A Self-Adaptive Maximum Likelihood Bit Synchronization Approach for a GPS receiver

Rui ZHENG, Institute of microelectronics, Chinese Academy of Sciences
MoHan CHEN, Institute of microelectronics, Chinese Academy of Sciences
Jie CHEN, Institute of microelectronics, Chinese Academy of Sciences

ABSTRACT
A self-adaptive maximum likelihood bit synchronization approach dedicated for GPS receivers is proposed. The approach introduces a normalized gap between the maximal and the submaximal bit energies to the conventional maximum likelihood method with fixed noncoherent accumulation times as an indicator, to constrain the noncoherent accumulation times for various signal powers self-adaptively. Simulations validate the approach is able to reduce the mean estimation time significantly, while the estimation error rate is guaranteed to be kept almost as low as the conventional method.

INTRODUCTION
For the 50 bps GPS navigation data modulated on L1 carrier, every transmitted bit contains twenty C/A codes. Therefore, there is an initial uncertainty of the bit boundaries in a GPS receiver. Detecting the bit boundaries is critical to demodulate navigation data bits, measure pseudoranges and adopt coherent integrations to improve the tracking sensitivity. Without external assistant, the GPS receiver has to estimate the bit boundaries, so as to fulfill so-called bit synchronization.

Histogram approach is a widely used statistical bit synchronization method\(^\text{[1]}\). The approach examines the statistic of sign changes of the prompt correlator output, which is obtained by integrating the received signal over one C/A code period. If the number of the sign changes at a certain candidate position, the position with greater sign one C/A code period. If the number of the sign changes at which is obtained by integrating the received signal over statistic of sign changes of the prompt correlator output, to 20dB-Hz. Zeidan\(^\text{[5]}\) proposed a Viterbi algorithm on the principle of maximum likelihood. References [6, 7] show the approach is suitable for signals with synchronization method \(^\text{[1]}\). The approach examines the boundaries, so as to fulfill so-called bit synchronization. Alternating generalized expectation maximization.

The ML approach usually fixes a large noncoherent integration times to guarantee the Estimation Error Rate (EER) low enough for weak signals, e.g. 200, which needs data of 4 seconds. However, 200 times of noncoherent accumulations is unnecessary for relative strong signals. Redundant noncoherent accumulations will prolong the bit synchronization procedure, so as the Time To First Fix (TTFF). A self-adaptive maximum likelihood bit synchronization approach is proposed. The approach constrains the times of noncoherent accumulation for various C/N\(_0\) self-adaptively, by introducing the normalized gap between the maximal and the submaximal bit energies as an indicator, while the estimation error rate is guaranteed to be kept almost as low as the conventional method. Simulations show the proposed approach is able to save more than 94.7% Mean Estimation Time (MET) for signals with C/N\(_0\) higher than 30dB-Hz, while the EER increases less than 5%, compared to conventional ML approach with fixed 200 noncoherent accumulation times, when a proper threshold is chosen.

DERIVATION OF ML APPROACH

SELF-ADAPTIVE ML APPROACH

SIMULATION RESULTS

CONCLUSION

REFERENCES