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Machine learning Approach for Hand off Security in Adhoc Network Applications

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Abstract: In this study, we develop a brand-new cognitive user emulation attack (CUEA) that can be used by unauthorised users to intercept spectrum handoff. Then, by introducing a coordinating cognitive user who determines the amount of trust of each cognitive user based on its behavioural traits, we present a secure handoff mechanism that can successfully fend off such an attack. The coordinated cognitive user can effectively identify malicious individuals by searching up the trust values. MATLAB simulations are used to verify the suggested mechanism's performance. The outcomes of the simulation demonstrate the effectiveness of the suggested system in terms of its propensity to correctly identify false authentication, detection rate, throughput rate, and transmission delay.

Keywords: Cognitive Radio Network, Spectrum Handoff Security, Fuzzy Logic, Data Delivery Ratio and Liveness.

1. Introduction:

The goal of cognitive radio (CR), a cutting-edge technology, is to make opportunistic and dynamic use of the spectrum bands that are currently underutilised. "Spectrum holes" or "white spaces" are the portions of spectrum bands that are not in use. Using CR technology, users can identify the underused spectrum bands, select the best one, and utilise them to their fullest potential. Spectrum sensing, spectrum assignment, spectrum mobility, and spectrum sharing are the four stages of the CRN spectrum utilisation process.

Spectrum Sensing

Only an unoccupied portion of the spectrum may be assigned to a CR device in a CR network. Therefore, the CR usage should detect the spectrum bands, save the information, and recognise the white areas. Generally speaking, there are three basic categories for spectrum sensing techniques:

- **Primary Transmitter Detection**

The main goal of this technique is to recognise the primary transmitter's signal, even though it is very weak. It is accomplished by neighbourhood observation. The techniques employed to find the transmitter are:

a. Matched Filter Detection: The Matched filter is a useful detector for stationary Gaussian noise when the CR user is aware of the primary user signal information. Due to the signals' characteristic spectral correlation qualities, any signal that would be lost in interference and noise can be found using a matching filter.

b. Energy Detection: Energy detection is a preferable option if the primary signal information is unknown. An energy detector measures the energy acquired on a primary band throughout the course of an observation time and confirms a spectrum hole if the analysed energy is below a predetermined threshold. Energy detectors frequently trigger false alarms brought on by unidentified signals because they are unable to discriminate between different signal kinds. [6] explains an analysis for threshold optimisation and decreased error probability.

c. Feature Detection: Every modulated signal has inherent periodicity or cyclostationarity, typically. To identify this feature, apply a spectral correlation function [10]. The ability of feature detection to overcome noise power instability is its main advantage. However, it requires significantly longer observation times and is computationally complex.

- **Primary Receiver Detection**

Finding Primary Users who are getting information inside a CR user's contact range is the primary receiver detection objective. Low leakage power is used in the primary receiver detection method to find the receiver's presence. Additional gear will be needed, such as a supporting sensor network for the principal receivers in that area. Although it is the best tool for finding spectrum gaps, it can only be used to identify TV receivers at this time.

- **Interference Based Detection**

For the purpose of measuring interference, the FCC has created an interference temperature model. The model shows that the radio station's signal is designed to operate in a band where the incoming power approaches the noise floor. As additional interfering signals appear at various locations around the service area, the noise level rises. By establishing an interference temperature threshold, or the most amount of interference that a receiver can tolerate, the interference temperature model regulates interference as it is measured at the receiver. The difficulty of this model is precisely measuring the interference temperature because cognitive

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users cannot distinguish between signals received from PU and interference.

2. Related Work:

In D2D communications, random contacts can be used to exchange data between nodes without the assistance of infrastructures or central control units, according to JianhuiHuang (2016) [10]. The limited spectrum in D2D communications severely limits the capacity for data delivery due to the large number of nodes and their high mobility. D2D can use idle licensed radio spectra from licensed networks to increase data delivery capacity thanks to CR technology.

Jiang Zhu(2017) [11] In the medical field, wireless sensor networks are used to collect multimedia information from multiple sources, such as video streams, images, voice, heartbeat, and blood pressure data. This requires more spectrum and higher bandwidth. In contrast, the radio spectrum of today is extremely congested due to the rapidly expanding popularity of various wireless applications. As a result, the cognitive wireless sensor network (CWSN), which makes use of the advantages of cognitive radio technology, is a promising solution to the problem of limited spectrum.

ArsanyGuirguis, (2018) [12] In the context of cognitive radio networks, typical routing protocols steer clear of areas where primary users are extremely congested, leaving only a small portion of the links available for the construction of secondary routes. Additionally, the quality of the links that are available is highly actuating due to the vulnerability of wireless links to channel impairments like multipath fading. In this paper, we propose Secret: a multi-bounce directing convention for mental radio organizations in which we coordinate the cooperative beamforming procedure with layer 3 steering.

YihangDu, (2019) [13] In multi-hop Cognitive Radio Networks (CRN), where knowledge of topology and spectrum statistics is difficult to obtain, the two primary challenges are reducing transmission latency and increasing energy efficiency. This study therefore proposes a quasi-cooperative multi-agent learning-based cross-layer routing protocol. Right off the bat, to mutually consider the start to finish deferral and power productivity, a complete utility capability is intended to frame a sensible tradeoff between the two measures.

Collaboration among nodes in cognitive wireless networks is a significant obstacle, according to Dingde Jiang (2016) [14]. This paper studies the cooperative multi-bounce directing in mental organizations. We propose another calculation to build the cooperative directing in multi-jump mental organizations. Primary and secondary users, as well as interference from other nodes, are taken into account by our algorithm.

3. Methodology:

"You can almost always build the same product without fuzzy logic, but fuzzy is quicker and less expensive." [16]. It is clear that conventional logic or classical logic has been superseded by fuzzy logic. The concept of partial truth, which contains truth values that fall between entirely false and completely true, has been taken into consideration using fuzzy logic. In [8][9], fuzzy logic is covered in full. Fuzzy logic is concerned with the relative value of accuracy. How crucial is it to have an accurate response when a general one will do? Fuzzy logic strikes a compromise between significance and precision, which humans have been doing for a very long time (see Figure 1).

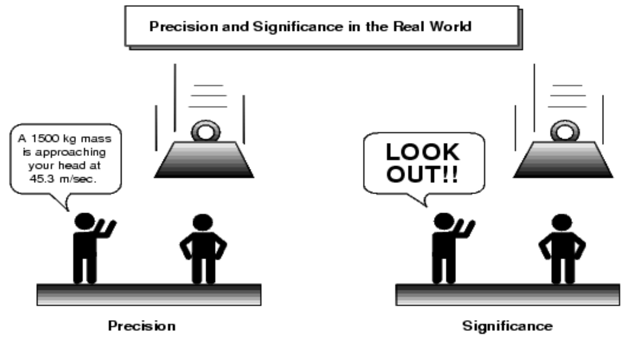

Figure 1: Precision versus significance (Source Matlab, 2013)

Input-output mapping using fuzzy logic has been viewed as a simple method of capturing expert knowledge. For instance, fuzzy logic determines the appropriate tip for the user based on their assessment of the quality of the service at the restaurant. Figure 2 shows a graphic illustration of input and output mapping.

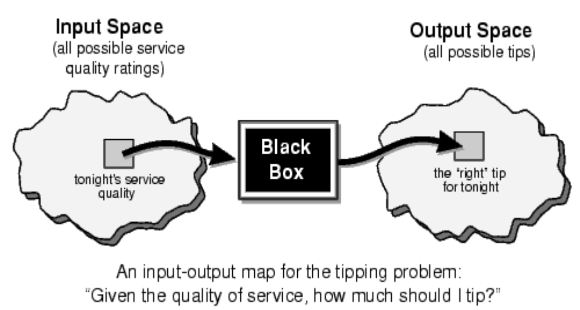

Figure 2: Mapping of input and output (Source Matlab, 2013)

Secure Handoff Mechanism

A CCU that analyzes and regulates CU activities by identifying and computing their TVs based on their communication behavior provides the identification and security of each CU during the handoff mechanism. The liveliness of the CU in the network, the data delivery ratio of intermediate nodes, and the number of nodes in the network all play a role in the detection and elimination of handoff threats. For two distinct scenarios, the proposed security mechanism is presented: 1) when the NU is recognized as CU or HCU, and 2) when the NU is identified as PU. During the spectrum handoff, the CU can be compromised by MUs that can introduce various malicious attacks into the CRNC environment. The spectrum handoff is initiated whenever a

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CU wishes to switch its ongoing transmission to another accessible channel with the arrival of the PU through packet transmission. This is done by recalling the previous key functions (i.e., spectrum sensing, spectrum decision, and spectrum sharing). To act as a legitimate PU or CU, the MU takes advantage of the time it takes to leave the current channel and take up a new, unused channel during the spectrum handoff [16].

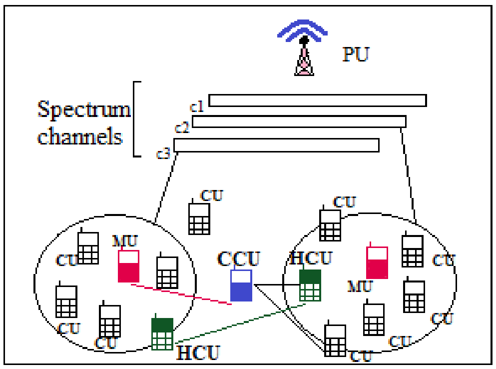

Figure 3: A typical CU handoff mechanism for CRNC

Using a CCU to compute the TF/TV of each CU, the proposed security mechanism aims to identify and address the newly discovered security threat in the CRN, known as CUEA. Figure 2 depicts the proposed mechanism's system model. It consists of an HCU, CCU, PU, and n CUs in a centralized CR environment. When a PU arrives, the HCU asks the CCU for a new channel and contains n CUs that use the PU's idle channels for communication. Figure 3 presents the flowchart of the proposed system whereamong n number of CUs, some are chosen as PU, MU, andHCU. In the beginning, the CCU looks at the type of users (PU, HCU, or CU) by looking at the characteristics of their communication. Once the PU is found, all communication is stopped. In addition, CCU stores every transaction in its database to analyze the user's trust value (behavior) if the user is CU. After a predetermined number of transmissions, CCU determines whether TV is legitimate as either 1 or 0, and if TV is identified as 0, CCU would permanently block the user as MU. In a similar vein, if the user is HCU, there may be a chance of MUintrusion in which HCU's real address is forged. By determining the HCU's ST from the lookup table, the CCU confirms the authenticity of the HCU. In the event that the trust worth of HCU and STof authentic CU is more prominent than the vindictive client, the user is permitted to embrace further correspondences; If not, the user is considered malicious.

4. Result and Discussion:

This work develops a cognitive radio network with two distinct areas, some main users (PU), and numerous cognitive users. Figure 4 shows the proposed CRN, which consists of 25 nodes with random initial positions and varying directions and displacements. And table 1's simulation parameters are displayed.

Table 1: Simulation Parameters

Parameters	Size
Network Area	400 m×400 m
Number of Users	25
MAC Protocol	IEEE 802.22
Routing Protocol	AODV
Simulation Round	500
Traffic Source	CBR
Packet Size	512 bytes
Antenna	Omni-Directional

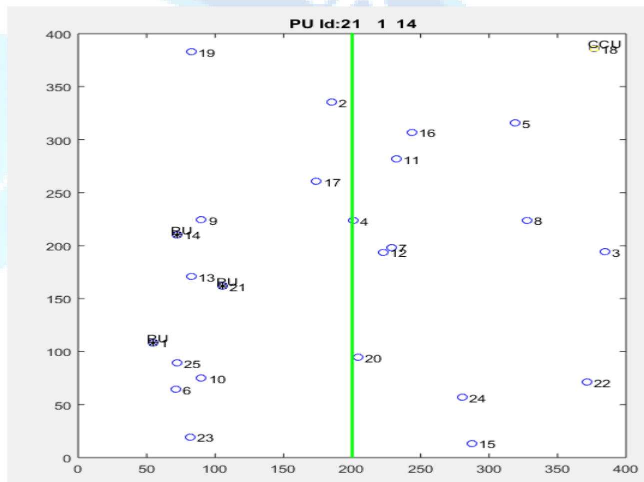

Figure 4: Distribution of nodes in CRN

Table 2: Initial position of nodes

Node Id	X coordinate	Y coordinates
1	58.9231	128.2515
2	193.2828	315.4887
3	383.7329	190.9195
4	202.5865	232.48
5	302.8266	313.0737
6	89.5164	63.0016
7	234.4993	207.6172
8	339.0788	223.1827
9	102.5929	209.5139
10	101.844	56.2221
11	11.967	276.5509
12	229.0163	211.8337
13	77.7849	181.2686
14	83.7736	190.9216
15	289.8133	15.5479
16	251.3725	315.4863

17	387.0993	5.2095
18	362.3857	369.7269
19	99.7087	386.5547
20	207.4924	96.3356
21	89.1704	181.2625
22	388.1204	51.8266
23	64.4627	3.4827
24	265.2205	58.6867
25	80.2153	109.2552

The beginning coordinates of each node distrusted at random in Areas 1 and 2 are displayed in Table 1. Uneven displacements are affecting the nodes' positions. The nodes that are located near the border of Areas 1 and 2 are considered to have undergone the handoff process.

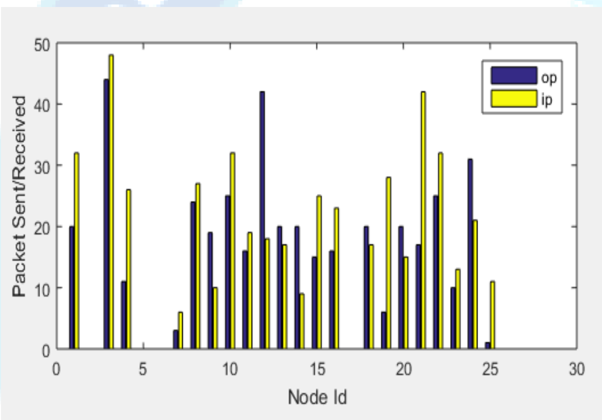

Figure 5: Packet sent and received by different nodes

Figure 5 displays the input and output values of the data for each node during a certain round. Each node's data plot is represented by a blue bar, and each node's data received is represented by a yellow bar. Here, just the sum of 25 nodes is taken into account.

5. Conclusion:

In today's increasingly digitalized applications of high-definition data, the need for a highly effective spectrum utilization scheme is growing. However, this has also brought about a variety of new security threats. A smart cognitive user-based attack emulation scheme for the cognitive radio network (CRN) that assists in exploiting intruders' attack during the spectrum handoff process is presented in this work. Additionally, I have proposed and developed a MatLab software simulation model with a highly secure handoff process that aids in successfully countering an attack by coordinating cognitive users under the supervision of those users. This simulation model uses fuzzy logic algebra to evaluate the trust value level of cognitive users as they go through the handoff process based on their behavioral characteristics.

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