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A SIMPLE TRANSMIT DIVERSITY TECHNIQUE FOR WIRELESS COMMUNICATION

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Abstract:

Impulse Radio Ultra WideBand (IR-UWB) commu- nication has proven to be an important technique for supporting high-rate, short-range, and low-power communication. In this paper, using detailed models of typical IR-UWB transmitter and receiver structures, we model the energy consumption per information bit in a single linkof an IR-UWB system, considering packet overhead, retransmissions, and a Nakagami-m fading channel. Using this model, we minimize the energy consumption per information bit by finding the optimum packet length and the optimum number of RAKE fingers at the receiver for different transmission distances, using Differential Phase-shift keying (DBPSK), Differential Pulse-position Modulation (DPPM) and On-off Keying (OOK), with coherent and non-coherent detection. The increasing demand for wireless communication introduces efficient spectrum utilization challenge. To address this challenge, cognitive radio (CR) is emerged as the key technology; which enables opportunistic access to the spectrum. CR is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and which are not, and instantly move into vacant channels while avoiding occupied ones..

Keywords — Cognitive Radio, wireless communications, mobility, Artificial Intelligence,

INTRODUCTION

Impulse radio ultra wideband (IR-UWB) communica- tions is regarded as an attractive solution to provide high bandwidth and low radiated power, especially for short-range wireless network applications [1]-[4]. Wireless sensor net- works (WSNs) have been used for applications ranging from environmental monitoring and health monitoring to security and surveillance [5][6]. These different applications for WSNs have vastly different bandwidth requirements. Take, for ex- ample, visual sensor networks (VSNs) for surveillance or health monitoring. These networks require a relatively large bandwidth to transmit and receive images or video in a timely manner, and a low radiated power to avoid interference with coexisting wireless systems. IR-UWB technology,in this case, has a great potential to facilitate the application of VSNs.The Cognitive Radio (CR) was presented officially by Joseph Mitola in 1999, and since, this concept has been very popular with researchers in several fields such as telecommunications, artificial intelligence, and even philosophy.

1. ARTIFICIAL INTELLIGENCE AND COGNITIVE RADIO

Some related work has been conducted on the improvement of link energy efficiency for battery-powered networks. Cui et al. studied the energy per information bit minimization problem for narrowband systems, considering the dependency of circuit power consumption due to modulation and coding schemes and the time duration of a packet containing L information bits for different coding schemes [8]. The authors proposed detailed power models of a typical narrow band trans- mitter and receiver and clearly pointed out the dependency of the power consumption on physical layer configurations, such as modulation schemes and coding schemes. They also extended their work to energy minimization in cooperative MIMO based networks, considering increased spectral effi- ciency and circuit power consumptions [12]. However, the effects of an ARQ scheme or the optimum selection of target bit error probability were not considered. Among the numerous enabling communication technologies for wireless networks, IR-UWB is intriguing due to its low- power high-rate feature. Artificial intelligence (AI) techniques for learning and decision making can be applied to design efficient cognitive radio systems.

A. Neural Networks

A multilayered neural network was used to model and estimate the performances of IEEE 802.11 networks. This neural network provides a black-box model for the non-linear relationship between the inputs and the outputs. This neural network model can learn from training data which can be obtained in an on-line manner when the real-time measurement data are available. Therefore, this model is suitable for a cognitive radio network for which a prompt response to the changing radio environment is required from an unlicensed user .

B. Fuzzy Logic

Fuzzy logic is often combined with neural networks that can adapt to the environment during the evolution of a CR system. A fuzzy logic control system can be used to obtain the solution to a problem given imprecise, noisy, and incomplete input information.

2. SYSTEM AND CHANNEL MODELS

We consider an IR-UWB system with a symbol repetition scheme. The coding rate $Rc = 1/Np$, whereNp, which is an odd number, is the coding parameter. Moreover, in order to avoid inter symbol interference (ISI), the maximum pulse rate is limited. Also, perfect knowledge of the channel is assumed at the receiver. The association of MAS and the CR can provide a great future for the optimal management of frequencies (in comparison with the rigid control techniques proposed by the telecommunications operators). In the case of use of unlicensed bands, the CR terminals have to coordinate and cooperate to best use the spectrum without causing interference.

A typical IR-UWB transmitter and a typical IR-UWB receiver with four RAKE fingers and maximal ratio combining (MRC) are shown in Fig. 1. When DBPSK, DPPM, and OOK are used at the transmitter.

3. QUALITY OF SERVICE IN VIDEO CONFERENCING

With the emergence of new services such as video conferencing and video streaming, the need to treat the frames one by one and to know how differentiate services becomes primordial. An interactive video conferencing cannot tolerate long delays because there is not enough time to retransmit lost packets. With a network that provides an acceptable throughput, we should control the delay (between the transmission and reception of a packet), jitter (delay variation), usually this type of applications does not tolerate large jitter to not damage the image and sound and of course we must also control the loss of images.

In the literature, we found that to have a good QoS in video conferencing, it is necessary that:

- Throughput must be > 384 Kb/s.
- Delay must be < 200 ms.
- Jitter must be < 30 ms.
- Packet loss must be < 1%.

4. PROBLEMATIC AND PROPOSED SOLUTIONS USING A SINGLE CRMT

The Figure 1 below shows a path followed by a mobile subscriber when it switches to an area where the signal quality drops to an unacceptable level (shown in red) due to a gap in coverage, we assume that the client uses video conferencing over the route. In this section, we demonstrate the results of minimizing the effective energy consumption per information bit modeled by equation.

Proposed Solution

After several incidents, the CR should be aware of the problem. Then, through some geolocations or the ability to learn the time of the day when this happens, the radio can anticipate the difference in coverage and know the necessary signal to the base station to change characteristics of the signals when the user approaches the deficient coverage.

B. Application

As mentioned above, we will use video conferencing in the case of a mobile user who needs to take a path where the signal quality drops to an unacceptable level due to a gap in coverage, giving a very low QoS. To better understand the influence of the packet length, the number of RAKE fingers.

C. First Question "WHEN"?

For the data classification, we used three different algorithms derived from the field of machine learning.

- The k-nearest neighbor's algorithm (K-NN) which is a supervised classification algorithm.
- The multilayer perceptron algorithm (MLP of neural networks).
- The C4.5 algorithm of decision trees.

Besides the optimization on packet length, number of RAKE fingers and modulation/combining/ detection schemes, the repetition coding parameter Np in repetition coding should also be adjusted to minimize Eb.

D. Second Question "WHY"?

Now , We will justify the usefulness of the CR, this by supposing that the spectrum sensing is already done by the receiver of our mobile terminal which is in this case a multimode wireless communication terminal (MWCT), so capable to support multiple access technologies such as GSM, UMTS or WiMAX. Besides the optimization on packet length, number of RAKE fingers and modulation/combining/ detection schemes, the repetition coding parameter Np in repetition coding should also be adjusted to minimize Eb. Now we assume that Np takes the values.Fig. 8 shows the overall minimum energy consumption per information bit for different repetition coding parameters. To show the influence of Np, the$E*b$ shown in Fig. 8 have been optimized over LL, M and modulation/repetition coding/detection schemes.

E. Optimum Configuration Table

The results of these optimizations can enable the transceiver to adapt by selecting the overall optimum configurations (including the modulation/detection scheme, the repetition coding/combining scheme, the packet length and the number of RAKE fingers) according to the expected transmission dis- tance through a lookup table.

- Favourable (best case): The receiver detects a free band and uses it during all the way without any interruption caused by the primary user.
- Unfavourable (worst case): The receiver does not detect any free band (empty set) or it detects some bands but their use interferes with the primary users. In this case the CR is not used because the secondary user should not disturb the primary users.

- Common (N frequency with N hops): The terminal uses a free band b1, then there is an interruption caused by the primary user, so it switches to another free band b2 (he made a hop).

CONCLUSIONS

In this paper, we provided the power consumption models of typical transmitter and receiver structures of IR-UWB systems. Then, under the assumption of a frequency selective time- invariant channel, we determine the optimum combination of the modulation scheme, the detection scheme, the repetition coding parameter, the combining scheme, the packet length, and the number of RAKE fingers at the receiver to mini- mize energy consumption per information bit. An optimum number of RAKE fingers exists under the assumption of a frequency selective time-invariant channel with a double exponentially decaying power delay profile.We presented in this paper a new approach that uses Cognitive Radio to improve wireless communication for a cognitive radio mobile terminal by enhancing the QoS of video conferencing application. Our contribution is positioned in learning from events (machine learning). Our expert role has allowed us to choose the throughput parameter to perform a classification that allows the terminal used to gain experience for future events that means that it will know when and where it will activate the cognitive radio. The usefulness of cognitive radio is a hypothesis that has been proved based on the required time for a connection to a new frequency band, and this, whatever of the number of frequency bands that a terminal used to remedy a failed connection.

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