A REVIEW ON INTELLIGENT AGRICULTURE SERVICE PLATFORM WITH LORA BASED WIRELESS SENSOR NETWORK

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Abstract – *With gaining high popularity, rapid development and increase in the Internet of Things(IoT) application, has been expanded to many fields. One of the top five markets for IoT growth is agriculture. In recent years, a new agricultural Information and Communication Technology(ICT), called Intelligent agriculture, which meets the needs of farmers for information collection, signal processing, data analysis and equipment control, has been developed. An intelligent agriculture service platform based on Wireless Sensor Network(WSN) and Long Range(LoRa) communication technology is proposed in this paper. LoRa is used as a network transmission interface. It is capable to solve the problems such as communication failure, save energy and many more. An agricultural intelligent agriculture service platform is to be developed to support environmental monitoring and to improve efficiency of agricultural management.*

Key Words: **LoRa-based, Agriculture, Internet of Things(IoT), Low Power Wide Area Network(LPWAN), Wireless Sensor Network(WSN).**

1. INTRODUCTION

A wide range of applications are supported by IoT . It is observed that most of the wireless communication technologies require high power consumption and provide short transmission distances hence do not meet the requirements of IoT applications for connections hence to overcome such problems LoRa technology has been proposed. LoRa devices and wireless radio frequency technology is a widely adopted long-range, low-power solution for IoT that gives telecom companies, IoT application makers and system integrates the feature set necessary to deploy low-cost, interoperable IoT networks, gateways, sensors, module products and IoT services worldwide. The goal of this project is to integrate IoT awareness and communication technology into an intelligent agriculture platform. This paper consists of an intelligent sensor network platform for agriculture application is to be designed and constructed.

A miniature greenhouse which is equipped with an automatic monitoring system is to be build. This monitoring system will constantly monitor environmental conditions in the greenhouse to ensure that it remains at preset temperature, light and humidity levels. If the current environmental conditions differ from the pre-set levels, the monitoring system will automatically turn on certain devices to return greenhouse to the required conditions [1].

For an automated greenhouse monitoring system four types of sensors are used during implementation. The sensors to be used are ambient light sensors, temperature sensors, moisture sensors and humidity sensors. These will connected to a microcontroller which will function as a main control unit. The values of the sensors will be transferred to control room via LoRa Module.

1.1 LoRa TECHNOLOGY

LoRa is a patented digital wireless data communication technology (EP2763321 from 2013 and US7791415 from 2008) spread-spectrum radio modulation originally developed by Cycleo of Grenoble, France and acquired by Semtech in 2012. LoRa uses unlicensed free sub gigahertz radio frequency bands like 169MHz, 433MHz, 868MHz in Europe and 915MHz in US. It is a spread spectrum modulation technique derived from chirp Spread Spectrum(CSS) technology. Chirp stands for 'Compressed High Intensity Radar Pulse'. It is a signal which frequency either increase or decrease with time. Chirp spread spectrum developed for radar applications. Chirp signals have constant amplitude and pass the whole bandwidth in linear or non linear way from one end to another end in certain time. It uses complete bandwidth to transmit signals. If the frequency changes from lowest to highest, it is called up-chirp and if frequency changes from highest to lowest, it is called down-chirp. This technique helps to transmit signals for very large distances. Chirp spread spectrum is resistive to Doppler shift[6].

The technology is presented in two parts- LoRa, the physical layer and Long Range Wide Area Network(LoRaWAN), the upper layers. LoRa physical layer includes 8 preamble symbols, 2 synchronization symbols, physical payload and optional CRC.

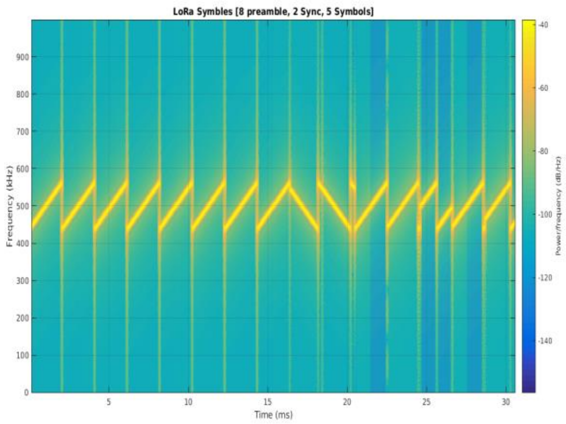

Fig -1: Spectrogram Of LoRa physical layer

Some features of LoRa technology are as mentioned below:

1. Long Range:

Connects devices up to 30miles apart in rural areas and penetrates dense urban or deep indoor environment.

2. Low Power:

Requires minimal energy with prolonged battery lifetime of up to 10 years, minimizing battery replacement costs.

3. Secure:

Features end to end AES128 encryption, mutual authentication, integrity protection and confidentiality.

4. Standardized:

Offers device interoperability and global availability of LoRaWAN networks for speedy deployment of IoT application anywhere.

5. Geolocation:

Enables GPS free tracking applications offering unique low power benefits untouched by other technologies.

6. Mobile:

Maintains communication with devices in motion without strain on power consumption.

7. High Capacity:

Supports millions of messages per base stations, meeting the needs of public network operators serving large markets.

8. Low Cost:

Reduces infrastructures investment, battery replacement expenses and ultimately operating expenses[7].

1.2 COMPARISON OF LoRa WITH OTHER TECHNOLOGY

There are numerous technologies in today's world that is used in IoT applications. Every technology has its own features, merits and demerits. One technology cannot serve all the applications of IoT. Each technology differs from other in different aspects. Applications also differ from each other in their requirements and their usage. Based on the requirement we can only choose a technology that is best suited for the specific application from the existing technologies. Wi-Fi is the most popular technology that has been recently evolved and is used in long distance communications. We have Bluetooth, ZigBee, etc for short distance as well and these can and are being used in various IoT applications. But in all of this battery is a major concern. LoRa enables secure bi-directional, low cost and mobile communication for IoT, smart city, machine to machine (M2M) and industrial applications. LoRa is rapidly gaining high popularity and is a preferred technology for IoT embedded systems because of its Long Range, high capacity of nodes in network, long battery life, bi-directional, secured and efficient network, interference immunity[2].

Table-1: Comparison of LoRa with other technologies[10]

Features	LoRa	ZigBee	WiFi	Bluetooth
Standard	IEEE 802.15.4g	IEEE 802.15.4	IEEE 802.15.1	IEEE 802.11
Modulation	Chirp Spread Spectrum(CSS)	Direct-sequence Spread Spectrum(DSSS)	Quadrature Phase Shift Keying (QPSK)	Frequency Hopping Spread Spectrum (FHSS)
Frequency	ISM 868/915 MHz	2.4 GHz, 868 MHz, 915 MHz	2.4 GHz	2.4 GHZ
Topology	Star	Mesh	Tree	Tree
Range	2-5km (Urban) 15km (Rural)	1-75 m & more	35-70 m(indoor) 100-250 m(outdoor)	1-10 m
Battery Lifetime	Long battery life	100-7000 days	0.1-5 days	1-7 days
Cost	Low	Low	Average	Low
Power Consumption	Low	Low	Low-High	Very Low

Fig -2: LoRa Module

2. REVIEW OF LITERATURE

Recently, wireless sensor networks have been deployed in many applications, which includes agriculture data collection, industrial controlling, logistics management, meterological monitoring and so on. LoRa provides new communication solution for wireless underground sensor network. A LoRa propagation testing node is presented in this paper. Tests about in-soil LoRa propogation characteristics related to volumetric water content, burial depth and payload are experimentally evaluated with the testing node. Some suggestions are proposed for LoRa-based Wireless Underground Sensor Network(WUSN) which is applied in soil[5].

Deployment of IoT devices, wireless sensors and sensor networks in agriculture can be a great help in monitoring environment and growing crops and having a network to support those devices is necessary to successfully utilize those resources. Recently, LPWAN have been recognized as an appropriate technology for agriculture use. LoRa is a representative network of LPWAN. It can be applied to IoT for agriculture due to its long range and low power capabilities. Currently most studies have shown LoRa communication capabilities in urban, mountains and maritime areas with little focus on agriculture use cases. Tree farming is a long term investment, requiring careful monitoring to mitigate loss; therefore, this paper provides an analysis about the impact of variant physical layer parameters on performance of LoRa networks in a tree-farm[3].

Besides the implementation in the smart city applications IoT has also found significant place in the agricultural and food production process. In this paper, an innovative power efficient and highly scalable IoT agricultural system is presented. This system is based on LoRaWAN network for long range and low power consumption data transmission from the sensor nodes to the cloud services[4].

3. SYSTEM DIAGRAM

System diagram of an intelligent agriculture platform with LoRa wireless sensor network is given in fig.3. The input to system is the values obtained from the sensors from farm. These are transmitted through LoRa transmitter and received by LoRa receiver at the receiver end. Accordingly, the output is displayed in the form of graph. If the values obtained are not in the range of preset value then controlling is done by automatically turning on certain control devices to return the system to required conditions.

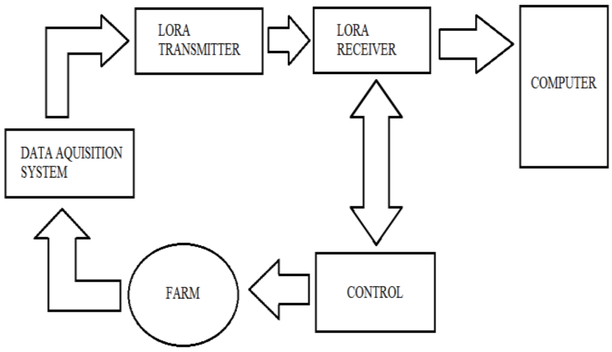

Fig -3: System Diagram Of Intelligent Agriculture Service Platform Based On LoRa

4. CONTROLLING ACTION OF SENSORS

Light Control:

After the sensor detects the lighting conditions, it sends a signal to the microcontroller. The microcontroller analyzes this signal and will then either turn on or off the light bulb.

Temperature Control:

After the sensor detects the temperature, it sends a signal to the microcontroller. The microcontroller analyzes this signal and then turns on or off the fan or heater to bring the conditions back to the preset levels and required temperature will be maintained.

Humidity Control:

After the sensor detects the humidity level, it sends a signal to the microcontroller. The microcontroller analyzes this signal and will then turn on or off the exhaust fan to bring the conditions back to the preset levels.

Moisture Control:

Detects presence of liquid or moisture between two wire leads and gives active high output. The exposed wire is porous; therefore it allows transmission of water vapors into the sensor. These exposed areas are engineered very thinly. Therefore the sensor responds very rapidly to changes in applied moisture, both when being dried (on process start-up) and when called into action if there is moisture ingress into a process. These are the types of sensors mainly used for, Interfacing with Microcontroller to detect liquid levels. Moisture detection for automatic watering of plants. Liquid level detection by putting multiple probes at each liquid level.

5. APPLICATION OF LoRa IN AGRICULTURE

In this paper, LoRa technology is used for Intelligent and smart agriculture and smart farming applications. From measuring environmental conditions that influence crop production to tracking livestock health indicators, IoT technology for agriculture enables efficiencies which reduce environmental impact, maximize yield and minimize expenses. LoRa based agriculture use cases have demonstrated significant improvements, such as 50% water reduction for commercial farms. LoRa technology's long range, low power wireless qualities enable the use of low cost sensors to send the data form farm to the cloud where it can be analyzed to improve operations[7].

6. BENEFITS

1. Better understand and plan for inherent variability of farm conditions.

2. Increase farm yields while reducing resource use.

3. Minimize in- field workload so farmer can tend to business operation.

4. Low maintenance costs thanks to LoRa sensors low power operation, ensuring batteries can last 10 years.

7. CONCLUSION

LoRa technology compliments various other technologies such as cellular network. In this paper, an overview of experimental measurements which will be done to determine sensor accuracy, select sensors for intelligent agriculture and develop a long range and low power sensing and communication service platform for intelligent agriculture. Hence in this paper, description about WSN and network communication technology(LoRa) which will be support intelligent agricultural data collection and equipment control is given.

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