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COOPERATIVE SPECTRUM SENSING SCHEME FOR VEHICLE TO VEHICLE COMMUNICATION

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ABSTRACT

The wireless access in Vehicular Environment (WAVE) protocol stacks to enable vehicular communication on the Dedicated Short Range Communication (DSRC) frequencies in RSU (Road Side Unit). All vehicular safety messages are over congested urban scenario. In DSRC might not provide sufficient spectrum for reliable of exchange of safety message. In this paper a blind detector is applied and tested on the vehicle level and spectrum sensing measurement by vehicle and the aggregating information in Road Side Unit which makes advantages deliver more accurate decision in dynamic vehicular environments. Cooperative Spectrum sensing algorithm is to aggregate the individual sensing data and decide on the vacancy of the sensed frequency bands. The performance of Cooperative Spectrum Sensing Algorithm are evaluated and tested in various vehicular scenarios using network simulator ns2. The obtained results prove the effectiveness of the system in detecting available ISM channels. The performance of the proposed approach is analyzed in terms of data packet delivery ratio, and end-to-end delay, control overhead and packet forwarding. This the results indicate that the proposed approach provide efficient and robust communication over VANET.

Keywords: vehicular adhoc network, wireless access, vehicular environment, dedicated short range communication, TDMA.

1. INTRODUCTION

The Vehicular Adhoc Network, each moving vehicle consider as nodes in the network which create Mobile Network. VANETs are distributed and self contained which contain both vehicle to vehicle communication and vehicle to road side unit [1].

VANETs can support many application based on safety and non safety. Vehicular can communicate through DSRC and WAVE. By using GPS, and advanced communication device can easily analysis its current position and share the information with other vehicle. In vehicular communication technology, Intelligent Transport System (ITS) can improve the traffic and safety efficiency. In ITS, proposed applications require the emergency notification message to be disseminated inan area and correct time. In this paper, we propose spectrum sensing scheme for message to be delivered to all vehicle in a certain area. Nodes exchange location information with its neighbors by continuous beacons. At the same time, source sends a message to destination. If the source is inside the interested region it will broadcast the message otherwise the message will be forwarded intermediary using Cooperative Spectrum sensing methods. The results of evaluation show that this Cooperative Spectrum sensing method can contribute to fairly high delivery ratio and it performs well in adaptability when the traffic is very heavy. Vehicular Adhoc Networks are distributes network that allow Vehicle to Vehicle and Vehicle to Infrastructure and communication node in VANET can share a whole range of communication from safety message to internet services. Modern vehicles are being equipped with a computation unit having built in transceivers called On Board Unit or OBU. On the infrastructure side (RSU) which is communicate via wired network or through the internet by use of high bandwidth license. IEEE 802.11p was developed at the physical and lower MAC layers and FCC allocate 5.9 frequencies GHZ which is amendment to the preexisting IEEE 802.11 standard [2]. Medium access control (MAC) protocol based time division multiple accesses can make best use of DSRC multichannel architecture. It divides the spectrum into 7 channels of 10MHZ each, one of which is the control channel and another protocol named Wireless Access in Vehicular Network covers all layers from network till the application layer. To decrease the rate of transmission collision multichannel TDMA MAC protocol [3] called VeMac is proposed to support high priority safety application in VANETs. A fixed time slot of the control channel is assigned for each node and length of each time slot are constant in VeMac [4] and [5]. The proposed system aimed at providing passing vehicles with spectrum available information for the IEEE 802a channels illustrated in Figure-1.

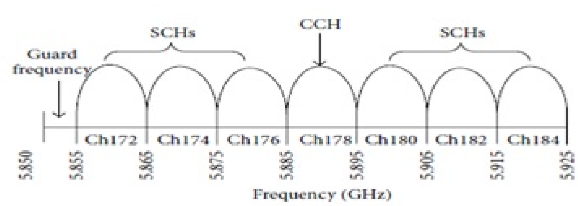

Figure-1. DSRC spectrum band and channels.

EEE 802a channels illustrated in figure 1.1illustrated in the RSU advised the vehicle about the free bands so they can cognitively use them when contention is inferred in the network. The aim of sensing scheme creation of accurate maps of the unlicensed ISM spectrum across the roads, identify the vacancies and allow passing vehicle to use white space for the Cognitive user (Secondary user or

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Unlicensed user). RSU perform fusion and decision on the free ISM channel and decision information is conveyed to the passing vehicle then enabling them to opportunistically use the white spaces in the spectrum.

2. RELATED WORK

In Cooperative Spectrum sensing frame work for energy detection and control channel check if service Si free in its area. When two user communicate, control channel can checks if the spectrum available for communication [6]. The RSU send the message about free band when the contention is inferred in the network. Thus opportunistically use the spectrum by cognitive radio approach [7]. Cooperative sensing scheme, each vehicle sense the spectrum for time interval and store the samples as binary value in a spectrum availability database at vehicle level. In RSU can aggregate of data in Spectrum Availability Database (SADB) and stored in the Central Spectrum Availability Database (CSADB) and broadcast it to other vehicle within in its spatial horizon [8]. We describe our proposed system from individual sensing at vehicle level and fusion at the RSU level for final decision in Figure-2.

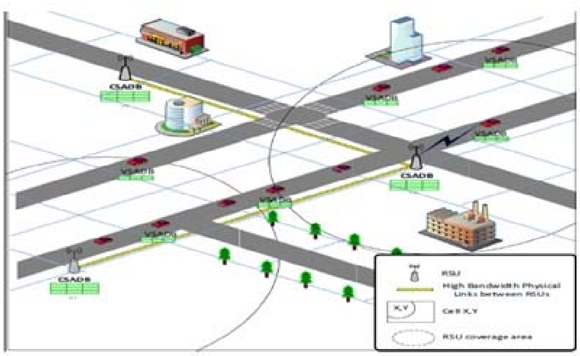

Figure-2. proposed Architecure.

3. PROPOSED SYSTEM

Proposed system aims to identify available ISM channel by control channel of 802.11 p DSRC. Vehicles sense the ISM spectrum in area and send the measurements to nearby RSU which makes decision about free channel in the sensed spectrum for passing the vehicle and proposed spectrum sensing system for mitigating the spectrum scarcity issue in DSRC control channel (CCH). In our proposed system roads are divided into segments which are called as cells. Each cells is set to around 50m which is around half of the range of Wi-Fi. Control channel makes decision about which time slot the vehicle can transfer the message and make decision about available channel for mitigate the spectrum scarcity. Vehicle can transmit the message among any one of service channel Si. Vehicle uses a blind detector to find out the availability of channel. Vehicle SADB send to RSU within its coverage area and the information stored in CSADB. Spectrum sensing at vehicle level can freely sense the spectrum during SCH time slots which is used to detect the primary user (licensed user) and cognitive user (secondary user or licensed user). During time SCH time slots each vehicle takes the collection of samples and put its input buffer SAE in VSADB. It contains Sample, (x,y), Chan, output, time. Where (x, y) used for cell identification, Chan is for Channel id, Output binary value coming from spectrum sensing method (0 or 1) and 0 for unoccupied primary user and 1 for occupied user. CVANET use an energy detection approach for spectrum sensing also known as radio meter [9]. Spectrum sensing based on energy detection model which is detect presence of primary user that is probability of detection Pd and absence of primary user Pf that is probability of False Alarms Pf which denote signal not detected.

4. SYSTEM MODEL

In energy detection scheme, detect primary signal of duration T and bandwidth of W. energy power will be detected first in the desired spectrum W and then compared with predefined threshold value for spectrum band available or not [10] & [11]. When the energy of the received signal is greater than the threshold, the blind detector indicates that whether the primary user is present or not. This will represent by the hypothesis H1 and H0. There is no primary which is represented by null hypothesis H0 otherwise which is represented by hypothesis H1 and overall method energy detection [12]& [13] has been illustrated in Figure-3.

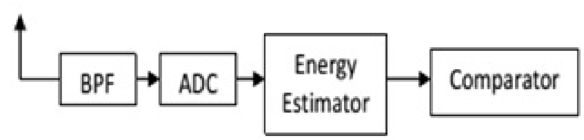

Figure-3. Sensing model of energy detection.

Mathematically it can be represented as in equation (1).

$$x(n) = \begin{cases} w(n)H0 \\ s(n) + w(n)H1 \end{cases} \tag{1}$$

Where n= 0,1,2,3…N which represent the number of samples, x(n) is represented as received signal, s(n) is transmitted signal by licensed user and w(n) is represented as noise signal.
Energy of signal represented as in equation (2).

$$Ed = \begin{cases} \sum_{k=0}^{k=N} (x[k])2 < \ \text{Pth} \quad \text{H0} \\ \sum_{k=0}^{k=N} (x[k])2 > \ \text{Pth} \quad \text{H1} \end{cases} \tag{2}$$

Where x(k) is FFT series of signal x(n) and is the threshold for detection. Performance of spectrum sensing is measured by two parameters. The detection probability (pd) which indicate primary user exists and false alarm probability pf which indicate no primary user present defined in equation (3).

Pd = prsignal detected/H1
Pf= 1-Pd no signal detected/ H0 (3)

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Aggregation of sample

Each vehicle sends the information to RSU and RSU aggregate all information from vehicles and format of the information (SAE, number of sample, speed time). The number of sample indicate aggregation of sample to be send to the RSU, speed measure the vehicle speed in km/h, and time stamp indicate freshness of data and denote the vehicle enter into the cell and leaving from cell.

Spectrum availability information

RSU collect the data sent by the passing vehicle and examine then update the decision for each (channel, cell) pair will be updated in the routing table for every time t interval which illustrated in Figure-4.

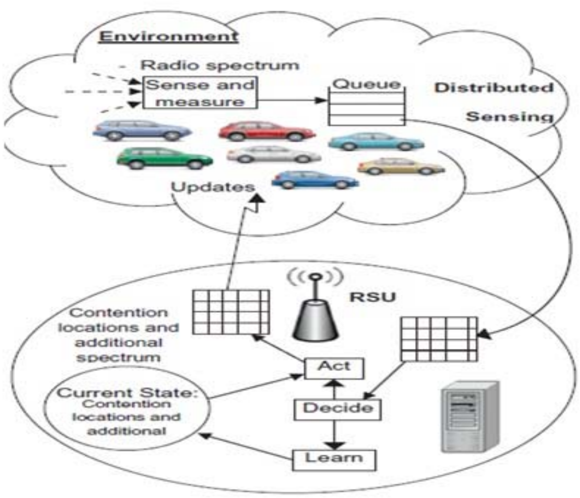

Figure-4. Logical diagram of proposed system.

Cooperative spectrum sensing methods

Step-1: Classify the vehicle into three types.Source, uninterested and interested.

Step-2: Message generated from source.

Step-3: Data format of message from source. (time, (area (x,y), (x,y)), data).

Step-4: Neighbor discovery Data format of neighbor list (Neighbor id, position (x,y), time).

Step-5: Unicast forwarding. Interested area responsible for unicast forwarding. Calculate distance$\alpha = \beta - \mu$ Set αwill be 20 m.

Step-6: MAC protocol based TDMA in DSRC. Six servicechannel and one control channel.

Step-7: Spectrum sensing at vehicle level.Create Vehicle Spectrum Availability, Database (VSADB).

Step-8: Spectrum Availability Entry (SAE) contain (Cell (x,y), Chan, output, time).

Step-9: Calculate output from Step 11.

Step-10: Aggregate VSADB in Control Spectrum Availability Database (CSADB).

Step-11: Calculate Energy detection based on broadcasting Signal at vehicle level.

Step-12: Set threshold pthif Ed<Pth then output = 0 (not busy) Else if Ed >Pth then output =1(busy)

Step-13: Add SAE, number of sample in buffer, vehicle Speed and time stamp in to the CSADB

Step-14: Assign (cell, chan) pair in control channel.

Step-15: All the information added into the AODV routing Table.

4. SIMULATION RESULTS

Simulations are carried out to evaluate the performance of the proposed approach. Here, NS2 is used as simulation environment to perform simulation. The performance of the enhancement approach is analyzed in terms of end to end delay, and packet delivery ratio respectively. Table-1 indicates the performance metrics and their corresponding formula.

Table-1.

S.no	Performance Metric	Formula
1.	Delay	$d = (packetdeparturetime) - (packetarrivaltime)$
2.	Packet delivery ratio	$pdr = \frac{numberofpackets\ received}{totalpacketssent} x\ 100$
3.	Control overhead	coh= (number of control route request + number control route reply) / total control packet send
4.	Data packet forwarding	dpf = Number of packet received time in second

Results

Figure-5 shows the number of packets that are transmitted by the proposed technique at varying time units. The horizontal line represents the distance in meters while the vertical line represents the end to end delay in bits per second. It is observed from the graph that the number of packets transmitted using the proposed approach is more when compared to the existing technique.

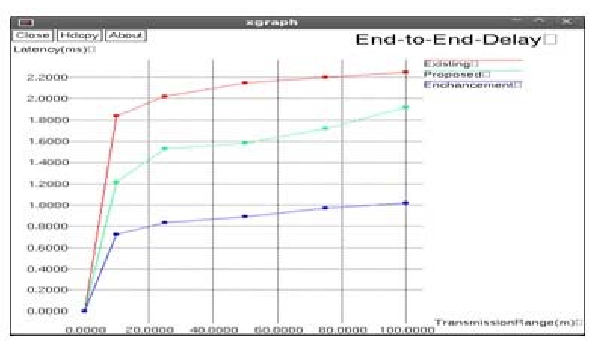

Figure-5. End to end delay.

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Figure-6 shows the packet delivery ratio of proposed technique at varying distance units. The horizontal line represents the distance in meters while the vertical line represents the packet delivery ratio. It is observed from the graph that the packet delivery ratio of the enhancement approach is more when compared to the existing technique.

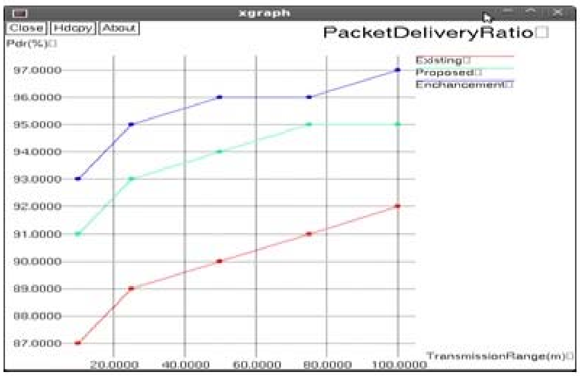

Figure-6. Packet delivery ratio.

Figure-7 shows the control overhead of proposed technique at varying distance units. The horizontal line represents the distance in meters while the vertical line represents the control over head. It is observed from the graph that the control overhead of the enhancement approach is more when compared to the existing technique.

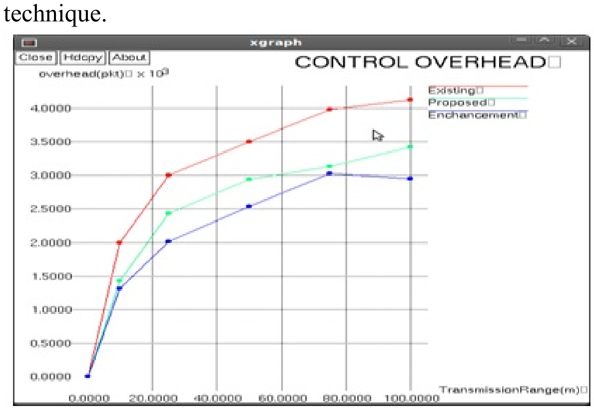

Figure-7. Control overhead.

Figure-8 shows the Data packet forwarding of proposed technique at varying distance units. The horizontal line represents the distance in meters while the vertical line represents the Data packet forwarding. It is observed from the graph that the data packet forwarding of the enhancement approach is more when compared to the existing technique.

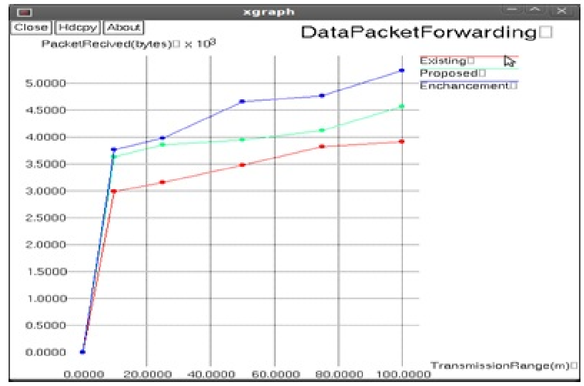

Figure-8. Data packet forwarding.

5. CONSLUSIONS

The development of intelligent vehicle safety systems is rapidly moving from autonomous systems relying on vehicle's own sensors towards cooperative systems utilizing Communications between vehicles or between infrastructure and vehicles. Cooperative vehicle safety system was developed for vehicles safety purpose. The cooperative vehicle safety systems (CVSs) of Vehicular Ad-hoc Network (VANET) provides vital vehicle tracking information. These are beneficial only if they delivered in a timely manner. Thus, in this paper an efficient Cooperative Spectrum Sensing Scheme is employed in the communication sub component of the CVS system to generate and transmit the location information of the vehicle rapidly. Simulations are performed to analyze the performance and the results indicate that the proposed approach provides efficient and robust communication between the vehicles.

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