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Range-Based Primary user Localization in Cognitive Radio Networks

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Abstract

In cognitive radio networks (CRNs), information regarding the positions of the primary users (PUs) is crucial as it may be helpful for improving the spectrum utilization and to avoid harmful interference. Existing Range-based methods require three or more than three known secondary users (SUs) to estimate primary user location and hence have the limitation that they cannot work if there are only two known secondary users available in the system. Also the existing methods cannot work if the precondition for applying Trilateration method is not satisfied (i.e. no common intersection point between the circles drawn for the secondary users). In this article we present Range based primary user localization technique to find out the location of PUs along with their transmit power. The proposed technique relies on the information collected from only two SUs to carry out the localization process unlike the existing techniques.

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Keywords: Cognitive Radio Networks; Angle of Arrival; Received Signal Strength; Localization

1. **Introduction**

In past few years, there has been an explosive hike in the number of wireless applications, and due to the scarcity of resources a reasonable usage of radio channels is required [1]. However, several studies prove that the spectrum utilization is poor in current fixed spectrum assignment policy [2]. CRNs have turned out as a revolutionary concept

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to ride out through this situation [3], [4]. There are two types of users in CRN: primary users (PUs) and secondary users (SUs) which are licensed and unlicensed users respectively. In CRNs, using spectrum sensing techniques, SUs can access the spectrum holes and the licensed spectrum opportunistically, until they cause stern interference with the PU. However, at any time, PU can access the spectrum regardless of the transmission carried out by SU. Due to this, PUs may experience stern interference till the transmission ends. So an important issue for CRN to work successfully is to determine the precise location of PUs, this can facilitate SUs to locate PUs and switch to free frequency if PU is detected.

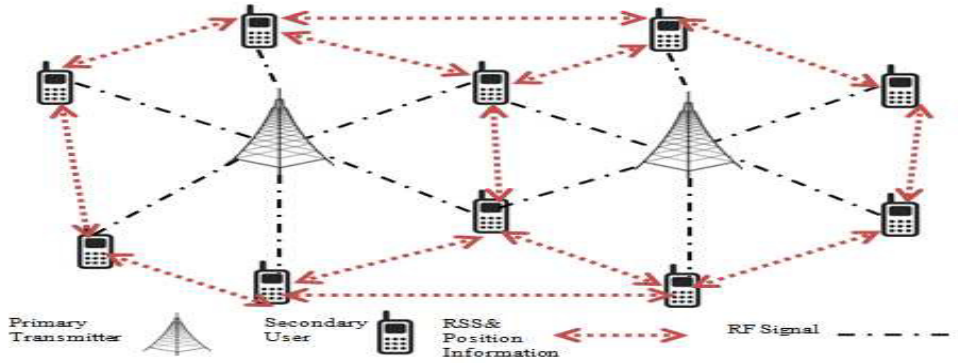

Fig. 1. System Model

Localization is a technique that is used to obtain position information of wireless nodes. In computer networks, localization is an issue associated with physical, medium access control and network layer. Spectrum sensing technique is essential for CRN, as it is used to identify if the primary user is present or absent. In some scenarios spectrum sensing cannot provide interference free environment to the PU.

Position information of the SUs and PUs can help CRN to detect spectrum holes with more accuracy and reliability and also to carry out power control techniques and position-based intelligent routing in CRN. The availability of position information of PUs along with spectrum sensing can help improve the performance of CRN and make it more reliable. Hence, detecting the PUs location in CRN is essential but an arduous task. In this article we present Range based primary user localization technique to find out the location of PUs along with their transmit power.

The proposed technique relies on the information collected from only two SUs to carry out the localization process. The localization task is accomplished by using both RSS and Angle of Arrival (AOA) concepts. RSS is used as a primary step to calculate distance of PU from SU. While AOA is used to decide among possible positions of PU after applying Trilateration method to the distance calculated. Hence our technique enables the localization of PU by using only two known SUs and as it relies on RSS and AOA concepts, which are both range-based we have entitled our work as Range-based PU localization in CRN.

Although a number of techniques have been developed to find out the position information of PU in CRN like Range-based and Range-free. The state-of-art techniques in range-based category cannot work:

- When there are less than three secondary users available to measure the PU's position as shown in Fig. 2. (b).
- When the precondition for applying Trilateration method is not satisfied (i.e. no common intersection point for circles drawn for the secondary users) shown in Fig. 2. (c).