Seasonally Adaptive Data Compression in LoRaWAN Using Huffman Coding

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Global warming has led to an increase in the frequency and intensity of heavy rainfall, heightening the risk of flooding at various scales. Early flood detection is a challenge in timely evacuations, particularly in forested areas since they are often affected first [1]. To address this challenge, we propose deploying sensor networks in forests using LoRaWAN, a low-power wide-area network protocol that supports long-term operation with sustainable energy sources.

Our approach focuses on reducing energy consumption in LoRaWAN by optimizing data compression. Specifically, we analyze meteorological data to identify seasonal frequency biases in temperature and humidity, enabling adaptive Huffman coding [2]. Given the minimal short-term temperature fluctuation, we further enhance efficiency through run-length encoding, which transmits alternating values alongside their respective durations. These methods effectively address LoRaWAN ' s 11-byte payload limit while improving transmission efficiency. Additionally, sensor-specific thresholds minimize unnecessary transmissions, further conserving energy.

To evaluate the proposed method, we compared compression ratios and power consumption between standard and compressed data transmission using the sensor data from Japan Meteorological Agency. Experimental results showed 88.77% compression with Huffman coding and 94.79% with Huffman and run-length encoding, with average code lengths of 1.8 and 3.9 bits, respectively. As the next phase, our experiment will be run using Arduino sensors over LoRaWAN. Furthermore, future implementation of ASICs could enable Huffman Deep Compression (HDC) with deep learning, further extending transmission efficiency[3].

References

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