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# LORA BASED SMART AGRICULTURE MONITORING SYSTEM

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**Abstract -** *Traditional agriculture is remodeling into resourceful agriculture with the advancement of the internet of Things (IoT). Low-cost and low-power are the prime factors to make any IoT network advantageous and admissible to the farmers. In this paper, we have developed a low-power, inexpensive IoT network for smart agriculture. In this system we have designed, implemented and analyzed long range communication protocol in agriculture system which is capable of measurement of factors affecting production and quality of crops. We have created the model hardware and software architecture which can be used to increase the efficiency of agricultural management.*

***Key Words***: **LORA, LDR sensor, PIC Controller, soil moisture sensor, temperature sensor , water pump.**

## 1. INTRODUCTION

The deployment of automated agricultural monitoring system has gained a great value in recent years due to its capacity to increase yields and to decrease water use. Water is distributed through a network of small tubes, pipes, and water storage tanks and it is then dripped steadily, but directly to the root .The uses of computers and electronics in the area of agriculture, specifically, in the irrigation systems have created new engineering and research challenges. In particular, wireless control of actuators for agricultural purposes has some technical difficulties because of the limited budget and power resources. However, in recent years, many different technologies have been developed to efficiently set up WSANs (Wireless Sensor and Actuator Networks). And many studies are conducted to examine their impact on transforming the agriculture. Over the years, techniques such as ZigBee™ and Bluetooth, have been prominent to establish low-power, short-range, multi-hop networks, which make use of the mesh network topology. Although these standards are considered low-cost systems, their restricted coverage (~100 meters) is a major drawback, that makes them difficult to be deployed in major irrigation systems. On the other hand, cellular networks, such as GSM or LTE, are capable of providing long range transmission to form WSANs, and they have been successfully tested to control irrigation systems, but solar panels are required for each node to compensate higher power consumption of cellular network. An another solution for building long-range, low-power and low-cost WSANs is the low-rate transmission technology, referred to as LPWAN (Low Power Wide Area Network).

The main differences between LPWANs and the previous technologies are the use of long-range radio links, deployment of the star network topologies and lowrate data transmissions. Sigfox, Ingenu, NB-IoT, DASH7, and LoRaWAN are examples of LPWAN . All of those technologies have coverage distance of various kilometers and have their own advantages and limitations , in terms of the cost, scalability, power consumption, data rate and etc. Since the wireless control of drip irrigation requires very small data exchange, any of these network types can be used. Among them, Lora is relatively new technology on top of which the LoRaWAN protocol operates. It has the highest radio link budget and the best "cost vs. range vs. power tradeoff among its competitors. That is why, for this project, LoRa modem has been chosen as a radio link Currently, there is a lot of development in LPWAN networks. However, one technology cannot solve all challenges. Thus, LPWANs area unit deployed to handle solely some on challenges in IoT. LPWANs are specifically targeting things wherever extended coverage is most required, with low value of preparation, involving devices that area unit delay tolerant, don't would like a high data rates and require low power consumption network. In particular, monitoring of a system or conditions is a perfect case where LPWANs fit. The goal of the work is to integrate IoTs awareness and communication technology into an intelligent agriculture platform. The accuracies of sensors of various types are measured and these sensors are integrated into multi-functional sensor component. Then, multi- functional sensor components are integrated with Lora wireless network components. In this work an intelligent sensor network platform for agricultural applications is designed and constructed. In this study we have used Lora technology with outstanding advantages in transmission range and energy saving .In addition, in order to increase the stability of the system, we also propose to apply Master/Slave medium access control method for Lora network.

## 2. BASICS OF LORA

In this section, we will introduce the LORA technology, the and the LoRa physical layer.

### Lora Technology

LoRa is a '**Lo**ng **Ra**nge' low power wireless standard intended for providing a cellular style low data rate communications network. Aimed at the M2M and IoT market, LoRa is ideal for providing intermittent low data rate connectivity over significant distances. The radio interface has been designed to enable extremely low signal levels to be received, and as a result even low power transmissions can be received at significant ranges. The LoRa modulation and radio interface has been designed and optimized to provide exactly the type of communications needed for remote IoT and M2M nodes. LoRa is the world's first commercially available wireless technology with low cost, long transmission range and optimal power consumption. The Table I below compares some parameters including transfer rate, transmission range, power consumption and cost between some popular wireless technologies. Accordingly, LoRa has shown its superiority in many aspects. Its only weakness is the data rate. However, in wireless sensor network applications, this is not an issue.

Table 1 Shows comparison of wireless Technologies.

| | Tx Range | Tx Rate | Tx Power | Sleep Power | cost |
|---|---|---|---|---|---|
| Bluetooth (FBT06) | 15 m | 3 Mbps | 20 mA | 16 uA | low |
| Wifi (CC3200) | 150 m | 3 Mbps | 75 mA | 3.5 mA | high |
| 3G/4G (U8300) | | 14 Mbps | 800 mA | 50 uA | high |
| ZigBee (REX3DP) | 100-200 m | 250 Kbps | 200 mA | 0.4 uA | low |
| LoRa (SX1278) | 3000 m | 2.4 Kpbs | 110 mA | 2.0 uA | low |

**Table-1** Comparison of wireless Technologies

**LoRa Physical Layer**

LoRa Physical layer is derived from the Chirp Spread spectrum (CSS) modulation with Forward Error Correction (FEC). Europe and North America use Industrial, Scientific and Medical (ISM) bandwidths, which are under the frequency 1 GHz. That allows to better compensate the Signal to Noise Ratio (SNR). CSS modulation enables a longer range of communication,with the help of Frequency Shift Keying (FSK), even without the increase of energy consumption. CSS also ensures immunity to the Doppler's effect.

Figure 1 Shows noise immunity:

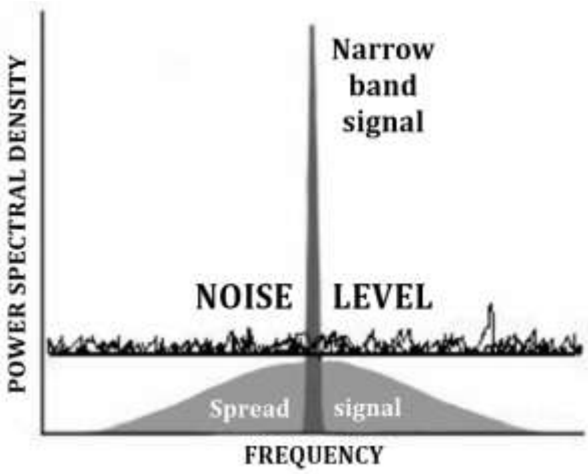


**Fig-1**. Noise level

**3. SYSTEM ARCHITECTURE**

The system architecture is designed as shown in Figure. It includes a Master (PC) and End Nodes (sensors).With this Master/Slave medium access control method, the Master station is responsible for allocating access to slaves as shown in the figure 2. Slaves are passive, so they only access the line and exchange the data when requested by Master.

Figure 2 shows the system architecture.

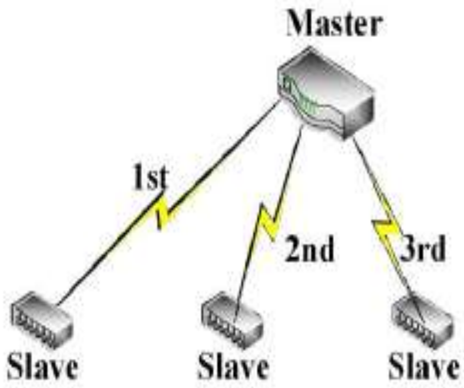


**Fig-2** System Architecture.

## 4. METHODOOLGY

### System Block diagram:

Figure 3 shows the system block diagram:

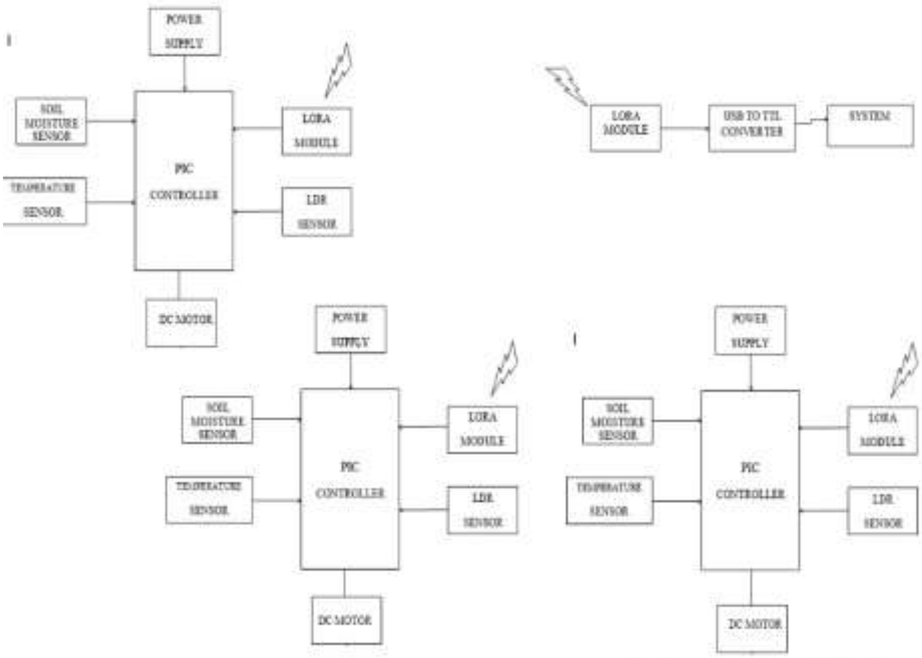


**Fig-3** System Block Diagram

There are 4 main blocks in the project. There is one main sink node and three sensor nodes. These three sensor nodes depict the three sections of the filed which we are going to monitor and control. The end nodes are the sensor nodes which perform the measurement of air temperature soil moisture and intensity. Also in the end nodes there are DC motors connected to control the water flow in the particular selected section of the field. The gateway collects and logs all the forwarded data and provides the logged data to the user interface. The link between endpoints and gateway and user interface is LORA based. The User interface is a computer software which allows us to monitor all the measured sensor parameters in the particular field section that we select and also control the water flow accordingly and remotely.

### Design of sink node

The main processing unit in control node is PC. The LoRa communication enables the PC to connect to field-level devices. In order to increase the processing capacity and reduce the load on the central processing unit, the LoRa communication block is equipped with a PIC microprocessor connected to the LoRa WIR1286 module via serial communication.Nearly every communication task in the LoRa network is handled by the PC.As we send a data request for a particular section of the field the request is processed and real time data of the field is send over to the control node ,this communication takes place LoRa to LoRa. The data send over LoRa on field is received on LoRa module connected to our computer via a CP module

Figure 4 shows the block diagram of the sink node.


**Fig-4**. Block Diagram of sink node.

Figure 5. shows the flowchart for sink node:

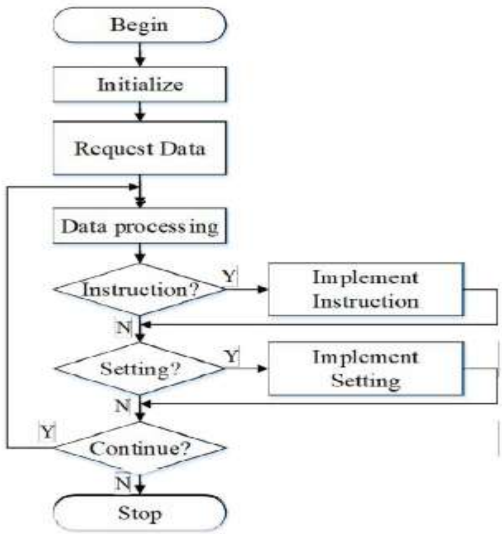


**Fig-5** Flowchart of sink Node

**Design of Sensor node**

There are six main blocks in the design of Sensor Node as shown in Figure 7. The controller in sink node handles LoRa communications task and communicates with sensors as well as processes the data given by sensor, so the PIC18F4520 microcontroller is selected to fulfill the need of processing capacity. The LoRa modem (WIR_1286) is connected to the PIC via serial communication. The temperature sensor is operated by the central processing unit via one-wire standard measuring from 0 to 50 degree (±2 _degree) of temperature. The parameter of soil moisture is also given by a smart sensor that is linked to the PIC through 2-wire synchronization standard. Besides, the connection between sink node and PC for address configuration is facilitated by the serial communication block. The configuration parameters for the device will be stored in the EPROM. The software's algorithm for Sensor Nodes is pointed below in figure 6.

Figure 6 shows the block diagram of the sensor node.

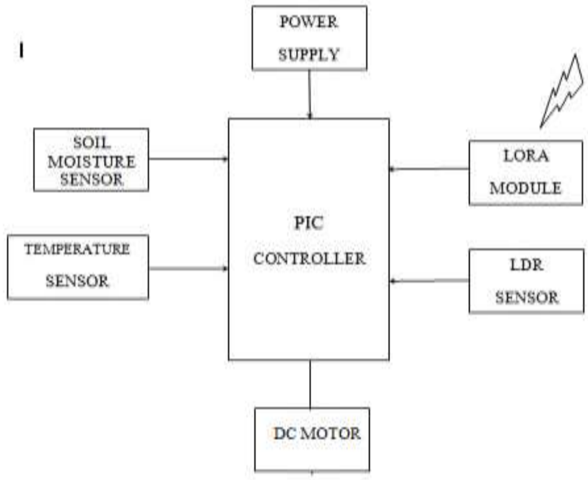


**Fig-6.** Block Diagram of Sensor Node.

Figure 7. shows the flowchart for sensor node:

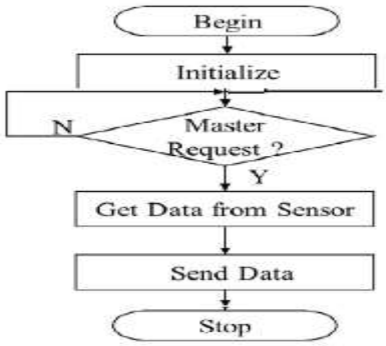


**Fig-7.** Flowchart of Sensor Node.

### 5. RESULTS

Figure 8 shows the software results:

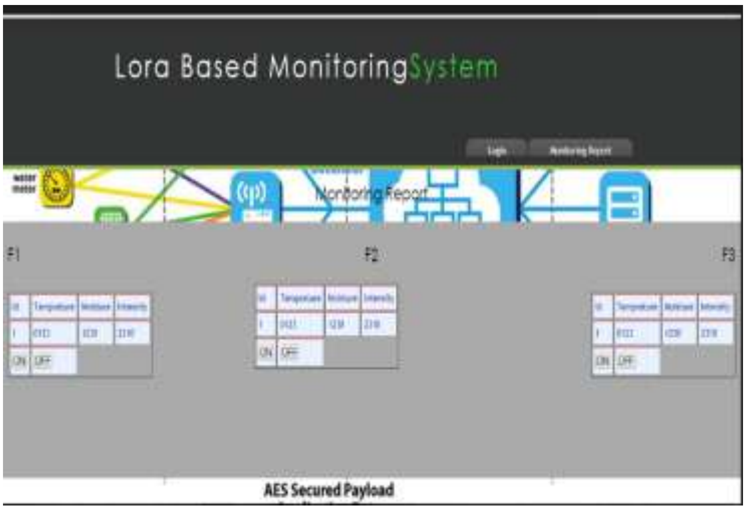


**Fig-8.** Software Results.

Figure 9 shows the hardware results:

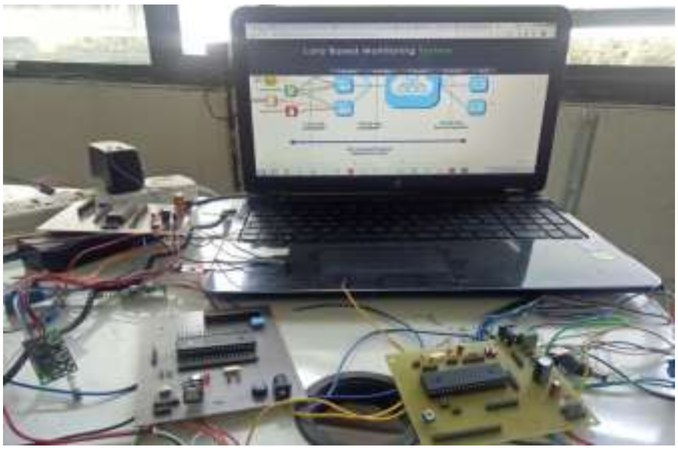

**Fig-9**. Hardware of the system.

## 6. CONCLUSION:

In this paper, the solution using LoRa technology for cost effective wireless control of drip irrigation system has been presented. The system which utilizes LoRa module to develop a smart agriculture control and monitor has been designed. We have presented the design of an automatic monitoring and control system which can be of benefit for greenhouse agriculture as well as normal fields including the overall structure of the system and design in detail of each component including hardware and software design. In this study we used Lora technology combined with the Master/Slave medium access control method to resolve the remaining issues of previous studies such as range and reliability of wireless network. A multi-sensor component and an integrated communications network are established. Wireless sensor networks and network communication technology are used to support intelligent agricultural data collection and equipment control. Furthermore we have introduced ability to regulate and observe the system remotely via computer software. With the results achieved the system will be further studied to improve the stability and reliability of the system so that it can be put into practice in the near future.

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