ABSTRACT

Wireless sensor networks (WSNs) have gained much popularity over the last decade in wireless and cellular computing research community. The sensor nodes in WSN measure physical conditions such as temperature, humidity, light intensity, environmental gases, medical parameters etc. In WSN, nodes acquire the required data, digitize and forward the data to the base station for further processing. However WSNs are resource constrained as nodes are limited in computation, storage, communication and energy resources. Data compression algorithms of sensor data lead to efficient utilization of energy in sensor network. Generally, processing of data by nodes require minimum power than transmission of the data in the network, hence use of data compression algorithm helps in bringing down the total power consumption by sensor nodes.

Huffman coding, DPCM scheme, S-LZW, Lossless entropy compression, Median-predictor-based data compression etc. are some of the light weight algorithms used for data compression which have been specifically designed for resource constrained WSNs. But using the light weight compression algorithms, the compression ratio achieved is not very high and not much suitable for real time data compression. Compressive Sensing (CS) is a data compression technique which offers very good compression ratio with better reconstruction quality. Applications of CS in WSN is of recent research interest as it offers high compression ratio, low bit error rate, high signal to noise ratio and low percentage root square distortion. The performance of CS based compression algorithms mostly depend on the sparsity of the signal of interest and hence it is required to increase the sparsity of the signal before the compression is performed. In this research work, modified CS algorithms are proposed to increase the sparseness of signals to improve the compression performance and hence minimizing the energy spent during transmission.

Threshold based CS is proposed for one dimensional data compression. The proposed threshold based CS provides better sparsity and hence improves the
performance by improving the Signal to Noise Ratio (SNR) and reducing the Mean Squared Error (MSE). Comparison of threshold based CS with standard CS is carried out and the simulation results show that for low correlated data, the algorithm provides better SNR and minimum MSE. For highly correlated data, threshold based CS algorithm does not provide significant improvement compared to standard CS.

For better performance of CS based compression algorithm for highly correlated data, differential encoding based CS is proposed. In differential encoding based CS, the sparseness of data is improved by considering the difference values of successive samples instead of the actual sample values of highly correlated data. The simulation results show that differential encoding based CS has low MSE and high SNR compared to CS without differential encoding.

In order to analyze a suitable sparsifying basis and modulation scheme for two dimensional (2D) signals in different channel conditions, various sparsifying basis (DCT / DWT) and modulation schemes (BPSK /QPSK /QAM) are applied using CS. It is observed from the results that DWT basis produces much sparser data than DCT basis and QPSK modulation is suitable in AWGN Channel whereas QAM is suitable in Rayleigh channel.

To compress medical image (DICOM image) and medical data (EEG and ECG signal), modified CS is used. Block based CS is suggested as a compression algorithm for large DICOM image compression. A high level of compression ratio with better reconstruction quality is achieved in the suggested method and hence this block based CS can be used for compression of large medical image.

Hardware implementation of the proposed threshold based CS algorithm is done using NI-WSN module. The results indicate that CS based algorithms are suitable for hardware implementation.