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도심 사거리 교차로 지역의 효율적인 뇌파전송 VANET 라우팅 프로토콜

조준모*

Efficient Brainwave Transmission VANET Routing Protocol at Cross Road in Urban Area

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요 약

최근에 전기자동차의 상용화가 머지않은 상황에서 운전자를 위한 다양한 전자적 기능들이 개발되어지고 있다. 특히, 뇌파(EEG)를 통하여 운전자의 상태를 모니터링하면서 졸음방지나 건강상태를 실시간으로 점검하는 기능들이 있다. 자동차 운전자의 뇌파를 의료기관 서버에 전송하여 관련 기능들을 제공할 수 있는데 이때 자동차간 또는 자동차와 노변장치간의 원활한 통신기능이 필수적이다. 따라서 본 논문에서는 도심의 교차로환경에서 원활한 EEG 통신기능을 제공하는 라우팅 프로토콜을 제시하기 위해 AODV, DSR, GRP, OLSR, TORA와 같은 5가지의 라우팅 프로토콜로 운영되는 무선통신망을 각각 설계하고 이를 OPnet 네트워크 시뮬레이션을 통하여 성능을 평가하고 결과를 제시하고자 한다.

ABSTRACT

Recently, various electronic functions are developed for car drivers as the advent of electrical automobile. Especially, there are functions to examine for preventing drowsy or healthcare through monitoring brainwave(EEG) of drivers in real time. This function can be provided by transmitting driver's EEG, and the network function for transmission among cars or between car and road side infrastructure is a vital issue. Therefore, in this paper, to provide efficient routing protocol for transmitting EEG data at a cross road in an urban area, 5 different wireless communication network applied each routing protocol such as AODV, DSR, GRP, OLSR, and TORA is designed and simulated in the OPNet network simulator, then it is evaluated for the result.

키워드

Brainwave(EEG), Routing, Vehicular Network, Network Performance Analysis
뇌파(EEG), 라우팅, 자동차통신, 네트워크 성능평가

Ⅰ. Introduction

Improving road safety is one of the major challenges in recent years. Attaining more effectiveness in the enforcement of road safety policies has become a key issue. The use of modern technologies in the context of Vehicular Ad-Hoc Network(VANET) could enable the design of a

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more convenient, frequent and effective enforcement system compared to the traditional human patrol controls[1].

Also, there are many EEG(: Electroencephalogram) related researches are currently underway[2]. The research is applied to special function like examining driver's health state or preventing drowsiness while driving in real time manner.

There are domestic researches related on that subjects are under going such as head up display that supports some vital information to the drivers, and self-control systems of car[3-4].

VANET is a hot research area in the field of ITS and vehicular telemetric. Routing is one of the key technologies in VANET and responsible for efficient data forwarding in ITS applications, especially for traffic information delivery in V2V (Vehicle-to-Vehicle) communications[5 - 7]. Although VANET can be considered as a special type of MANET, the classical MANET routing protocols cannot be applied into VANET directly for serious performance degradation[8]. This is because VANET has some notable features. In VANET, the distribution of the vehicle positions and the flow of data packets are constrained by the road topology. In addition, the high mobility of the vehicles leads to frequent network topology changes [8-9].

In this paper, five well-kown routing protocols will be applied to a EEG transmitting cross road in urban area of VANET. The topology applied each routing protocols will be designed and simulated in a OPNet simulator. In section II, the basic issues related to the EEG signals and its transmitting environment at VANET will be discussed. Then, in section III, the EEG signal transmission of VANET adopted each routing protocols at cross road environment will be described. Then the simulation results and evaluation is summarized in section IV. Finally, the best routing protocol among them will be discussed and suggested in section V.

Ⅱ. EEG Brainwave and Vehicular Ad-hoc Network

2.1 EEG Signal Transmission

The brain system produces electrical signals at a variety of frequencies. Early EEG researchers were limited in their ability to record EEG signals by AC current artifacts and the inability to filter out 60Hz noise precisely. Thus, the EEG was recorded by using simple 'band pass' filters that allowed relatively clean signal detection only below 30Hz, while ignoring signals above that frequency. The EEG is classically composed of four frequency bands: delta(0-3Hz), theta(4-7Hz), alpha(8-12Hz), and beta(13-24Hz). The EEG is classically described as occurring between 0 and 30Hz, recent work and precise notch digital filtering has defined a gamma frequency greater than 24Hz extending to 50-60Hz[10].

The electrical activity of the brain can be described in spatial scales from the currents within a single dendritic spine to the relatively gross potentials. Neurons, or nerve cells, are electrically active cells that are primarily responsible for carrying out the brain's functions. Thousands of post-synaptic currents from a single neuron's dendrites and body then sum up to cause the neuron to generate an action potential. This neuron then synapses on other neurons, and so on. Fig. 1. shows an example of 60 channels of brainwave obtained from scalp electrodes placed on the head overlying the cortex. Average alpha wave can be peaked to show that an event triggered average of the EEG signal centered on the negative peaks of alpha waves that exceeded a threshold of $-50\mu V$ in each channel for some typical subject and experiment.

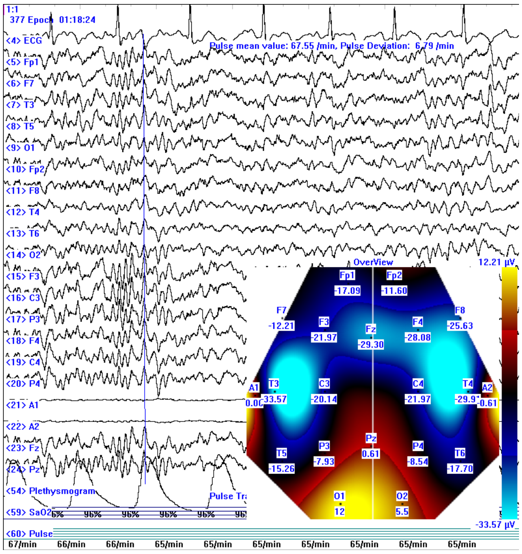

Fig. 1 Brainwave signal channels

2.2 Transmitting EEG at cross road VANET

To transmit EEG signals at the vehicular ad-hoc network, the characteristics of the VANET should be identified. The mobility protocols aim to maintain end-to-end connections between mobile nodes and their corresponding nodes even if mobile nodes change their points of attachment of the access network.

For example, it is important to investigate if current Mobile IP protocol is suitable for VANET environment since road and safety conditions impose different requirements. Mobile ad-hoc networking technology is important to support car-to-car communications. Ad hoc routing protocol is needed for relaying signals, local alarms, and group-interested of information. With these protocols, VANET users can be served through radio access technologies that better match user terminal capabilities and service requirements while providing efficient use of radio resources[11].

III. EEG Transmission of VANET at Cross Road Environment

For transmitting EEG data at a cross road in an urban area, 5 different wireless communication network applied each routing protocol such as AODV, DSR, GRP, OLSR, and TORA is designed and simulated in the OPNet network simulator.

Each topology is designed as a round trip 2 lanes crossroad in urban area and there are 4 groups of vehicles in a row driving through the crossroad. Every vehicles has the same speed.

For example, The Fig. 2 shows the basic network topology suggest in this paper. The 'mobile_node_25' shown in Fig. 2 is a vehicle heading to the crossroad, and the 'node_0' is a fixed roadside infrastructure. All the vehicles in the same vertical line along with the 'mobile_node_25' are meant to transmit EEG data to the 'node_0'.

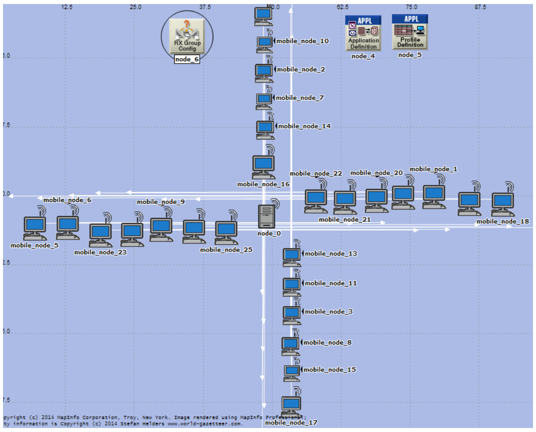

Fig. 2 A topology of EEG VANET

IV. Simulation Result and Analysis

The network topologies applied for each routing protocol are simulated in the OPNet simulator for a performance evaluation.

The following Fig. 3 is the throughput of each routing protocol network shown that the GRP has the worst performance among all. The performance of AODV and the DSR showed steady state and the DSR showed little better record. The OLSR is better than the GRP but, the depth of fluctuation was severe because of the moving cars at the cross road. The TORA sometimes exceeds the throughput of the DSR, but I conclude that the best performance of the throughput is the DSR because of the steadiness.

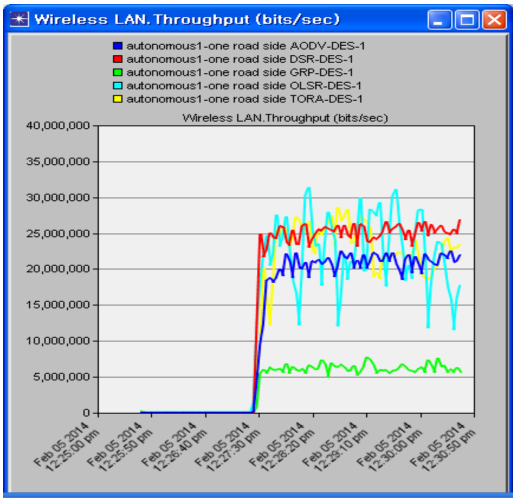

Fig. 3 Comparison of throughput

The Fig. 4 is the delay of each routing protocol network. The DSR showed worst case performance. For the application of EEG communication, reducing latency is the most important factor in this scenario. So we can say at this moment that the DSR could be the worst routing topology among all. Other routing protocols are similar at the beginning, but the TORA showed better results later on. So, for the delay issue considered as an important matter in the application, the TORA is the best performance among all so far.

There are two types of 'data dropped' in OPNet simulator, one is data dropped by the buffer overflow and the other is by the retry threshold exceeded.

The comparison of data dropped by buffer overflow is shown in Fig. 5. DSR showed worst case, and other routing protocols showed similar results. The AODV showed worse performance as

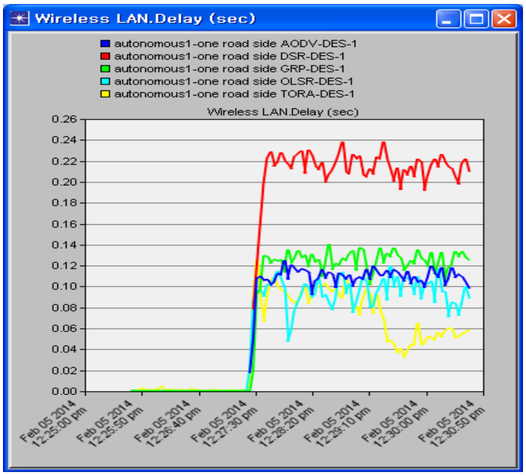

Fig. 4 Comparison of delay

the car moves, but the TORA showed better performance as time goes.

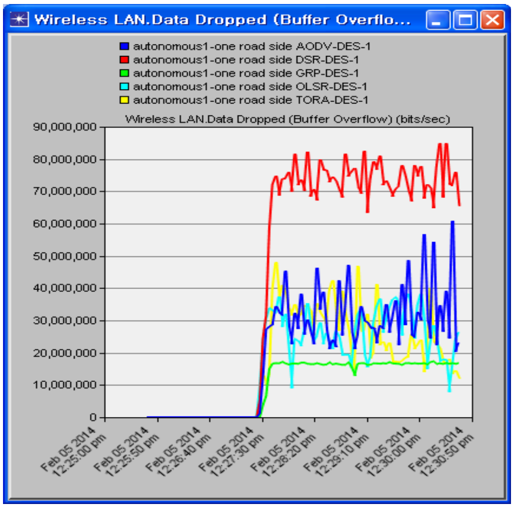

Fig. 5 Comparison of data dropped

Fig. 3 to Fig. 5 are the result of the global performance. According to the result the best routing protocol is TORA so far. Moreover, we need to verify not only the global network performance but also the individual nodes. Let's look into one of the node in this network. The Fig. 6 shows the traffic sent rate of the 'mobile_node_25'. The graph also shows that the TORA showed the highest rate of transmission.

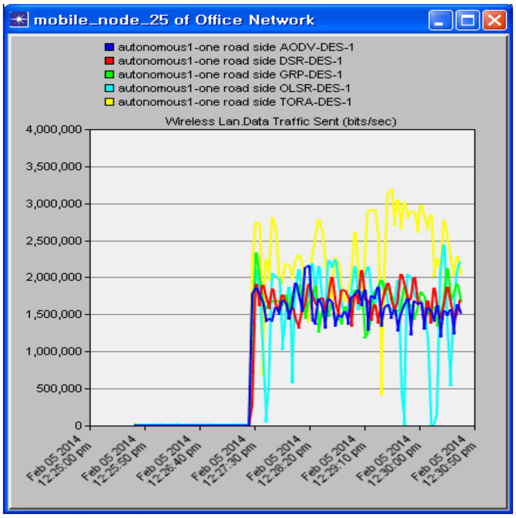

Fig. 6 Traffic sent rate of a node

Therefore, for the main conclusion, the TORA is the showed overall best routing protocol among others.

V. Conclusion

There are many researches are under going for new electronic automobile functions such as preventing drowsy or healthcare through monitoring brainwave(EEG : Electroencephalogram) of drivers in real time. For the efficient network of the application an efficient routing protocol is needed. For transmitting EEG data at a cross road in an urban area, 5 different wireless communication network applied each routing protocol such as AODV, DSR, GRP, OLSR, and TORA is designed and simulated in the OPNet network simulator. For the conclusion, the DSR and TORA showed great performance result. However, the drivers security is protected in realtime, the latency should be minimized. Therefore, the best routing protocol in this scenario is TORA.

For the further study, the suggested scenario adopted with sensor devices will be studied rather with common wireless LAN.

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