Blind Signal Modulation Recognition through Clustering Analysis of Constellation Signature

A Thesis submitted by
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Conclusion and Future Scope

The technology in the field of wireless communication is changing rapidly. Lots of research is heading towards improving spectral efficiency, higher throughput, and reliable communication link. Adaptive Modulation and Coding is one such technique that can achieve these objectives. Significant research on this technology has already been carried out. Most of the techniques for blind signal modulation detection cannot be modified further to include more modulation schemes. Either the features cannot differentiate the modulation scheme, or in the case of supervised learning methods, the system requires training. In this thesis, these issues are considered, and new algorithms based on unsupervised learning are developed. The following sections conclude different research work presented in the thesis, and future scope of work has been explored.

8.1 PARAMETER ESTIMATION

To extract the symbol points from the passband signal, systems require different parameters viz. carrier frequency, symbol rate, symbol timing offsets. Carrier frequency is estimated using the power spectrum of the required range of frequency for which the AMC system is deployed. A new method for symbol rate estimation and phase offset estimation is proposed. Most of the work in literature considers constellation points directly assuming all these parameters known while the present work estimates all these parameters to extract constellation points from the blind signal.

While the present considers slow and flat fading channel and signal input single output system, it can be extended to frequency selective channel and multiple input multiple output system. Further incorporating channel estimation techniques can improve the performance of the system.

8.2 MODULATION CLASSIFICATION ALGORITHM

In this thesis, different clustering algorithms are introduced in the field of modulation classification. Modulation classification using the OPTICS clustering algorithm has been proposed. The algorithm is reliably classifying different modulation orders of ASK, PSK, and QAM. Unlike the conventional algorithms in the literature, the proposed methodology is generalized for any orders ASK, PSK, and QAM. Linear regression introduced can differentiate ASK from other modulation domains and the line's slope can simultaneously estimate phase offset. Apart from the clustering algorithm, a local density-based HLD algorithm is proposed.

Work is further extended to the implementation of another developed algorithm on FPGA. Most of the works in the literature lacks detailed information on the implementation of an algorithm on the practical system. A detailed explanation of the implementation is explained such that work can be replicated and can be further worked upon in the improvement of optimizing hardware resources and complexity of the system.

All the present work can be extended to include more modulation schemes like MSK, OQPSK, etc. Further modulation classification in OFDM systems can be explored. As the wireless industry is thriving, newer modulation schemes like spatial modulation and space shift keying come into the picture to fulfill higher data rates. Conventional orthogonal multiple access technologies serve a single user in one orthogonal resource block. Hence non-orthogonal multiple access is considered as an important candidate for future wireless technology. In all these scenarios, the modulation classifier can save the overhead in data frames, resulting in the improvement of spectral efficiency and system throughput.

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