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TRACKING SYSTEM USING LoRaWAN TECHNOLOGY

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Abstract - *The LoRaWAN (Long Range Wide Area Network) is a new Wireless System technology in the recent trends. This LoRaWAN test bench project consists of, Arduino Shield, LoRa Shield and Arduino Microcontroller to operate as the LoRa Gateway. LoRa Module needs Arduino Microcontroller and LoRa/GPS Shield. LoRa/GPS will be powered by LoRa Client, and it will send the data of GPS location to the LoRa Gateway where the location received will be stored in its Data Log periodically. Gateway Server will be at stationary mode during the experiment while the LoRa Client will be mobile. The testing evaluation will be done in rural and sub-rural scenarios. It was found that in a sub-rural scenario, the communication between two devices has a better performance compared to the rural scenario. LoRaWAN communication in the rural area shows that with higher interference due to high rise buildings available, the communication will be less efficient. This issue can be solved by installing LoRaWAN tower in the middle of the area. However, this work shows that LoRaWAN platform has the probable to replace the use of IoT infrastructure on the existing Wireless Standard, as currently the LoRaWAN can be enabled at three different frequency bands, 433MHz, 868MHz and 915MHz.*

Key Words: Arduino shield, Client Server, Gateway server, LoRaWAN.

1. INTRODUCTION

The evolution of wireless technology has provided the path to the revolution of the Internet of Things (IoT). IoT technology has opened up too many integrated smart and intelligent devices and application, which ease the tracking and operating from everywhere and anywhere. It is regarded as one of the solutions to ease exploration access among places.

Recently, IoT-based applications which perform monitoring and tracking of devices, human or animal activity usually adopt the short-range communication technologies such as Bluetooth, Wi-Fi to transmit the data to the cloud or mobile phone of a particular user. However, these communication systems have issues of coverage limitation or large energy consumption, which are not suitable for some specific IoT applications, e.g., monitoring of animals or trees in large farms. Thus, Long Range Wide Area Network (LoRaWAN) technology is seen as a auspicious communication method in a smart observing system. In this system, a introductory experimental study for performance and capability evaluation of a LoRa-based movement tracking system will be developed and presented. This system aims to appraise the performance of the tracking system in rural and sub-rural scenarios. This system consists of a scenario where a static LoRa-enabled tracking device (LoRa Gateway) also acts as the data accumulation server and a LoRa-enabled mobile user (LoRa Client). GPS is required in order to determine the location of the mobile user.

In a recent development, different communication alternatives had been employed in IoT deployments for various tracking and monitoring applications. These technologies include RFID, ZigBee, WSN, such as IEEE 802.15.4-based architectures, cellular systems, e.g., GSM (Global System for Mobile communications), 3G, and 4G, or VHF/UHF-based solutions.

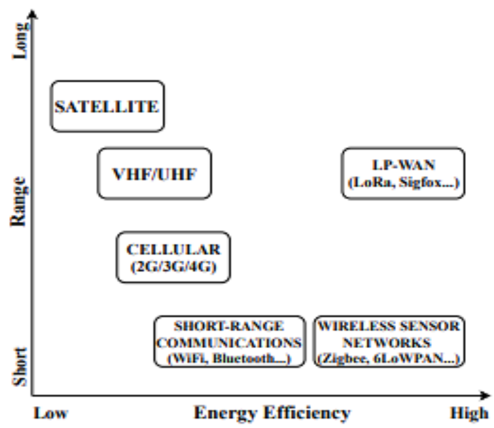

Fig.1: Comparison of Different Communication Technology for Energy Efficiency vs Communication Range

However, many outcomes in monitoring applications using these technologies are shown in which include less energy efficiency, higher cost, short-range communications and frequent disconnection in a wireless link. Fig. 1 shows the comparison of different communication technologies for energy usage and communication range. Hence, this paper will provide experimental view of circuit of tracking system using LoRa technology.

1.1 Proposed System

The LoRa tracking system is prospective to cover the migrant user movements when in motion. The migrant user will determine its location rhythmically using a GPS localization and transmit to the monitoring device using LoRaWAN technology. The system will be tested in two different scenarios which are in rural and sub-rural scenarios. The interpretation of the evaluation will be analyzed with the precision of the data polling of the prospecting device from the migrant user. With the LoRa tracking system interpretation, users can better understand the real-time movements and the difference in data monitoring for both scenarios using the LoRa environment.

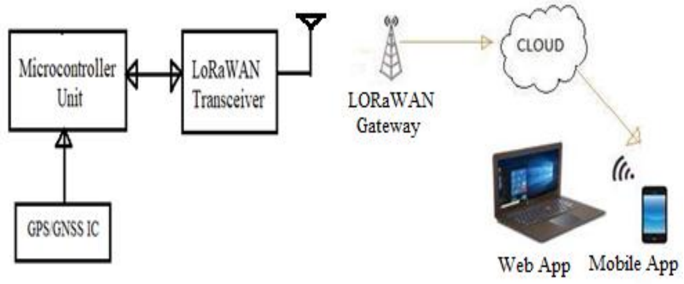

Fig. 3.2: Block Diagram of Tracking System using LoRaWAN Technology

2. Component Details

2.1 LoRa Module

LoRa is a less power wide area network (LPWAN) protocol invented by semtech. It is based on spread spectrum intonation techniques derived from chirp spread spectrum (CSS) technology. LoRa module works o technology named LoRaWAN which is the communication protocol and system architecture for the network, while the LoRa physical layer enables the long-range communication link. LoRaWAN is also responsible for managing the communication frequencies, data rate, and power supply for all devices. Devices in the network are non-synchronous and transmit when they have data available to send. information sent by an end-node device is received by multiple gateways, which forward the data packets to a centralized network server. The network server remove impurities and duplicate packets, performs security checks, and controls the network. Data is the forwarded to application servers. The technology shows highly reliability for the moderate load; however, it has some performance issues related to sending acknowledgements.

Fig.4.1: LoRa Module

2.2 LoRa Gateway

The LoRa sensors sends data to the LoRa gateways. The LoRa gateways connect to the internet via the standard IP protocol and send the data received from the LoRa embedded sensors to the Internet i.e., a network, server or cloud. The Gateways devices are always connected to a power reference. LoRaWAN supports communication in both directions. A single LoRaWAN Gateway can assists 1,000s of devices or nodes, multiple Gateways provide flexibility to smart solutions.

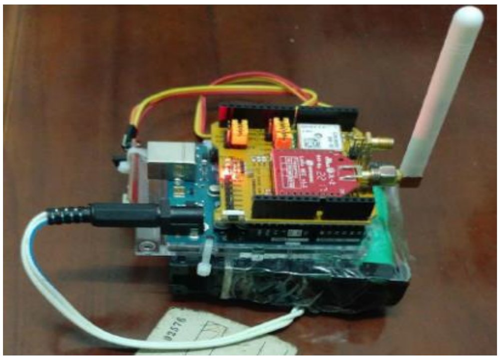

Fig.4.2: LoRa Gateway

2.3 LoRa Client

2.3.1 Arduino Microcontroller

Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a software which require embedded C, or IDE (Integrated Development Environment) that runs on your computer, used to write up and upload computer code to the instrumental board. Arduino Uno is a microcontroller board consists of the ATmega328P which has 14 digital i/o connectors (of which 6 can be used as PWM outputs), 6 analog inputs from sensors, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP head connectors and a reset switch.

Fig.4.3.1: Arduino Microcontroller

2.3.2: LoRa/GPS Shield

An expansion board for LoRa/GPS for using with the Arduino is The LoRa/GPS Shield. This system is purposeful for those who are interested in developing LoRa/GPS solutions. The LoRa/GPS Shield is collection of LoRa/GPS Shield mother board and Lora. In the LoRaWAN, the LoRa/GPS Shield is based on the SX1276/SX1278 transceiver. The transceivers of the LoRa/GPS Shield highlight the LoRa long range modem that provides ultra-large range spread spectrum communication and great impediment immunity which reduces current consumption. LoRa also delivers remarkable advantages in both blocking and choice over conventional regulation techniques, solving the traditional design arrangement between range, impediment immunity and energy consumption.

In the part of GPS, the add on L80 GPS (base on MTK MT3339) is originated for applications that use a GPS connected via the serial ports to the Arduino such as timing applications or general implementation that require GPS information.

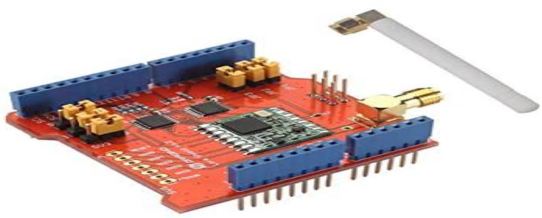

Fig.2.3.2: LoRa/GPS Shield

2.4 Software Details

In this software development, several software is required for successful implementation. Arduino IDE 1.8.7 is being employed for program coding and communicating to the microcontroller. ITN Converter is used to transfer a route make by a GPS or mapping software to additional GPS or mapping software. Then, the Keyhole Markup Language (KMLCSV) will convert the data generated from GPS format to the file format for Google Earth software. The Google Earth and KMLCSV Converter is used for location positioning conception.

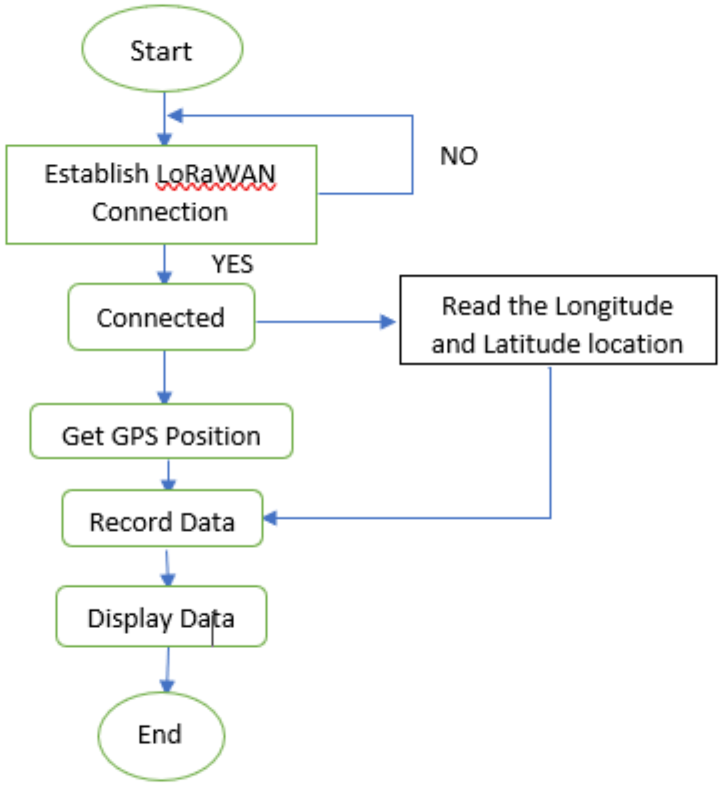

Fig. 2.4: The Flowchart of LoRa-Tracking System

The schematic and associate of the system is performed to test and evaluate the operation and performance of the LoRa tracking system. To set up the devices Arduino programming is used. A debug assembly is conducted before uploading the code to the Arduino Module. Fig. 2.4 shows the flowchart for the LoRa tracking system in this work. It shows that both of the LoRa devices will begin initially with set up their communication with each other. Once they are fastening, the LoRa client will read its position (Longitude and Latitude) from the GPS module and send data of the GPS information to the LoRa gateway via LoRaWAN. The server saves the location sent by Lora gateways and displayed on the Google Earth application.

The communication linking the LoRa gateway and LoRa-Client are tested to verify its attachment with each other. Figure shows the LoRa and GPS Shield are attached to the top of Arduino UNO for the LoRa-client. It is found that the LoRa Module needs to use an antenna in order to provide harmonious communication for both LoRa-Track Client and Gateway. The antenna gain used in this work is 3 dBi in order to be suitable with the LoRa frequency. However, if required, it can also be upgraded to 5, 7 or 9 dBi. The data received by the client user via the GPS module as introduced earlier are transmitted to a LoRa gateway via the LoRa transmission system. The system will be tested at the rural and sub-rural area to evaluate the number of logs received by the LoRa gateway. The numbers of records will determine the performance of the system improved in this work for each scenario. The simplification is shown by how many points of location can be empowered from the client node to the LoRa gateway using LoRaWAN even at an extra-large distance. Then, the location points are determinate on Google Earth to display the trace of the route of the LoRa client movement at both scenarios. LoRa gateway is place and fixed at a particular position while the client node will be moving from 1 position to another. The devices will be tested on the various condition and places. The data is then collected and recorded in Data record via a flash drive USB.

3. CONCLUSIONS

Investigations and observations have been made to ensure the successful developments for this project. A systematic study was used to analyze the effect of the radio frequency on environment or populated area. It is suggested for future invention; high gain antenna should be used instead of the built-in module to achieve great performance and higher accuracy. For example, an increase from the 3dbi to 5~7dbi can be added to support higher coverage area.

It is also suggested to use a smaller module and battery pack to implement a smaller but compact prototype. It is also found that the usage of Arduino YUN Shield in this prototype is not user-friendly since the problem occurred where the YUN Shield program and the Data log will be erased every time the LoRa Gateway reboots. Hence, an alternative way is to use the SD Card Module for data logging.

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