HEARSMOKING SMOKING DETECTION IN DRIVING ENVIRONMENT VIA ACOUSTIC SENSING ON SMARTPHONES

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Abstract:

Driving safety has drawn much public attention in recent years due to the fast-growing number of cars. Smoking is one of the threats to driving safety but is often ignored by drivers. Existing works on smoking detection either work in contact manner or need additional devices. This motivates us to explore the practicability of using smartphones to detect smoking events in driving environment. In this paper, we propose a cigarette smoking detection system, named HearSmoking, which only uses acoustic sensors on smartphones to improve driving safety. After investigating typical smoking habits of drivers, including hand movement and chest fluctuation, we design an acoustic signal to be emitted by the speaker and received by the microphone. We calculate Relative Correlation Coefficient of received signals to obtain movement patterns of hands and chest. The processed data is sent into a trained Convolutional Neural Network for classification of hand movement. We also design a method to detect respiration at the same time. To improve system performance, we further analyse the periodicity of the composite smoking motion. Through extensive experiments in real driving environments, HearSmoking detects smoking events with an average total accuracy of 93.44 percent in real-time.

Keywords : Smart phones,Vehicles,Sensors,Acoustics,Automobiles,Mobile computing,Safety

1.INTRODUCTION

With rapid development and great success of automotive industry, more and more vehicles have been put into use. On one hand, these modern means of transports bring people with much convenience in daily life. On the other hand, various issues related to road safety increase and arouse wide public attention. A series of efforts have been undertaken by traffic departments or government organizations to improve road safety, such as installing surveillance cameras and making traffic rules, which can in some way regulate driving behavior.

Among different undesirable driving habits, smoking is a kind of behavior that can easily distract a driver's attention and cause danger. Unfortunately, most of drivers fail to realize the risk of smoking. According to a report published by the National Institutes of Health drivers who are smoking are even more distracted than people who are using cell phones, on average. The Federal Motor Carrier Safety Administration (FMCSA) also conducts its own 5- year study into the dangers of smoking during driving a truck. They find that smoking is a source of distraction in 90% of distraction-related crashes. This equates to approximately 12; 780 crashes over the 5-year examined period. Health damaging also should not be ignored. The British Medical Association (BMA) highlights a research indicating that because the driver smokes, the levels of toxins in a car can up to 11 times higher than that in a smoky bar. The cigarette smoke not only harms the driver himself/herself, but also harms other passengers especially children. Many countries and areas, such as UK and Japan, have ban smoking policy for commercial vehicles, including vans, buses, taxis and company cars Some ridesharing companies, like Uber and Lyft also do not allow smoking in vehicles. But in some areas, these companies are not allowed to install monitoring equipment in cars, which makes them lack of cheap and effective detection methods. Furthermore, suppose that the detection results could be uploaded to the transportation department, then the police could further understand the driver's state when dealing with traffic accidents. Therefore, it is highly desirable to develop an easy-deployment and low-cost smoking detection system that can help companies and transportation departments to check drivers' smoking events.

There have been several existing works on cigarette smoking detection by leveraging different types of devices, such as cameras, gas sensors and Wi-Fi devices. A smoking behavior detection system is proposed based on the human face analysis, which can detect whether the person in the image is smoking by locating mouth and processing white balance. Some solutions exploit the usage of various technical sensors, such as ionization detector, photoelectric detector and gas-sensitive detector. Smokey which depends on commodity Wi-Fi infrastructures, leverages the smoking patterns leaving on Wi-Fi signals to identify the smoking activity even in the non-line of- sight and through-wall environments. However, these works suffer many problems. In particular, the methods based on computer vision heavily depend on good lighting and weather condition. Moreover, Uber and Lyft are not allowed to use the cameras and other recording devices due to privacy regulations in some areas .Other methods based on specific sensors are costly or difficult to be deployed in cars.

Nowadays, smart phones become powerful with enriched inertial sensors, such as microphones, speakers and accelerators, which can be used to sense various aspects of driving conditions. Researches that focus on improving the quality of daily driving by using smart phones emerge in quantity. V-Sense is a vehicle steering detection middleware that can run on commodity smart phones to detect various vehicle maneuvers, including lane-changes, turns and driving on curvy roads. Several systems put their attentions on estimating vehicle speed by using GSM signal strength traces accelerometers and GPS sensors .However, to the best of our knowledge, a ubiquitous smoking detection system designed for driving environment is still absent. Smart phones, with their powerful capability and usability in driving, is highly ideal to act as the platform of a smoking detection system. In view of the aforementioned situations and motivations, we take the first attempt to build a novel smoking detection system, which uses acoustic sensors in smart phones, to detect drivers' smoking behaviors in real driving environment. The basic idea is that the smart phone emits acoustic signals by its speaker and receives reflected signals by its microphone, and then analyses the received signals to detect whether the driver is smoking or not. The system naturally has two advantages: smart phones are widely available and low-cost to use. In addition, leveraging acoustic sensors is a non-contact way that does not require any device to put on.

To realize this smoking detection system, we face three major challenges in practice. Firstly, there are multiple body movements when a driver is smoking during driving, e.g., steering with one hand, holding cigarette with another hand, putting up and down the cigarette, inhaling and exhaling smoke with chest expanding and shrinking. All of these movements need to be distinguished and tracked. Secondly, in real driving environment, acoustic signals are easily suffered from multipath interference. Due to the limited space in the car, surfaces of various car facilities and human body can reflect acoustic signal, especially the signals of multiple reflection paths from different parts of the driver's chest when he/she is breathing. When the driver puts up and down the cigarette, the movement of the whole arm also has multipath effects. So removing different multipath interferences is necessary. Last but not least, some motions like drinking and eating have similar behavior patterns to smoking, which are very confusing to a detection system. Thus, it is a necessity to analyse the composite smoking motion to accurately detect smoking activity.

To address the above challenges, we propose a smoking detection system, named Hear Smoking, which only uses acoustic sensors on smart phones in driving environments. We first analyse the smoking behaviors of 17 drivers, and find the typical smoking steps of drivers. To perceive motions, we let the smart phone speaker sends designed acoustic signals. The acoustic signals are reflected by surrounding objects and then received by the smart phone microphone. To get distances between reflectors and the smart phone, we calculate Relative Correlation Coefficient (RCC) of the collected data. Further, we get a set of sequence profiles from RCC profiles. Each sequence profile describes distance changes between moving objects and the smart phone over a period of time. According to our observations, when a driver is smoking, his/her main moving parts are hands and chest, so Hear Smoking focuses on detecting movements of hands and chest. For hand movement detection, we innovatively transform a sequence profile into a two-dimension image, and then send the image to a carefully designed Convolutional Neural Network (CNN) to identify whether there is a movement that matches the smoking hand movement pattern in the sequence profile. For chest movement detection, we perform Fast Fourier Transform (FFT) to find out waveforms in sequence profiles that fit human breath rate. Then a major breath path is selected to eliminate multipath interference. We analyse the amplitude and period of the waveform to determine whether there is a breath similar to smoking breath. If both hand movement and breath pattern fit the characteristic of those in a smoking event, we then analyse the periodicity of the detected composite motion

to improve system performance. Finally, we get an analysis result whether the driver is smoking or not. To meet realistic demands, we collect training data using smart phones for 5 months to build the system model. We implement Hear Smoking on different versions of Android platforms and comprehensively evaluate its performance in various environments. Experiment results show that Hear Smoking is reliable and efficient in real driving environments.

Our contributions are summarized as follows:

_ We study the unique patterns of smoking behaviors during driving. Based on our findings, we propose a smoking detection system, Hear Smoking, which uses acoustic sensors embedded in smart phones to detect smoking events of drivers. To the best of our knowledge, we are the first to design a smoking detection system by only using smart phones.

_ We divide the smoking detection into hand movement classification and respiration identification. We innovatively combine acoustic signal processing with CNN-based image classification into Hear Smoking. After that, we design the methods of composite analysis and periodicity analysis to obtain the final detection result.

_ We conduct extensive experiments in real driving environments. Hear Smoking achieves an average total accuracy of 93:44% for smoking event detection.

The rest of this paper is organized as follows. We review related work in Section 2. In Section 3, we summarize the smoking steps and introduce the acoustic signals used in our work. Then we describe the system design in Section 4. Implementation and experimental results are presented in Section 5. Finally, we draw our conclusion in Section 6.

2. LITERATURE SURVEY

2.1 DIFFERENT AUTHORS DISCUSSION:

To realize this smoking detection system, we face three major challenges in practice. Firstly, there are multiple body movements when a driver is smoking during driving, e.g., steering with one hand, holding cigarette with another hand, putting up and down the cigarette, inhaling and exhaling smoke with chest expanding and shrinking. All of these movements need to be distinguished and tracked. Secondly, in real driving environment, acoustic signals are easily suffered from multipath interference

2.2 DOMAIN DESCRIPTION:

After investigating typical smoking habits of drivers, including hand movement and chest fluctuation, we design an acoustic signal to be emitted by the speaker and received by the microphone. We calculate Relative Correlation Coefficient of received signals to obtain movement patterns of hands and chest. The processed data is sent into a trained Convolutional Neural Network for classification of hand movement.

3. PROBLEM STATEMENT

3.1 EXISTING SYSTEM:

Driving state detection using smartphones. With the increase of public awareness about road safety, many works on driving state detection using smartphones emerge to improve the quality of daily driving. SenSpeed is a system for accurate vehicle speed estimation, which can estimate vehicle speed by integrating the readings of accelerometers in smartphone. D3-Guard proposes a drowsy driving detection system, which leverages audio sensors in smartphones, to detect drowsy actions and alert drowsy drivers. TEXIVE uses smartphones to distinguish drivers from passengers and detect texting operations during driving according to irregular and rich micro-movements of users. V-Sense develops a vehicle steering detection middleware that can run on commodity smartphones to detect various vehicle maneuvers, including lane-changes, turns, and driving on curvy roads. Various kinds of works indicate the powerful capability of smartphones and embedded sensors. However, research about smoking detection in driving environment using smartphones is absent. This motivate us to propose HearSmoking to detect and alert drivers' smoking behavior

Smoking detection in contact manner. Technologies and studies on smoking detection using specialized devices, e.g., smart bracelets, smartwatches and chest belts, have been developed for some time. HLSDA is a smoking detection algorithm, which collects various sensor data from a smartwatch and recognizes smoking behavior. PACT is another wearable sensor system based on support vector machines. It detects smoking events by monitoring cigarette-to-mouth hand gestures in a contact manner. By capturing arm movements and breath puffs from 6-axis inertial sensors worn on two wrists of the user, puffMarker builds a model based on 10-fold cross-validation to detect cigarette smoking. Another study investigates the differences in brain signals of craving smokers, noncraving smokers, and non-smokers. This study uses data from resting-state EEG devices to train predictive models based on residual neural networks, and can distinguish the three groups. These works are all based on contact manner that need users to wear additional devices. Thus, they either cost high price to deploy or suffer inconvenience in daily using. Non-contact and device-free methods are needed for the smoking detection.

Smoking detection in non-contact manner. Non-contact methods are proposed by using civil cameras, gas sensors, Wi-Fi devices, etc. Smokeyis a smoking detection system that depends on Wi-Fi infrastructure. It leverages the smoking patterns leaving on Wi-Fi signals to identify the smoking activity even in the through-wall environments. A self-determined mechanism is proposed to analyse smoking related events directly from videos by combining color re-projection techniques, Gaussian mixture models and hierarchical holographic modeling framework. Besides cameras, gas sensors are widely used. UbiLighter detects cigarette smoking by using a gas sensor embedded in lighters to capture the gas from burning tobacco. A smoking monitoring method uses a microphone to distinguish smoking breath from non-smoking breath. However, due to the great influence on accuracy that ambient noises would bring by only using the microphone, the system is not suitable to be used in cars. The methods based on computer vision heavily depend on lighting and weather condition. Moreover, companies are not allowed to use the cameras and other recording devices due to privacy regulations in some areas .Other methods based on specific sensors are costly or difficult to be deployed in cars.

HearSmoking. Different from existing works, HearSmoking detects drivers' smoking behaviors only using smartphones. HearSmoking can be applied in many ways. It can help to supervise the drivers of nosmoking vehicles, such as taxis and buses. In particular, HearSmoking is very suitable to be used in Uber and Lyft, since if a passenger complaint a smoking driver, it is easier for Uber and

Lyft to obtain evidence from HearSmoking. It can also work with other systems to

improve driving safety. For example, it can be integrated with the ubiquitous driving modes and navigation systems on the smartphones. Furthermore, if the detection results are uploaded to the transportation department, the police can further understand the driver's state when dealing with traffic accidents.

3.2 DISADVANTAGE OF EXISTINTG SYSTEM:

An existing system that doesn't focus on improving the quality of daily driving by using smartphones emerge in quantity. An existing system doesn't focus on multiple body movements when a driver is smoking during driving, e.g., steering with one hand, holding cigarette with another hand, putting up and down the cigarette, inhaling and exhaling smoke with chest expanding and shrinking.

4.PROPOSED SYSTEM

4.1 PROPOSED SYSTEM:

we propose a smoking detection system, named HearSmoking, which only uses acoustic sensors on smartphones in driving environments. We first analyse the smoking behaviors of 17 drivers, and find the typical smoking steps of drivers. To perceive motions, we let the smartphone speaker sends designed acoustic signals. The acoustic signals are reflected by surrounding objects and then received by the smartphone microphone.

To get distances between reflectors and the smartphone, we calculate Relative Correlation Coefficient (RCC) of the collected data. Further, we get a set of sequence profiles from RCC profiles. Each sequence profile describes distance changes between moving objects and the smartphone over a period of time. According to our observations, when a driver is smoking, his/her main moving parts are hands and chest, so HearSmoking focuses on detecting movements of hands and chest. For hand movement detection, we innovatively transform a sequence profile into a two-dimension image, and then send the image to a carefully designed Convolutional Neural Network (CNN) to identify whether there is a movement that matches the smoking hand movement pattern in the sequence profile. For chest movement detection, we perform Fast Fourier Transform (FFT) to find out waveforms in sequence profiles that fit human breath rate. Then a major breath path is selected to eliminate multipath interference. We analyse the amplitude and period of the waveform to determine whether there is a breath similar to smoking breath. If both hand movement and breath pattern fit the characteristic of those in a smoking event, we then analyse the periodicity of the detected composite motion to improve system performance. Finally, we get an analysis result whether the driver is smoking or not. To meet realistic demands, we collect training data using smartphones for 5 months to build the system model. We implement HearSmoking on different versions of Android platforms and comprehensively evaluate its performance in various environments. Experiment results show that HearSmoking is reliable and efficient in real driving environments.

_ We study the unique patterns of smoking behaviors during driving. Based on our findings, we propose a smoking detection system, HearSmoking, which uses acoustic sensors embedded in smartphones to detect smoking events of drivers. To the best of our knowledge, we are the first to design a smoking detection system by only using smartphones.

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_ We conduct extensive experiments in real driving environments. HearSmoking achieves an average total accuracy of 93:44% for smoking event detection.

4.2 ADVANTAGE OF PROPOSED SYSTEM:

The system proposes a smoking detection system, named HearSmoking, which only uses acoustic sensors on smartphones in driving environments. The system analyses the amplitude and period of the waveform to determine whether there is a breath similar to smoking breath. If both hand movement and breath pattern fit the characteristic of those in a smoking event, we then analyse the periodicity of the detected composite motion to improve system performance.

5.IMPLEMENTATION

5.1 Service Provider

In this module, the Service Provider has to login by using valid user name and password. After login successful he can do some operations such as Login, Browse Smoking Datasets and Train & Test Data Sets, View Trained and Tested Accuracy in Bar Chart, View Trained and Tested Accuracy Results, View Prediction Of Smoking Detection, View Smoking Detection Type Ratio, Download Predicted Data Sets, View Smoking Detection Type Ratio Results , View All Remote Users

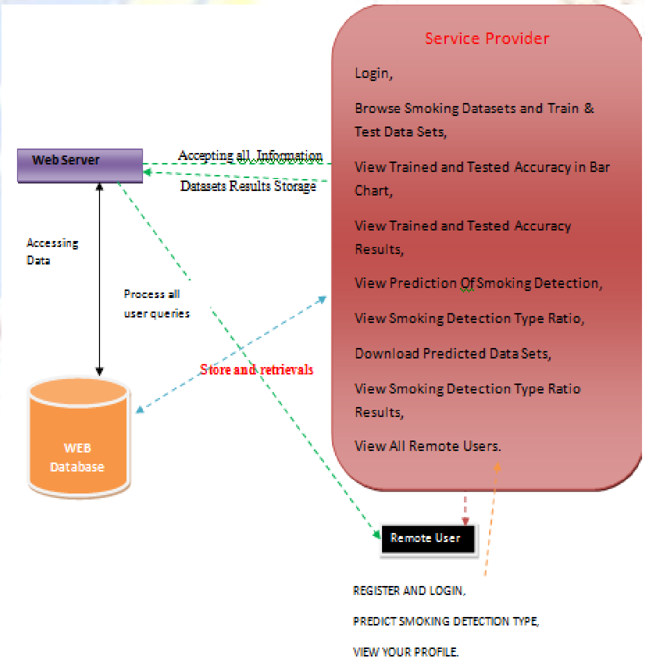
5.2 View and Authorize Users

In this module, the admin can view the list of users who all registered. In this, the admin can view the user's details such as, user name, email, address and admin authorizes the users.

5.3 Remote User

In this module, there are n numbers of users are present. User should register before doing any operations. Once user registers, their details will be stored to the database. After registration successful, he has to login by using authorized user name and password. Once Login is successful user will do some operations like REGISTER AND LOGIN, PREDICT SMOKING DETECTION TYPE, VIEW YOUR PROFILE.

6. SYSTEM ARCHITECTURE



8.CONCLUSION

In this paper, we address how to detect cigarette smoking activity during driving to improve road safety. Through literature survey and experimental verification, we find some characteristic smoking patterns in driving environment. We propose a smoking detection system, named Hear Smoking, which leverages acoustic sensors on smart phones to detect cigarette smoking events of drivers when they are driving. Hear Smoking takes advantages of RCC and CNN to detect both hand movements and respirations of the driver. Methods of composite analysis and periodicity analysis are designed to improve system performance. We conduct extensive experiments in different driving environments. Hear Smoking can detect smoking events with an average accuracy of 93:44% in real-time, which indicates that it works efficiently and reliably.

9. FUTURE ENHANCEMENT

We study the unique patterns of smoking behaviors during driving. Based on our findings, we propose a smoking detection system, HearSmoking, which uses acoustic sensors embedded in smartphones to detect smoking events of drivers. To the best of our knowledge, we are the first to design a smoking detection system by only using smartphones.

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