

SENSING AND DETECTION OF A PRIMARY RADIO SIGNAL IN A COGNITIVE RADIO ENVIRONMENT USING MODULATION IDENTIFICATION TECHNIQUE

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ABSTRACT

In today's society, the need for the right information at the right time and the right place as well as increased number of high bandwidth wireless multimedia services and the explosive proliferation of smart phone and tablet devices has led to increase in demand for and use of radio spectrum, which is the primary enabler of wireless communications. With this increase, the principal engineering challenge in wireless communications domain is now on how to effectively manage the radio spectrum to ensure its sustainability for future emerging wireless devices, since virtually all usable radio frequencies for wireless communications have been licensed to commercial users and government agencies.

Traditionally, the approach to radio spectrum management has been based on a fixed allocation policy, whereby licenses are issued to users or operators for the usage of frequency bands. With a license, operators have the exclusive right to use the allocated frequency bands for assigned services on a long-term basis. However, over the last ten years, this strict allocation policy has been subjected to a lot of criticism because of its observed contribution to radio spectrum scarcity and underutilization.

In mitigating these negative effects of the current radio spectrum management policy, one of the suggested measures is to open up the licensed frequency bands to unlicensed users on a non-interference basis to licensed users. In this new spectrum access system, an unlicensed or secondary user can opportunistically operate in unused licensed spectrum bands without interfering with the licensed or primary user, thereby reducing radio spectrum scarcity and at the same time increasing the efficiency of the radio spectrum utilization.

In achieving this objective, there is a need to develop a radio engine that can sense its environment to determine the presence of primary users. Cognitive radio is seen as the enabling technology for opportunistic spectrum sharing. It is a radio with the capability to sense and understand its environment, and proactively alter its operational mode as needed to avoid interference with a primary user. To ensure interference-free use to the primary user, spectrum sensing and detection has been observed as a key functionality of cognitive radio.

However, there is currently no single sensing method that can reliably sense and detect all forms of primary radios' signals in a cognitive radio environment. Therefore, in order to achieve this goal, this thesis addresses the problem of accurate and reliable sensing and detecting of a primary radio signal in a cognitive radio environment. The principal research issue addressed is the possibility of sensing and detecting all forms of primary radio signals in a cognitive radio environment. This objective was achieved by developing an adaptive cognitive radio engine that can automatically recognize different forms of modulation schemes in a cognitive radio environment.

The thesis pictures spectrum sensing as the combination of signal detection and modulation classification, and uses the term Automatic Modulation Classification (AMC) to denote this combined process. The hypothesis behind this detection method is that, since all transmitters using the radio spectrum make use of one modulation scheme or another, the ability to automatically recognize modulation schemes is sufficient to confirm the presence of a primary user signal while the opposite confirms absence of a primary user signal.

The research work methodology was divided into two stages. The first stage involves the development of an automatic modulation recognition (AMR) or AMC using an Artificial Neural Network (ANN). The second stage involves the development of the Cognitive Radio Engine (CRE), which has the developed AMR as its core component. The developed CRE was extensively evaluated to determine its performance. The overall numerical results obtained from the developed CRE's evaluation shows that the developed CRE can reliably and accurately detect all the modulation schemes considered without bias towards a particular Signal-to-Noise Ratio (SNR) value, as well as any modulation scheme. The research work also revealed that single spectrum sensing and detection method can only be achieved when a general feature common to all radio signals is employed in its development rather than using features that are limited to certain signal types.