Distributed Body Sensor Network Using V2V/V2I Communications For Safety Driving - An Overview and A New Proposal

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Abstract

As the traffic problem increases, we are seeing a dramatic increase in the number of mentally stressed and angry drivers. Driver is the most important and valuable component of a vehicle. That is why, it is essential to monitor driver's stress and anger level for safety driving. Physiological parameters such as heart rate, heart rate variability, respiration rate, respiration waveform, will be monitored using a body sensor network consists of multiple physiological sensors placed at the driver's body. When a driver's stress or anger level reaches the danger level, an alarm notification will be send to neighboring vehicles, or roadside infrastructure and most importantly nearby traffic police emergency service using V2V/V2I communications for VANETs (Vehicular Ad-hoc Networks) to restrict the vehicle for avoiding collisions. The proposed scheme will be useful for intelligent transportation systems (ITS) to improve the road safety by distributing vital physiological information from a body sensor network.

Background

With more than a billion vehicles on the roads today and growing, road safety has quickly become a major challenging issue to deal with within the transportation industry. Alarming statistics indicate that road accidents produce more than 1.35 millions of fatalities per year [1]. In light of these facts, it is becoming obvious that novel alternatives within the transportation industry are deemed necessary. Subsequently, V2V/V2I (Vehicle-to-Vehicle/Vehicle-to-Infrastructure) communications are quickly becoming a major milestone of the next generation intelligent transportation systems (ITS) design to ensure improve safety. On the other hand, body sensor network (BSN), which consists of multiple sensors attached to the body, can be an effective framework to collect different physiological data and extract vital physiological parameters to monitor mental stress and anger levels of a driver.

Objectives

The objectives of our new proposal are as follows:

1. To design and implement a smart body sensor network, which will incorporate low cost, and lightweight noninvasive sensor electrodes for collecting physiological data (EEG and respiration data).
2. To develop novel event monitoring algorithms incorporating artificial intelligence (AI) and physiological signal processing to monitor whether a driver is undergoing with mental stress or anger.
3. To establish VANET communication link enable to disseminate warning messages to the neighboring vehicles (vehicle to vehicle (V2V)) and/or roadside units (vehicle to infrastructure (V2I)).
4. Finally, develop a prototype system useful for ITS to improve road safety by distributing vital physiological information from a body sensor network and managing the emergency situations saving not only driver's life but also lives of many more by avoiding collisions.

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Concluding Remarks

This study overview the distributed ad-hoc sensor networks with a new proposal for traffic safety due to its utmost importance for safe driving. This new framework under the proposed research methodologies could able to monitor both the stress and anger which are the critical factors for causing road accident. This paper also shows how new emerging technologies, like VANET, distributed BSN, can play a major role in ITS.

Research Methodology - Outline

Our proposed methodology consists of the following stages:
Stage 1: Study existing stress detection methods using physiological data.
Stage 2: Investigate information dissemination schemes and their protocols using V2V/V2I communications.
Stage 3: Propose novel methods for monitoring stress and anger of a driver by extracting useful features from physiological data and evaluate the methods using available as well as recorded data.
Stage 4: Establish Vehicular Ad-hoc NETwork (VANET) to enable real-time (low latency) wireless communication between vehicles (V2V) to dissipate the warning messages to the neighboring vehicles for road safety.
Stage 5: Similarly enable the communication link between vehicle and RSU (Road Side Unit) (V2I) for sending emergency messages to the nearest police station.
Stage 6: Perform test runs in the OPNET network simulator.
Stage 7: Finally, test the prototype system in the practical environment to evaluate the feasibility of its implementation.

The methods/models/protocols and the corresponding operations to be adopted here, are listed below:

1. Savitzky- Golay filter for preprocessing.
2. Spectro-temporal models and probabilistic models for bio-inspired feature extraction using a body sensor network.
3. Sequential methods and discriminative methods for feature selection.
4. Statistical techniques such as Kalman and particle filtering methods for data fusion.
5. Advanced techniques including affinity propagation and consensus methods for clustering and classificication.
6. VANET's protocol to establish V2V communication. Note that VANET is supported by DSRC/WAVE wireless technology, which requires extremely short latency and operates in 5.9 GHz frequency band of 75MHz of spectrum having seven 10 MHz channels standardized by IEEE802.11p and IEEE 1609.4 protocols. However, there need to handle some challenges with DSRC technology including higher multipath delay spread, choice of proper modulation scheme, coding, and PAPR reduction in OFDM [2].
7. A multi-hop data dissemination scheme as proposed in [3], to disseminate emergency messages to the nearest police station.

References

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