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GLOBAL NAVIGATION SATELLITE SIGNAL SYSTEMS OPTIMIZATION BY EMPLOYING MACHINE LEARNING FOR CODING-DECODING METHODS ADJUSTMENTS ACCORDING TO THE ELECTROMAGNETICALLY VARIANCES AND INTERFERENCES CAUSED BY COMMUNICATION CHANNELS DENSITY

Abstract

It is known that there are many Global Navigation Satellite Signal (GNSS) systems orbiting the Earth because of new communication technologies constant development. This fact drops several technical complications, such as interference, loss of information and decoding lag due to many active communication channels. The above represents a great problem for the communication between great satellite constellations. Lately, Code Shift Keying (CSK) modulation method represents a great opportunity to benefit the data transmission by increasing the transmission rate of band-limited spread spectrum signal. However, according to recent research, demodulation time is affected by the Coding-Decoding Methods (CDM) due to the access to codeword complexity; this generates the necessity of dynamic CDM adjustments. It depends on electromagnetic circumstances and signal descriptive variables, such as band width or codewords symbols variety.

The current advances on Machine Learning (ML) strategies have provided a great tool for GNSS systems optimization, due its optimum solution deployment mechanism. In this case, CDM represents the optimum solution searched which will be obtained considering the demodulation/decoding technique advantages.

This paper considers 3 different decoding methods for programming a dynamic ML algorithm, all these methods employ CSK modulation, but vary the functionality accordingly with demodulation performance, receiver's complexity and codeword duration. The most important of the above variables depends on the instantaneous signal's fade and noise. The first method is the classical decoding method for CSK modulation. The second one is based on Bit-Interleaved Coded Modulation with Iterative Decoding (BICM-ID) and Horizontal Dimension Multistage Decoding (HDMD), which combines error correcting codes into an iterative process to improve the reliability of the decoded information. The third solution employs Q-ary channel code for using symbols as fundamental information units, instead of using bits

when decoding is performed.
For the development of the ML algorithm of optimization, a fade and noise conditions scanning needs to be effectuated, and the adjustment of CDM will depend mainly on the electromagnetic circumstances of Satellite's orbit, the band width required for that instance, and the data transmission-recovering speed according to the data variety. This is because each CDM proposes different advantages over the others.
This research journey presents a ML algorithm development to relate different modulation methods to provide the most optimum signal demodulation and decoding on GNSS by instance, with an enormous reach on space navigation systems for exploration missions or planetary dynamic monitoring performed by great satellite constellations.