Multi-Channel Slotted Aloha Applied In Reporting To FC

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Introduction

This poster is to show how to improve the corporative detection through modeling a reporting phase and fusion rule by using a multi-channel slotted aloha and majority rule in Cognitive Radio. The phase of sensing here will have the majority of slots in addition to having the capture feature implemented in this model. Finally, the simulation will show an improvement in the detection probability.

- Cognitive Radio (CR)
- Primary User (PU)
- Secondary User (SU)
- Multiple Access protocol founded to organize the SUs transmitting through the sheared bandwidth
- Fusion Center (FC)

Although there is a large number of cognitive radio nodes, it is difficult to assign a bandwidth or sub-band to each cognitive radio nodes to send its report. Having the large number of reports is better for accuracy of detection, which, accordingly, shifts us to use a random access as a multiple access technique. The importance lies in sending the report as fast as we can to have a priority, and to take advantage of the vacant spectrum. Consequently, the slotted aloha is chosen.

System Model

- Considering is given to N SUs in geographical area trying to sense the spectrum (cooperative sensing).
- The frame of detection will be divided between the phase of sensing and the phase of reporting. Most of the frame will be used for sensing to improve the probability of detection.

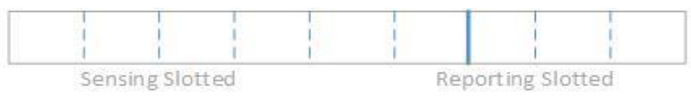

Fig.1

- Each SUs will send their detection report to the FC randomly to one of the specified m slots for reporting by using a multi-channel slotted aloha with capture of 0 dB.
- The FC will implement its majority rule on the captured reports to make a decision for the spectrum status.
- This model will be expressed as following;

$$P_d = \sum_{k=i}^{M} \binom{M}{k} p^k (1-p)^{M-k} \qquad i = \frac{M}{2} + 1$$

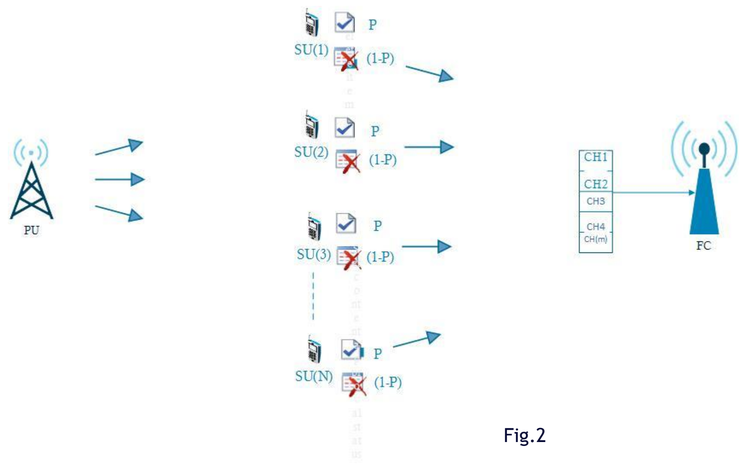

Fig.2

Cooperative Spectrum Detection

Cooperative sensing is the process in which the detection is to be made more accurate and effective, due to the fact that a decision for the spectrum status has to be taken according to more than one cognitive user's detection. This scenario will help in evading an adverse choice that interferes with the PU's signal or the SU that tends to not use white noise. Cooperative spectrum detection is expressed as following;

$$Q_d = \sum_{l=n}^{N} \binom{N}{l} P_d^l (1-P_d)^{N-l} \qquad n = \frac{M}{2} + 1$$

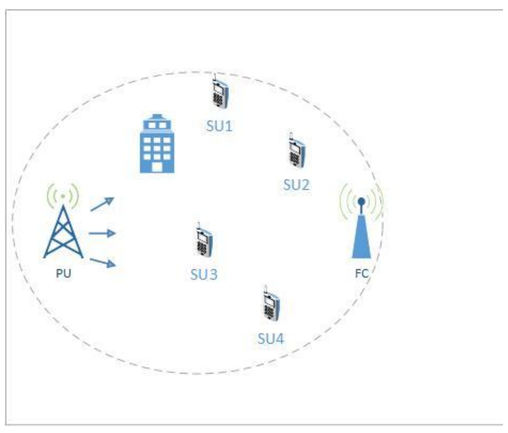

Fig.3

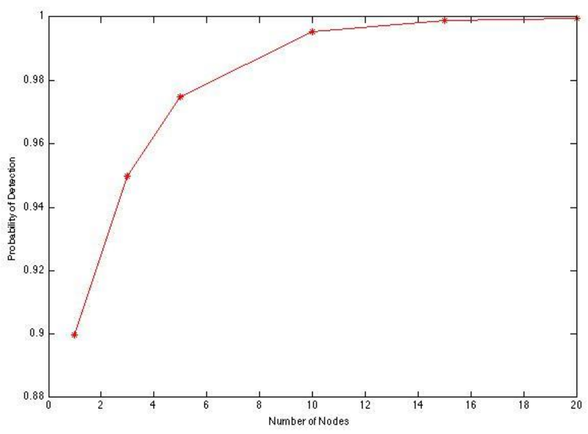

Fig.4

Cooperative Sensing using 20 SUs and the probability of detection for each one is 0.9

Slotted Aloha

Slotted aloha is one of the random access techniques in Multiple Access. It has many features and does not need a setup to use the channel from the nodes, which is faster and less time consuming. It could be among many nodes. Slotted aloha can be explained as following:

$$S = G \times e^{-G}$$

Capture

Wireless system faces multipath and interference from other channel. Since we are using a random access technology, we need to use a feature that decreases the collision and increase the throughput. Even if there are many packets coiled at one slot, the received station should still capture one packet. The power of each received signal will differ from the others because of the shadowing or Rayleigh fading. Thus, if the case is the multiple copies, using multipath, or it is the distance when the SUs have different distance from the FC.

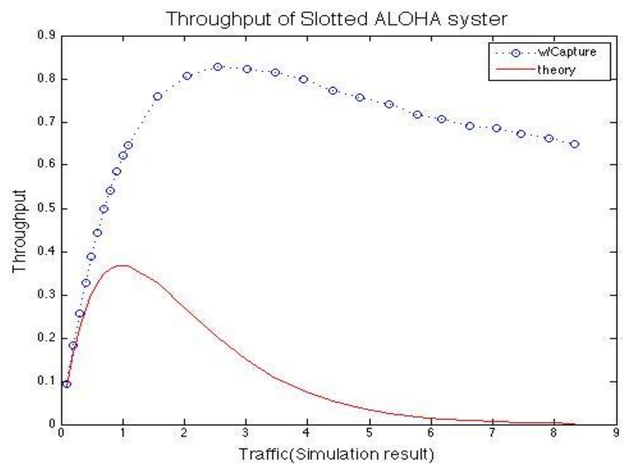

Fig.5

With and without capture(0 db)

Multi-Channel Slotted Aloha

When the system specified has many slots for reporting to the FC, it is considered as a multi-channel slotted aloha in which each slotted is independent channel.

Simulation Results

Rayleigh fading is considered in all following simulation results.

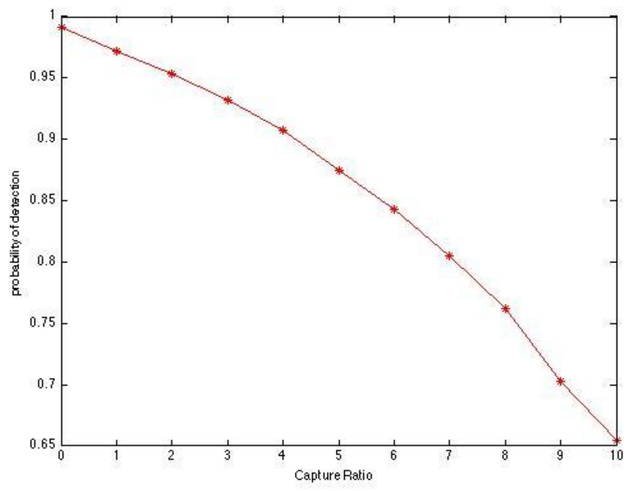

Fig.6

Appling the model with changing of capture ratio in dB, using 5 channels and 30 of SUs with the probability of detection for each one is 0.9.

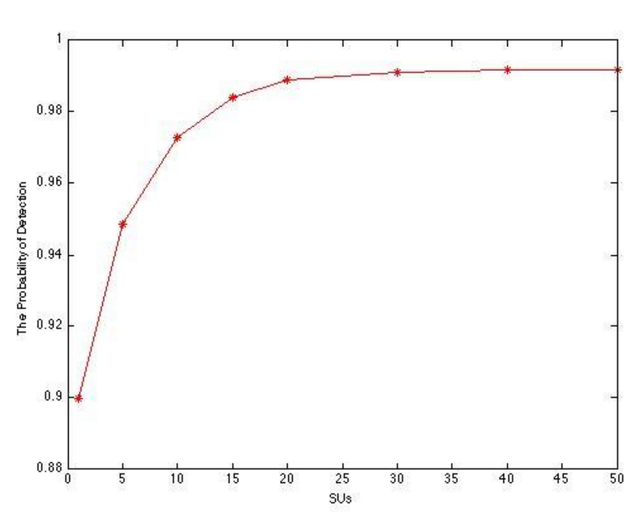

Fig.7

Appling the model with changing the number of SUs with the probability of detection for each one is 0.9, using 5 channels and a capture ratio of 0 dB.

Conclusion

- Using a multi-channel slotted aloha with capture at the reporting phase increases the detection performance by using the feature of cooperative detection. When limited reporting slots have been chosen, the majority rule makes a decision for the spectrum status.
- We search for an optimal way for sensing and sending the SUs reports to the FC and end with an accurate rule for this detection.
- The numerical result shows how we used limited slots for reporting while also taking advantages of all SUs detection.