cheap induction, and its flexible nature in sensor position. These wireless sensor networks assist for data collection and wirelessly collaboration between devices. These sensors technology gives the advantage of accessibility and convince as they are small and cheap and exert for analysis in several applications. But still these sensors are not perfect, they still need a lot of improvement for data and signal transmission, data routing and processing. Since WSN are only competent of constrained and limited transmission range, storage space and processing. In this paper we'll discuss some issues that needs to improve in order to make efficient transmission and other related aspects. We'll also discuss some applications that are used in real life environment. In the end we'll give some solutions that will help to solve our discussed issues.

Keywords— Wireless Sensor Network, Applications of WSN, WSN, Issues, Challenges, Solutions

1. INTRODUCTION

Today is the era of modern technology, where technology is emerged in our lives and our lives are dependent on these technologies. Now a days, Sensors are everywhere such as in cars, in our computers, in gadgets in factories, in transport, in machines etc. The definition of Wireless Sensors can be explained as group of nodes that collect and collaboratively sense data in order to control the surroundings and environment as stated and

corresponded to several conditions. Wireless sensors network also allow collaborative interaction among different computing devices, surroundings and persons etc.

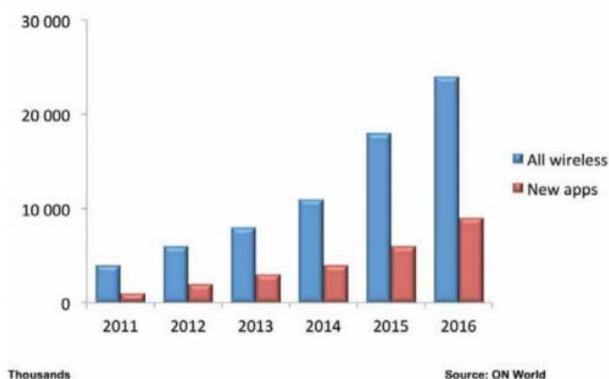
In the past, Basically the utilization of Wireless sensor networks was started in the last of 20th century. United State Defense Advanced Research Projects Agency (DARPA) established Distributed Sensor network (DSN) for military purposes [16]. in the past, technology wasn't notable and wasn't supposed to be in common hand so DSN meant to use cheap nodes communicates with each other however operate independently by military. In the last of twenty centuries, the sensors weren't small in sizes but huge i.e. bigger than standard box size and the use of sensors was also very limited as the detailed use of applications wasn't explored. But now a days, as the technology is evolved so much, as the communication, perception technology via sensors evolved so much as well as different application areas are investigated.

Now a days, every node in wireless sensor networks is obliged to percept some physical condition and environmental phenomena, such as light, humidity and temperature etc., In order to process and perceive some information and take some action according to specific constraints.

Generally, WSN are divergent in their kind and characteristics where several hundreds and thousands of small sensors suppress heterogenous attributes of different nodes. If we considering a single node, we can assume that node holds low processing ability, transmission power and space [12-16]. even though these nodes suppresses limited power, the implementation of these sensors are exerted in many applications areas. As a matter of fact, wireless sensor network is quite interesting area in research and sill in progress.

The research direction of wireless sensor networks was move towards progress in 1988 and getting an worldwide attention by researchers and scientist. In the beginning the research was more concentrated on

network technologies and network processing information. As the research evolve, the researchers focus on the problem how to shrink the size of sensors and reduce the cost of sensors. Small size of sensors bring a tremendous change in the field of WSN. Different application areas tried to adopt the use of sensors. In the result, todays sensors can be found easily in almost every field. In 2016, Hatler et al. [17] reported economical and industrial use of sensors. According to them, approximately 11 million dollars of sensors are used in industries. A report presented by Freedonia Group is shown below:



Wireless sensing points installed globally

Around 24 million wireless enabled sensor and actuators are deployed around the globe.

2. Literature Review

As the technology is evolving day by day and changing our lifestyles as well. Now a day's sensors can be found in every corner of our lives, in car, in our phones, computers, machines, factories on in different gadgets etc. Wireless Sensors networks can be explained as different set of nodes that percept data and information and may direct the environment according to different conditions, that may permit interaction between persons, computing devices and adjacent environment [1].

The significance of WSN is defined in the context of Structural health monitoring due to its increasing demand of reliability and safety needs. An introduction of new technology based on structural health monitoring system is initiated with defined advantages and comparison with traditional system. The challenges brought out by SHM are also reported and non-functional requirements are defined in context of precedence [2]. In the context of Security issues that are related to Software -Defined WSN, different challenges werediscussed, and an approach was designed in order to solve basic and several profound issues [3]. A survey is conducted, and different applications specifically target tracking, commercial applications, environmental monitoring, traffic monitoring, habitat monitoring, smart homes

sensor applications are presented in the context of Security issue [4].

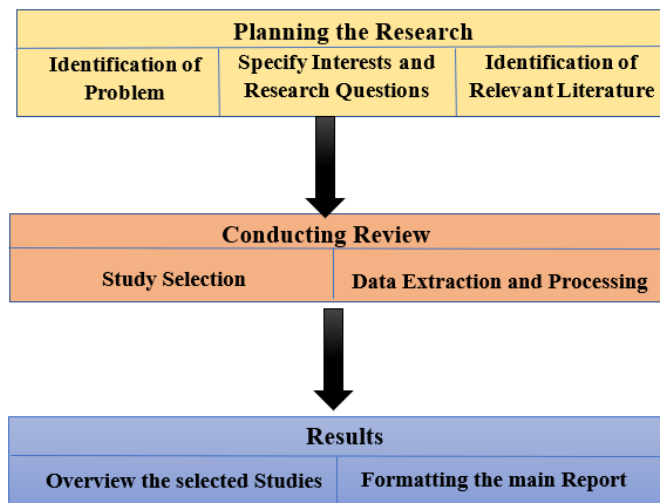
Challenges were composed in the context of mobile terminal technology, different parameters that affect on the performance of network were also inducted. Divergent issues were debated in terms of Reliability, stability, and security. Comparison was executed based on different parameters such as size, scalability, time delays sand energy efficiency [5]. The importance of WSN in hardware manufacturing technology in the light of security, stability and reliability was presented. A survey was also conducted in the consideration of challenges faced by WSN[6]. Wireless Sensor Network were also discussed in the context of Underwater wireless sensor Networks(UWSNs), the utilization of UWSNs examined and the different methodologies were discussed that assist to solve challenges and issues[7].

WSN were also explored in the light of data handling. The researchers explained paradigm of big data, the conjunction of big data and WSN and related issues. The defined problem was considered as processing challenge of sensor network [8]. Wireless Sensor networks are also emerged with industrial technology. Equipment for extraction, transportation, refining can be emerged with WSN. The increasing need for oil and gas companies to observe, maintain, control and secure the whole prosses in an impressive manner were discussed. The solution related to numerous aspects were presented that may help these companies to work in an efficient manner. A comprehensive literature review and brief description and comparison was also done in the context of different sectors (upstream, midstream, downstream) of gas and oil companies [9].

Now a days, a demand for scalable communication networks is increasing so the entities can be observed based on physical nature and environmental condition. Wireless sensor networks are very promoting in nature because of its precise sensing, cheap induction, and its flexible nature in sensor position. As WSN hold out many advantages but still there are many challenges because of its susceptibility characteristics. Different issues related to different fields were demonstrated in the light of non-functional requirements [10].The challenges were also discussed in the context of cloud computing technologies, mobile wireless network etc. in IOT perspectives. Privacy and Data integrity challenges were reviewed in whole research paper [11].

3. Research Methodology

We conducted systematic literature review for getting the detailed knowledge for challenges and issues of WSN. In order to review the literature we did follow some pattern i.e. panning the research, conducting review on WSN, and in the final step report each step in order to give a detailed report about WSN(Fig 1). We'll discuss each step individually.



3.1 Planning the Research

We did the planning of our research under circumstances of following activities.

3.1.2 Identification

First, we point out that there's need for literature in the field of WSN in order to classify challenges and applications of WSN. To understand the challenges of WSN and finding the application areas can further be very useful for future studies.

3.1.3 Specify interests and Research questions

For literature, we first identified our interest of study and design some research question in order to be more specific.

1. What are the main application domains of WSN?
2. What are the sensor nodes and why they are important?
3. What are the issues that endure WSN?

for finding the answers of our identified research questions we searched literature and related articles on Google Scholar, IEEE, Science direct and Springer. The purpose of choosing those digital libraries are that the collection of studies available on those digital libraries are authentic.

3.2 Conducting Review

The identification of literature was based above mentioned research questions in order to be specific about our problem and stick with research. In order to

do investigation, on digital libraries we put keywords on search bar and repeatedly get the information. The whole set of search is done by using some Boolean operations such as Issues of WSN, (Issues of WSN) OR (Application areas of WSN) etc.

3.2.1 Study selection

We did some investigation on the topic of issues and problems of WSN and select papers by reviewing the abstract and conclusion that gives us the idea whether it is related to our interest of research or not. We choose papers that were in English and have at least one of the following:

- Studies that some issues
- Studies that provide comparison of WSN
- Studies that validates existing methods
- Studies that are discussed under some application areas.

We did some further investigation and set our described below:

- Studies related to application areas of WSN
- The other resources such as literature, thesis, websites
- Studies published before 2016
- The documents about WSN

3.2.3 Data extraction and processing

In order to gather the data from selecting paper, a technique that called data extraction is applied in order to assists the above-mentioned research questions. In order to give the answers of RQ1 , the domain and all aspects related to WSN we identifies. In order to get the answer of research question 2 , the literature was read and the application area are extracted.

3.3 Results

We gives a detailed report on above mentioned questions and further classify our problems into different groups Such as classification of Applications , Classification of Nodes of Sensors, Classification of issues. We also did the detailed study on WSN and gives some solutions that are related to those issues that can be applied in order to do more progress in the field of WSN.

This section presets the details that how the results are obtained and generated for this review. This section is divided into two groups, i.e. overview of selected studies and reporting the review.

3.3.1 Overview of Selected Studies

In the investigation of our research of above 100 papers, 12 papers was extracted in order to identify

the areas of our research and 13 papers was selected in order to find the issues and challenges currently faced in the field of WSN. After reviewing abstract only papers that met our terms and conditions are further investigated.

3.3.2 Reporting the review

In order to report the review on above mentioned requirements, a detailed study is conducted and investigates the answers of our research questions. The answer of Research question and further details are mentioned in Section 4.

4. Discussion

This section deliberates that how data is gathered from different studies so we can get the answers of the questions that are mentioned in section 3(Methodology). The purpose of this study is to present the overview of wireless sensor networks combined with challenges of wireless sensor networks.

RQ1: What are the main application domains of WSN?

We did a huge research in context of applications of Wireless sensor networks. After reading literature we classified applications of WSN in different groups. We classified application of WSN into 4 groups named as army and defense applications, health monitoring applications, environmental contextual applications and other applications.

Army and Defense Applications

Army and defense application involve monitoring and observation in battlefield. Sensors that used in army and defense applications are as follow:

- War zone investigation and monitoring
- Checking bombs, well disposed powers, ammo and gear
- Appraisal of fight injury
- Biological, synthetic and atomic assault observation and recognition
- Imposters sensing on war or base area
- Identification of enemy units.
- Intelligence
- Targeting systems

Health Monitoring Applications

Most WSN are used in health department, this involves observation and Intensive care of people such as health conditions. In Different other context, sensors can also be used to get information of drugs via codes. Some other areas are described below:

- Heartbeat, beat checking

- Telemonitoring of human physiological information
- X-rays, observation of internal body.
- Drug organization

Environmental Contextual Applications

Many WSN are used for environmental observation and monitoring. Many of them are momentary, temporary and short timed according to the nature of work and projects. However some environmental sensors are long termed and installed once like glacier monitoring, earthquake observation. Some of them are described below:

- Humidity sensing
- Temperature sensing, earthquake detection
- Fire detection (forest, house etc.)
- Weather forecast
- Flood detection
- Agriculture irrigation

Other Applications

- Car tracking and tracing
- GPS
- Presence of different obstacles and objects.
- Home automation
- Automatic temperature diversity in Office, home etc.
- Greenhouse Monitoring

RQ2: What are the sensor nodes and why they are important?

Sensor node in wireless sensor networks are obliged to percept some physical condition and environmental phenomena, such as light, humidity and temperature etc., In order to process and perceive some information and take some action according to specific constraints.

The significance of Sensor Nodes can be ensured as the sensor nodes percept physical attributes in order to provide some output. We also did the research on type of nodes used in WSN and further categorized them into 4 groups i.e. Underground WSN, Mobile WSN, Multimedia WSN and Terrestrial WSN.

Underground Wireless Sensor Networks

Underground wireless Sensor nodes are installed underneath of water, soil, cave etc. for observation, monitoring, exploring and detection for tragedy avoidance. But the drawback of deployment of underground WSN is that they are impressively expensive. the other problem that may that may arise in case of underground WSN is the batteries of these WSN cannot recharged and replaced if damaged, in that case a huge loss can be expected. To design or

setup these WSN, an arrangements, planning and groundwork is required.

Multimedia Wireless Sensor Networks

Multimedia Wireless Sensor Networks holds large bandwidth, high link quality and huge power. Multimedia WSN can store, process and repossess data very efficiently because of its high processing powers. Nodes can be referred as cameras, microphone, and more supplementary sensors that used to observe surrounding and other aspects.

Terrestrial Wireless Sensor Networks

In terrestrial WSN, nodes are installed in arbitrary pattern, but nodes can also be installed in grid pattern. Terrestrial WSN accommodates different techniques such energy reduction, routing protocol techniques.

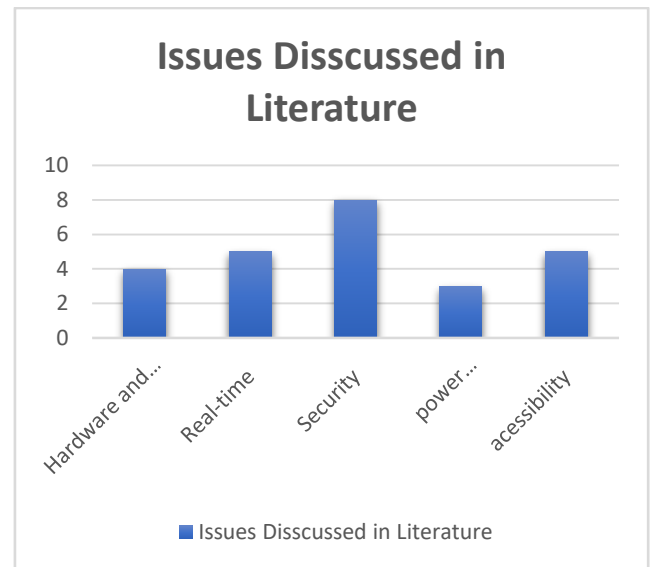
Mobile Wireless Sensor Networks

Mobile sensor nodes can be referred as sensor nodes that have ability to relocate. These sensors can sense physical attributes based on self-configuration such as whether checking or area location via GPS. The significant advantage of mobile WSN is that it can be used for surveillance, observations, target tracking etc.

RQ3: What are the issues that endure WSN?

We did a research on challenges and issues of WSN and categorized into several groups that contains the information about challenges and issues of WSN namely power, accessibility issues, security issues, hardware and software issues and time synchronization issues etc..

These challenges were addressed in literature and after detailed study of literature we make a chart of these issues in order to get the knowledge about importance of these issues.

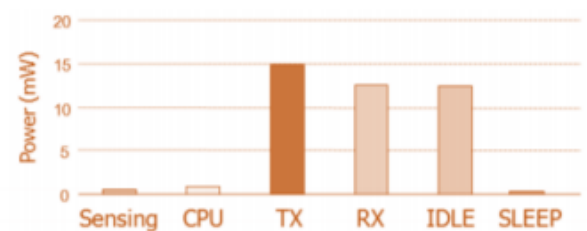


We'll define these challenges one by one with the combination of proposed solutions.

Power Management issues

In order to do processing and several operations, sensors need some resources power or energy in order to work in efficient manner. so there's an immense need of management of those power resources. Power consumption of sensors states can be categorized in TX, RX, Sleep, Sensing, CPU and idle states. The energy is basically devoured in data gathering, observation, sensing, monitoring, processing and data communication between different nodes. Nearly all of energy is consumed during communication and collaboration between nodes and processing the information. power that used throughout the communication between nodes and transmission of data, requires approximately a single bit of 100m which can collectively deals with 3 thousand instructions per second. Conversely, sensors also need energy in order to handle base station queries and studies shows that during that time as the other nodes are idle at that moment so this phenomenon could cause power issues.

We reviewed several studies and make a graph oh energy consumption during sensor processing.



The above graph shows the fact that most energy is consumed during idle state and in TX/RX states.

These above-mentioned issues related to power consumption of WSN can be solved via efficient way of and well-organized algorithms that manage TX/RX states and operations in organized manners.

Nodes can be organized and programmed in such a way that will sense idle states and converge those nodes in some efficient working. The threshold can be defined in order to that helps to assists those nodes that transfer and communicate data. There's also a need of management of list, processing details of nodes states. Based on that list, analysis of power consumption easily captured. The major goal of power management is to keep nodes alive as long as possible.

Accessibility Issues

The analysis of sensor nodes is very critical to observe and monitor, but there's a great need of monitor those node in order to get the details of every moment. Efficient routing algorithms and protocols can be implemented in order to make sure all nodes working properly and efficiently.

Challenges in real life surroundings

Mainly challenges are related to real world environment. The main issue related to related time is sensors are supposed to deliver data and information in a constrained time so the true output can be generated, and the appropriate actions are measured accordingly. However sensors are not intended to process data regarding real life surroundings and environment. However sensors processed data at high speed within a given time constraint and supposed that it'll fulfill all requirements. These issues can be measured in real-time category issues that also include issues related to data transmission, fusion, classification security, and processing information. Real time problems usually point out different problems and services. This problem can be solved via feedback and routing algorithms. The demand of real-time protocols is significantly increased as well as there's a need to maintain and develop some associated analysis techniques in order to handle real-time issues.

Security Issues

Security issues are the one that is most demanding in research and considered as most critical issues. Many researchers did a research these issues and provide proposed some solutions but still as the world is getting advance there's a more demand of security solution. As the WSN data move in the air and proceeds to specific location so they are more brittle and delicate as anyone can observe those signals and data. Security demand increase in military applications as well as commercial applications to avoid malicious attacks, i.e. denial of Services and unauthorize access.

We divided security issues in several categories for better understanding of these issues of WSNs.

- **Data Authenticity**

Data in networks traveled in packets. Each packet contains number of bits and bytes of messages. An attacker can mislead and fool the packet if somehow got an idea about the format of packet that is explained in WSN Protocol Stack. The false injected packet may drive wrong and incorrect information which leads to wrong decisions. To overcome such type of issues an approach and algorithm can be used that can preserve the signature , secret key response time.

- **Data Confidentiality**

confidentiality is a confirmation of legitimate access to data. The crucial and major problem in security of WSN is data confidentiality challenges. The transfer path i.e. radio spectrum is open and influential medium that can be effortlessly observed. An attacker can obstruct information of packets. Further these apprehend packets can be modified with misguided and wrong information. in order to keep up information private, standard methodology is used to transmit all information after encryption with secret key that only a receiver possess. Cipher Block Chaining is one of the solutions of data confidentiality issues.

- **Data Integrity**

Data integrity can be referred as the consistency of data throughout the whole process. Data integrity issues can be solved by message integrity coded.

Hardware and Software Issues

As we discussed before, hardware and software issues can be discuss in terms of size , processor, memory and speed etc. Regularly, sensor hub has microcontroller, handset, sensor and energy backup to gather or sense information and send to microcontroller for handling. The information is send to sink node after processing. Microcontroller likewise chargeable for essential WSN capacities and correspondence conventions and protocols. For storage, ,memory information, flash memory is recommended to use in hubs since flash memory is modest and quick. These hardware problems are also lied in under power management crises in some conditions. microcontroller should work in three state rest, dynamic and inactive in order to work efficiently.

Time Synchronization issues

As the sensor nodes are different in nature so they are steered independently, that's why sometimes synchronization issues are raised due to ambient and uncertain data.

5. Conclusion

In this paper, we investigate some issues and challenges and proposed some possible solution that can helps to solve those challenges. We also discuss some application areas of WSN. We also classified application areas and nodes of WSN. We further classify challenges of WSN in several categories. In future our proposed solutions can be implemented, and different algorithms can be generated and investigated.

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