Energy Efficient Co-Operative Spectrum Sensing Based On D-S (Dempster-Shafer) Theory for Cognitive Vanet Network

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Abstract- A cognitive radio (CR) is an intelligent radio transceiver proposed to utilize the optimum wireless channels in its vicinity. It automatically detects available channels in wireless spectrum, and then consequently changes its broadcast or reception parameters. Cognitive radio enabled vehicular ad hoc networks (CR-VANETs) is one of the promising architecture in the future VANETs. To deal with these issues, an energy-efficient co-operative spectrum sensing scheme is proposed which can select a representative sensor node set in Cognitive Radio Sensor Network (CRSN), under given constraints. The representative nodes set which consists of the nodes can provide gains for detecting the licensed users (LU) states is a subset of the nodes deployed in the network. Based on the spectrum detection information provided by the selected representative nodes, the D-S theory of evidence is employed to derive the activity states of LU while keeping the same spectrum sensing accuracy if not better. NS2 simulation results are provided to demonstrate the suitability of the CF-CPSC for scenarios of practical interest in CR-VANET

Indexed Terms- Cognitive Radio Vehicular Adhoc Network (CR-VANET), Dempster-shafer (D-S), licensed users (LU), Cognitive Radio Sensor Network (CRSN)

I. INTRODUCTION

Improvement in road safety and in-vehicle entertainment is the need of an hour as the number of vehicles is increasing on roads. As a result, advancement in new services and applications for vehicles is rising today. For example collision avoidance applications, vehicle-to-vehicle communication (V2V), information collection for smart cities in synergy with the help of wireless sensor networks [6], safety and traffic monitoring. Such applications can be supported by a newly emerged technology, i.e., cognitive radio vehicular ad hoc network (CR-VANETs). Vehicles, personal mobile devices and smart roadways infrastructure (SRI) are enabled by connectivity in CV systems for sharing data and for providing people with safety, alerts and warnings [12]. As the underlying infrastructure, Vehicular Ad hoc networks (VANETs) can facilitate applications and services of CVs [11].

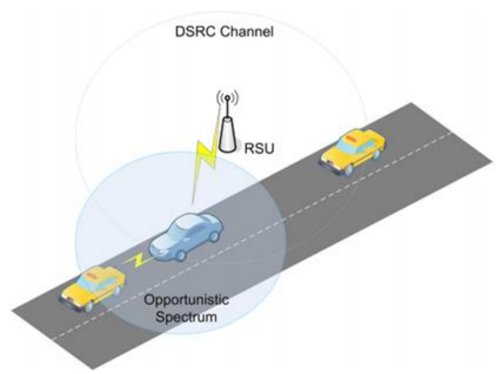

Fig1 Vehicle to Vehicle Communication

With the various developing and emerging remote applications, the demand for radio spectrum has increased drastically, but only a few available bands can be allocated [3]. The dearth of available spectrum in wireless communications can be reduced by using cognitive radio (CR) technology as it allows unlicensed (secondary) users (SUs) to work in licensed spectrum bands [3][4]. The requirement for this is that primary user's (PUs) communication should not be disturbed by SUs. It means, the presence of PU should be detected by SUs and the spectrum should be left for PU to use. On the other hand, for accommodating SUs, PUs need not make any change. In VANETs, CR technology can be used to mitigate the spectrum limitation issue.

Implementation of efficient cognitive radio for VANET has to face many problems such as there is still a considerable portion of the licensed spectrum which is unused. Other issues such as cognitive implementation architecture, common control channel and joint spectrum sensing cannot be ignored [1] [5].

II. RELATED WORK

As the safety of many road travelers and their passengers is at stake, algorithms for VANETs need to be designed with extreme care in order to avoid any unwanted incidents. Fawaz and Ghandour [12], Felice and Chowdhury [13], Kim and Oh [14], Husheng and Irick [15], Nyanhete et al. [16], and Rawat [17] propose stand-alone CR spectrum sensing techniques. Fawaz and Ghandour [12] propose a structure comprising RSUs, local acquisition and processing units (LAPUs), and vehicles. Decisions for spectrum holes are taken by RSUs and LAPUs, and CR technology is used to decrease the load on the control channel (CCH) of the IEEE 802.11p/WAVE spectrum. Felice and Chowdhury [13] propose a scheme that each vehicle may be assigned a TV channel to sense and use it independently, and vehicles share the spectrum availability information among each other for future usage. This scheme has no coordination and cooperation and hence may cause interference with the primary user network in the case of any misdetection. In [14], it is proposed that vehicles may utilize Wi-Fi and ISM (2.4 or 5 GHz) bands in urban areas and may share the sensing information for future usage. In [15], a spectrum sensing scheme based on belief propagation is proposed. In this scheme, every vehicle sends the information related to presence or absence of primary user signals in its range to its neighbors. Each vehicle based on received information and its own prediction detects and uses the spectrum. Also, in [16], every secondary user senses and uses the available spectrum holes on its own and also shares the information with neighbors. In [16], a three-state model has been proposed. The first state occurs if a hole is detected, the second if a primary user is present, and the third if a secondary user occupies the channel. This scheme also insists on individual sensing and utilization of the spectrum.

III. PROPOSED SYSTEM

Detecting activity states of Licensed Users (LUs) has great significance for the utilization of limited radio spectrum, especially when activity states of licensed users can be more accurately detected. However, the spectrum detection will always have the wrong detection of a LU state, and it will result in increased communication overhead, extra network energy consumption, and node premature death. To deal with these issues, an energy-efficient cooperative spectrum sensing scheme is proposed which can select a representative sensor node set in Cognitive Radio Sensor Network (CRSN), under given constraints. The representative nodes set which consists of the nodes can provide gains for detecting the LU states is a subset of the nodes deployed in the network. Based on the spectrum detection information provided by the selected representative nodes, the D-S theory of evidence is employed to derive the activity states of LU while keeping the same spectrum sensing accuracy if not better.

3.1 The Representative Nodes Selection

Before performing representative nodes selection, we propose a node filtering method on the domains of sensor nodes. The proposed node filtering method removes the nodes who are highly inactive, and the reliability lower than a given threshold. Filtering these nodes could reduce computation loads in later steps, and the final spectrum sensing accuracy will likely to be improved.

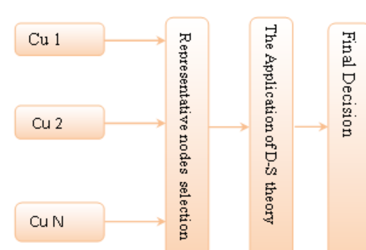

Fig 2. The overview of the proposed cooperative spectrum sensing.

Let *S* denotes the whole nodes set in the network, the goal is to select an appropriate representative nodes *s* from *S*, so that the state of LU can be judged only using the spectrum sensing results from *s* .

There are three basics but necessary constraints as follows, which can restrict the upper bound of the number of selected nodes (*s*) in the subset.

$$s \leq S, \ Rel_j \geq \lambda, \ E_n^j \ \geq \ E_{\min}$$

where e *j R l* is the reliability of node *j* , *j n E* is the residual energy of node *j* , lamda is the fixed reliability threshold, and min *E* is the fixed minimum residual energy threshold.

3.2 Energy Cost Function

In order to provide a quantification of the energy consumption of spectrum sensing *T E* is defined as the total energy consumption. It is composed of *s j E* and *t j E* that are the energy consumed by the *j–th* sensor in spectrum sensing and transmitting sensing results to the sink node, respectively (The energy consumed in computational component for decision making is much lower than that of the RF module. Therefore, the energy consumption for decision making is not taken into consideration).

Based on the definition, *T.E(Total Energy)* can be defined as

$$E_T \ = \ \sum_{j=1}^{n} b_j (E_{sj} \ + \ E_{tj})$$

Our goal is to minimize the total energy consumption while meeting the constraints. Therefore, the optimization objective function can be derived as

$$\begin{aligned} \min \ E_T \ &= \ \sum_{j=1}^{n} b_j (E_{sj} \ + \ E_{tj}) \\ s.t. \ \sum_{j \in s} b_j \ &\leq \ S \\ E_n^j \ &\geq \ E_{\min}^j \\ Rel_j \ &\geq \ \lambda \\ S \ &= \ \{ j \mid b_j \ = \ 1, j \in s \} \end{aligned}$$

By solving this equation the number of representative nodes can be derived then the total energy consumption can be greatly reduced, which can also guarantee the spectrum sensing accuracy.

IV. RESULTS AND DISCUSSION

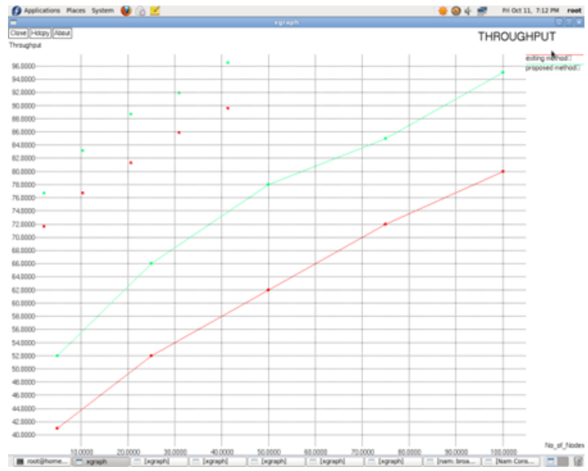

Fig 3. Throughput of the system

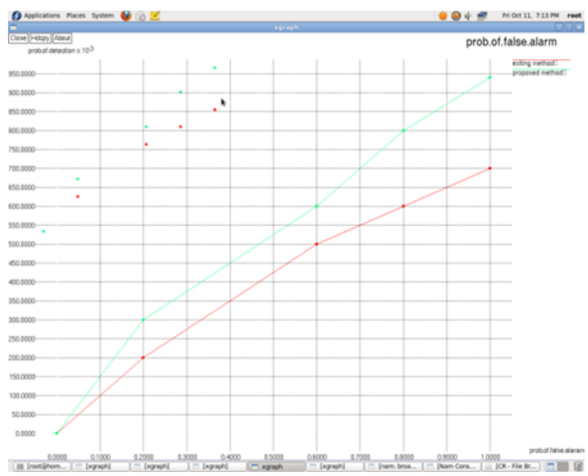

Fig 4.Probability of False Alarm

In this, the Energy Consumption, Probability of false Alarm, Throughput, and latency of the proposed system improved over an existing system

V. CONCLUSION

In this work, we propose an energy-efficient cooperative spectrum sensing scheme based on Dempster-Shafer theory of evidence for CR-VANET. It is carried out in two steps, which are representative sensor nodes selection and decision making based on

D-S theory of evidence. The proposed representative sensor nodes selection algorithm can efficiently utilize the nodes' historical data to filter out those inactive and less reliable nodes. Then the D-S theory of evidence is adopted to calculate the selected sensor nodes' reliability based on their current information to decide which sensor nodes should be used to perceive the state of licensed users. Simulation results show that the proposed scheme is more energy efficient than other existing ones.

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