MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY

A FUZZY LOGIC BASED CHANNEL ALLOCATION SCHEME FOR COGNITIVE RADIO NETWORKS

BY

DENNIS GEORGE OZHATHIL
BSc EE (Mak)

A DISSERATION SUBMITTED TO THE DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE IN ELECTRICAL ENGINEERING DEGREE OF MAKERERE UNIVERSITY

NOVEMBER 2014

Abstract

Cognitive radio technology offers a line of research that enables the exploitation of the radio frequency spectrum by unlicensed users who are permitted to share this spectrum with the condition that they cause minimum interference to the legacy or licensed users. The cognitive radio employs intelligent techniques to identify a spectrum vacancy and utilizes it in an opportunistic manner. Such avenues of research have become a necessity in a fierce market where the scarceness of the spectrum has resulted in a corresponding increase in spectrum price.

Decision making about channel allocation is complicated by variations in the radio frequency environment and lack of complete information about this generally dynamic operating radio environment. A fuzzy logic based reasoning was used to support the channel selection decision of the cognitive radio as this paradigm of artificial intelligence is suited to the conditions of uncertainty and imprecise information that is characteristic of an open and broadcast wireless radio environment. The process of channel selection for a cognitive radio transmitter was modeled as a multi-objective optimization problem that was solved using a discrete fuzzy logic decision making technique as opposed to the more popularly used continuous fuzzy logic. This work presents a discrete fuzzy logic based optimization technique which operates using only the ordinal information on the ranking of preferences attached to the objectives of maximizing the signal to interference and noise ratio at the intended secondary user receiver and minimizing the interference power at other primary users.

This work utilizes a cross layer design to achieve better coordination between the different layers of the communication protocol of the cognitive radio. A hybrid fuzzy logic based protocol that spans the physical and network layers to enable the exchange of information and control signals that will reduce the multi-objective optimization problem to a singular problem of achieving a high network throughput using the optimal channel selected for use by a potential cognitive radio user is proposed.

With the aim of enhancing the human-like characteristics of learning and understanding within the cognitive radio user through “seeing and observing” the environment, the results did show that the fuzzy system was able to model a human operator decision process in selecting the best spectrum bands based on the channel-state information available to it. The hybrid fuzzy logic based protocol is seen to successfully achieve opportunistic spectrum utilization by using just linguistic descriptions of the input variables. The simulations showed that the fuzzy technique is able to achieve a performance objective of attaining a maximum network throughput with high efficiency in mimicking a human decision making process.. It is also seen that whereas the technique is intelligent, it does need to be tuned or taught to yield rational results.