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Application of Huffman Code in Data Processing of JUNO Electronics

1. Introduction
The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose neutrino experiment designed to determine neutrino mass hierarchy and many related searches, which will make a great contribution to high-energy physics.
In this paper, Huffman dynamic coding is applied to data processing and plays a good effect since it is an efficient data compression algorithm. The main content of this research is to evaluate the effect of this algorithm in real-time data processing and Trigger judgement.

2. Algorithm Selection
The data in this experiment is sampled from photomultiplier tubes. The signals of each PMT are continuously gathered by readout board, then sampled by ADC. The signal will be judged as Hit signal once its energy reaches the trigger threshold and meets the PMT hit time.
Taking the characteristics of the data into account, it is possible to reduce data volume without losing useful information. A scheme can be easily implemented through dynamic Huffman Coding.

3. Performance in data compression
It’ s proved an efficient way when using the designed dynamic coding table to compress large amounts of data. Moreover, the compressed data can be fully recovered back to the original data since the compression is lossless. The simulation results show that this algorithm can achieve a compression ratio of 25%.

4. Application in Trigger
In the real experimental environment, the value between two sampling points does not differ much. In addition, the data is essentially the differential value of adjacent sampling points after Huffman coding. At the same time, the data show obvious fluctuations in the arrival of the Hit signal. Therefore, taking these properties into account, Huffman coding shows its unique advantages in trigger judgement. The simulation results show that this algorithm has a good performance on trigger.

5. Energy derivation
After our deduction, the encoded data was proved having exact correspondence with particle’ s energy. Meaning the algorithm has exact physical meaning when used at trigger judgement.

Summary

The Jiangmen Underground Neutrino Observatory (JUNO) is a neutrino experiment for multiple physic research, with a huge liquid scintillator and 18,000 photomultiplier tubes placed in deep underground. The special experimental environment, which the associated readout electronics will be placed underwater, requires electronic system to be highly reliable and as simple as possible. The data from each photomultiplier tube will be sampled at 1GHz through ADC, therefore processing and transmission of large amounts of data is another problem we need to solve. In this paper, Huffman dynamic coding is applied to data processing, using the designed dynamic coding table to compress large amounts of data efficiently. Moreover, the compressed data can be fully recovered back to the original data since the compression is lossless. The simulation results show that this algorithm can achieve a compression ratio of 25%. In addition, the compression in the algorithm is essentially the differentiation of the original data, having obvious characteristics, thus provides a new way for trigger. We acquired Hit signals successfully by setting new trigger thresholds with the compressed data. After deduction, it is verified that there is a mathematical correspondence between the compressed data and signal energy, which provides a new method for Hit signal acquisition.

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