

# AN EFFICIENT COMPRESSIVE DATA GATHERING AND REMOTE SENSING FOR LARGE SCALE WSN USING ZIGBEE AND RSSI

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**Abstract**—Monitoring environment is one of the most efficient applications of Wireless Sensor Networks. The wireless sensor network that consists of sensors, for a providing surveillance application. In the existing system there are only limited application which leads to high cost, unsatisfied monitoring and the sensor node location based on the distance cannot be identified. In the proposed system, the embedded ZIGBEE interfaced along RSSI have emerged and been used as wireless devices. ZIGBEE network that is used to connect different devices at a frequency around 2.4GHz. It is used in many applications recently in technology capabilities across each of the core processes involved in sensing and monitoring—data analysis, collection, infrastructure connectivity, and data mining. The RSSI embedded with ZIGBEE system mainly used for detecting the accurate node position. Wireless sensor networks (WSNs) and RSSI systems provide an excellent and efficient infrastructure for data acquisition, distribution, and processing. Remote area can be monitor and data can be transmit. Gas leakage, temperature monitoring, fire detection, water level monitoring, landslide detection are the some of the examples of the WSN applications.

**Keywords**—RSSI, remote monitoring, ZIGBEE, remote control.

## 1. INTRODUCTION

Forest fires are considered as a major and permanent problem in the forests. Every year, forest fires cause enormous and

irreparable damage to forest ecosystems and in some cases threaten residential regions. There are many factors that cause fire risk in forest, such as high temperatures and prolonged drought periods, the high speed winds, the configuration of the forest ground and the extremely flammable vegetation. In this project proposed is detecting forest fire by ZIGBEE. The PIC 16f877a is chosen as hardware core of general network node. In the external of PIC controller, temperature sensor is configured to monitor the corresponding data are transmitted to the receiver unit. The receiver decides whether the environmental status leads to forest fire or not. The sensor values are processed and transmitted from the transmitting section through ZIGBEE. In the receiver end, these values are received by the controller and detect data.

ZIGBEE is a wireless connection network that is used to connect different devices data. For medical applications also this ZIGBEE is widely used. The ZIGBEE can transmit and receive the devices signal about 1km. This can be operated from any distance to any point of control. The transaction is done with the help of local network support. Since we are using the networks

ZIGBEE this makes the user to communicate for internal system.

The exponential increase in the number of devices with digital connectivity will require new connection and management processes. Addressing and identifying a population of potentially tens of billions of devices requires reliable, scalable and flexible systems to work between industry entities and consumers. The combination of these technology developments means that information is now gathered from more human and machine-based sources, and analyzed and disseminated than ever before.

## 2. RELATED WORK

The technical brilliance and development in different fields has led to a drastic in our lives, one among them is embedded systems. The application of these devices is to monitor the environmental status. ZIGBEE used for wireless connection. This chapter examines recent developments in technology capabilities across each of the core processes involved in sensing and monitoring—data collection, infrastructure connectivity, and data mining and analysis. It also looks at how sensing and monitoring processes are evolving in ways that no longer require human intervention, using the communications infrastructure of the internet through the ‘internet of things’ and machine-to-machine communications using mobile and internet-based technologies.

Sensors are fundamental elements of all machines that gather data, require feedback for their operation or are required to provide a Human Machine Interface (HMI). Purpose-specific sensors that are observable

by instruments have been developed to enhance the scope and range of measurements. Electronic sensors based on semiconductor devices have been integrated with computers and communications networks to provide useful information-gathering solutions.

Technological developments in materials and electronics have led to the miniaturization and integration of sensors into intelligent devices and systems that not only measure and analyze but also act on the resultant information. Intelligent sensors can also consolidate observations, and aggregate and analyze data locally to conserve downstream communications and analysis resources. Today, autonomous and connected sensors are able to selectively sample and measure many physical properties such as temperature, force, pressure, flow, position, and light intensity without impacting on the properties being measured.

## 3. METHODOLOGY AND WORKING PLAN

The project will be carried out on the following sequential stages:

1. Research: it will be done during the whole development of the project and whenever it is necessary. A deeper research will be needed at the beginning of each stage to get acquainted with the topic and the objective. It will also be necessary to become familiar with the tools to be used.

2. PCB design (schematics and layout). The PCB will be the base of the node. It is worth to mention that, in this stage, a selection of

the components of the node will be performed.

3. Node construction: PCB manufacture and component assembling process.
4. Testing of the board connections.
5. Programming of the microcontroller.
6. Utilization of the system to obtain data of the RF module power consumption.
7. Check of the whole system.
8. Addition or optional improvements.

#### 4.SENSOR NETWORK PLATFROM

In sensor network unit two types of sensors are used. There are Temperature Sensor MEMS. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is proportional to temperature.

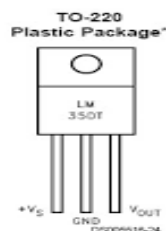


Fig.1. Temperature sensor, temperature range  $-40^{\circ}\text{C}$  to  $+110^{\circ}\text{C}$ , this is the TO 92 package

The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration. It uses single power supplies, or with passive and negative supplies.

The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

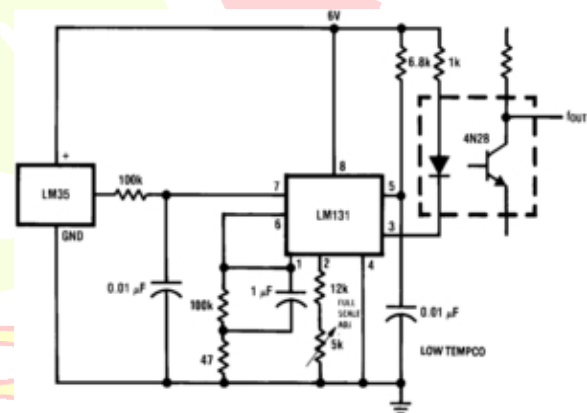


Fig.2. the LM35 series are precision integrated-circuit temperature sensors

**MEMS** (Micro-Electro Mechanical System)based accelerometers are devices that measure the proper acceleration. The physical acceleration is measurable by sensors. In relativity theory, proper acceleration is the physical acceleration experienced by an object. These sensors are part of the sensing cluster of ubiquitous technologies. Sensing technologies make

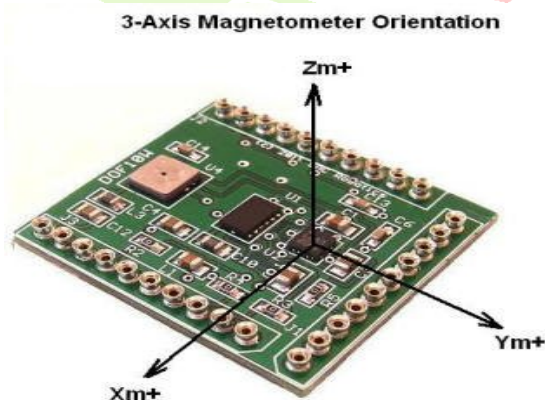
use of physical parameters from the environment, such as dimension, pressure, force and light. An accelerometer measures weight per unit of mass, a quantity also known as g-force. Measuring g-forces allows users to for instance interact with products by means of gesture recognition.

MEMS-based accelerometers are available in 1-, 2- and 3-axis configurations, in low-g or high-g sensing ranges. MEMS-based accelerometer with capacitors is typically a structure that uses two capacitors formed by a moveable plate held between two fixed plates. Accelerometers are one of the simplest but also most applicable micro-electromechanical devices. The most common are based on capacitors and gas chambers. Under zero net force the two capacitors are equal but a change in force will cause the moveable plate to shift closer to one of the fixed plates, increasing the capacitance, and further away from the other fixed reducing that capacitance. This difference in capacitance is detected and amplified to produce a voltage proportional to the acceleration. The dimensions of the structure are of the order of microns.

Fig.3.9 Degree of Freedom sensor for attachment to the Wasp Data Logger or as a standard MEMS sensor platform.

## 5. Design of Remote Monitoring and Controlling System

This section deals with the design of remote monitoring and controlling systems. To design a system, we considered a home automation network. The proposed system is an embedded system which will closely monitor and identify the environmental parameters taken from the sensors and transmitted through the ZIGBEE module. This eliminates the difficulties involved in the system by reducing human intervention to the best possible extent. The system comprises of sensors, microcontroller and detecting modules. This system monitors the relevant node which identifies the location or distance using the RSSI module. Sensors are generally part of a more comprehensive monitoring or data acquisition system that conditions, processes, converts and transports data. ZIGBEE is flexible in performance and is battery operated. ZIGBEE can be used in different applications such as building automation, industrial control and medical data collection.



at its Best !!!



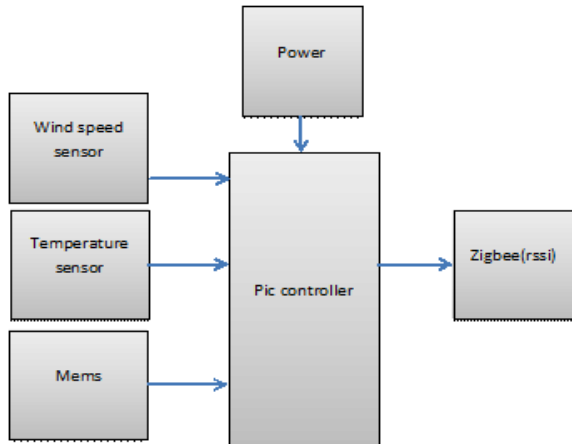


Fig.4. operation process of node 1 unit.

RSSI is a generic radio receiver technology metric, which is usually invisible to the user of the device containing the receiver, but is directly known to users of wireless networking of IEEE 802.11 protocol family. In node 1 unit three sensors units are used. Wind speed sensor is used for calculating the air seep. Temperature sensor is used for monitoring the temperature level. MEMS are dimension based sensor. Three sensors value is given to PIC microcontroller. Controller is compare the sensors level to the reference level, if value is exited ZIGBEE wireless module transmit the sensor value to monitoring unit.

In node 2 having two type of process sensing and automation process. Three types of sensors are used in node 2 unit. They are gas sensor, temperature sensor, fire sensor. Fire also known as combustion is a sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the products of combustion being, heat, smoke & electromagnetic radiation (light).

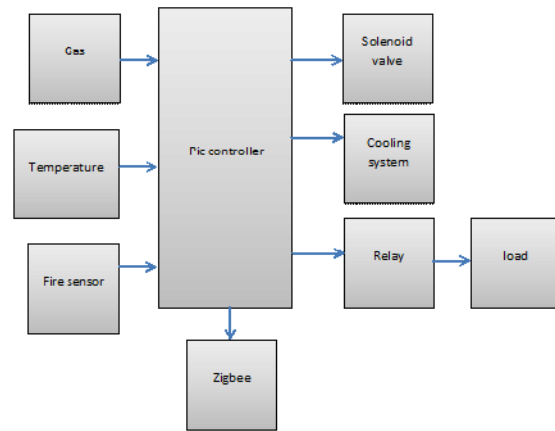


Fig.5. block diagram of node 2 unit.

Gas sensor and fire sensor are used for fire detection process. Three sensors value is given to PIC microcontroller. Controller is compare the sensors level to the reference level, if value is exited automation process solenoid valve opening, cooling fun running and load connect through relay are running.

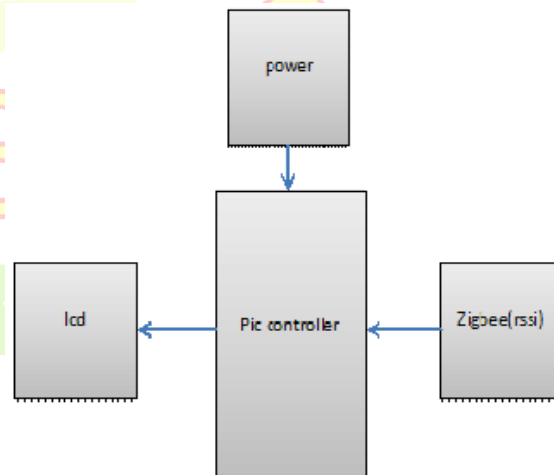


Fig.6. monitoring unit

Monitoring unit is received the signal from node 1&2 through wireless module. Sensors value and automation process are monitor in this unit.

## 6.DESIGN OF WIRE LESS NETWORK MANAGEMENT PLATFORM

Localization in wireless sensor networks has drawn significant research attention in recent years, since many real-life applications need to locate the source of incoming measurements as precise as possible. In this paper, two popular localization RSSI and ZIGBEE wireless module used.

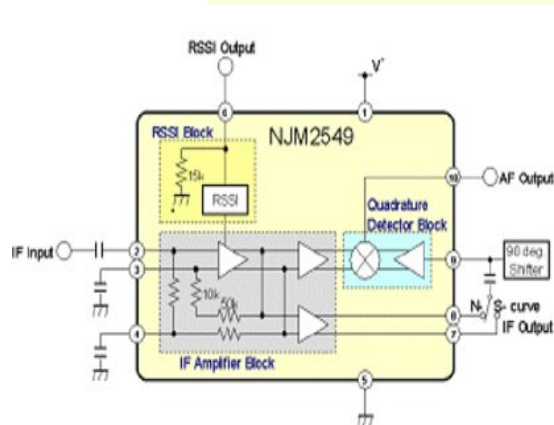


Fig.6. Block Diagram of RSSI

The indoor localization problems, where no GPS signals are able to be received, require wireless sensor networks. Improvements in the processor technology make it possible to locate multiple sensors to be used in outdoor localization problems. Several distance estimation techniques, based on the communication between located sensors, are present. RSSI is the most applicable one of indoor monitoring. And the position estimation process is performed based on the distance data derived from the RSSI measurement.

In an IEEE 802.11 system, RSSI is the relative received signal strength in a wireless environment, in arbitrary units. RSSI is an indication of the power level being received by the antenna. Therefore, the higher the RSSI number, the stronger the signal. RSSI can be used internally in a wireless networking card to determine when the amount of radio energy in the channel is below a certain threshold at which point the network card is clear to send (CTS). Once the card is clear to send, a packet of information can be sent. The end-user will likely observe a RSSI value when measuring the signal strength of a wireless network through the use of a wireless network monitoring tool like Wireshark, Kismet or Insider. As an example, Cisco Systems cards have a RSSI\_Max value of 100 and will report 101 different power levels, where the RSSI value is 0 to 100. Another popular Wi-Fi chipset is made by Atheros. An Atheros based card will return an RSSI value of 0 to 127 (0x7f) with 128 (0x80) indicating an invalid value. There is no standardized relationship of any particular physical parameter to the RSSI reading. The 802.11 standard does not define any relationship between RSSI value and power level in mW or dBm. Vendors and chipset makers provide their own accuracy, granularity, and range for the actual power and their range of RSSI values (from 0 to RSSI\_Max). One subtlety of the 802.11 RSSI metric comes from how it is sampled—RSSI is acquired during only the preamble stage of receiving an 802.11 frame, not over the full frame. A study in 2009 showed that RSSI cannot necessarily be used to reliably gauge distances in a wireless sensor network.

Single distances can be determined by the functional correlation to the signal strength. If the distances between a number of  $N > 2$  base stations and a mobile terminal are already known the position estimation can be efficiently calculated by using the LSE method.

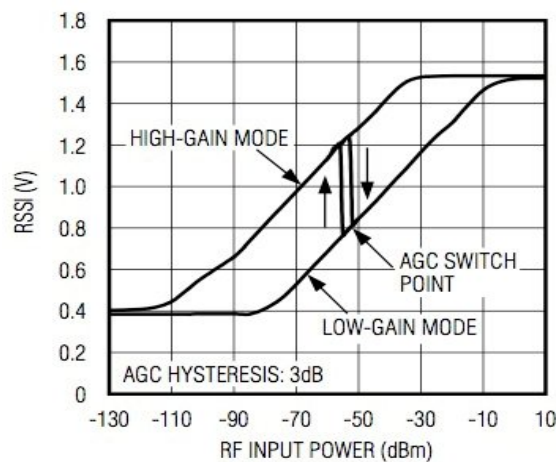


Fig.7. dBm, reducing RSSI output. The AGC Disables attenuation when RSSI drops below 680 mv.

RSSI or received signal strength indication can go from 0 to -100 generally the higher (closer to 0) the better and the closer to 100 the worse. Currently my iMac is 20 feet (line of sight) from my wireless base station and fluctuates between -57 and -58 and is connected at full speed. My laptop which I can roam around the house with never goes lower than -60 and never higher than -51. The number to pay much more attention to is the Transmit Rate - the transmit rate will drop if you have too much noise or interference or if you are too far away from the base station.

An information management and localization of wireless sensor network platform need have quicker processing speed and strong information management functions. In this design, we focus the core ZIGBEE building wireless sensor network gateways hardware platform. ZIGBEE is a specification that defines a set of high level protocols for low cost and low power Wireless Personal Area Networks (WPANs). It does not require infrastructure (no need for access point) or when it does, it is usually pretty simple. It is employed principally for monitoring or control tasks which require low cost, reliability, security and low power consumption (long battery life) where high range or high rate communication is not needed. ZIGBEE is specified by a consortium of manufacturers, distributors and users called ZigBee Alliance which is also a trademark property of Philips Corporation.

1. Network and Application Support layer: The network layer permits growth of network sans high power transmitters. This layer can handle huge numbers of nodes. This level in the ZIGBEE architecture includes the ZIGBEE Device Object (ZDO), user-defined application profile(s) and the Application Support (APS) sub-layer.

The APS sub-layer's responsibilities include maintenance of tables that enable matching between two devices and communication among them, and also discovery, the aspect that identifies other devices that operate in the operating space of any device.

The responsibility of determining the nature of the device (Coordinator / FFD or RFD) in the network, commencing and replying to

binding requests and ensuring a secure relationship between devices rests with the ZDO (ZIGBEE Define Object). The user-defined application refers to the end device that conforms to the ZIGBEE Standard.

2. Physical (PHY) layer: The IEEE802.15.4 PHY physical layer accommodates high levels of integration by using direct sequence to permit simplicity in the analog circuitry and enable cheaper implementations.

3. Media access control (MAC) layer : The IEEE802.15.4 MAC media access control layer permits use of several topologies without introducing complexity and is meant to work with large numbers of devices.

Network topologies: ZIGBEE supports three routing types with the subsequent topologies

1. Star: one PAN coordinator (master) with one or several end-devices (slaves), up to 65534. The main characteristics are that all devices must be inside the PAN coordinator range and the low latency (2 hops maximum route path). This is the simplest topology.

2. Tree: each device can be connected to several children but just to one parent. The routing type, "net mask" hierarchical style, is a bit more complex than in the star topology since it must support multi-hop but it is still simple to implement.

3. Mesh: in mesh networks FFDs can connect with any other device in its range. The routing is based upon a modified version of Ad-hoc On Demand Distance Vector (AODV). FFDs can issue a route discovery command that floods the mesh to

find the routes to any destination. The routes are determined from the replies to that command and are stored in record tables. The complexity of the network increases as the number of devices grows requiring more memory to save the addresses in the routing tables

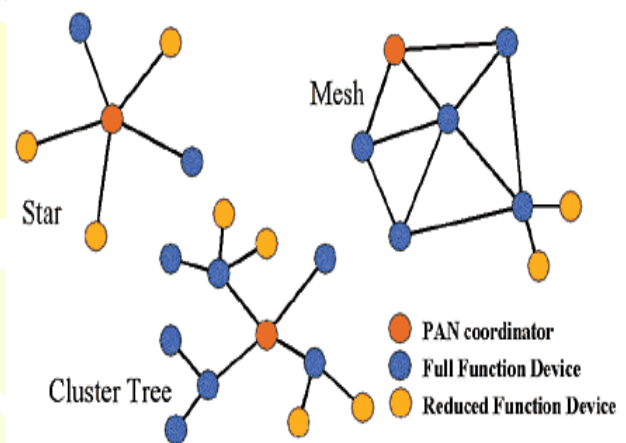


Fig.8. ZIGBEE Network Topologies

## CONCLUSION

A step-by-step approach in designing the microcontroller based system for measurement and monitoring the essential parameters in the surroundings, i.e. temperature, wind speed and position. The results obtained from the measurement have shown that the system performance is quite reliable and accurate.

The system has successfully overcome quite a few shortcomings of the existing systems by reducing the power consumption, maintenance and complexity, at the same time providing a flexible and precise form of maintaining the environment.



The continuously decreasing cost of hardware and software, the wider acceptance of electronics systems in forest disaster management and an effective control system in large scale industrial areas of agricultural production, will result in reliable systems that will address several aspects of quality based on the results. Further improvements will be made as less expensive and more reliable sensors are developed for use in advance development.

Although the enhancements mentioned in the previous chapter may seem far in the future, the required technology and components are available, many such systems have been independently developed, or are at least tested at a prototype level. Also, integration of all these technologies is not a daunting task and can be successfully carried out.

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