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Performance of ES920LR LoRa for Monitoring Health Status on LoS and Non-LoS Environment

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***Abstract*—ES920LR is a type of LoRa in Japan, this type of LoRa has a frequency specification of 920 MHz and a range of 3 km at Free Space Path Loss (FSPL), the ES920LR is tested using a Pulse sensor and placed in an arm position to detect heartbeat in humans and send multipoint from the transmitter to several receivers with different hurdles. the test Result from comparison between LoS and Non-LoS From the Line of Sight (LoS) building position test, the RSSI (-dBm) value is -119 dBm at a distance of 710 meters, and the PRR (%) 93.94%. Besides, the LoRa ES920LR is incorporated with the Leafony Board. With the small size of the ES920LR, it will make it easier to apply Drones to get the results of the analysis of Spreading Factor (SFs), GPS Position, and RSSI (-dBm).**

Keywords—LoRa, LoS, nlos, RSSI, FSPL

I. INTRODUCTION

Recently, the human need for the Internet of Things (IoT) - based health services with Big Data has headed towards popularity. Almost all human needs have been supported by new features in the world of the Internet, including developments in Big Data, Algorithms supporting Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Internet of Things (IoT) for the various fields, WSNs with LPWA and LPWAN [1-4], and various other new technologies. Furthermore, this research focuses on health management in terms of monitoring the heart rate [5]. In the last few cases, a person has had a heart attack, this is unavoidable so that cases of death from a heart attack have increased from year to year. Accordingly, the data in table 1 is taken from the Ministry of Health of the Republic of Indonesia in 2013. The highest possibility of heart failure or heart disease or coronary heart disease occurring at ≥15 years of age is in West Java in data from the Ministry of Health of the Republic of Indonesia in 2013 [6]. This proves that heart disease is one of the biggest causes of death, apart from what happened today, namely COVID-19 from the beginning until now (December, 2020) and has not ended until now this outbreak, upright, the COVID-19 problem is a health problem that is difficult to handle, apart from immunity, it is also a very fast spread.

Furthermore, the Part of heart (artery) has sections as shown in figure 1 [7], and in this research, it focuses more on the arteries, i.e., the vessels that carry blood from the pulse to the heart.

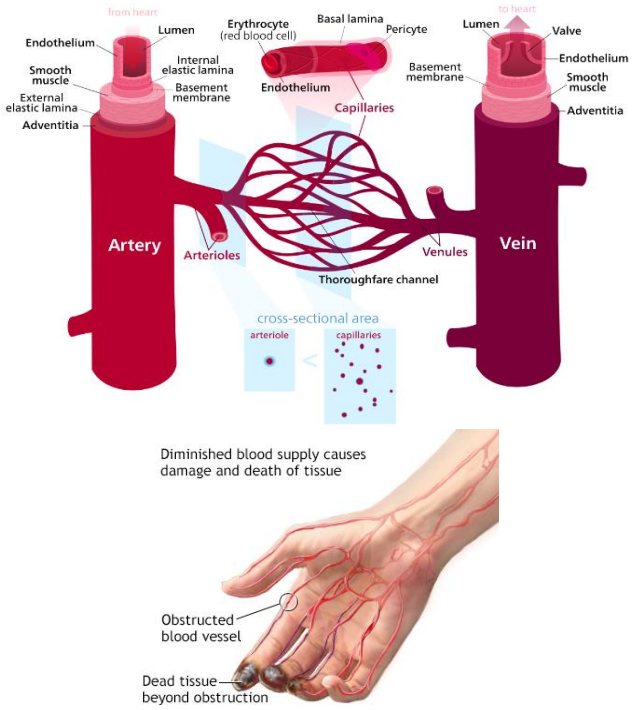

Fig. 1. Artery and vein.

And in the prototype developed in this research, the focus is on the heartbeat of the artery vessels at the fingertips, as shown in Figure 1 [7]. The function of the artery or blood vessel is to send blood (oxygen on hemoglobin) to all parts of the body to and from the heart, including the tips of the fingers. After exploring the focus of the problems that will be raised in this research, Furthermore, the core of the problem moves to the environment used by the prototype in this research, namely Line of Sight (LOS) [8-11] and Non-Line of sight (Non-LOS), which means that Non-Los is a condition where the

communication process is blocked by various types of obstructions that will be discussed in the next section. Accordingly, the prototype used in this research focuses on heartbeat monitoring.

II. Fundamental Parameters

One of the parameters used is the Received Signal Strength Indicator (RSSI).

A. Received Signal Strength (RSS)

The RSSI stands for Received Signal Strength Indicator which is expressed in mW and dBm (when measuring), the RSSI range is -30 dBm (strength signal) and -120 dBm (weak signal). In this research, RSSI of LoRa radio signals will be analyzed within a distance of the Free Space area and obstacle area (tree, building, and hill). This Obstacle will cause attenuation of the signal due to three factors, i.e., diffraction, detailed reflection and scattering will be explained further. RSSI is also caused by SNR (Signal Noise Ratio) [1] which is expressed in units of dB. Signal Strength Classification can be seen in table 1.

TABLE I. Signal Strength Classification

Signal Level Range (dBm)	Classification	Score
-120 to -95	Extremely Bad	1
-95 to -85	Bad	2
-85 to -75	Average	3
-75 to -65	Good	4
-65 to -55	Very Good	5
-54 to -30	excellent	6

B. ES920LR LoRa Specification

Furthermore, LoRa ES920LR dimension and specifications can be seen in Figure 2 and table 2. The dimensions of the ES920LR are 16.94 x 23.93 mm.

Fig. 2. ES920LR dimension.

TABLE II. ES920LR LoRa Specification

Specification	Description
Model	ES920LR
JAPAN Government Certification / Standard ISM Band	ARIB STD-T108
Frequency	920.6 – 928.0 MHz
Modulation type	LoRa Modulation CSS (Chirps Spread Spectrum)
Number of Channels	37 ch (at 125 kHz bandwidth or less)
	18 ch (at 250 kHz bandwidth)
	12 ch (at 500 kHz bandwidth)
Bandwidth	62.5 kHz – 500 kHz
Spreading Factor	7-12
Transmission Speed	146 bps – 22 kbps
Transmission Output	13 dBm (20 mW)
Receiver Sensitivity	-118 dBm ~ -142 dBm
MCU	ARM Cortex M0+
Memory	Flash ROM : 128 KB, RAM : 16 KB
Power Consumption	Tx : 43 mA (13 dBm setting) Rx : 20 mA During Sleep : 1.7 uA (when the timer starts)
interface	UART, SPI, I2C, ADC, GPIO
Antenna	Wire Antenna, External Antenna (U.FL)
Power Supply Voltage	2.4 Volt to 3.6 Volt
Operating Temperature range	-40 ~ +85º Celsius
Connection Terminal	26QFN
Board Mounted PCB	SMT mounting type
Dimensions	24.00 x 17.0 x.2.3 mm
Construction Design Certification acquired	Certification Number : 006-000412

III. Methods

One of the methods used is by using the Adaptive Data Rate (ADR) [3]. ADR is also referred to as a mechanism for managing data through input in terms of energy efficiency. In addition, the advantage of the ADR mechanism is that it reduces Packet Loss (bytes), which means reducing lost heartbeat (bpm) data. And there is a change in sending data from Prototype End devices 1, End devices 2, etc. therefore, that the battery used in each End Device can be more economical and effective, if it is not used or is being alternated in sending heartbeat data (bpm), End Devices will be off as soon as possible.

IV. Results and Analyze

In-Line of sight, Non-Los, and packet loss conditions, the analysis results are obtained as shown in Figure 3, Figure 4, and Figure 5. And the ES920LR LoRa multi-node delivery in Line of Sight and Non-Line of Sight conditions can be seen in Figure 6.

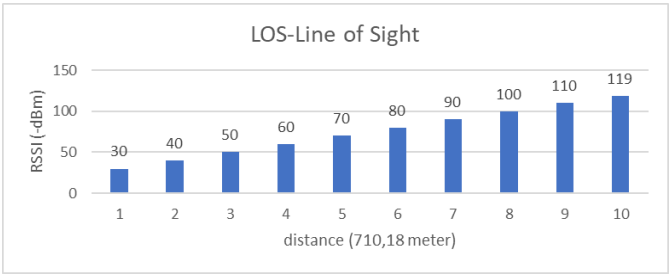

Fig. 3. Line of Sight (LOS) analyse result.

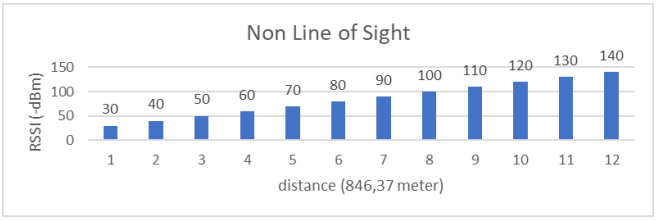

Fig. 4. Non-Line of Sight (LOS) analyse result.

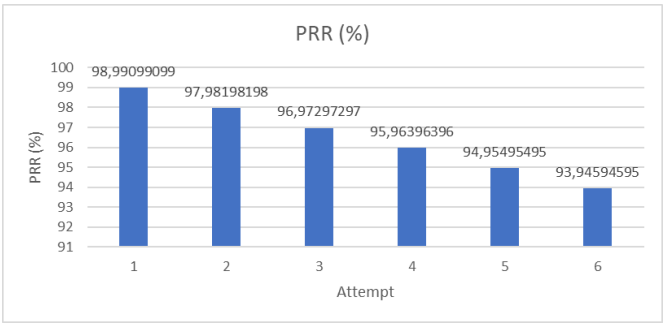

Fig. 5. PRR (%) from the experiment.

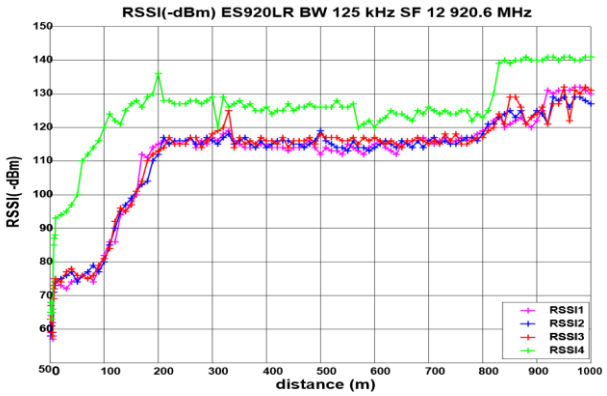

Fig. 6. The experimental data multi node on LoS and Non-LOS.

V. Conclusion

The signal reception level (RSSI) in dBm and data throughput on LOS is better than Non-Los and also influenced by Obstacles. More detail, ES920LR LoRa have a performance evaluation of attenuation (dB), e.g. FSPL LoRa at 3 km without obstacle (LOS) is ~ 80 dB, with an obstacle at the same distance, attenuation occurs (N-LOS) to ~ 130 dB, Radio Propagation on the Bad Weather : drizzle -110 dBm (~ 1 km), and Heavy rain (~ 140 dbm) with a parameter attenuation rain approachment and approximation. Result of Measurement RSSI on d0 or a : RSSI Theory : - 47 dBm, RSSI Rx : -49 dBm, RSSI Signal analyzer measurement : -44 dBm, RSSI Signal analyzer2 chirp signal : -35 dBm, and RSSI Signal analyzer3 : -46 dBm, The packet data sent to the ThingSpeak application server and can be seen in real-time on devices that have an internet connection. The LoRa signal can be analyzed using the Signal Analyzer and produces a Signal Strength value (-dBm).

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