Monitoring Location Prototype Using Lora Module

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Abstract. The number of child abduction cases in Indonesia today is always increasing every year, this has given concern to parents in leaving their children to play outside the home. Therefore, a device that can detect the presence of children when outside the home was needded. At this time, some devices can monitor ones location easily and quickly, such as Smartwatch and GPS Tracker, but the device must be connected to the internet With these conditions, it needs a device that can transmit information in real time without any dependence LoRa module are using low frequency radio as data transmission medium, can be built a Location monitoring prototype without connecting to internet network. From the examination results, the built system successfully shows the real time location coordinate point with a maximum data transmission limit of 2 KM for Line Of Sight (LOS).

I. Introduction

The child is a treasure that is so precious for parents, so the information about its becomes very important for the parents. The abundance of kidnappings makes the parents become more concentrated to always ensure the existence of his child at any time. Based on data obtained from the Indonesian Child Protection Commission (KPAI), that in the range of 2014 to 2017 the number of child abduction cases is increasing every years. As in 2014 the number of child abduction cases according to KPAI is 51 cases, while in 2015 increased to 87 cases, and in 2016 increased sharply to 112 cases. And in early 2017 the number of child abduction cases has reached 23 cases. The number of child abduction cases is motivated by five things. They are an illegal adoption, retaliation or ransom, commercial sex exploitation, organ sales, and forced labor to become street children, beggars and helpers.

With the increasing cases of kidnapping makes parents become always worried at the time when their children are outside the home. So parents need a system that can supervise their children when outside the home. With the development of Internet of Things that integrates the development of computer network technology and sensors, the system can develop smart cities and smart home [1]. Several studies have undertaken the development of smart cities that aim to monitor the existence of children outside the home using several different technologies. Such as the construction of child monitoring system in the school zone area [2]. In this monitoring system, Zigbee and GPS modules are used to monitor the presence of children in the school environments at real time, so by using CCTV and GPS,

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the system can monitor the presence of children in the school zone. This system can also alert alarms to data centers when children are not in the school zone. Another study aimed to monitor child activity is automation child monitoring (ACM) system using wireless network [3]. This ACM system used android smartphone to monitor the child's location in real time. By using GPS sensors, accelerator sensors and mobile GIS, this system can provide information to parents through messages displayed on android smartphone in the form of location when the child is lost. This system is controlled by a GSM module that requires an internet connection to transmit its GPS data to related parties. While in the study of An Mobile Safety Monitoring System for Children [4], the child monitoring system uses Bluetooth technology as the child's location transmission media to be displayed on android smartphone. This system is able to provide child's location information on child guard through Bluetooth communication that will give a sense of security to the parents when the children are in the observation area or not. This system integrates GPS sensors, accelerator sensors and mobile GIS (Geographic information system) so that these sensors are able to provide the characteristics of high reliability, short response time and high accuracy and can produce a device that provides a level of security for the child. But this system has a weakness, they are the power of bluetooth and distance limited, because the maximum distance that can be used for children monitoring is 50 m in open areas and 28 m in blocked areas of the walls,

From some of the above research indicate that the problem of distance and power of device become the main weakness in transmission of children data location, so to improve the reliability of child's location monitoring system required a device that can give maximum distance for transmitting child's data location. In addition, devices used for data transmission must require minimal electrical power so that the system can continue to monitor the location of children for long periods of time. According to [5], Low Power Wide Area Network (LPWAN) is a solution to build a network for far enough coverage area and using very small power so that LPWAN concept is widely used to develop the technology of Internet Of Things (IoT). So in this research, the children location monitoring system is built using LPWAN concept that use LoRa module as data location transmission media. And the system which is built do not need the internet connection.

2. Literature

2.1Long Range Radio

LoRa is one of the Low-Power Wide Area Networks (LPWAN) protocol whicdesigned to fulfill IoT requirements. LPWAN act as a wide coverage for IoT devices. LoRa Alliance describer LoRa as the physical layer or the wireless modulation utilized to create the long range communication link[6]. Furthermore, LoRa has significant advantage compared to another communication technology. Its low powered and long range capability exceeds any other standard. A single gateway or base station can cover entire cities or hundreds of square kilometers.[7] For example, the LoRa transmitter chip created by Semtech, SX 1276 could reach 168 dB maximum link budget.[8]

2.2 LoRa Module/GPS HAT

LoRa that is integrated with GPS HAT is an expansion module for building a WAN LoRa that is operated with Raspberry Pi 3. This module is based on SX1276 / SX1278 transceiver made by Semtech. LoRa / GPS HAT is equipped with L80 GPS (base on MTK MT3339), specially designed for applications that use GPS by connecting via serial port on Raspberry Pi. This device can be used for applications such as timing, geolocation, indo or positioning or other applications requiring GPS information. Data transmission and reception on the

LoRa / GPS HAT has a wide spread spectrum as well as the ability to cope with high interference with low power consumption. LoRa / GPS HAT can achieve sensitivity up to 148 dBm at low cost.

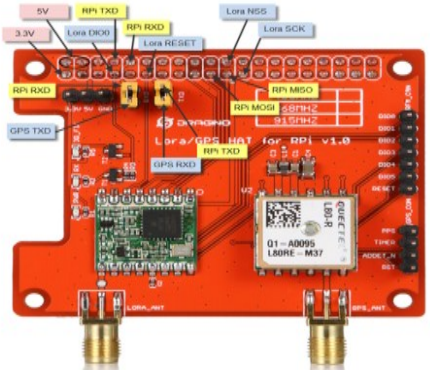

Fig 1. LoRa/GPS HAT Module[8]

At the figure 1, This board can calculate and predict the orbit automatically using ephemeris data stored in the internal flash memory, so that the HAT can improve position quickly even on indoor signal levels with low power consumption. [8] It also can adjust on/off time to achieve a balance between positioning accuracy and power consumption in accordance with environmental and motion conditions. GPS also supports automatic antenna switching function. It can achieve switching between the internal patch antenna and the external active antenna.

2.2 GPS (Global Positioning System)

GPS is an electronic navigation system that can receive information from 4 – 12 satellites so as to indicate position on the surface of the Earth. GPS satellites will transmit satellite positions and GPS receiver distance from satellites. This information is processed and displayed by the GPS receiver. GPS is an open, non-proprietary telecommunications system but a copyright ownership of a rapidly growing and constantly growing company.

GPS is comprised of three segments: satellite constellation, ground-control/monitoring network, and user receiving equipment. The control segment (CS) tracks and maintains the satellites in space. The CS monitors satellite health and signal integrity and maintains the orbital configuration of the satellites. Furthermore, user receiveing equipment provide navigation, timing and several apps.

As seen in Fig. 2, the GPS constellation consists of 24 satellites orbiting the Earth at an altitude of 20,200 kilometers. Orbit is set with the assumption that every point on Earth can see at least four satellites at any time. each satellite orbit the Earth approximately once in 12 hours at a speed of about 11,000 kilometers per hour. GPS satellites have panels Solar energy collectors for generating electrical energy needs.[9]

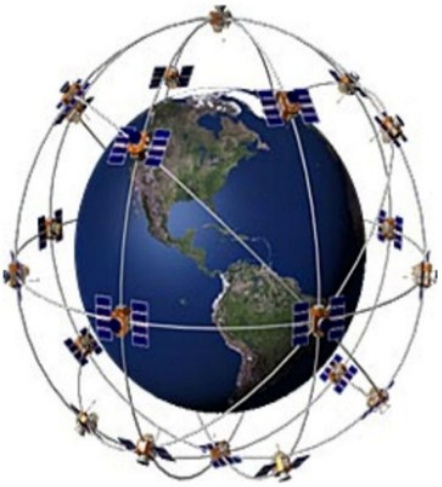

Fig 2. GPS Constellation (9)

3. Methodology

In this research, clild location monitoring system using LoRa with a frequency of 3-300 MHz, assuming LoRa module has a wide range with high efficiency of power usage. Figure 3 below shows an integrated module with Raspberry Pi 3 as processors, this configuration is made with the assumption that the receiver is not connected to the public network.

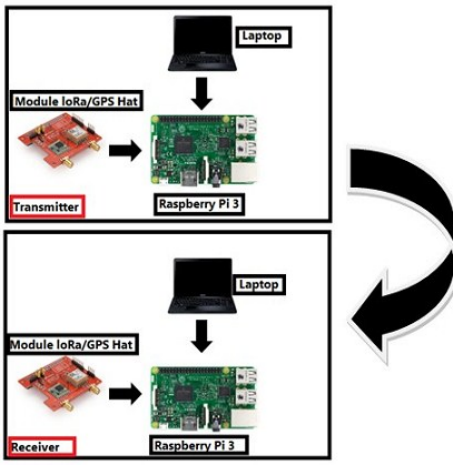

Fig 3. LoRa – Raspberry Pi 3 Configuration

In Figure 3 above, shows the laptop device used as a system controlling on Raspberry Pi 3. Raspberry Pi 3 serves as a microcontroller for LoRa / GPS HAT which is used as a radio packet transceiver.

4. Result & Analysis

To obtain data comparison of system accuracy then the testing process is done for configuration of Line of Sight (LOS) and Non Line Of Sight (NLOS). LOS configuration

is a test configuration where the receiver and transmitter positions are in a straight line and are not blocked by a barrier so it is expected that the testing process can take place at a great distance. While NLOS is a test configuration where there is a barrier between transmitter and receiver that can block radio wave propagation, as for the purpose of the NLOS method is to determine the magnitude of the obstacle effect on the number of lost signals.

4.1 Line of Sight (LOS) Testing

The childreen location monitoring system using the LOS scenario is done in Batununggal residence, Bandung, Indonesia. In this test a child carries a device that is equipped with LoRa Transmitter. Then he walks with a maximum distance of 2 Km, the child's location information will be sent to the LoRa receiver, in this scenario a child is in a position facing each other with the receiver and not obstructed by the obstacle. In Figure 4 below shows the location data received by the receiver when a child moves 2 Km from the receiver or observation center point.

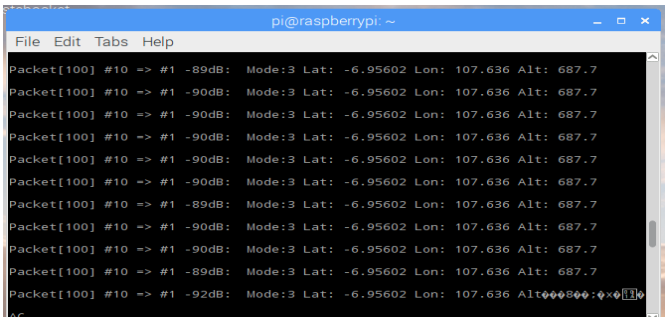

Fig 4. Location monitoring for distance 2 Km of LOS scenario

Figure 4 shows the LoRa transmission configuration capable of transmitting GPS data for transmitter and receiver distance of 2 km. As for the delay of sending data at a distance of 2 km is 5 seconds.

4.2 Non Line Of Sight (NLOS)

The location for child location monitoring system that use NLOS scenario is in the Griya Bandung Asri Residence, Bandung, Indonesia. In this scenario location the child's position with the center of observation (receiver) is blocked by the house or tree.

In the NLOS scenario, a child moves away from the receiver at a maximum distance of 350 m. and the position of transmitter and receiver obstructed by the many obstacles of trees and houses. The monitoing results of the transmit data location using LoRa is shown by figure 5.

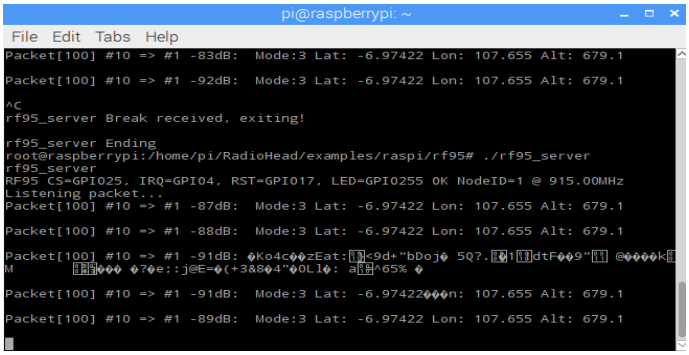

Fig 5. Location monitoring for distance 350 of NLOS Scenario

From Fig. 5 it is seen that the NLOS data communication between the transmitter and receiver is successful. The delay value obtained for this test is 3 seconds.

Below are completed survey from various distance for LOS dan NLOS testing.

Table 1. LOS testing Result for various distance

Distance (KM)	Location	delay (s)	Data GPS		
			Latitude	Longitude	Altitude
1	Batununggal residence	5	-6.95602	107.636	687.7
2	Batununggal residence	5	-6.95602	107.636	687.7
2.5	Batununggal residence	59	-6.97422	107.655	682.4
3	No Location is detected	-	-	-	-

From Table 1 above, the system can send data location for maximum 2.5 km distance with delay is 59 s. The Dragino/Semtech stated LoRa/HAT could reach 168 dB maximum link budget. For Non LOS, see table 2 below.

Table 2. NLOS testing result for various distance

Jarak (m)	Lokasi	delay (s)	Data		
			Latitude	Longitude	Altitude
100	Griya Bandung Asri Residence	3	-6.97422	107.655	679.1
200	Griya Bandung Asri Residence	5	-6.97422	107.655	679.1
300	Griya Bandung Asri Residence	60	679.1	107.655	679.1

From the above NLOS tests, it appears that the obstacles between the transmitter and receiver are very influential in the transmission of radio waves, because they cause the decrease in the intensity of the transmitted radio wave signal. The the more trees that block between the transmitter and receiver make the intensity of the emitted signal decrease and the delay time of radio waves transmission becomes increase. The maximum distance

between transmitter and receiver for this scenario is 300 m.. This need further research in spite of maximum link budget stated by Dragino that could reach 168 dB.

5. Summary

Realtime location monitoring and tracking by integrating the loRa module with GPS successfully shows the location in real time. The use of LoRa as a device that functions to transmit and receive radio waves is better when compared to access point, this is because LoRa uses lower power, besides location data can be transmitted with transmitter distance and receiver further that is reach 2 km if using the LOS scheme and 350 m if between the transmitter and receiver there is a barrier (NLOS).

The LoRa further reasearch is to integrate the LoRa module with the processor to be placed on the smartwatch, which aims to detect the location of a person. In network side, to increase coverage and efficiency of LoRa Networking.

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