

Title: Machine Learning-Optimized Compact Frequency Reconfigurable Antenna With RSSI Enhancement for Long-Range Applications

Author: Muhammad S. Yahya; Socheatra Soeung; Sharul Kamal Abdul Rahim; Umar Musa; Saeed S. Ba Hashwan; Md. Ashraful Haque

Abstract: This study presents an innovative and compact monopole antenna with dual-band frequency reconfigurability for LoRa applications. It operates within the 915 MHz and 868 MHz frequencies, aligning with the designated bands for use in America, Asia and Europe. No existing compact reconfigurable antenna with these features for LoRa applications within ISM bands below 1 GHz is known. Employing an economical FR-4 substrate in its design, the antenna attains a compact size of $40 \times 42 \text{ mm}^2$ ($0.12\lambda_0 \times 0.12\lambda_0$), where λ_0 denotes the wavelength in free space corresponding to 868 MHz. A single RF PIN diode enables seamless switching between 868 MHz and 915 MHz bands. Design, simulation, and optimization employed CST MWS® software. Supervised regression Machine Learning (ML) models predicted resonance frequencies, with Gaussian Process Regression emerging as optimal, achieving R-squared and variance scores of 92.87% and 93.77%, respectively. A maximum gain of 2 dBi at 915 MHz and 70% efficiency, boasting good radiation patterns and matching was demonstrated by the antenna. Experimental validation in a football field at Universiti Teknologi PETRONAS, Malaysia, assessed the proposed antenna's performance on a LoRa transceiver system based on LoRa SX1276. The Received Signal Strength Indicator (RSSI) of the proposed antenna consistently exceeded the conventional commercially available monopole antenna by an average of -12 dBm at every point up to 300 m, showcasing enhanced signal reception. The antenna proves promising for wireless sensor nodes in long-range applications.

Keywords: Dual-band , LoRa , PIN-diode , Reconfigurable , RSSI

DOI: <https://doi.org/10.1109/ACCESS.2024.3355145>

<https://ieeexplore.ieee.org/document/10401914>