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Global Positioning Satellite Data Transmission Using Low Power Long Range Transceivers

Roderick Puvok and Jedol Dayou*

Energy, Vibration & Sound Research Group (e-VIBS), Faculty of Science and Natural Resources, Universiti Malaysia Sabah (UMS), Jalan UMS, 88400 Kota Kinabalu, Sabah, MALAYSIA

This paper presents the development a special global positioning satellite (GPS) tracking device that uses low power long range wireless transceivers instead of the typical Satellite Modem and global system for mobile (GSM) methods. The GPS data, provided by an independent GPS device powered using Arduino module, is fed into Low Power Long Range (LoRa) transmitter. The GPS data signal from LoRa transmitter received and processed using a LoRa receiver at some remote distance. It was found that the system is capable of transmitting and receiving data up to 4 km away. Indirect indication on the receiver module shows that only a small portion of signal was loss at 4 km away compared to when they are next to each other. This shows a huge potential of tracking a movement of an object of interest in a long range of distance with simple protocol and at low cost using LoRa transceivers.

Keywords: GPS tracking; wireless technology; internet of things; low power long range technology; transceivers

I. INTRODUCTION

Movement tracking has been an important part in many sectors and have been essentials in many industries. It allows end-users to monitor the movement of either precious assets or vehicle or even test subject for many reasons including safety or even for research purpose. Movements are hard to be monitor trough visual especially when it comes to long range and area with poor visibility, it is then the tracking device is important. Subject to be monitored its movement are impossible to be wired. So, often wireless technology which uses radio-frequency is used as a medium between the subject and the end-users to pass information of location data. Movement tracking can realized using GPS tracking device such as GSM-GPS Tracker, Satellite-GPS tracker. For GSM-GPS tracker, GPS data that produced by GPS module in the tracker are sent in a form of SMS to the SMS Centre to be sort out, then to the tower, from the tower to the recipient, frequencies used are GSM band frequencies which are 900 MHz and 1800 MHz (Radio-Electronics.com, 2018a), GPS data received then integrated into map. For Satellite-GPS tracker, GPS data that is produced by GPS module in the tracker are sent in a form of GPS data to the reachable satellite, it is then send again to other satellites under its link and to the recipient server. Frequency used are depends on the provider, for example 1616 MHz to 1625 MHz for Iridium satellite (Radio-Electronics.com, 2018b). The GPS data received are integrated into map for visualization. Unfortunately, these GSM-GPS tracking methods have their limitations and drawbacks. For example, it is limited to areas with telecommunications provider coverage. In addition, it is also relatively costly service to use as a tracker medium as it may requires sending hundreds of SMS per day to update the device location. The satellite-GPS tracking is an expensive service subscription fees in order to operate. Similar to GSM-GPS tracker, it is a service that relies on the satellite provider. Not to mention the data received could be delayed, since there is a frequency propagations delay between the satellites and the tracker data transfer.

A relatively new device was introduced quite recently

*Corresponding author's e-mail: jed@ums.edu.my

that capable of transmitting and receiving data under low power consumption with long coverage range. The device is widely known as Long Range (LoRa in short) communication device that is receiving growing interest for autonomous communication. It utilizes ISM Band for examples 915 MHz, 868 MHz and 433 MHz which is free to use worldwide. With the aim of providing a simple yet efficient tracking method to those who need it, this research was initiated in handling GPS data by using LoRa technology. The ability of the LoRa wireless transceivers to reach ultra-long range, and to penetrate in dense urban and indoor region and rural areas (SEMTECH, 2018) on low power consumption makes the idea of tracking device based on LoRa are highly achievable.

II. HARDWARE COMPOSITION

The complete transmitter section consists of a LoRa transceiver and a GPS device that attached on an Arduino board that acts to supply power to both devices as well as for other necessary programming requirements. Once powered, the GPS module locks to reachable satellites and start to feed out GPS data to the LoRa transmitter. The transmitter then sends out GPS data that will be picked up by an identical LoRa transceiver that is assigned to receive a data signal. The data received is fed into Arduino board for preprocessing before sending it into a computer where the GPS data are displayed. Figure 1 shows a simplified diagram of the hardware composition and its data flow.

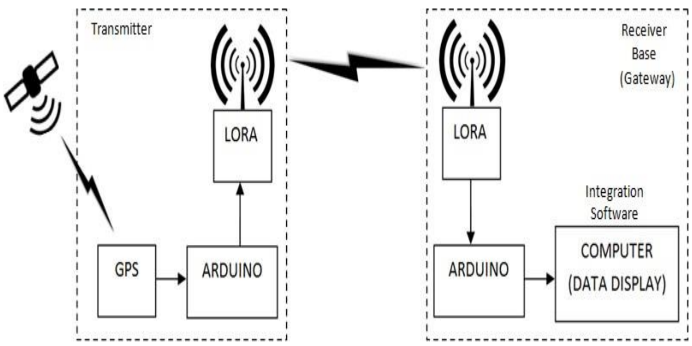


Figure 1. Simplified diagram of low power long range tracking device's GPS data flow.

III. RANGE EVALUATION AND TESTING

A series of tests was carried out to evaluate the ability of the LoRa transceivers modules in establishing connection at the distance of 1, 2, 3 and 4 kilometers away. These tests were conducted where the receiver are placed on top of the Kota Kinabalu city airport radar site overseeing the city (Figure 2), whereas the transmitter is placed inside a car that is driven on a distance road (Figure 3).

Figure 2. Receiver placed on the airport radar site overseeing Kota Kinabalu city.

Figure 3. Transmitter placed inside a car derived away on cities roadside.

The clear indication for successfully established LoRa connection between the receiver and transmitter is when at the serial monitor on the computer of the receiver receives and consistently displays the GPS data from the transmitter, and the positioning accuracy was evaluated using smart mobile phone GPS applications.

IV. RESULTS AND DISCUSSION

Figure 4 show no serial data was displayed on the computer monitor when the transmitter was switch off. On the other hand, series of data were displayed when the GPS transmitter was powered up as shown in Figure 5. For both figures, the transmitter and receiver were placed next to each other to serve as baseline data in evaluating the connection between the two devices when they are set apart. Up to this point, only the latitude and longitude data are the focus of interest.

As the transmitter was driven away from the receiver in a car, the latitude and longitudinal data received changed accordingly. In Figure 6(a) for example, the geo-location was shown in the range of (5.9399, 116.0698) when it is 1 km away from the receiver. As the receiver was driven further away, the geo-location coordinates was shown as (5.9331, 116.0760) at 2 km away (Figure 6(b)), (5.9216, 116.0771) at 3 km away (Figure 6(c)) and (5.9144, 116.0827) at 4 km away (Figure 6(d)). The map locations in all figures shows the GPS location extracted from smart mobile phone map application for comparison. In addition, for cross-reference purpose, the geo-location coordinate for Kota Kinabalu city given by gps-coordinates.net (2018) is given as (6.0327, 116.1182).

Sats	HDOP	Latitude (deg)	Longitude (deg)	Fix Age	Date	Time	Date Age	Alt (m)	Course --- from GPS	Speed	Card ----	Distance ---- to Receiver	Course	Card ----	Chars RX	Sentences RX	Checksum Fail
****	*****	**********	***********	****	**********	********	****	******	******	*****	***	********	******	***	0	0	0
****	*****	**********	***********	****	**********	********	****	******	******	*****	***	********	******	***	0	0	0
****	*****	**********	***********	****	**********	********	****	******	******	*****	***	********	******	***	0	0	0
****	*****	**********	***********	****	**********	********	****	******	******	*****	***	********	******	***	0	0	0

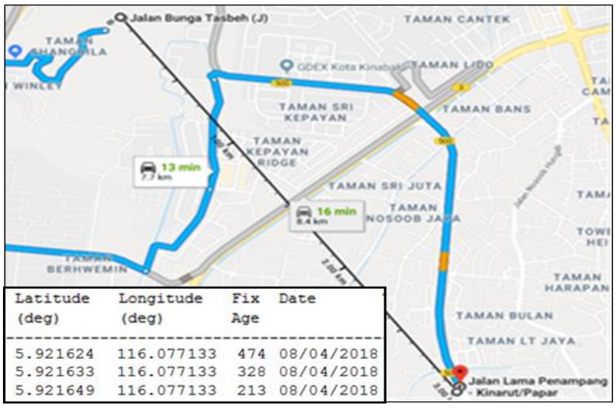
Figure 4. Serial monitor indicating no connection established between transceivers.

Sats	HDOP	Latitude (deg)	Longitude (deg)	Fix Age	Date	Time	Date Age	Alt (m)	Course --- from GPS	Speed	Card ----	Distance ---- to Receiver	Course	Card ----	Chars RX	Sentences RX	Checksum Fail
4	7.3	5.878231	116.100448	553	08/05/2018	17:09:15	668	29.20	353.60	1.35	N	11251	325.31	NW	14506	46	0
4	7.3	5.878228	116.100448	706	08/05/2018	17:09:16	821	29.10	353.60	1.48	N	11251	325.31	NW	15049	48	0
4	7.3	5.878225	116.100448	25	08/05/2018	17:09:18	39	28.70	353.60	0.26	N	11251	325.31	NW	15819	52	0
4	7.3	5.878219	116.100448	113	08/05/2018	17:09:19	241	28.40	353.60	1.07	N	11251	325.31	NW	16531	54	0
4	7.3	5.878217	116.100448	290	08/05/2018	17:09:20	417	28.30	353.60	1.76	N	11251	325.31	NW	17225	56	0
4	7.3	5.878213	116.100448	397	08/05/2018	17:09:21	510	28.40	353.60	0.78	N	11251	325.31	NW	17770	58	0

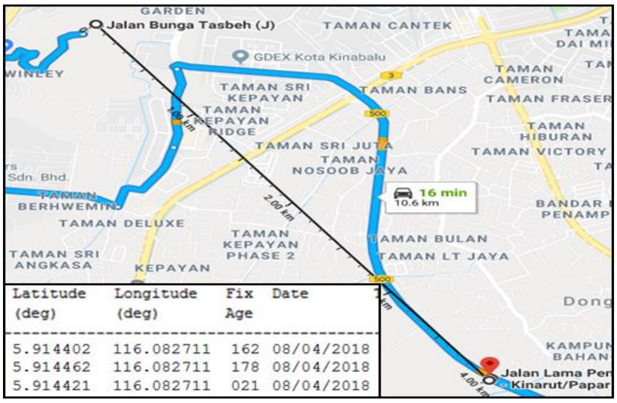
Figure 5. Serial monitor indicating connection established between transceivers.

(a) Transmitter 1 km away from receiver (b) Transmitter 2 km away from receiver

Figure 6. Serial data shown by the receiver as the transmitter was driven away from the receiver.



(c) Transmitter 3 km away from receiver



(d) Transmitter 4 km away from receiver

Figure 6. Serial data shown by the receiver as the transmitter was driven away from the receiver (continue).

V. CONCLUSION

In this paper, the ability of a Long Range or LoRa module to send and receive GPS data was presented. The LoRa transmitter, coupled with GPS module and controlled by Ardunio board was driven away up to 4 km distance from the receiver in Kota Kinabalu city, Sabah, Malaysia. It was shown that up to this distance, the system is capable of providing reliable geo-location of the transmitter in terms of latitude and longitudinal coordinate. Although the distance tested was considered short in reference to some long distance tracking applications, it is quite sufficient to show its potential application, for example to track the movement of an object in a city.

VI. ACKNOWLEDGMENT

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VII. DISCLAIMER

Due to the nature of the project presented in this paper, actual components of the transceivers device are not revealed.

VIII. REFERENCES

[1] Dempsey, JS and Forst, LS 2011, '*Police: Introduction to policing*', Clifton Park, NY: Delmar Cengage Learning.

[2] Gps-coordinates.net. 2018, '*GPS Coordinates*' (https://www.gps-coordinates.net/). Accessed on 16 April 2018.

[3] Radio-Electronics.com 2018a, '*GSM Frequencies and Frequency Bands*' (http://www.radio-electronics.com/info/cellulartelecomms/gsm_technical/gsm-frequency-frequencies-bands-allocations.php). Accessed on 12th September 2018

[4] Radio-Electronics.com 2018b, '*Iridium Satellite Technology, Theory and Frequency Bands*' (https://www.radio-electronics.com/info/satellite/communications-systems/iridium-theory-history-technology-frequency.php). Accessed on 9th September 2018

[5] SEMTECH 2018, 'What is LoRa®?' (https://www.semtech.com/technology/lora/what-is-lora). Accessed on 12th April 2018