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Mobility Handoff Mechanism for Body Area Sensor Networks on Healthcare

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ABSTRACT: *In expanded healthcare area of wireless sensor networks(WSNs) to enhance mobility station research is recognized as important issue. Body area sensor networks(BASNs) are type of WSNs aim to be deployed on persons in order to collect physiological parameters for healthcare monitoring purposes. In these applications, the lack of BASNs/WSNs connectivity is not admissible. In this context, this paper aim at Quality of Service(QoS) and real-time mobility handoff mechanism in WSNs. This research drafts a fuzzy handoff algorithm and correspondent fuzzy rules for taking reliable handoff decisions in WSNs.*
Keywords: *Body area sensor networks , Fuzzy, Handoff*

I. INTRODUCTION

Body area sensor networks (BASNs) promise novel uses in healthcare, fitness, and entertainment. Each BASN consists of multiple interconnected nodes on, near, or within a human body, which together provide sensing, processing, and communication capabilities. Mobility support of body area sensor networks in expanded service area of wireless sensor networks (WSNs) is a great challenge and increases the applicability of these technologies [1]. To achieve a continuous connectivity with body nodes with mobility support, it is important to develop handoff mechanisms that can handle with link transitions between different access points (APs). WSNs are promising technology that can identify and then exploit the spectrum opportunities. In WSNs, the spectrum can be utilized by two kinds of users: Primary Users (PUs) and Secondary Users (SUs). The PUs are those users having exclusive licenses to use certain spectrum bands for specific wireless applications, so their Quality-of-Service (QoS) should be guaranteed with certain thresholds, i.e., the PUs may allow for some unhurt degradations in their QoS levels. These handoff mechanisms allow the ubiquity in BASNs/WSNs, once they must work properly in a self-behavior without human intervention. The handoff mechanisms must ensure continuous nodes connectivity if there is an AP available to cover the area of these nodes. Most of the handoff mechanisms based the decision to search another AP on the evaluation of certain parameters that can be organized in two groups, i.e., the movement parameters and the communication parameters [3]. Main focus among all these decisions and efforts is to enable WSNs to sense the spectrum holes effectively, communicate as required without causing interference to PU and to increase QoS to PU. Rather tradeoffs for decision to control signal strength (SS) or switch to another frequency needs to be adopted [4]. In this paper, we propose to tackle this issue in computationally traceable fashion using fuzzy logic. The proposed fuzzy handoff algorithm (Section III) is based on fuzzy logic to combine all these “uncertain” signal strength of QoS metrics. Section II outlines some handoff mechanisms. We conclude the paper in Section IV.
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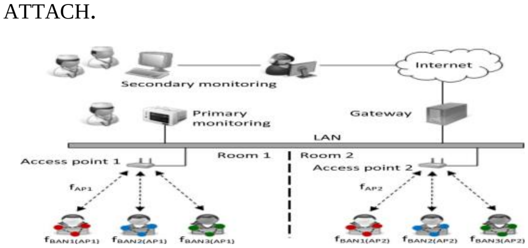
II. RELATED WORKS

Recent approaches to support sensors’ mobility in WSNs and body area sensor networks (BASNs) are reviewed. It is assumed that available contributions for WSNs can be integrally transferred to BASNs. The WSN receives the BASN at its receiver and involves itself in a decision making process to accommodate a new user requesting the spectrum allocation. This requires a decision making considering certain factors, such as the secondary user’s requirements as parameters like, its modulation scheme, channel coding, data rate and power consumption *etc*. This enables the decision making process to make a comparison between the user’s specifications against the available pool of the solutions received from the BASNs environment. The decision making process is to assign appropriate resources to SUs only as long as they are needed for a geographically bounded region, that is, a personal, local, regional, or global cell. For efficient use of the spectrum, one must detect the spectrum holes (unused spectrum). The main function of cognitive user is sense, manage, mobile, and share the spectrum. It is difficult to search and detect the unused channels. The SU has to use a strategy to sense and manage the unused spectrum (channels). Detecting spectrum holes without any errors (false alarms) and then efficiently allocating the unused spectrum is a critical issue. Once the unused spectrum is detected, the cognitive user decides to transmit on a selected high utility channel based on detection analysis (outcome). Trusting the detector, minimizing the interferences, and avoid the collisions are part of the resource (spectrum) allocation problems. If the probability of detection accuracy is extremely high, then the channel will be allocated using the channel allocation policies. The channel allocation policy must avoid the collisions and interferences.

The secondary users adopt several methodologies to identify spectrum holes, learn from current communication environment, and exploit the opportunities to grab the spectrum without disturbing the PUs. This means that the cognitive users can create flexible access to the spectrum. They can partition the spectrum into a large number of orthogonal channels and complete the transmission simultaneously with a flexible set of channels. Such partition can be designed using a distributed approach for dynamic spectrum access. WSN adopts the opportunistic spectrum sharing approach, which allows the SUs to coexist with PUs who are the legacy spectrum holders. PUs has provision to access communication channels at any time. SUs need to sense the radio environment, and opportunistically utilize available spectrum. Meanwhile, they need to adapt to local behaviors of PUs and vacate the spectrum immediately when the presence of primary users is detected. In [3], the authors proposed the concept of primary exclusive region and formulated the relationship between the outage probability and primary exclusive region. Cho and Andrews [4] proposed the concept of interference radius and discussed the relationship between the interference and relative distance. A probability-based power control strategy for dynamic spectrum access was proposed in [5]. In that paper, the WSN link utilizes spectrum only when it is not utilized by the PU link. One of the ways is the use of "Cognitive Radio", according to the decision making architecture that can be used more efficiently by introducing artificial intelligence. This enables the radio to learn from its environment, considering certain parameters [6]. Based on this knowledge the radio can actively exploit the possible empty frequencies in the licensed band of the spectrum that can then be assigned to other processes in such a way that they don't cause any interference to the frequency band that is already in use. This makes the efficient usage of the available licensed spectrum possible. The design of WSN is very challenging issue due to complexity, modularity, information imprecision and interpretability [7]. Fuzzy logic is chosen for the decision making because it is very much suited for non linear, imprecision and multivalued problems as it is capable of making real time decisions. This research will focus on the fuzzy decision making to opportunistically utilize spectrum in a BASNs/WSNs heterogeneous cognitive radio network.

III. IMPLEMENTATION OF FUZZY HANDOFF ALGORITHM

WSNs facilitate the collection of vital signs in people from their BASNs with a health condition, and their subsequent transmissions to on/off-site locations for continuous monitoring. The BASNs/WSNs technologies that will help to keep patients in relatively good/stable condition at home, which incurs a much lower cost to the healthcare provider, contrary to hospitals. Therefore, home-based health care monitoring is best suited to BASNs/WSNs implementations. Fig. 1 illustrates the BASNs/WSNs heterogeneous cognitive radio network, which in fact adheres to the two tiered architecture. The above-described approaches, based on movement and communication requirements, assume a continuous monitoring message exchange between BASN nodes and APs to realize the time to start a handoff procedure. Figure 2 illustrates the operating principle of a handoff mechanism. When a node loses its connection with an AP, it starts immediately the mechanisms to find another one to attach.



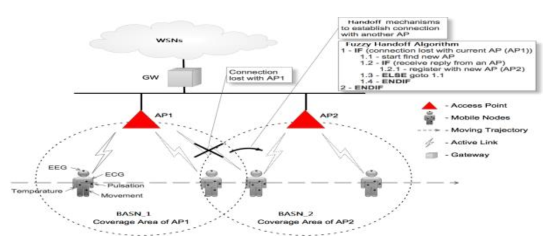


Figure 1. Depiction of a healthcare monitoring system of patients operating of handoff at home based on BASNs/WSNs

Figure 2. Illusion of the system and mechanism

In present scenario, the spectrum is distributed among service providers on mutually exclusive / non shared basis. This way of spectrum distribution is called fixed spectrum assignment and the licensed user as primary user (PU). As per the observations of federal communication commission (FCC) of USA, many of the frequency bands are unoccupied most of the times. This underutilization of spectrum motivated the researchers to think in terms of spectrum holes and described as: A spectrum hole is a band of frequencies assigned to a primary user, but, at a particular time and specific geographic location, the band is not being utilized by that user. The secondary users (SU) opportunistically utilize these holes for communication without causing interference to PU. A fuzzy based handoff mechanism is designed for SU to coexist with the PU for better spectrum utilization. The fuzzy based work is done for spectrum handoff decision to be taken by SU in a decentralized network. Spectrum handover is initiated when interference at PU exceeds certain threshold or if QoS at SU is not satisfactory. This forms the basis for the algorithm proposed in our work as the following:

Fuzzy Handoff algorithm:

IF (connection lost with current AP(AP1))
start find new AP
fuzzy handoff decision evaluation
If (receive reply from AP)
register with new AP(AP2)
ELSE go to 1.1
ENDIF
ENDIF

1. The aforementioned, *fuzzy handoff decision evaluation* infers the need for handoff from the signal strength (SS) of the acknowledgement QoS and from the AP1 of the PU, if available. If the decision is to handoff, the SU moves to the AP2 of the PU. In the proposed *fuzzy handoff decision evaluation* of the study for selecting the best suitable secondary user to access the spectrum, the determining parameters which are considered are: The input , for proposed *fuzzy handoff decision evaluation*(Figure 3), fuzzy variable of SS are assigned to one of the five fuzzy sets, “very low”, “low”, “medium”, “high” or “very high”, which are optionally classified into five levels. This QoS strategy gives more clues on the weakness and strength of input variables and helps generating more accurate output data. Table 1 illustrates the needs of performing handoff depending on the SS levels. For example, when the value of SS is “very low”; this condition indicates that handoff should be encouraged immediately or the handoff needs is “very high”. We define the handoff in cases of having “high” or “very high” need in output.

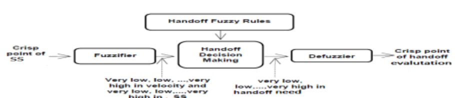


Figure 3. fuzzy handoff decision evaluation

Table 1. fuzzy handoff decision evaluation rules

SS	Handoff Needs
Very low	Very high
Low	High
Medium	Medium
High	Very low
Very high	Very low
Very low	Very high
Low	High
Medium	Medium
High	Low
Very high	Very low
Very low	Very high
Low	High
Medium	Medium
High	Low
Very high	Very low
Very low	Very high
Low	Very high
Medium	High
High	High
Very high	High

The five linguistic descriptors are used as the SS input to the fuzzy handoff decision evaluation and the opportunistic spectrum access decision for spectrum availability is the output of this fuzzy handoff algorithm. The simulation results are shown in Fig 4. It may be seen from the results that the chance of taking decision increases if the signal strength of the channel offered by primary user is high and the distance between primary and secondary users is low.

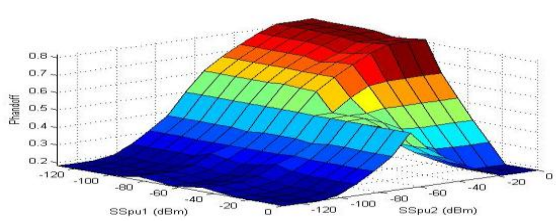


Figure 4. The simulation results of fuzzy handoff algorithm

IV. CONCLUSION

New ICT based solutions for eHealth care are very promising approaches, however, to be efficient they should also be improved for being accepted by patients. This paper studied fuzzy handoff solutions for body area sensor networks on healthcare monitoring. A fuzzy handoff algorithm is proposed that performs handoff decision according to several important metrics, combining them using fuzzy rules. The employment of fuzzy logic might be helpful, for very complex processes, when there is no mathematical model for highly non-linear processes or if the processing of expert knowledge is to be performed. This research will be planning to implement and integrate the proposed handoff mechanism in standard WSN protocols such as ZigBee and 6LoWPAN, to demonstrate its feasibility and efficiency.

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