Boosting signal strength of LoRA wireless communication

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***Abstract*— This paper presents an effective method to boost the RSSI, the received signal strength on a moving path of LoRa wireless networking without change in digital circuitry or power amplifiers. Replacing the wire antenna as the conventionally used sensor by a printed Yagi-Uda antenna as a novel one designed to have a higher gain signifies increments of the RSSI at distant positions in the LoRa system with the same battery. The RSSI has risen by more than 10 dB at distances from 200m to 700m with DLP-RFS1280 as the LoRa device in comparison to the conventional configuration in the device.**

Keywords—RSSI, LoRa, Radio Link, Printed Circuit Board Sensor, Transmitting Antenna.

I. INTRODUCTION

Long-Range(LoRa) networking technology has become a highlight on the stage in that its TX and RX devices communicate over hundreds of meters [1-3]. This is attractive to those who hope to build sensor networks over a very wide area without setting mobile carriers' base-station antennas, and has expanded applicability to localization and electricity-metering. LoRa has its own gateways and nodes interacting with sensors distributed over real-estates like streets, campuses and fields. In this paper, a LoRa communication instrument is realized for improving the received power at several hundred meters in distance. The antenna as the sensor for the transmitting device of the LoRa system goes through a change from a wire antenna as the conventional one to a printed Yagi-Uda antenna. The proposed RF sensor is designed to radiate the RF power of a higher gain than that of the commercial antenna. Resonating at 2.45 GHz, the end-fire antenna outperforms the conventional one by nearly 9 dB when the far-field patterns are measured at the anechoic chamber. This enables the RSSI to be boosted for the proposed antenna-combined LoRa module by over 10 dB at far-distances on the path in the real experiments. This is a very effective way to the radio link more reliable even with the use of the same battery power. The street of the town is taken and the position of the TX device from the RX is varied from 200m to 700m as the far range after standing near the RX to 200m as the neighboring range for LoRa link instrumentation..

II. ELEMENTS FOR LORA NETWORKING DEVICES AND ANTENNAS AS THE RF SENSOR

The LoRa communication instrument is built with TX and RX devices each of which consists of the chipset drivin the wireless module, an antenna as the RF sensor and the battery. The RX is connected with a notebook computer that gives the command to the module and takes and stores the data generated by the chipset.

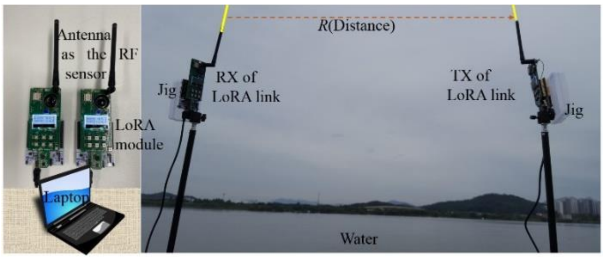
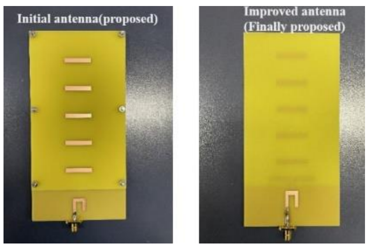
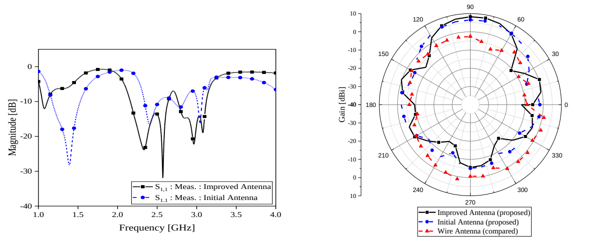


Fig. 1. A pair of modules for the LoRa communication setup and an example of face-to-face placement in a neighboring

Fig. 1 shows the TX and RX modules before and after being put in a LoRa test site. To push up the RF power at the far-range without adding a power-amplifier or battery cells to the module, a cost-effective and technologically advanced way is to change the wire antenna to a new one. It should not be big, but must overcome the drawbacks of the omni-directional antenna [4].



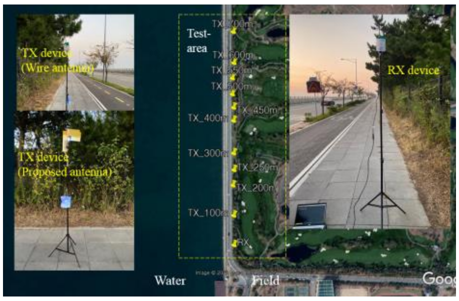
(a)



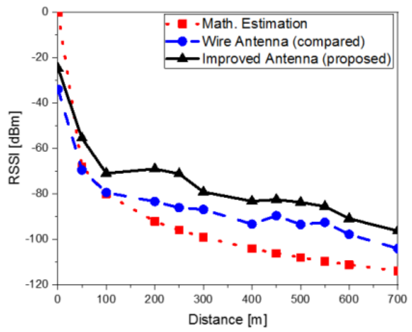
(b) (c)

Fig. 2. Fabrication and measurement of the proposed antenna and (a) Prototypes of the initial and improved structures (b) S11 of the proposed antennas (c) Measured far-filed patterns showing the enhancement in antenna gain.

The prototypes are shown in Fig. 2(a). The top and bottom layers are attached to the initial antenna through bolts instead of glue, which is practical. S11-curves in Fig. 2(b) present the antennas from the two steps in the design have good impedance match at 2.4 GHz. Fig.2(c) shows the proposed antenna has the gain higher than the commercial antenna by around 9 dB.



(a)



(b)

Fig. 3. Field-test to check enhancement in RSSI of LoRa radio link (a) Zoom-out map with the locations of the TX and RX (b) RSSI of the proposed antenna over a wide-open range greater than that of the commercial antenna.

The street of a sea-side town is selected as a wide-open area. The RX device using the conventional antenna is stationary and the location of the TX module is moved away from the RX side as in Fig.3(a). The distance increases from the vicinity of the RX through 200m to 700m. The RF sensor of the TX device is connected with the wire antenna at first and then changed to the proposed antenna for each distance. covering the spot near the RX up to 700m all together, the RSSI-curve by the proposed antenna combined LoRa device is obviously greater than that by the wire antenna. This is validated by Fig. 3(b) that compares the curves and refers to the mathematical estimation of path loss.

III. Conclusion

This paper suggests an effective and advantageous method to build a LoRa instrument with significantly improved RSSI in the long range of radio communication. Limited in the battery power, without taking costly means like additional power-amplifiers or revamping digital circuitry, the RF sensor as the passive component in the LoRa wireless module has been changed from the wire antenna to the PCB Yagi-Uda antenna that turns out to provide the developer with improvement in the RSSI at long distances. Especially, the Yagi-Uda antenna as an end-fire structure is devised to focus the field-flux and guide the dense field toward the RX wireless module at the resonance frequency. The proposed antenna radiates the far-field wave with the gain approximately 9 dB higher than the conventional one. To deal with the stronger wireless networking, this novel sensor is connected to the LoRa module and taken to the test site to validate the method. In the field test, compared to the commercial antenna and cases reported in others' papers, the RSSI from the LoRa instrument is 12 dB~39 dB greater than theirs at distances of over a few hundred meters.

Acknowledgment *(Heading 5)*

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References

[1] LoRa Alliance® and DLMS User Association, The Whitepaper: A Solution for Successful Interoperability with DLMS/COSEM and LoRaWAN®. LoRa Alliance Org., April 2019.E. P. Wigner, "Theory of traveling-wave optical laser," Phys. Rev., vol. 134, pp. A635–A646, Dec. 1965.

[2] M. de Castro Tomé, P. H. J. Nardelli and H. Alves, "Long-Range Low-Power Wireless Networks and Sampling Strategies in Electricity Metering," IEEE Trans. Industrial Electronics., vol. 66, no. 2, pp. 1629-1637, Feb. 2019

[3] Aloÿs Augustin, J. Yi, T. Clausen, and W. M. Townsley. "A Study of LoRa: Long Range & Low Power Networks for the Internet of Things," Sensors 16, no. 9: 1466, Sep. 2016

[4] M. K. Khattak, C. Lee, H. Park, and S. Kahng "A Fully-Printed CRLH Dual-Band Dipole Antenna Fed by a Compact CRLH Dual-Band Balun," Sensors 2020, 20, 17, 4991