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Master Thesis Defence

Entitled

PERFORMANCE ANALYSIS OF UNDERGROUND-TO-ABOVEGROUND COMMUNICATION IN AGRICULTURAL IOT NETWORKS

By

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Abstract

This thesis investigates the potential of LoRa, a low-power, wide-area networking technology, for establishing reliable communication between underground sensors and aboveground infrastructure. We comprehensively analyze LoRa's performance in both single-hop and multi-hop configurations, considering the impact of diverse environmental factors such as soil composition, moisture content, underground transmission distance, and path loss on signal propagation. We delve into the crucial role of the spreading factor (SF) within the LoRa communication system, analyzing its influence on network performance. Furthermore, we develop a comprehensive mathematical model for bit error rate (BER) under various channel conditions, including additive white Gaussian noise (AWGN) and Rayleigh fading, encompassing multi-hop networks with decode-and-forward relays. Through simulations employing realistic Rayleigh fading scenarios, we validate the accuracy of our theoretical models. Our key findings highlight the importance of optimizing network parameters, particularly the SF, to achieve superior bit error rate performance, ultimately enhancing the overall network reliability. We demonstrate that multi-hop LoRa networks offer a significant advantage over single-hop configurations, especially in challenging underground environments. This extended reach via multi-hop makes LoRa a compelling technology for large-scale, reliable communication networks in diverse agricultural applications.