APPLICATION OF WSN FOR ENVIRONMENT MONITORING IN IOT APPLICATIONS

Ms. Padwal S. C.[1], Prof. Manoj Kumar[2]

[1]M.E. (VLSI & ES),SVCET,Rajuri.

[2]Asst. Prof., Department of E&TC Engg., SVCET,Rajuri.

ABSTRACT

The Internet of Things (IoT) can be defined in many different ways, and it encompasses many aspects of life such as connected homes,connected cities,connected cars and roads, roads to devices that track an individual s behaviour. By 2025 it is expected that one trillion Internet-connected devices will be available with mobile phones as the eyes and ears of the applications connecting all of those connected things. IoT made it possible for billions objects to communicate over world wide over a public, private internet protocol network In 2010. In 2010 -11 the number of everyday physical objects and devices connected to the Internet was around 12.5 billion. IoT ecosystem gives high intention to Smart cities, Smart cars, Public safety, Smart Industries and Environmental Protection for future protection. The Internet of Things (IoT) provides a virtual view,via the Internet Protocol, to a huge variety of real life objects. Its appeal is the ubiquitous generalized access to the status and location of any "thing" we may be interested in. The Internet of Things (IoT) can be defined as the network of physical objects, devices, vehicles, buildings and other items which are embedded with electronics, software, sensors, and network connectivity,enabling these objects to collect and exchange data.

WSNs are integrated into the "Internet of Things",where sensor nodes join the Internet dynamically, and use it to collaborate and accomplish their tasks. Wireless sensor networks (WSN) are well suited for long-term environmental data acquisition for IoT representation. In this paper, it is proposed to implement a WSN platform that can be used for a range of long-term environmental monitoring for IoT applications. This paper presents functional design of WSN for IoT application.

Keywords: Environment Monitoring, IOT, Raspberry PI, Sensor Nodes,Wireless Sensor Network.

I. INTRODUCTION

The future Internet, designed as an "Internet of Things" is foreseen to be "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols" [1]. To achieve different tasks it is possible for any object including computers, sensors, RFID tags or mobile phones to dynamically join the connected devices network by a unique address. These devices collaborate and cooperate efficiently in task completion. Covering a wide application field, inclusion of WSNs in this scenario can play an important role by collecting surrounding context and environment information for analysis and monitoring.

Key enablers for the IoT paradigm are : RFID and WSN. RFID is well known and established for low-cost identification and tracking. WSNs bring IoT applications richer capabilities for both sensing and actuation. In fact, WSN solutions already cover a very broad range of applications, and research and technology advances continuously expand their application field.

However, the "typical" requirements of WSN for use in IOT are difficult to define due to wide range of Wsn applications [2]. The generic WSN platforms can be used with good results in a broad class of IoT environmental monitoring applications. However, many IoT applications in open environment have stringent requirements, such as very low cost, large number of nodes, long unattended service time, ease of deployment, low maintenance, which make these generic WSN platforms less suited for implementation.

This paper is arranged through chapter I to chapter VII Chapter I gives brief idea about paper and previous work related to project. Chapter II explains about various application areas of WSN & IOT. Chapter III contains information about IoT requirements for environment monitoring. Chapter IV is introducing proposed system and key components of system. Acknowledgement and conclusion is provided in chapter V and VI respectively.

WSN environmental monitoring includes both indoor and outdoor applications. The outdoor applications include the city deployment category (e.g., for traffic, lighting, or pollution monitoring) or the open nature category (e.g., chemical hazard, earth-quake and flooding detection, weather forecasting, precision agriculture). The reliability of any outdoor deployment can be challenged by extreme climatic conditions, but for the open nature the maintenance can be very difficult and costly.

II. APPLICATIONS OF WSN

Technology advances in wireless communications and electronics have enabled the development of low-cost, low-power, multi-functional sensor nodes that are small in size and communicate untethered in short distances. These tiny and generally simple sensor nodes consist of sensing units, data processing, and communicating components [3], [4], [5]. A large number of such nodes deployed over large areas can collaborate with each other. To be cost-effective, the sensor nodes often operate on very restricted energy reserves. Premature energy depletion can severely limit the network service [4]–[7] and needs to be addressed considering the IoT application requirements for cost, deployment, maintenance, and service availability. Open nature deployments [8]–[12] and communication protocol developments and experiments show that WSN optimization for reliable operation is time-consuming and costly. It hardly satisfies the IoT applications requirements for long-term, low-cost and reliable service, unless reusable hardware and software platforms [13] are available, including flexible Internet-enabled servers to collect and process the field data for IoT applications.

This paper contributions of interest for researchers in the WSN field can be summarized as: 1) detailed specifications for a demanding WSN application for long-term environmental monitoring that can be used to analyze the optimality of novel WSN solutions, 2) specifications, design considerations, and experimental results for platform components that suit the typical IoT application requirements of low cost, high reliability, and long service time, 3) specifications and design considerations for platform re-usability for a wide range of distributed event-based environmental monitoring applications, and 4) a fast and configuration-free field deployment procedure suitable for large scale IoT application deployments.

The wide wireless sensor network application field can be divided into three main categories according to [3]: Monitoring space, monitoring objects and monitoring interactions between objects and space.

Example for first Category is Environment monitoring. WSNs are deployed in particular environments including glaciers, forests, and mountains in order to gather environmental parameters during long periods. Temperature, moisture or light sensor readings allow analyzing environmental phenomena, such as the influence of climate change on rock fall in permafrost areas [14].

Structural monitoring is one of the possible illustrations of second category. By sensing modes of vibration, acoustic emissions and responses to stimuli, mechanical modifications of bridges or buildings indicating potential breakages of the structure may be detected.

Monitoring interaction between objects and space is the combination of both previous categories and includes monitoring environmental threats like floods and volcanic activities [15]. By extending application area of WSN, we can apply WSN to medical field for health monitoring.

Figure 1 - 3 shows various application areas for WSN, such as agriculture, military, medical field, surveillance using fire detection,etc.

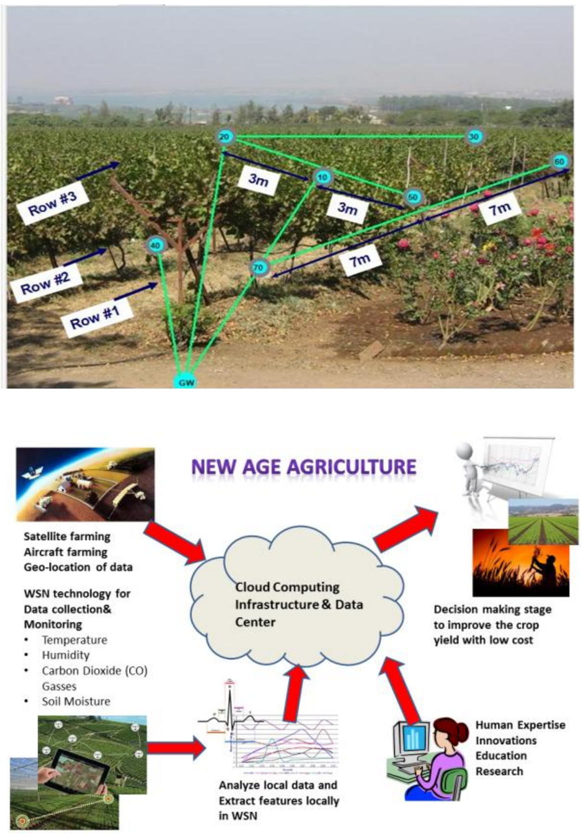

Figure 1. WSN application in Agriculture

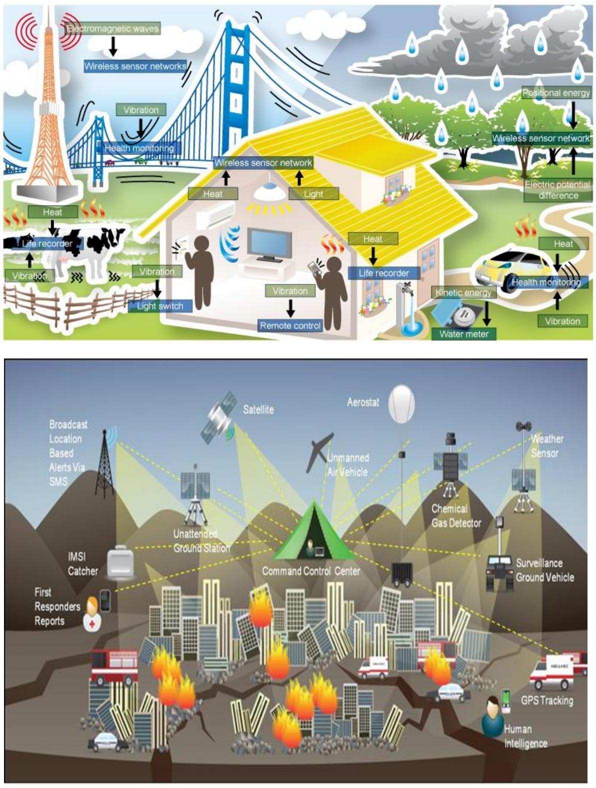

Figure 2. WSN application in Surveillance System

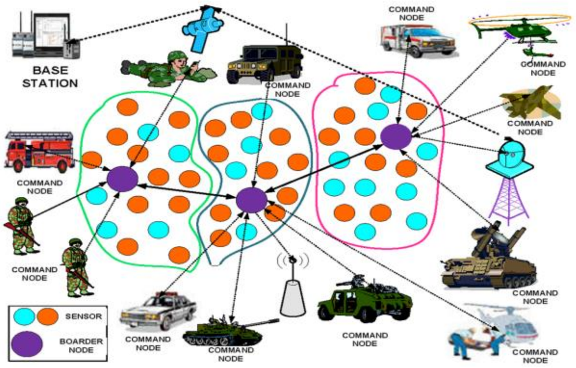

Figure 3. WSN application in Military

III. IOT ENVIRONMENTAL MONITORING REQUIREMENTS

WSN data acquisition for IoT environmental monitoring applications is challenging in open nature fields. These may require large sensor numbers, low cost, high reliability, and long maintenance-free operation. At the same time, the nodes can be exposed to variable and extreme climatic conditions, the deployment field may be costly and difficult to reach, and the field devices weight, size, and ruggedness can matter as they can be transported in backpacks. Most of these requirement are found in application of wildfire monitoring [16-17].

The system requirements can be summarize as :

a. Hardware : sensors, actuators, connectors, interface boards, input and display panels, routers, computers, generators, transformers, etc.

b. Software :communication, data filter and fusion using IoT feature programmed system.

IV. PROPOSED SYSTEM

The proposed architecture of the system for environmental monitoring and management based on IoT contains four layers:

a. Perception layer

b. Network layer

c. Middleware layer

d. Application layer.

The below figure shows the all the layers of proposed system.

a. Perception layer :

The perception layer is mainly used for collecting data and other information of detailed factors of physical world (targets or tasks) in environmental monitoring and management, usually including real-time datasets, models/methods, knowledge, and others. The real-time data collection based on IoT is related to multi-sensors.

b. Network Layer :

The network layer performs basic functions of data and information transmission through the interconnection of systems and platforms. The network layer mainly consists of access networks and transport networks. Access networks are short-range wireless networks, usually consist of Sensors

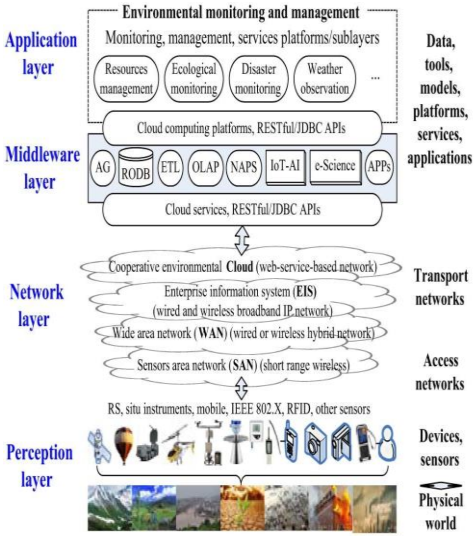

Figure 4. Proposed System

Area Network (SAN), 2G, 3G, WiFi, and ZigBee are common components to support the connection of things .In transport networks, various Wide Area Networks (WANs) of wired or wireless hybrid network are usually subsystems of EIS with wired and wireless broadband IP network, and EISs could be connected to the cooperative environmental cloud with Web service-based global network transport protocols [HyperText Transfer Protocol/ Transmission Control Protocol (HTTP/TCP) and Constrained Application Protocol/User Datagram Protocol (CoAP/UDP)], and Internet Protocol version 4/Internet Protocol version 6 (IPv4/IPv6) are common technologies or standards for the transport networks.

c. Middle layer :

The middleware layer is a set of sub-layers for the management of data, software/tools, models and platforms, and interposed between the network layer and the application layer. Interactions between components, interfaces, applications, and protocols were implemented by representational state transfer (RESTful) APIs or Java database connectivity (JDBC) APIs.

d. Application layer :

The application layer provides the functions of storing, organizing,processing, and sharing the environment data and other information obtained from sensors, devices, and Web services, as well as the functions of taking professional applications in environmental monitoring and management, such as resources management .The application layer is the top level and represents the final task of IIS for environment decision management and planning service.

Perception layer: The perception layer is mainly used for collecting data and other information of detailed factors of physical world.

Network layer: The network layer performs basic functions of data and information transmission as well as the interconnection of systems and platforms. Here LAN is used for transmitting or receiving the data.

Application layer: Application layer does the work of middle layer also. The layer is responsible for interaction of data to n fro from network layer and is also responsible for processing of the data received for environmental management.

Application involves the usage of 3 sensors 1. Temperature sensor 2. Light sensor 3.dry/wet sensor. The data from the sensors are collected and processed using a processor and is send to the authorized person's email through Internet.

V. COMPONENTS

a. ARM7 Processor : ARM7 is a group of older 32-bit ARM processor cores licensed by ARM Holdings. This generation has introduced the Thumb 16-bit instruction set with improved code density compared to previous architectures. The most widely used ARM7 designs implement the ARMv4T architecture, but some implement ARMv3 or ARMv5TEJ. Von Neumann architecture is used by all of these designs. The few versions comprising a cache do not separate data and instruction caches due to the Von Neumann architecture.

b. ARM11 : The ARM1176JZF-S processor incorporates an integer core that implements the ARM11 ARM architecture v6. It supports the ARM and ThumbTM instruction sets, Jazelle technology to enable direct execution of Java bytecodes, and a range of SIMD DSP instructions that operate on 16-bit or 8-bit data values in 32-bit registers.

The ARM1176JZF-S processor features :

- Provision for Intelligent Energy Management (IEMTM).
- TrustZoneTM security extensions
- High-speed Advanced Microprocessor Bus Architecture (AMBA) Advanced Extensible
- Interface (AXI) level two interfaces supporting prioritized multiprocessor implementations.
- An integer core with integral EmbeddedICE-RT logic .
- An eight-stage pipeline .
- Branch prediction with return stack .
- Low interrupt latency configuration .
- Internal coprocessors CP14 and CP15 .
- Vector Floating-Point (VFP) coprocessor support .
- External coprocessor interface .
- Instruction and Data Memory Management Units (MMUs), managed using MicroTLB structures backed by a unified Main TLB .
- Instruction and data caches, including a non-blocking data cache with Hit-Under-Miss(HUM) .
- virtually indexed and physically addressed caches 64-bit interface to both caches .
- Level one Tightly-Coupled Memory (TCM) that you can use as a local RAM with DMA .
- Trace support.
- JTAG-based debug.
- ARM1176JZF-S architecture with Jazelle technology

The ARM1176JZF-S processor has three instruction sets:

1. The 32-bit ARM instruction set used in ARM state, with media instructions
2. The 16-bit Thumb instruction set used in Thumb state
3. The 8-bit Java bytecodes used in Jazelle state.

c. AT 89C2051 Microcontroller Features :

- Compatible with MCS®-51Products
- 2K Bytes of Reprogrammable Flash Memory
- 2.7V to 6V Operating Range
- Fully Static Operation: 0 Hz to 24 MHz
- Two-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 15 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial UART Channel
- Direct LED Drive Outputs
- On-chip Analog Comparator
- Low-power Idle and Power-down Modes
- Green (Pb/Halide-free) Packaging Option

d. Temperature Sensor : LM35 converts temperature value into electrical signals. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

e. Moisture sensor : Soil moisture sensors measures the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors. One common type of soil moisture sensors in commercial use is a Frequency domain sensor such as a capacitance sensor. Another sensor, the neutron moisture gauge, utilize the moderator properties of water for neutrons. Cheaper sensors -often for home use- are based on two electrodes measuring the resistance of the soil.

f. Light Dependent Resistor : LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1,000,000 ohms, but when they are illuminated with light, the resistance drops dramatically.

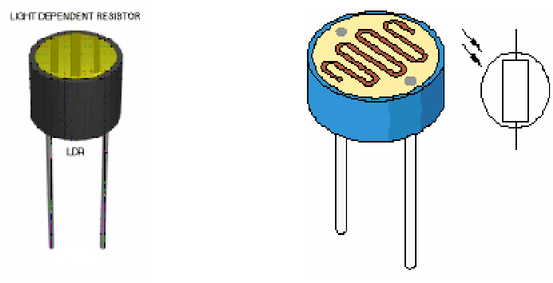

Figure 5. LDR

g. RASPBERRY PI : The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC),which includes aARM1176JZF-S 700MHz processor (The firmware includes a number of "Turbo" modes so that the user can attempt over clocking, up to 1GHz, without affecting the warranty), VideoCoreIV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and long-term storage. The Foundation's goal was to offer two versions, priced at US$25 and US$35.

Figure 6. Raspberry PI

h. Application server : The main purpose of a WSN application server is to receive, store, and provide access to field data. It creates the low power communication segments, with latency-energy trade-offs, and the fast and ubiquitous end user field data access by IoT applications.

The full custom server software has the structure shown in
Fig. 7. It provides interfaces for :

• field nodes (gateways);

• the operators and supervisors for each field;

• various alert channels;

• external access for other IoT systems.

Two protocols are used to interface with the field nodes (gateways) for an energy-efficient communication over unreliable connections: normal and service (boot loader) operation.

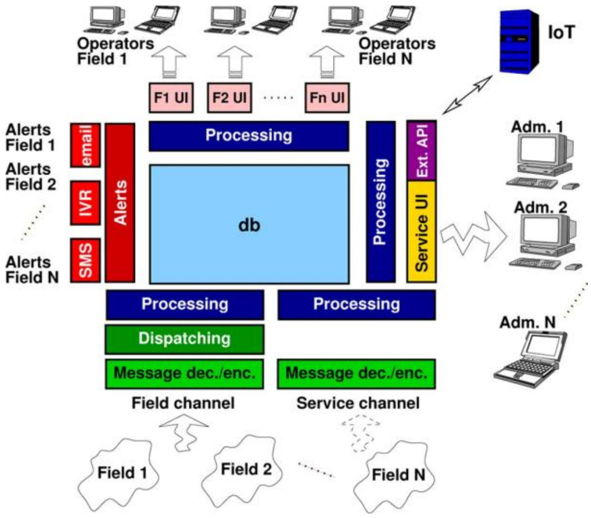

Figure 7. Application Server Interfaces.

VI. ACKNOWLEDGMENT

This paper is aimed towards implementation of WSN for environment monitoring in IoT by suggesting solutions for various problems faced while implementing WSN in real world. All requirements of IoT to be achieved from WSN and functional specifications are studied here.

VII. CONCLUSION

WSNs are traditionally considered key enablers for the IoT paradigm. However, due to the widening variety of applications, it is increasingly difficult to define common requirements for the WSN nodes and platforms. All aspects of the WSN platform are considered: platform structure, flexibility and reusability, optimization of the sensor and gateway nodes, optimization of the communication protocols for both in-field and long range, error recovery from communications and node operation, high availability of service at all levels, application server reliability and the interfacing with IoT applications. Of particular importance are IoT requirements for low cost, fast deployment, and long unattended service time.

All platform components are implemented and support the operation of a broad range of indoor and outdoor field deployments with several types of nodes built using the generic node platforms presented.

REFERENCES

[1] "Internet of Things in 2020: Roadmap for the Future," 2008, online, http://www.smart-systems-integration.org/public/internet-of-things.

[2] P. Harrop and R. Das, Wireless sensor networks 2010–2020, *IDTechEx Ltd, Cambridge, U.K., 2010.*

[3] F. Zhao and L. Guibas, Wireless Sensor Networks: An Information Processing Approach.*San Francisco, CA: Morgan Kaufmann, 2004.*

[4] I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks",*IEEE Communications Magazine, pp. 102–114, Aug. 2002.*

[5] C. Chong and S. Kumar, "Sensor networks: Evolution, opportunities, and challenges," in *Proceedings of IEEE, Aug.2003.*

[6] K. Martinez, P. Padhy, A. Elsaify, G. Zou, A. Riddoch, J. Hart, and H. Ong, "Deploying a sensor network in an extreme environment," *Sensor Network., Ubiquitous, Trustworthy Comput., vol. 1, pp. 8–8, Jun. 2006.*

[7] A. Hasler, I. Talzi, C. Tschudin, and S. Gruber, "Wireless sensor networks in permafrost research—Concept, requirements, implementation and challenges," in *Proc. 9th Int. Conf. Permafrost, Jun. 2008, vol.1, pp. 669–674.*

[8] R. Szewczyk, J. Polastre, A. Mainwaring, and D. Culler, "Lessons from a sensor network expedition," *Wireless Sensor Netw., pp. 307–322, 2004.*

[9] G. Tolle, J. Polastre, R. Szewczyk, D. Culler, N. Turner, K. Tu, S. Burgess, T. Dawson, P. Buonadonna, D. Gay, and W. Hong, "A macro-scope in the redwoods," in *Proc. 3rd Int. Conf. Embedded Netw. Sensor Syst., New York, 2005, pp. 51–63.*

[10] L. Bencini, F. Chiti, G. Collodi, D. Di Palma, R. Fantacci, A. Manes, and G. Manes, "Agricultural monitoring based on wireless sensor network technology: Real long life deployments for physiology and pathogens control," in *Sensor Technol. Appl., Jun. 2009, pp. 372–377.*

[11] S. Verma, N. Chug, and D. Gadre, "Wireless sensor network for crop field monitoring," in Recent Trends Inf., Telecommun. Comput., *Mar. 2010, pp. 207–211.*

[12] Y. Liu, Y. He, M. Li, J. Wang, K. Liu, L. Mo, W. Dong, Z. Yang, M. Xi, J. Zhao, and X.-Y. Li, "Does wireless sensor network scale? A measurement study on GreenOrbs," in Proc. *IEEE INFOCOM, Apr. 2011, pp. 873–881.*

[13] C. Hartung, R. Han, C. Seielstad, and S. Holbrook, "FireWxNet: A multi-tiered portable wireless system for monitoring weather conditions in wildland fire environments," in Proc. 4th Int. Conf. Mobile Syst., Appl. Services, New York, 2006, pp. 28–41.

[14] I. Talzi, A. Hasler, S. Gruber, and C. Tschudin, "PermaSense: investigating permafrost with a WSN in the Swiss Alps," in Proceedings of the *workshop on Embedded networked sensors (EmNets), 2007.*

[15] W. Werner-Allen, K. Lorincz, M. Ruiz, O. Marcillo, J. Johnson, J. Lees, and M. Welsh, "Deploying a Wireless Sensor Network on an Active Volcano," *IEEE Internet Computing, vol. 10, no. 2, 2006.*

[16] Narasimhan, V. Lakshmi, Alex A. Arvind and Ken Bever, 2007. Greenhouse Asset Management Using Wireless Sensor-Actor Networks, Proceeding of *Int. Conf. On Mobile Ubiquitous Computing, Systems, Services and Technologies, pp: 9-14.*

[17] Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," *IEEE Communications Magazine, pp. 102–114, Aug. 2002.*

	Ms. Padwal S. C. is student of Master of Engineering (VLSI & Embedded System) in SVCET,Rajuri. Author is working on project Long-Term Environment Monitoring in IoT applications using WSN. Project aims towards increasing life time of devices in environment monitoring for agricultural field by deploying WSN. By use of sensors and wireless communication in IOT, an system design is proposed so that environment around soil in farm is maintained.
	Prof. Manoj Kumar is Assistant Professor in Electronics and Telecommunication Department of Sahyadri Valley College of Engineering & Technology, Rajuri. He is also working as PG-coordinator in E&TC Department.