UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LOCATION TRACKING SYSTEM BY USING LoRa

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology Electrical and Electronic of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

……..

(Project Supervisor)

ABSTRAK

Dalam kehidupan sebenar, kegunaan radio penhantar dan penerima sentiasa mendapat perhatian kerana setiap teknologi seperti ZigBee, Bluetooth, dan RFID mempunyai akibat positif dan negatif sendiri. Seperti hari ini, industri menghasilkan teknologi baru radio penhantar dan penerima yang mempunyai keupayaan untuk penghantaran dalam jarak jauh yang dikenali sebagai LoRa. LoRa dijelaskan jarak jauh. Projek ini menekankan LoRa dari segi pengesanan lokasi. Matlamat projek ini untuk membangunkan sistem pemantauan lokasi menggunakan modul Dragino LoRa, Global Positioning System (GPS) dan Arduino dan untuk menganalisis data dari segi jarak dan kelewatan dikesan untuk longitud dan latitud. Hasilnya juga menunjukkan sistem itu dapat mengesan data yang dihantar dalam jarak 290 meter dari *Line of Sight* (LOS) sambil menambah bahawa pelaksanaan LoRa lebih tinggi 1 meter dari tanah adalah lebih baik. Untuk membuat kesimpulan, semakin kurang penangguhan, semakin baik prestasi rangkaian penghantaran. Projek ini ditekankan kepada sistem yang menyediakan kos rendah, penggunaan kuasa yang rendah dan mudah tetapi berkesan dilaksanakan.

ABSTRACT

In real life, radio transceiver performances always get attention as each of the technology as ZigBee, Bluetooth, and RFID have their own advantages and disadvantages. As today, the industry produced the new technology of radio transceiver that have capability for transmission in long range that known as LoRa. The goals of this project to develop a location monitoring system using Dragino LoRa, Global Positioning System (GPS) and Arduino module and to analyze the data in term of detectable range and delay for longitude and latitude. Results also shows the system is able to detect the transmitted data within 290 meters of Line of Sight (LOS) distances adding to that the LoRa execution better 1-meter height from the ground. To conclude, the lesser the delay, the better the performance of transmission range. This project is emphasized of the system that provide low cost, low power usage and simple but efficient implemented.

DEDICATION

To my beloved parent Tuan Ab Aziz bin Tuan Lembut and Elis Rafizanory Binti Ramly also my supervisor Puan Norlezah binti Hashim who sacrificed and work hard as I did to make this work possible.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

Arduino IDE - Arduino Integrated Development Environment

BLE – Bluetooth Low Energy

BW – Bandwidth

CPU - Central Processing Unit

EPROM – Erasable Programmable Read-Only Memory

FEC - Forward Error Correction

FSK – Frequency Shift Keying

GPS – Global Positioning System

GSM – Global System Mobile Communication

IC – Integrated Circuit

IoT – Internet of Thing

LoRa – Long range

LoRaWAN – Low Power WAN protocol

LOS - Line of Sight

LPWAN – Low Power Wide Area Network

LTE - Long-term Evolution

MAC – Media Access Control Addresses

NB-IoT – Narrow Band Internet of Thing

PCB - Printed Circuit Board

PWM – Pulse Width Modulation

QoS - Quality of Service

RSSI – Received Signal Strength Indicator

SRAM – Static RAM

TTL - Transisitor-Transistor Logic

UDP – User Datagram Protocol

UMTS – The Universal Mobile Telecommunications System

USB – Universal Serial Bus

CHAPTER 1

INTRODUCTION

1.0 Introduction

In this study, it all about the location tracking by using radio transceivers Long Range (LoRa). The project mainly focused to collect and deliver the location data automatically from broad range to meet quickly evolving the technologies nowadays. However, there are a lot of technologies of radio transceivers that exist but it still not being fulfilled the requirement as it needs improvised. Hence, the location tracking system developed to convenience user meanwhile it could save in terms of cost and consumption of power. The data location tracking consists of longitude and latitude that managed trace location of object, vehicles, animals and so on.

This section provides overall overview regarding this study. The problems, objectives also scope of work this project be explained briefly.

1.1 Problem Statement

Today, the technologies of radio transceiver have become known and grown enormously as it able to communicate between client and server at the same time able to fulfil the requirement of industry and technologies. The technologies mentioned is Long Range (LoRa) that provides performance for long range with low power measure.

Animal health monitoring and tracking is a growing interest use case. It can see a lot of academic and industrial project exist for dairy herd health monitoring and wildlife animal tracking. (Todolov, 2014) stated that animals could be spread over vast areas. Hence, size and weight limitations of wearable devices must be respected, which it limits the size and capacity of battery. Also, battery replacement is a difficult and expensive process. In order to overcome this problem, low energy consumption is essential to extend the network lifetime. Normally, some animal tracking project use GSM to transmit collected data to ensure the coverage over a large area. Nevertheless, its high consumption of energy of GSM and lack of coverage in the deployment area do not meet the essential requirements of the applications.

Tracking system by using LoRa it able to exploit transmitted packages to observe and calculate the real time of position with no use of GPS and GSM (Fargas & Petersen, 2017). In this study it mentioned that the combination of GPS receivers and GSM network for transmission to overcome problem for people who are suffered dementia disease. Although it could overcome for dementia problems, but it still has downside as it need to energize the battery every few days because it low of battery

lifetime. This study stated that a low cost device designed that enables the geopositioning with a long last battery lifetime beneficial to the user in aspect of able to cover what the need and want of people.

The technologies exist such as Bluetooth, Wi-Fi and ZigBee contributed the development of LoRa as to fill the gap between short range and typically high-bandwidth (Blenn & Kuipers, 2017). As the LoRa become familiar it realized that it is inexpensive low-power transceivers that are able to operate for long periods especially LoRa able to build Internet of Things (IoT) where it will include many battery-operated or energy-harvesting devices in addition is to have inexpensive low-power transceivers that are able to operate for long periods.

(Duffield and Shepherdson, 2015) said that African savanna elephants and Asian elephant normally confronted requirement to follow their area because of their high knowledge, sheer size and complex social structure. In truth, the zoo scientists as of late grasped GPS innovation to contemplate the separation of elephant's strolling. As beginning perception, it portrays the proof that African elephants in vast zoo displays walk removes that relate with wild elephants under non-outrageous conditions. Be that as it may, information gathered are constrained because of Asian elephants in more ordinarily measured shows.

Refer to (Swanepoel, Dalerum, & van Hoven, 2010), it mentioned that the usage of GPS should be consider on how animal action during attached the devices, topography and also seasonality as it might affect the GPS to achieve the objective on tracking and the bias result of GPS technology used for animals. Other than that, the single attempts used GPS is failed accounted for the majority of location failures, the failures might cause by temporary blockage to satellites. The possibility of

failures significantly increased during the day and there were indication rising during wet season compare to in the dry season.

In this research the purpose is to determine the behavior and location of wild animals, as it needs to be monitored in some way. Typically, to be able to detect animals remotely, an electronic device or also known as tag is attached to the animal. According to (Markham, 2008), the devices used ZebraNet and TurtleNet placed GPS enables wireless devices on zebras and turtles respectively. However, the devices are only suitable to attach to larger size of animals thus it limits their deployment scope to a section of the Animal Kingdom.

Internet of Things (IoT) is a new wave of technology that efficient through automation and optimization but the deployment restricted due to many numbers of devices at the same time it is cannot cover high range of communication distances. The used of mobile communication for examples GSM, GPRS, 3G, 4G an d LTE are very expensive devices and it not operate good especially for autonomous devices that need power on the devices used battery for month (Pham, 2017). Other than that, LoRa can be deployed as the specification is large-scale interoperability or using fully ad-hoc solutions. Based the specification mentioned it implemented refer to the specific application's profile realized.

Local Area Network (LAN) as WiFi, Bluetooth 4.0 and ZigBee are well established technology. The biggest problem with many LAN is the battery consumption and short ranges link budgets. Other than that, fundamentally mobile networks like LTE was developed for better data throughput and it not best when it comes to power consumption. Both LAN and Cellular Network are quite expensive to deploy in a wide area for instance to cover a whole city. All these statements mentioned, a more efficient method is suggested to overcome these issues by using

Low Power Wide Area Network (LPWAN), LoRa. LoRa and the Internet of Things (IoT) have become the most important branches of modern telecommunications which need best in class battery life. LoRa needs very minimal cost for deployment at the same time it did not need to be licensed. The improvement of technologies benefits world mostly for telecommunication industrial as technology explosive today it is because LoRa able operates long ranges of tracking capability between nodes. It gives large link budgets more than 22 km in Line of Sight (LOS) links which it helpful in monitoring bigger area as an example cattle farm. As the link budget is large and real time tracking, cattle theft and spread of infection can be overcome from occur.

1.2 Objectives

The main objectives of this project are:

i. To develop a location monitoring system using Dragino LoRa, GPS and Arduino module

ii. To analyze the data in term of detectable range and delay for longitude and latitude

1.3 Scope of work

The scopes of this research work are established according to the objectives mentioned. This location tracking system is built using Dragino LoRa with Arduino. The Dragino LoRa GPS Shield detect the location and the data will transmit to

Dragino LoRa Arduino Shield. Additional, Arduino Uno and Mega used as microcontroller will set as the core controller for governing the input and output for this project. The data of the location will display on serial monitor of Arduino IDE as an output of the tracking location system. This study is emphasis on tracking location of animals by using radio transceivers.

1.4 Cost Involved in Project

In this part, the cost involved in this project explained in detail adding with the features of hardware used based on the requirement of Location Tracking System by using LoRa.

Table 1.1: Cost Involved in Project

Hardware	Unit	Description	Price
Dragino LoRa/GPS Arduino Shield v1.2	1	The shield used with frequency 915 MHz that developed for LoRa /GPS solutions	RM 135.84
Dragino LoRa Arduino Shield	1	The shield used with frequency 915 MHz that compatible with Arduino board.	RM90.00
Arduino Uno	1	Arduino UNO board one of the most robust board that can be used for beginner	RM45.00
Arduino Mega	1	Arduino Mega board is suitable for more complex projects	RM85.00
Yun Shield v2.4	1	Provide Internet connectivity and storage for Arduino board	RM 130.37
			Total = RM 486.21

1.5 Expected Results

In the end of this research, it is expected to develop location tracking system by using LoRa as radio transceiver. The Dragino LoRa GPS Shield act as transmitter to detect the location then it will transmit to the Dragino LoRa Arduino Shield that behavior as receiver. Dragino Yun Shield used as the main of this system to ensure the transmission is success. When the signal could transmit receive so as a result the data of longitude and latitude displayed on serial monitor automatically in real time. The project can be improvised more in term of battery lifetime at the same time increased the transmission range of signal. In other words, it able to transmit the signal in widely area either it is outdoor or indoor.