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Fuzzy-logic-based channel selection in IEEE 802.22 WRAN

Gyanendra Prasad Joshi, Srijana Acharya, Sung Won Kim *

Department of Information and Communication Engineering, Yeungnam University, 712-749, Gyeongsan-si, Gyeongsangbuk-do, Republic of Korea

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ABSTRACT

IEEE 802.22 WRAN standard does not specify algorithm for selecting *operating* channel from *backup* channel list and prioritizing the *backup* and *candidate* channels. Because all the channels in the *backup* and *candidate* channels list are not with the same properties, selecting channels randomly from the list may decrease the networks performance. We propose an approach of ranking channel according to behavior of primary users on the channel and RSSI value. It utilizes fuzzy-logic-based algorithm for prioritizing channels in the *backup* and *candidate* channels list. Performances of the networks with fuzzy-logic-based channel selection and random channel selection are compared.

1. Introduction

In the IEEE 802.22 wireless regional area network (WRAN) [1], channels are classified into two categories, namely available channels and unavailable channels. Channels that are currently used by any primary user (PU) such as analog TV, digital TV or wireless microphones are the unavailable channels.

The available channels are categorized in the following channels. (i) Operating, (ii) Backup, (iii) Candidate, (iv) Protected (v) Occupied, and (vi) Unclassified. The base station (BS) maintains all the available channel sets and the customer-premises equipment (CPE) maintains only operating, backup, and candidate channel lists.

The update duration of these lists are different among themselves, and also between BS and CPE. For example, on the CPE side, the operating set is confirmed by every received superframe control header (SCH), backup and candidate sets are updated after receiving the downstream channel descriptor (DCD) message, and the protected set is updated after receiving the channel occupancy update (CHO-UPD) message. After synchronization, BS sends a CHO-UPD message to update the occupied channel set for the newly connected CPEs. In case of BS, channel sets are updated after each quiet period either periodically or demand-based [2].

IEEE 802.22 WRAN standard does not specify the algorithm for selecting the operating channel from the *backup* channel list and the *backup channel* from the *candidate* channel list. If the channels are selected randomly, there is a possibility of selecting channels with lower quality affecting the network performance. To mitigate such possibilities, we propose a fuzzy-logic-based approach for ranking channels according to behavior of PUs on the channel. The proposed fuzzy-logic-based approach prioritizes channels and helps to promote and demote the channels to and from operating, backup and candidate channels.

Fuzzy-logic is applied in various telecommunications domains, because it is useful in very complex processes. Recently, it has been popular for decision making process in cognitive networks [3–11]. With the anticipation that IEEE 802.22 WRAN has cognitive radio conception [12],

* Corresponding author. Tel.: +82 53 810 2483.
E-mail addresses: joshi@ynu.ac.kr (G.P. Joshi), sriz@ynu.ac.kr (S. Acharya), swon@yu.ac.kr (S.W. Kim).

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integrating artificial decision making system for channel selection may enhance the systems performance.

2. Fuzzy-logic-based channel selection

To mitigate the complexity of the algorithm, the proposed algorithm uses two fuzzy logic controllers (FLCs). First fuzzy logic controller (FLC-1) considers the behavior of the PUs on the channel, such as how often PUs come on the channel, and once they arrive on the channel, how long they occupy the channel.

Figs. 1–3 show the fuzzy inference system (FIS) of FLC-1. In this Mamdani-type FIS, there are two membership functions as shown in Figs. 1 and 2. First input is behavior

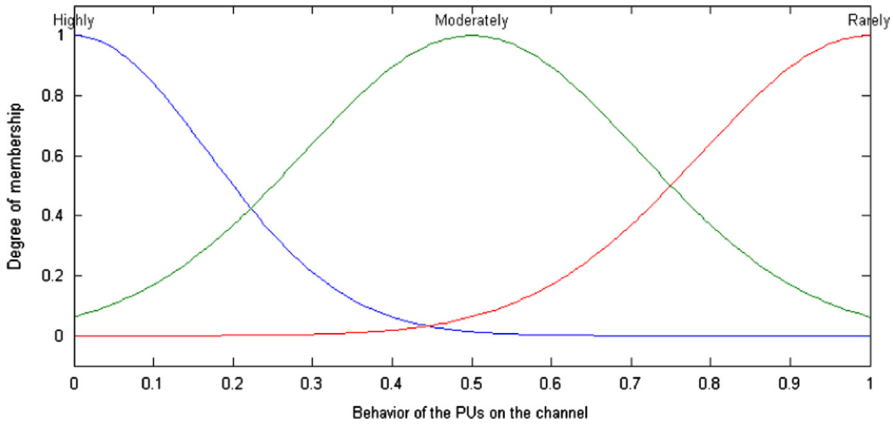

Fig. 1. MF showing how often PUs come on the channel.

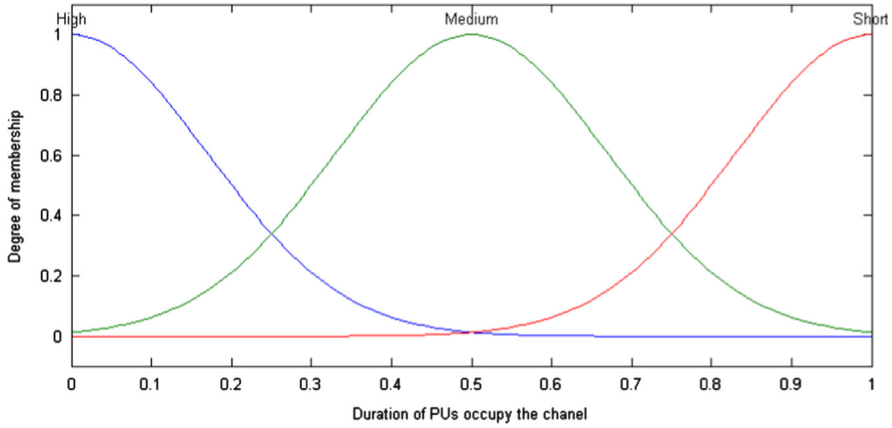

Fig. 2. MF showing for how long PUs occupy the channel once they arrive.

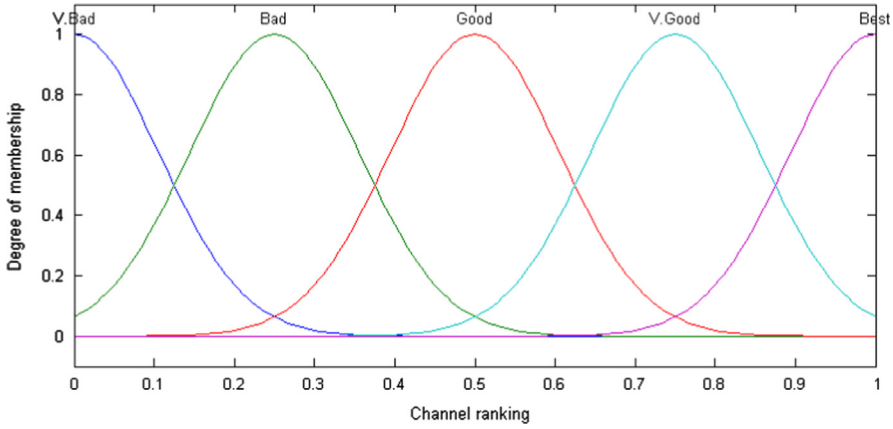

Fig. 3. Output MF plot.