Original Article

Analysis On Wireless Sensor And Actor Networks System To Detect Changes In Environment

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Abstract

The research community has given Wireless Sensor and Actor Networks (WSANs) more emphasis lately. This is mostly attributable to the fact that they can actively participate in the environment through the actors as an expansion to Wireless Sensor Networks (WSN). To transfer instructions among nodes, actors, and the central station—who may come from different manufacturers and employ various communication protocols—this, however, poses new difficulties. Another crucial feature is the WSAN's capacity to show information to interested parties or to take operator commands in the clearest and also most user-friendly manner feasible. In this study, we suggest an architecture for connecting the various WSAN layers to the central stations, enabling the construction of a straightforward interface that would simplify the use of WSANs in terms of control and data acquisition.

Keywords: WSN(Wireless Sensor Networks), WSAN(Wireless Sensor and Actor Network

1- Introduction

A Wireless Sensor and Actor Network (WSAN) is a group of topologically sprinkled sensor and actor nodes, which communicate together using a wireless environment. The network has a two-fold function, action, and reaction, action by the sensors and reaction by the actors. This solution is special because it deals with irrigating multiple crops at the same time. Only the crops which require water get the response from the actors in the form of sprinklers. This is possible by clustering the field based on its requirements.

The basic structure of a sensor is composed of four units namely the power unit, sensing unit, processing unit, and communicating unit. The sensor takes the input from alterations of present conditions in the adjoining environment. These inputs require an analog-to-digital converter to convert the input into electric signals for further transmission. Each node has a processor to make necessary computations or forward the input received to the next node or the base station as the case may be. The coordinating node or the Base Station, by manipulating the data it receives, can supervise and exercise control over the WSAN. This station also transmits the required information to users and the related network. The combined use of sensor and actor nodes, helps a WSAN to perform Collaboratively accumulating information through data manipulation which is gathered at several points of interest spread over the field.

The uninterrupted advances in technology have made it practical to attain exceptional speed, sensing ability, communication, and processing power. All these advances with a small-sized sensor make this setup efficient and fruitful in day-to-day life. The inexpensive setup of sensors and actors finds its usage in several places. Earlier it was used mainly for military usage, nowadays they support an escalating range of applications

2- WSAN vs WSN

Here we will try to differentiate diagrammatically between the Wireless sensor networks and wireless sensor and actor networks. Figure 1 portrays an outline of a wireless sensor-only network and figure 2 portrays the wireless sensor and actor networks.

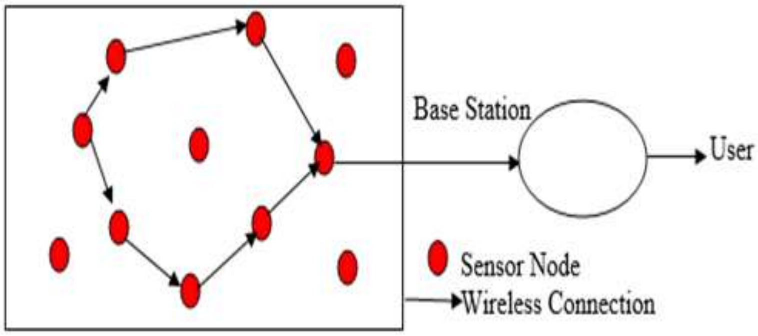

Figure 1 :The basic structure of the Wireless Sensor Network

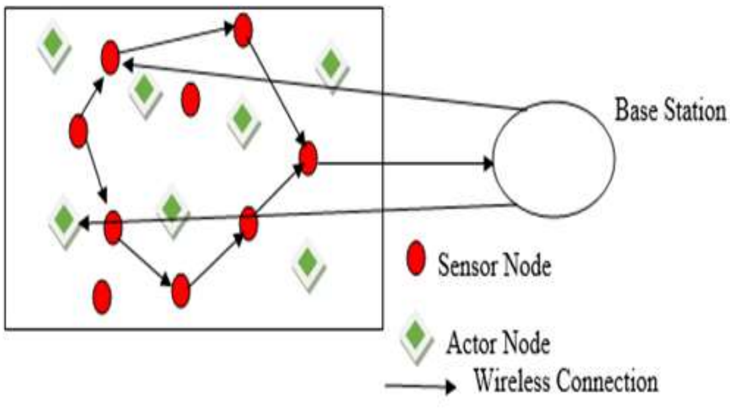

Figure 1 :The basic structure of the Wireless Sensor and Actor Networks

In the case of a wireless sensors-only network, the sensors perceive the changes in the surroundings, and this report is forwarded to the base station which interprets the input received and the report is sent to the user. The communication is wireless from sensors to the base station and from the base station to users.

Meanwhile, in a wireless sensor with an actor-network, the information collected by the sensor nodes is forwarded to the base station which again redirects the actors in the vicinity of the event. The messages are again forwarded using wireless technology in all directions.

WSAN can have numerous sensor nodes that enable the collection of environmental data and numerous actors (robots, actuators) that carry out activities and modify the environment. These actions may be preprogrammed by an operator or determined by the collected sensor data. In a WSAN, sensors and actors form an ad hoc network and communicate with one another as needed. The actors and sensors may be capable of communicating with a centralized access point that serves as both a data sink and a hub from which the actors receive all of their orders. Such nodes could also be numerous.Many of the issues faced by WSAN are taken into account and detailed in [53], which also divides WSAN into two categories: WSAN with automated architecture and WSAN with semi-automatic architecture. In the first category, the actors serve as sinks for the sensor network by receiving data from the sensors and relaying it to them. In the alternative architecture, data is transmitted to a single sink, from which actuators obtain all the information they require.

Due to their capacity to remove the human element from interactions with the environment and regulate responses in case of emergencies, WSANs are growing in popularity among researchers. There are numerous difficulties that need to be addressed by the community, but many of them have already been taken into consideration and some of them have solutions provided [54][3][4].

WSANs enable the use of various types of sensors that are present in sensor nodes, but they expand their capabilities by allowing the use of even sensors with higher energy consumption than those that might be taken into account in WSNs. It would be simple for a mobile robot actor to collect visual information from the surroundings using the camera on the robot. The WSAN has access to this information as well, which could be used in one of its applications. As a result, WSANs have more sensing capabilities and are better suited for a variety of tasks, including perimeter security, preventing forest fires, search and rescue operations, etc.

3-WSN node architecture

The regular hardware of a wireless sensor node comprises a sensor unit, a processing unit, a storage unit, a radio unit, and a power unit. Additional blocks present in some application nodes are locating blocks, energy harvesting blocks, and actuators[13][14]. Figure 1 illustrates the connection of the major components of a sensor node.

3-1- Sensing Unit

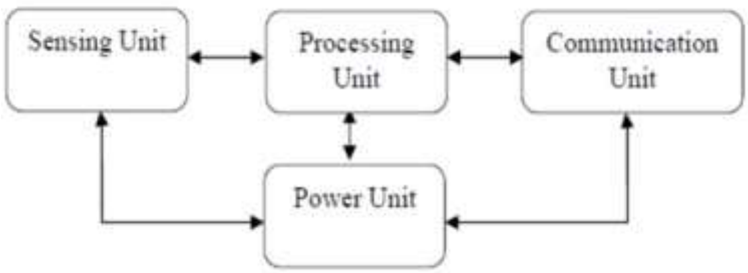

Figure 3 :Block Diagram of Sensor Node

The primary purpose of a wireless sensor network is to detect environmental parameters. Due to bandwidth and power limitations, WSN nodes typically use only low data rate sensors. Multimode discovery is an advanced feature that includes multiple sensors on the board of a single node. For example, common sensors such as temperature, humidity, light, and acoustic sensors can all be on the same sensor board. The detection area of a sensor node depends on the type of physical sensors used on that node. The figure 3 depicts the units involved in a sensor node which include a sensing unit, a processing unit, a communication unit and a power unit.

Wireless sensor networks employ the Sensor Network Architecture (WSN). It can be used to a variety of locations, including schools, clinics, institutions, and highways, for a variety of purposes, including emergency preparedness, security management, and catastrophe maintenance.

Layered Network Architecture and Clustered Architecture are the two forms of design employed in WSN. The explanations for these are provided below.

i. Layered Network Architecture:

Layered Network Architecture uses a single robust base station and a small number of sensor nodes. Concentric layers are used to organize network nodes.
There are five levels total, including three tiers.
The 5 layers are the first five layers of OSI which includes network, transport, session, presentation and application layer. While the tiers include managing tasks, managing mobility and managing power.

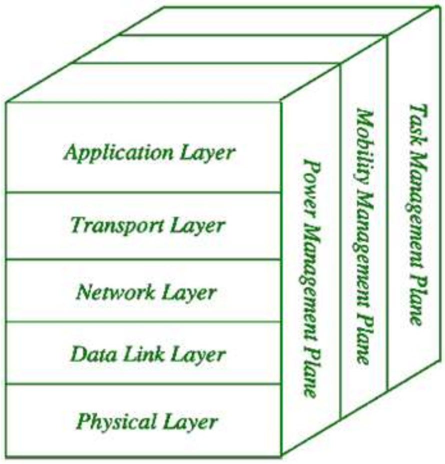

Figure 4 : Diagram for Layered Architecture.

Since each node only participates in short-distance, low-power transmissions to surrounding nodes, Layered Network Architecture has the advantage of consuming less power than other Sensor Network Architecture. It is more fault tolerant and scalable.

ii. Clustered Network Architecture:

In a clustered architecture, sensor nodes form groupings, or clusters, on their own. Its foundation is the cluster-based Leach Protocol. Low Energy Adaptive Clustering Hierarchy is the abbreviation for the Leach Protocol.

Features of the Leach Protocol:

- It is a clustering architecture with a two-tier structure.
- The sensor nodes are organized into clusters using a distributed algorithm.

- The Time-division multiple access (TDMA) schedules are produced by the cluster head nodes in each autonomously formed cluster the autonomously formed clusters.
- It uses the Data Fusion idea, which reduces its energy consumption.

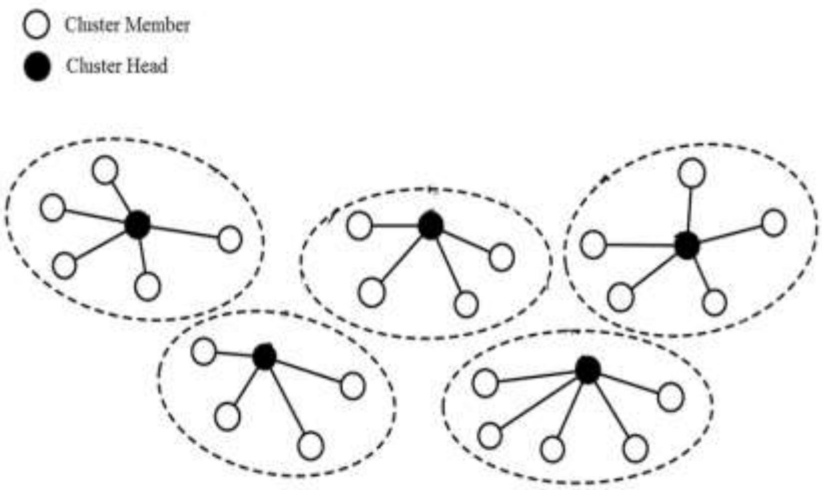

Figure 5 : Clustering in WSANs.

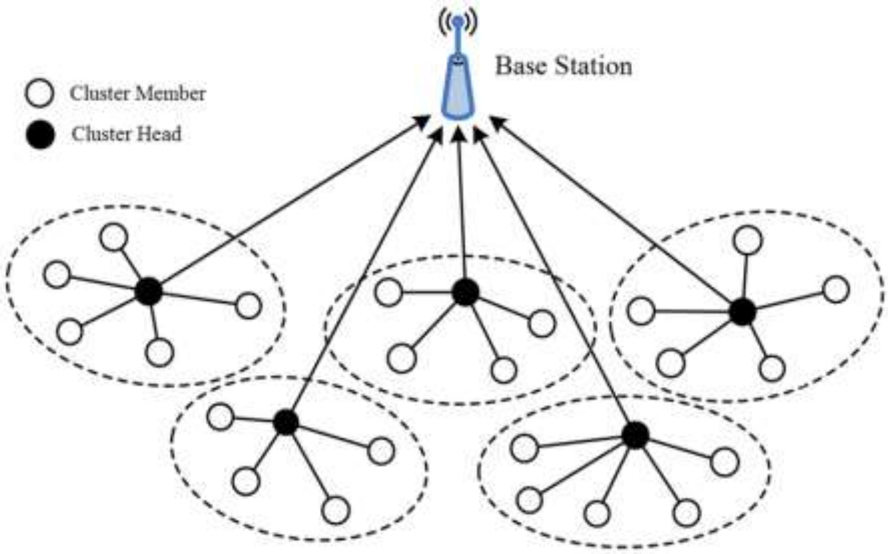

Figure 6 : Cluster Network Architecture.

Since it has the ability to combine data, Clustered Network Architecture makes for an extremely useful sensor network. To gather information inside each cluster, each node talks with the cluster head. The base station receives the information collected by each of the established clusters. Each cluster's cluster formation and cluster head selection is a separate, autonomous distributed process.

3-2- Processing Unit

Typically, this is a low-power embedded processor designed to perform finite processing of identified data. The best processing unit for a sensor node is a microcontroller. Nodes perform tasks, process data, and control the functions of other components. Alternatives available as processing units are generic PC microprocessors, digital signal processors, or application-specific integrated circuits (ASICs). Integrated processors are often heavily used in processing units. However, sensor networks can be heterogeneous and enclose an insufficient number of nodes with relatively high computing capacity.

3-3- Memory Unit

The physical size of a sensor node is a significant factor in many utilizations, so it is important to keep the node size as small-scale as possible. Another aspect is cost containment. Memory is limited to reduce node cost. Most sensor nodes are intended with little memory for processing. It usually uses a few kilobytes of RAM for program storage to execute instructions and a few kilobytes of additional flash memory for data storage to store the collected and processed data. Advances in technology are expected to increase storage capacity over time [55][56].

3-4- Radio Unit

Wireless sensor networks use the Industrial, Scientific, and Medical (ISM) bands that provide free radio, wide spectrum allocation, and worldwide coverage. Other options for wireless hauling media are radio frequency, optical(laser) communications, and infrared. Among them, RF communication in the 2.4 GHz band is the most suitable communication for many WSN applications around the world. In general, radio devices work in three distinctive ways Send, receive and sleep. Power consumption is much higher in transmission mode. Power utilization is also higher in receive mode compared to the sleep mode, so the radio usually goes into sleep mode when there is no data to disseminate.

3-5- Power Supply Unit

A typical power source for the sensor node is a battery. The lifetime of a sensor node usually depends heavily on the lifetime of the battery. Batteries provide power for sensors, communications, and data processing. Since more energy is required to transmit data from the sensor nodes, communication should be minimized. In many exercises, wireless sensor nodes are located within reach, so battery charging may be limited or impossible. Most commercial nodes use two AA alkaline batteries or one Li-AA battery.

3-6- Location Finding Unit

For embedded sensor networks, sensor locations are required for external measurement or monitoring. Otherwise, the data is invalid. For example, if a sensor detects negative activity in a monitoring area, it should alert a sink or control station. The information should be of the type of service based on the location and classification of the adverse event. So, depending on your application requirements, some nodes may have locator units. You can usually get GPS information by communicating with satellites. However, even in these applications, due to cost constraints, only some nodes can be equipped with GPS functionality.

3-7- Actuators

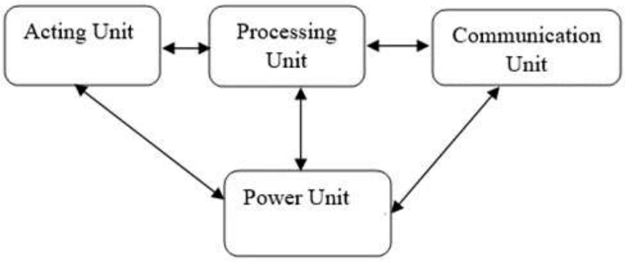

Figure 7 : Block Diagram of Actuator Node.

Instead of simply determining different parameters, operators are always encouraged to activate control signals based on monitored information related to the monitored process. For these scenarios, actuators are dressed with sensor nodes. A device that performs control tasks according to commands from a sink or control station. This is a new requirement from the sensor network point of view. Actuators have high power requirements, and the protocol for sending
commands from a sink is different from receiving data from a sensor at the sink. These changes must be handled in hardware and software before they are implemented in the sensors network.

4-Power Conservation in Wireless Sensor and Actor Nodes

A wireless sensor node is a set of five different devices: a power source (battery), a sensor device, a processor, and a transceiver and and actor. Therefore, energy savings apply to each or all of these units [46]. Energy savings have been achieved by using electronic components that consume less electricity. Sometimes achievements have to be sacrificed toachieve this goal as well. This performance loss is compensated by deploying more sensor nodes to monitor the same area (higher-density deployment). The microprocessor is an important part of the processing unit. There are many microprocessors on the market. You can carefully choose a processor with lower power requirements for a particular application. The power consumptionof a processor depends on two important factors: the operating voltage and the operating frequency. Dynamic Voltage Scheduling (DVS) is an energy-saving mechanism that takes into account both factors: The transmitter-receiver unit consists of a receiver node/other sensor receiver and a radio receiver that serves to provide an uninterrupted communication link. Energy consumption in the communication process is much higher than all other processes in the sensorynode [47][48]. For example, a significant amount of energy can be saved by installing an energy-efficient receiver. Wireless sensor nodes can also perform some simple calculations to reduce the amount of data to transmit [45][49][50].

5-Applications of WSAN

WSANs undoubtedly enjoy astounding abilities making it suitable for an extensive scope of applications. Wireless sensor networks have applications in agriculture fields, environment monitoring, military surveillance, health tracking, industrial tracing, etc. We will discuss the sensing and processing abilities of different wireless sensor and actor networks. Earlier, Wireless sensor networks (WSNs) were used to detect only the change in surroundings using sensor nodes. The need to have reaction or response to the sensed information gave rise to the network of wireless sensor and actor networks. Let us see a few examples of its application:

A military base that houses essential information, weapons, machines, military officers, and troops needs tight security and surveillance. Such kinds of bases are always under the radar of the enemy. The information it houses is crucial for any enemy state. Automatic sensors are installed everywhere to detect any unwanted intrusion. As soon as the sensors detect the intrusion the information is conveyed to the concerned department in the form of a message, alarm or any other form. The sensor does the action and the alarm in turn is the reaction or response to this activity. The specialized sensors can even be used to detect radioactive, biologically active, chemically and nuclear active substances. The latest missiles like S400 from Russia used in warfare has a system to detect the incoming missiles from a range and destroy it in air itself i.e. quite before it hits the target.

In the Health realm, wireless sensor networks can be used as patient tracking appliances to detect the temperature of the patient, the motion activities of the patient, and smartwatches that track the various motion and pulses of the body including breathing, heartbeat, etc. All these devices used in health care have a centralized observing unit that collects and manipulates the input received as body parameters. Assistance at home is possible with a wearable sensor that sends messages to a handheld device which further notifies the user who is monitoring from a distant place with the help of the internet.

WSN can be used for the proactive detection of tsunamis, forest fires, Volcanic eruptions, and seismic activities related to tectonic plate movements. Humidity sensors, water quality monitoring sensors, and gas and smoke sensors are other useful devices that are used in environmental monitoring.

In the agricultural domain, the aging of the crops can be detected through time-to-time pictures of the field. The soil moisture and air temperature sensors can record the water requirements of the crops from time to time.

Meanwhile, wireless networks in their phase face some significant complications. These complications are based on their area of implementation.

Military Usage:

- A little sensor that is simple to conceal.
- Network that is fault tolerant, or one that can survive losing a specific number of nodes.
- A strong and resilient network for unanticipated circumstances.

Health Usage:

- Wearable nodes need to be small sized and light in weight.
- Message transmission must be immune to risks, dependable and quick.
- No need of long-range communication enabled devices.
- Crucial signal jamming needs to be avoided at any cost.

Environmental Usage:

- Fault tolerant network i.e. it can bear the loss of certain number of nodes.
- Nodes need to be adaptable to changing physical conditions.
- Message transmission must be immune to risks, dependable and quick.
- Network must be fault tolerant to bear the loss of a number of nodes.

Agriculture Usage:

- Nodes need to be adaptable to changing physical conditions.
- Message transmission must be immune to risks, dependable and quick.
- Network must be fault tolerant to bear the loss of a number of nodes.
- Sturdy network for extreme weather conditions.
- Requirement of high transmission capabilities for long range information transfer.

Industrial Usage:

- Safety norms of the particular industry needs to be followed.
- Dimension of the nodes are application dependent.

- Electromechanical intrusion tolerant network is the need inside the premises of an industry.

Indoor Urban Usage:

- Low communication range required.
- Privacy criteria is a major concern.
- Nodes need to be compact and portable.
- Gadgets must have non-combating interference in an indoor scenario.

6-Environmental Monitoring System

Environmental monitoring and alert system is a key use of WSANs that has a significant potential impact. With this improved technology, these applications expand greatly. Environmental tracking systems (EMSs) are often created and utilized for sensing, observing, and managing environmental variables like temperature, light, pressure, and humidity. Understanding the weather and how it affects people is crucial given the unpredictability of the weather. The procedures, actions, and data-gathering techniques utilized for monitoring, assessing, and keeping track of evolving environmental conditions are all included in EMSs [6]. Using sensors spread out over broad areas, data that mimic normal climate variables like heat, daylight, and wind pressure are gathered and then communicated to a server.

6-1- Applications for Environment Monitoring Systems

EMSs have been used in a variety of applications to help individuals with their daily tasks and improve their way of life and future. Cost and time are reduced by using EMSs. EMSs have expanded quickly in a variety of beneficial applications, including agricultural monitoring, ecosystem monitoring, tracking for dangerous chemicals, domestic monitoring, surveillance in greenhouses, monitoring for radiation, monitoring for climate change, and monitoring for forests. The community is starting to understand the benefits of utilizing and developing WSN technology in their daily lives today [7]. Application areas for WSANs in the environment include:

1-Monitoring precision agriculture: One growing application of WSNs is precision agriculture monitoring, which is used to track, sense, and regulate the usage of pesticides as well as crop, soil, and weather characteristics in sizable agricultural fields[7].

2- Greenhouse Monitoring: This technique is crucial for keeping track of solar irradiance and ensuring that the environmental variables remain stable. To make it simple for the user to operate, detect, and monitor the greenhouse via an Internet connection, the system may be web-based and remote-controlled. The user can access and manage the data gathered from all over thanks to the system [8].

3-Climate Monitoring: The climate is changing rapidly all around the planet at the moment. Sea ice busting, rising sea levels, increasing lake temperatures, heat waves, glacier melting, and many other major consequences of these changes compelled attempts to be made to create systems that aid in controlling and monitoring weather patterns [9].

4- Forest Monitoring: Because forests are crucial to maintaining ecological balance and diversification, it has become imperative to put in place a system for keeping track of the surrounding environment. The topic of forest monitoring systems has been emphasized in number of studies [7].

5- Air Pollution Tracking: Despite having been regarded as a very difficult undertaking, this is one of the most significant applications of EMSs. Data have been frequently gathered and documented over the years. This process took a significant amount of time and cost a lot of money. WSNs are being used to improve the efficiency and simplicity of the air pollution monitoring procedure, as well as the accuracy and speed of data documentation[10]. WSNs are being used to improve the efficiency and simplicity of the air pollution monitoring procedure, as well as the accuracy and speed of data recording[10].

6- Flood and Fire Detection: Setting up sensor networks in the forest to monitor and detect the source of such destructive fires is one of the several environmental applications that WSNs have created. The similar concept has been employed for flood detection utilizing weather sensors, which are utilized in the flood tracking and monitoring system to identify, sense, anticipate, and ultimately prevent floods or lessen their consequences [7].

7-Radiation Detection: The development of WSNs for radioactivity detection has drawn considerable attention in a number of nations across the world. The usage of these technologies may be crucial in aiding security services and other authorities involved with radiation encountering to ascertain and keep track of the radiation levels in affected regions and places as well as prevent endangering the lives of workers [12].

6-2- Leverages of Using WSANS

1. Affordable
2. The least amount of power when compared to conventional wired networks
3. simple to increase or decrease the coverage area.
4. No wiring is required.
5. Petite size.
6. appropriate for current applications
7. A mechanism for local and centralized monitoring.

6-3- Drawbacks Of Using WSANS

1. When compared to regular wired networks, it is slower.
2. Less reliable and simple for hackers to breach.
3. Influenced by great distances and impediments like walls.

7-Obstacles Faced by WSANS

The following are the crucial considerations that need to be made when installing WSNs in order to obtain a good, stable, and effective surveillance system:

1. Power consumption: The most effective and well-liked method for monitoring applications is the use of wireless sensor nodes. However, since these low-power wireless nodes are typically placed in awkward or hard-to-reach locations, replacing the battery on a regular basis will be problematic and uncomfortable. The radio transceiver unit of the WSANs demands large quantities of power, thus it is crucial to make sure that there is always appropriate capability available for the system [5]. It is also crucial to ensure that the cells used in the system can function properly for a long time.

2. Fidelity : To prevent potential sudden and unexpected crashes, WSANs must be easy to use and perform predictably. Preventing the administration of WSANs by individuals without knowledge is yet another issue that is worth taking into account since consumers might not be acquainted with WSAN applications. During the transmission of data packets, changes to the area of interest could occur. As a result, attaining reliability is crucial to preventing packet loss[7].

3. Security: This word is frequently used. It includes privacy, anti-playback, non-repudiation, integrity, and authentication. The potential risk of these data being compromised by hackers during distribution over networks has grown as the reliance on information and data collected through WSNs has grown. The security for the transmission of these data through WSNs is ensured by the implementation of several techniques, including steganography and cryptography [3].

4. Robustness: WSNs need to be capable of withstanding equipment failure issues and network congestion with weak signals. For instance, the impact of climatic factors like rain, humidity, and windstorm may result in short circuit issues and system rebooting [7].

5. Flexibility: In order to meet the requirements of WSANs, a specialist user must be able to make modifications to the stations of WSANs at any moment, including adding, replacing, or transferring stations. For instance, the user might have to relocate certain stations if the nodes' present location is no longer within signal-transmission range.

8-OMNeT++ used to model WSANs

A simulation framework for object-oriented discrete-time networks is called OMNeT++. It has a generic architecture, making it applicable to a range of problem domains:

One of the domain includes wireless and wired connectivity infrastructure modeling. Modeling and simulation of any framework where the discrete event methodology is appropriate and can be easily mapped into units conversing by establishing communication is possible. This includes modeling of protocols, queueing networks, multiprocessors, and other decentralized hardware systems, validating hardware architectures, assessing performance criteria of complex software systems, and more.

Instead of serving as a simulator of anything specific, OMNeT++ offers the architecture and tools needed to create simulations. A component architecture for simulation model is one of the core components of this infrastructure. Models are constructed from reusable parts known as modules. Well-written modules can be assembled in many different ways, much like LEGO blocks, and are really reusable.

Composite units can be created by integrating modules and connecting it through ports. Module nesting depth is unrestricted. Modules communicate via passing messages, which can include any type of data structure. Modules can send information straight to their destination or over preset paths using gates and links; the latter is ideal for wireless simulations, for instance. Units may well have attributes that can be employed to modify the behaviour of the module or the architecture of the model. Simple modules, which are found at the bottom of the module hierarchy, include model behaviour. The simulation library is used by simple modules that are written in C++.

Different user interfaces can be used to execute OMNeT++ simulations. The finest user interfaces for batch execution are command-line interfaces, but graphical, animation user interfaces are very helpful for demonstration and troubleshooting.

The simulator is quite portable, as are the tools and user interfaces. They may be constructed on the majority of Unix-like operating systems either out of the box or with just slight adjustments, and they have been verified on the most popular operating systems.

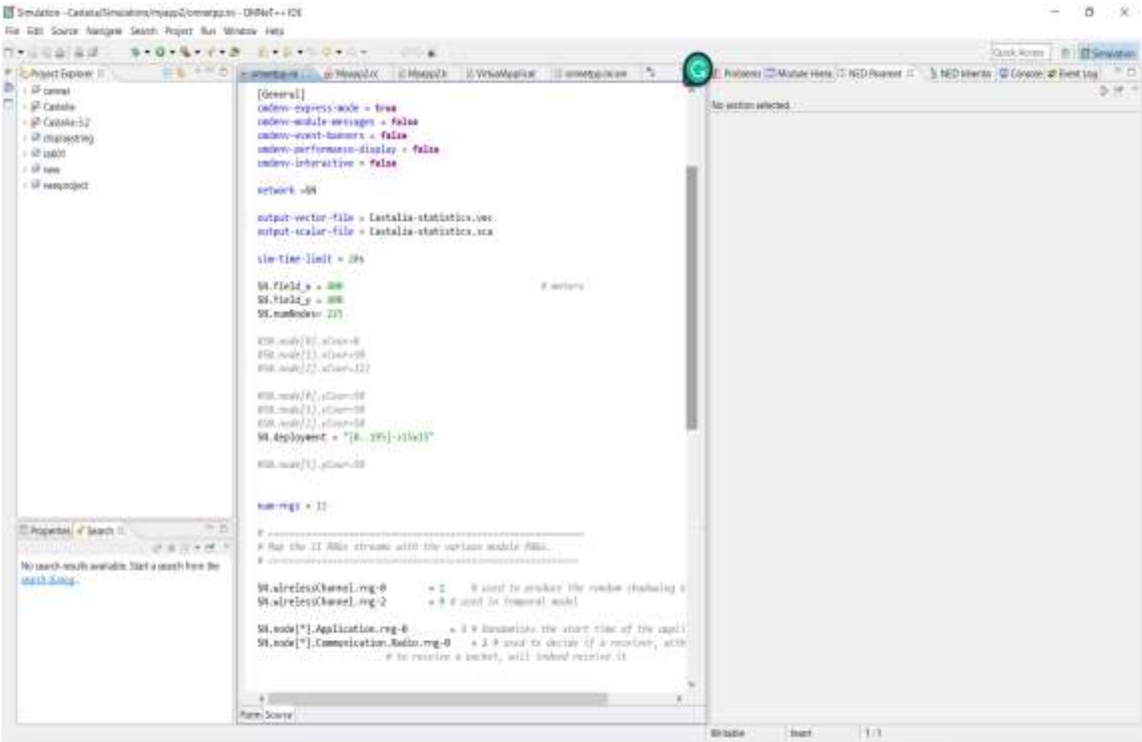

Figure 8 : The picture is a screenshot taken from Simulation part of Omnetpp software.

OMNeT++ additionally offers distributed simulation in parallel. For interaction across segments of a parallel distributed simulation, OMNeT++ can make use of a variety of techniques, such as named pipes or MPI. It is simple to add new parallel simulation algorithms or to expand the existing ones. It only takes a little setting to run models in parallel; no extra instrumentation is required. Because simulations may be done in parallel even while running under the GUI, which offers thorough feedback on what is happening, OMNeT++ can even be used to demonstrate parallel simulation algorithms.

8-1- OMNeT++ models include the following components:

Describe a NED file

The network topology architecture is stored in a network definition file made by OMNET++, a programme used to create network simulators. This file is used to describe the conceptual network structure that will be mimicked by the programme.

Additional Details

NED files need not define how the network will behave. Instead, a companion C++ source code file defines their behaviour (.CC or .CPP file). The net can be simulated after a NED file and associated C++ behaviour file are produced.

It is possible to build network description files using a plain text editor or the OMNeT++ IDE, that comes as part of the OMNeT++ distribution package.

The ability to establish the type of messages and add required fields to them is provided via message definitions (.msg files). The message definitions will be converted by OMNeT++ into complete C++ classes. The ini files is another type of file which is used for initialization purposes.

In a WSAN, the omnetpp.ini file is used for assigning values to physical sensor nodes. This value is further used for various purposes by sink nodes for calculations as per requirements.

9-Hardware components in Wireless Sensor and Actor Networks used in Farm

Due to a lack of technology, farms face numerous issues. Controlling and keeping an eye on the agricultural elements is crucial. The soil's moisture content, the water table, and security are all crucial agricultural characteristics. The network that is provided is the sole foundation of the global system for mobile communication.

In the subject of agriculture, wireless sensor and actor networks are frequently utilized. It offers a fresh approach to agricultural research. Crop observation, crop management, management of water resources, and environmental conditions are just a few advantages provided by WSN. Each "node" in a WSN, which might number in the tens of thousands or even more, is connected to a single sensor.

9-1-Sensor Network Node Components

- a radio transceiver.
- a microcontroller.
- a circuit for electronics.
- power source.

9-2-Qualities of “WSAN”

- Battery-powered or energy-harvesting nodes are constrained by power consumption
- Movement of nodes
- Ability to deal with node failures and ease of use
- scale-ability for extensive deployment
- the capacity to endure challenging environmental conditions

9-3-Standards and Specification:

- Wireless HART
- IEEE 1451
- ZigBee /802.15.4
- ZigBee /IP
- 6LoWPAN

Hardware: Making inexpensive, small sensors is a significant difficulty for WSN nodes. Adoption of sensor networks involves the use of very low power data collecting techniques.

Software is a collection of instructions, data, or computer programmes that are used to run machines and carry out particular activities. It is the antithesis of hardware, which refers to a computer's external components. A device's running programmes, scripts, and applications are collectively referred to as "software" in this context.

Parts of Wireless Sensor and Actor Networks are mobility, operating system and security.

For complicated systems, the OS manages resources. These resources can be found in a normal system like processors, memory, timers, discs, mice, keyboards, network interfaces, etc. The OS's responsibility is to organize and regulate how these resources are distributed to users. Then, application programmers can use system calls to access various OS services. System resources are multiplexed by an OS both in terms of time and space. With time multiplexing, various programmes use the resources sequentially. Separate applications can access different areas of the resource while perhaps operating simultaneously thanks to space multiplexing. A new strategy is needed for OS design in WSNs given the resource limitations of typical sensor nodes in a WSN.

WSAN in agribusiness: The use of wireless sensor and actor networks is becoming more widespread in this sector of the economy because they relieve farmers of the maintenance-intensive task of maintaining wires in challenging conditions. Water tank levels in a gravity-fed water system can be monitored using a pressure transmitter, while wireless I/O devices can be used to regulate the pump and measure water use, which can then be wirelessly relayed back to a central control station for invoicing.

Additionally, WSANs are utilized to regulate temperature, humidity, and nutrient levels. Farm manager contacted through email or text message when these parameters fall below a certain level**.**

9-4-ZIGBEE

Developed to support low-cost, low-power wireless machine-to-machine and internet of things networks, Zigbee is a standard-based wireless technology.

Zigbee technical details:

- Wireless personal area networks are what it is (WPANs).
- On 2.4 Ghz, 900 MHz, and 868 MHz, Zigbee operates.
- The defined rate for Zigbee is 250 kb/s.
- Compared to other WPANs, like bluetooth, it is easier to use and less expensive.
- long-range data consistency

Types of ZigBee devices:

- Zigbee coordinator (zc)
- Zigbee router(zr)
- Zigbee end devices(zed)

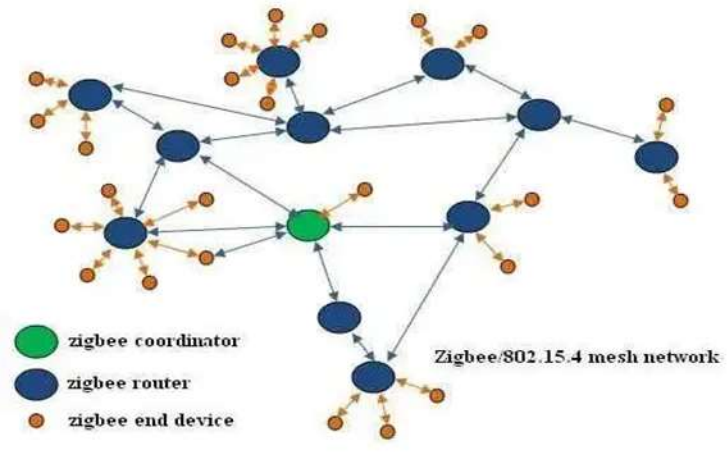

Figure 9 : Types of Zigbee devices.

Sr.no.	**Feature**	**WI-fi (IEEE 802.11b)**	**Bluetooth (IEEE 802.15.1)**	**Zigbee (IEEE 802.15.4)**
1.	**Data rate**	**11Mbps**	**1Mbps**	**250Kbps**
2.	**Data type**	**Video,audio,graphics,pictures, files**	**Audio, graphics, files**	**Small data packet**
3.	**Range(m)**	**100**	**10**	**100**
4.	**Complexity**	**Complex**	**Very complex**	**Simple**
5.	**Nodes per master**	**32**	**7**	**64,000**

Table 1 : Comparison of Wi-fi, Bluetooth and Zigbee

9-5-Graphical comparison between wifi, Bluetooth and zigbee

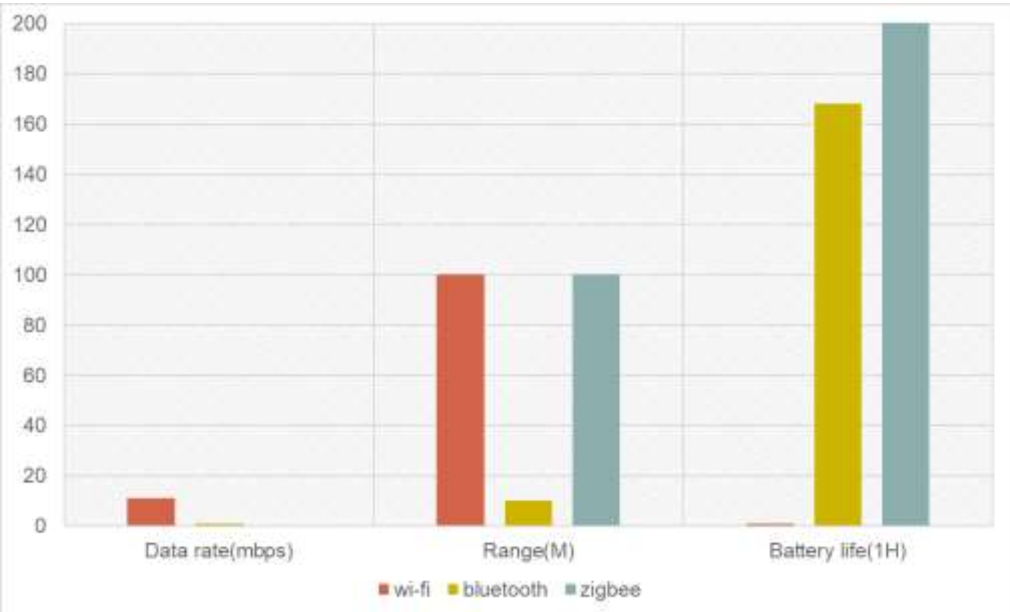

Figure 10 : Graphical representation of comparison between wi-fi, Bluetooth and zigbee..

Application Profiles (Zigbee):

- Zigbee Home Automation
- Zigbee Telecommunication services
- Zigbee Health care
- Zigbee Retail Services
- Zigbee Agriculture Services.

9-6-Wireless HART

A wireless communications protocol for process automation applications is called wireless HART. While keeping existing HART tools, commands, and devices compatible, it gives HART technology wireless capabilities. Wireless HART was created to use mesh networking.

IEEE 1451 (Institute of electrical and electronic engineers):

IEEE created the IEEE 1451 standard for intelligent transducers. The Sensor Technology Technical Committee of the Instrumentation and Measurement Society describes a collection of open, typical, network-independent communication interfaces for integrating sensors.

6loWPAN:

An IPv6 protocol called 6LoWPAN is an extension of IPv6 over Low Power Personal Area Network. The purpose of this protocol, as implied by its name, is that it operates on the Wireless Personal Area Network, or WPAN.

With open IP standards like TCP, UDP, HTTP, COAP, MATT, and web-sockets, it functions quite well.

Zigbee is a reduced energy approach. ISM hand is used to operate wireless sensor networks. Zigbee devices have extended battery lives when utilized in applications with modest data rates and power consumption. Comparing Zigbee technology to Bluetooth and Wi-Fi, it is more efficient. The Zigbee module's range has now been enhanced to 5 kilometers. Zigbee hardware is required for agricultural applications.

10-Conclusion

The irrigation system being used in India is extremely basic. To effectively irrigate the field, one must have a thorough understanding of both the field and the weather. But a typical farmer may not always have access to this kind of information and experience. Therefore, this technique is difficult for many Indian farmers. Therefore, an automated irrigation system using wireless sensor and actor networks is required to enable productive and efficient irrigation in different cropping systems, which have the advantage of increasing productivity, especially in areas with space limitations. Multiple cropping not just to boosts crop production and improves soil utilisation, it also increases yield from a little amount of land.Various aspects of setting up a wireless network are studied. Set up and configuration of the network is done on Omnetpp simulator. Sensor nodes and Actor nodes are set up. Different sensor node components to detect changes in surrounding(as per requirement) are compared which can be used in real life. WSAN are best for localized and centralized monitoring with easy increase and decrease of coverage area.

11- References

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