

Seasonally Adaptive Data Compression in LoRaWAN Using Huffman Coding

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Global warming has led to more frequent heavy rainfall, increasing the risk of floods on various scales. Early detection is crucial for timely evacuations, particularly in forested areas that are often affected first [1]. To address this, we propose deploying sensor networks in forests and mountains using LoRa-WAN, which supports long-term operation with sustainable energy sources.

Our approach aims to reduce energy consumption in LoRaWAN by optimizing data compression. 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, run-length encoding further enhances efficiency by transmitting alternating values and their durations. These methods address LoRaWAN's 11-byte payload limit while improving transmission efficiency. Additionally, sensor-specific thresholds minimize unnecessary transmissions, further conserving energy.

We evaluated our method by comparing compression ratios and power consumption between standard and compressed data transmission using Arduino sensors over LoRaWAN. Experiments showed 88.77% compression with Huffman coding and 94.79% with Huffman plus run-length encoding, with average code lengths of 1.8 and 3.9 bits, respectively. This approach is not limited to precipitation data and can be extended to other sensor types, supporting future disaster countermeasures. Future use of ASICs could enable Huffman Deep Compression (HDC) with deep learning, further extending transmission efficiency[3].

Referencess

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