Spectrum Sensing Analysis in Wireless Communication System

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Abstract- *Due to the rapid growth of new wireless communication services and applications, much attention has been directed to frequency spectrum resources and the way they are regulated. Considering that the radio spectrum is a natural limited resource, supporting the ever increasing demands for higher capacity and higher data rates for diverse sets of users, services and applications is a challenging task which requires innovative technologies capable of providing new ways of efficiently exploiting the available radio spectrum. In this article we explores the application machine learning techniques in enabling the cognition capability of cognitive engine in spectrum sensing. The proposed algorithms are evaluated under extensive simulation runs. The investigations in this work we propose a novel technique which is able to accurately predict the false alarm probability, error rate and signal to noise ratio.*

Keywords:- Wireless communication, cognitive radio network, Spectrum sensing, Error rate, False alarm probability.

INRODUCTION

Cognitive radio is widely expected to be the next Big Bang in wireless communications, Spectrum regulatory Committees in many countries have been taking steps to open the door to dynamic spectrum access using this technology and also laying down the rules for its implementation. International organizations have also been striving for standardizing and harmonization this technology for various applications. Cognitive radio concepts can be applied to a variety of wireless communications scenarios, a few of which are described in this document. Cognitive radio concepts can be applied to a variety of wireless communications scenarios, a few of which are described in this document additionally, the major functions and applications of cognitive radio and components of cognitive radio and implementation issues are reviewed. There are several definitions of CR and definitions are still being developed both in academia and through standards bodies, such as FCC, IEEE-1900 and the SDR Forum.

The usual topology of wireless sensor networks involves having many network nodes dispersed throughout a specific physical area. There is usually no specific architecture or hierarchy in place and therefore, the wireless sensor networks are considered to be ad hoc networks. An ad hoc wireless sensor network may operate in a standalone fashion, or it may be connected to other networks, such as the larger Internet through a base station. Base stations are usually more complex than mere network nodes and usually have an unlimited power supply. Regarding the limited power supply of wireless sensor nodes, spatial reuse of wireless bandwidth, and the nature of radio communication cost which is a function of the distance transmitted squared, it is ideal to send information in several smaller hops rather than one transmission over a long communication distance.

Wireless Sensor Networks (WSN) is one of emerged technology that is being rapidly adopted due to their flexibility and use in a various environments. Networks protocols in WSN have to achieve fault tolerance whenever individual node is failed and energy consumption [5] as to be reduced. Moreover the routing protocols in WSN should have capability to perform local collaboration to reduce the bandwidth requirements, since the channel bandwidth is shared among all the sensor nodes in the network. WSN's are one of best technology for monitoring critical situations and remote fields which far away from the human perspective. Network lifetime can be defined as the time elapsed until the first node (or the last node) in the network depletes its energy (dies).

II. Radio Spectrum

Radio spectrum is a limited natural source which is regulated around the world by international and national regulators. The International Communication Union (ITU) and in particular, its Radio communication Sector (ITU-R) have the core responsibility of the governance of the radio spectrum. At the international level of allocation which is done by ITU, the use of radio spectrum is regulated for different type of services on a regional basis.

At the national level, in most countries the use of radio spectrum is managed by the government. For example, the Federal Communications Commission's (FCC) is responsible for radio spectrum regulation in the United States, while in the United Kingdom it is regulated by the Office of Communications (Ofcom). Radio spectrum allocation and management, traditionally, can be divided into two categories: licensed and unlicensed [5]. Over unlicensed bands, users can freely transmit without any licensing requirements, while in licensed bands, the right of the use of a frequency band is assigned through the sale of a license. This approach assigns fixed spectrum allocation, operating frequencies and bandwidths with constrains on power emission which limits their range. Hence, most communication systems are designed so that to increase spectrum efficiency within the assigned bandwidth using different modulation, coding, multiple antenna configuration and other techniques [6].

Since demands on wireless applications are explosively increasing, the radio spectrum is becoming more occupied. Because of this, the static spectrum allocation policy will result in spectrum scarcity. Convict between the spectrum scarcity due to the traditional static spectrum allocation policy, and ever increasing service demands has motivated research groups to investigate innovative schemes, that can solve the problem of the spectrum allocation. However, radio spectrum usage pattern shows that large portion of the licensed bands are under-utilized.

III. Proposed Work and Result Analysis

Over the past two decades, the application of artificial intelligence to cognitive radio networks has received a lot of attention [2]. The motivation to use learning techniques came from the fact that historical wireless data collected over time contains a lot of variations and features. Thus, the collected historical data can be used to predict future patterns. In the context of wireless cognitive radio, the network has high degrees of freedom.
Therefore, deriving an input-output relation is not a simple task.

Machine learning algorithms can be applied to learn and estimate the input output function of the system through the use of data examples without complete knowledge of the system parameters. Machine learning techniques are divided into three main categories: supervised learning, unsupervised learning, and reinforcement learning. In this section we will give a brief overview of the learning techniques and their applications in cognitive radio networks. Machine learning techniques have been widely used in the literature of CR networks to perform tasks such as feature classification, clustering, and control. The choice of the learning technique to be implemented in the CR network mainly depends on the type of data that is presented to the system, i.e., labeled or unlabeled data and the nature of the learning problem at hand (will be discussed later). Below figure summarizes some of the machine learning techniques widely used in the context of cognitive radio networks and their corresponding learning problems.

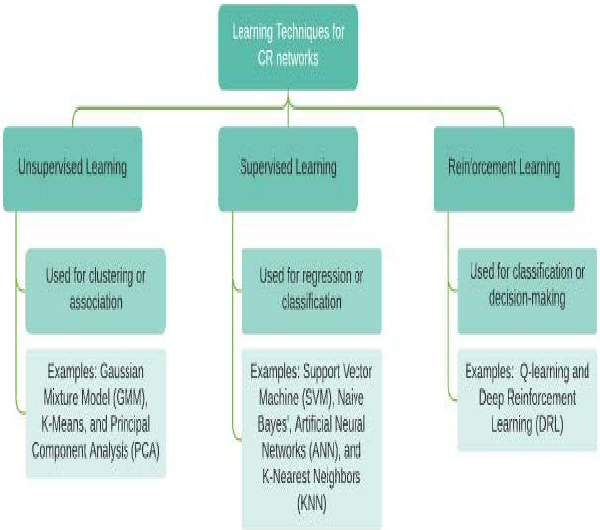

Figure 1: Taxonomy of learning techniques for CR networks.

The configuration and classification process for CNNs used in modulation classification occurs in two stages. The first encompasses the convolutional operations, the stage that performs the feature extraction. The layers consists of kernels that convolve over the input, in this case RF signal, and during training these kernels are updated such that the resulting output of the convolutional layer is the distinguishing features. Once the feature extraction is accomplished in this stage, they are then fed into a fully connected neural network that leverages these learned features to make a decision on the classification. A fully connected neural network consists of layers of nodes where each node in a given layer is fed the output of each node from the previous layer. These inputs are weighted and summed together and run through an activation function to provide non-linearity to the process, creating the output of a given node. The output from the last layer is fed through a softmax function to create psuedo-probabilities for each potential modulation scheme, indicating the network's confidence in each. A generalized block diagram that illustrates the architecture of a CNN used for modulation classification is shown in below figure.

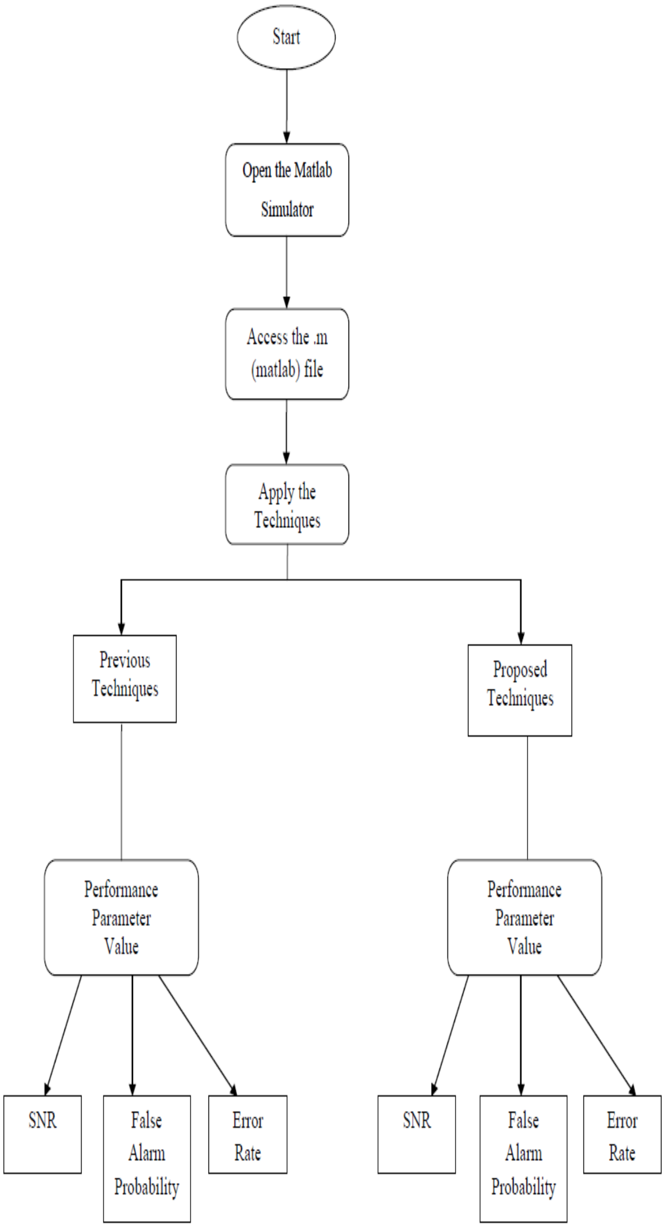

Figure 2: The above flow graph represent that the experimental work for the previous and proposed techniques.

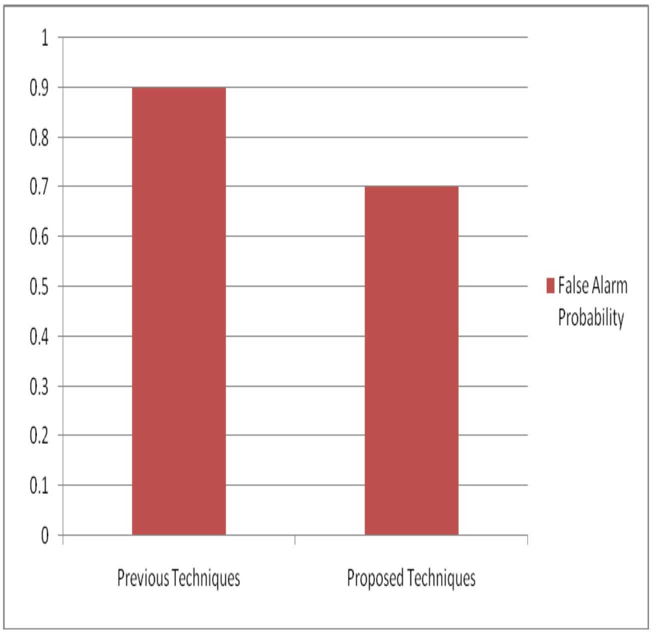

Figure 3: The above graph shows that the previous and proposed techniques comparative experimental work for the false alarm probability parameter.

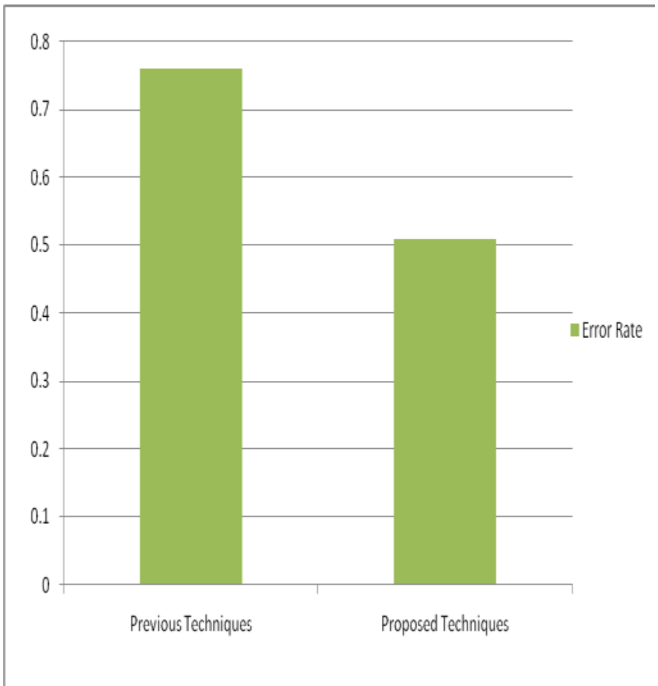

Figure 4: The above graph shows that the previous and proposed techniques comparative experimental work for the error rate parameter.

IV. Conclusion

Wireless sensor networks (WSNs) have been increasingly considered an attractive solution for a plethora of applications. The low cost of sensor nodes provides a mean to deploy large sensor arrays in a variety of applications, such as civilian and environmental monitoring. Most of the WSNs operate in unlicensed spectrum bands, which have become overcrowded. Learning-based CR networks are able to use accumulated knowledge through spectrum observations to enhance their cognitive ability. Therefore, in this paper we have proposed an spectrum sensing performance using the machine learning techniques, and find the comparative experimental study for the previous and proposed work.

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