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DETECTDUI AN IN CAR DETECTION SYSTEM FOR DRINK DRIVING AND BACS

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ABSTRACT

As one of the biggest contributors to road accidents and fatalities, drink driving is worthy of significant research attention. However, most existing systems on detecting or preventing drink driving either require special hardware or require much effort from the user, making these systems inapplicable to continuous drink driving monitoring in a real driving environment. In this paper, we present *DetectDUI*, a contactless, non-invasive, real-time system that yields a relatively highly accurate drink driving monitoring by combining vital signs (heart rate and respiration rate) extracted from in-car WiFi system and driver's psychomotor coordination through

steering wheel operations. The framework consists of a series of signal processing algorithms for extracting clean and informative vital signs and psychomotor coordination, and integrate the two data streams using a self-attention convolutional neural network (i.e., C-Attention). In safe laboratory experiments with 15 participants, *DetectDUI* achieves drink driving detection accuracy of 96.6% and BAC predictions with an average mean error of 2 _ 5*mg/dl*. These promising results provide a highly encouraging case for continued development.

INTRODUCTION

In 2018, The US suffered 10, 511 deaths from drunk driving crashes [1]. The WHO reports that, in high-income countries, as many as 20% of fatally injured drivers have excess alcohol in their blood.1 COVID-related deaths may dwarf these numbers, but it is important not to lose our pre pandemic perspective. Tens of thousands of deaths per year due to drink driving is a staggering loss of life. At an estimated cost of $44 billion2 for just one year in the US alone [1], the economic impact is not insignificant either. According to the newly-enacted Halt Act (H.R. 2138) [2] and Ride Act (S.B. 1331) [3], drunk-driving prevention technology will be a safety standard for all new cars in the future. There is an urgent demand for in-vehicle drunk-driving detection systems to help prevent drunk-related accidents.

Most traditional methods for detecting drunk drivers need to interrupt the driving process. To administer a breathalyzer, the police must hail the driver to pull over, giving the driver time to implement means of avoiding detection. Blood tests
are invasive, and require the driver to stop. Similarly, urine tests and pupil measuring tests require special operations and expert examiners. While it is desirable to detect whether the driver is drunk before driving and prevent potential risks, it is possible that alcohol consumption takes time to take effect and the driver may consume alcohol during driving. Therefore, the most reliable way is to have a continuous monitoring of drunkenness during driving without interfering the driving process.

In this regard, there are many existing studies on leveraging sensing technologies to determine inebriation levels and Blood Alcohol Content (BAC). You *et al.* [4] devised a transdermal sensing wristband with an accompanying smart phone app connected via Bluetooth that calculates and tracks a person's BAC, while Jung *et al.* [5] developed a smart phone attachment that performs a colorimetric analysis on saliva. Nonetheless, these systems require extra devices, some of which are expensive. Researchers have found others ways to detect drunkenness with only smart phones. Kao *et al.* [6], for example, devised an app that measures a person's walking patterns with an inference model that learns to detect abnormal gaits associated with inebriation. Bae *et al.* [7] use the sensor data a person's phone collects to train a machine learning model to distinguish between drinking and non-drinking episodes. Similarly, Markakis *et al.* [8] also focus on changes in a person's unique patterns of coordination to determine inebriation. These solutions discern psychomotor and cognition skills under the influence of alcohol. However, they require users to perform certain activities that interfere with the driving process.

Our solution is a passive continuous drunk-driving detection system called *Detect DUI*. *Detect DUI*

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Volume 12, Issue 2, 2024

measures a person's vital signs through WiFi signals and their psychomotor coordination through steering wheel operations. However, the complicated driving conditions make it challenging to extract clear vital signs and it is essential to find a non-disturbing way of measuring psychomotor coordination. We manage the interference through a multi-step process. To eliminate reflections from other passengers and from car interiors (e.g., seats, windows), we leverage power delay profile to separate the direct reflection from the chest of the driver from multipath interference. WiFi signals are carried by multiple subcarriers. Different subcarriers have different sensitivities to subtle chest motions. To take full advantage of the diverse information from all subcarriers and avoid interference, we adopt principal component analysis (PCA) to sift noises and preserve the first principal component. Due to bumpy driving conditions, the received signals contain sudden changes with increased amplitude. We remove sudden changes and preserve only signals during relatively stable driving periods, which show a clear cyclic pattern that corresponds to breathing cycles, but the heartbeat pattern is drowned due to its much weaker amplitude. To address this problem, we propose a novel adaptive variational mode decomposition (AVMD) method to separate the mixed signal into multiple modes, and then keep the modes that relate to breathing and heartbeat respectively. Previous works usually measure psychomotor coordination of a person using interactive games or operations with a smart phone or computer, which is not applicable to the driving environment. We find a natural way to gauge the psychomotor coordination of the driver by monitoring their steering wheel operations. In particular, we use IMU to record the acceleration and gyroscope data during operation. In this way, we obtain a continuous monitoring of psychomotor coordination of the driver without interfering with their driving. Integrating the vital signs and the psychomotor signals is done with neural networks and an attention mechanism. Random Forest (RF) is then used to predict concrete BAC values. Trials with 15 volunteers show that *Detect DUI* was able to detect a drunken driver with 96.6% accuracy. Further, it was able to predict a person's BAC within a mean absolute error (MAE) of 0.002% to 0.005%.

Detect DUI can be supported by in-car IMU and WiFi systems. The lightweight learning-based detection model can be deployed locally, with data collected to fine-tune the model locally without privacy leakage.

In summary, the contributions of this research include:

• As far as we are concerned, *Detect DUI* is the first contactless method of detecting drink driving, including measuring the driver's BAC that can be administered
while driving.

• We have proposed a series of signal processing algorithms for extracting human vital signs from Wi Fi signals given chest motions with high levels of accuracy.

• We have proposed to use C-Attention to combine the information of vital signs and psychomotor coordination to reach a well-round drink driving prediction.

• Extensive experiments on 15 individuals show *DetectDUI* is able to distinguish normal driving from drink driving in real-time with a 96.6%-accurate estimation and the driver's BAC to within an MAE of 0.002% to 0.005%

EXISTING SYSTEM

A. Drunkenness Detection

Hardware-Based Detection: First used in the United Kingdom in the 1970s [17], breathalyzers are the world's most commonly used tools for testing inebriated drivers. Over its years of usage, researchers have connected breathalyzers, as well as other types of breath alcohol sensors, to smartphones via Bluetooth to improve BAC tracking, especially for self monitoring by drivers themselves. Example systems include: BACtrack Mobile Pro [18], Breathmeter [19]. One major disadvantage of breathalyzers is that the results are highly susceptible to the oral environment [20] and certain diseases (e.g., diabetes, liver and kidney diseases [20]), which may lead to false detection. Alternatives to breathalyzers include SCRAM, a transdermal sensor that measures the wearer's BAC through their sweat every 30 minutes [21]. The same kind of system is available in a tight wristband that fits closely to the skin [4]. However, SCRAM-based systems require a close contact between the skin and the sensor. Any space or anything between the skin and the sensor will affect the detection accuracy. Moreover, these systems require users to purchase extra devices or sensors, which may be expensive.

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Camera-Based Detection: Camera-based drunk driving systems have also been developed [22], [23]. In [22], facial landmarks and motions are recognized in images to detect whether the driver is drunk driving or not. In [23], an audiovisual database is utilized to realize bimodal intoxication detection. However, camera-based approaches are sensitive to lighting conditions and there is potential risk of privacy violation [24].

Behavior-Based Detection: The side effects of alcohol consumption include arrhythmia [14], slowed respiratory rates [15], impaired psychomotor performance [8], and unsteady gait [6]. This abnormality in vital signs and behaviors can be leveraged to detect whether the user is under the influence of alcohol. Bae *et al.* [7] developed a smart phone based system to track the drinking episodes of users based on built-in sensors (e.g., accelerometer) and the smartphone status (e.g., battery and network usage). Leveraging alcohol's influence on motor coordination and cognition,

Markakis *et al.* [8] designed five human-computer interactions to detect BACs (such as swiping or touching the screen in particular ways), akin to the finger-to-nose DUI tests. However, these works require users to interact with their phones (swipe the phone or engage in games), which interrupts the driving task and cannot offer a continuous drunk driving detection.

Disadvantages

- An existing methodology doesn't implement variational mode decomposition method.
- DetectDUI can't measure a person's vital signs through WiFi signals and their psychomotor coordination through steering wheel operations.

PROPOSED SYSTEM

- As far as we are concerned, *DetectDUI* is the first contactless method of detecting drink driving, including measuring the driver's BAC that can be administered while driving.
- We have proposed a series of signal processing algorithms for extracting human vital signs from WiFi signals given chest motions with high levels of accuracy.
- We have proposed to use C-Attention to combine the information of vital signs and psychomotor coordination to reach a well-round drink driving prediction.
- Extensive experiments on 15 individuals show *DetectDUI* is able to distinguish normal driving from drink driving in real-time with a 96.6%-

accurate estimation and the driver's BAC to within an MAE of 0.002% to 0.005%.

Advantages

- The proposed system DetectDUI detects drink driving and predicts BAC through a driver's vital signs and psychomotor coordination.The system shows the architecture of DetectDUI. In DetectDUI, vital signs are tracked through a WiFi sensing system and writing as datasets.
- The system proposes a novel adaptive variational mode decomposition (AVMD) method to separate the mixed signal into multiple modes, and then keep the modes that relate to breathing and heartbeat respectively.

IMPLEMENTATION

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 and Train & Test Data Sets, View Trained and Tested Accuracy in Bar Chart, View Trained and Tested Accuracy Results, View Prediction Of Drink Driving Detection, View rink Driving Detection Ratio, Download Predicted Data Sets, View Drink Driving Detection Ratio Results, View All Remote Users

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.

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 DRINK DRIVING DETECTION TYPE,VIEW YOUR PROFILE.

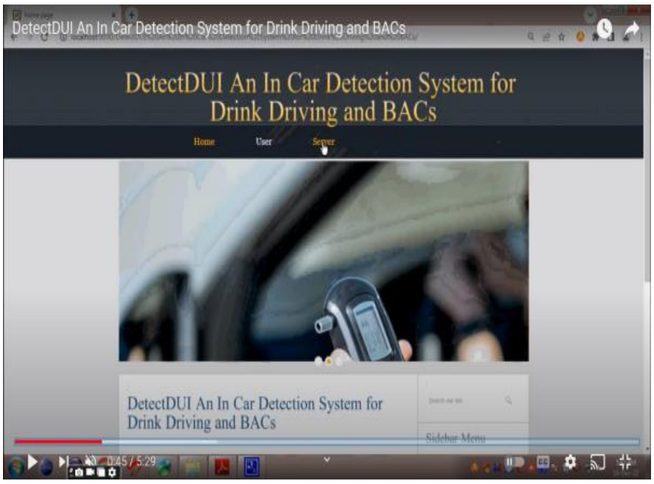

Fig.1. Home page.

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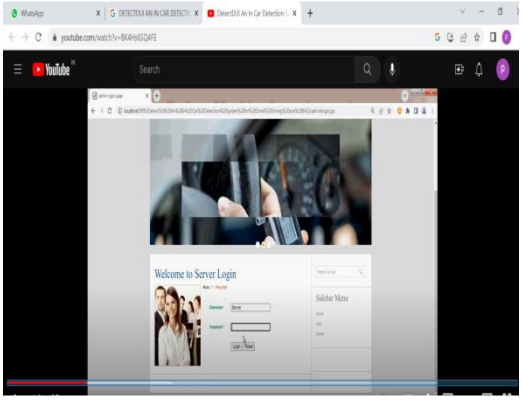


Fig.2. Login page.

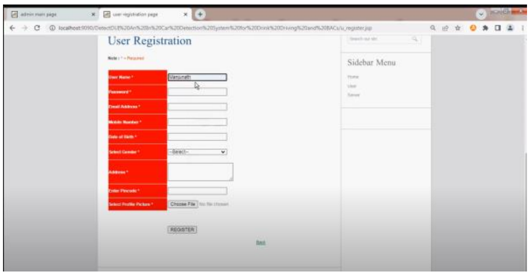


Fig.3. User Registration.

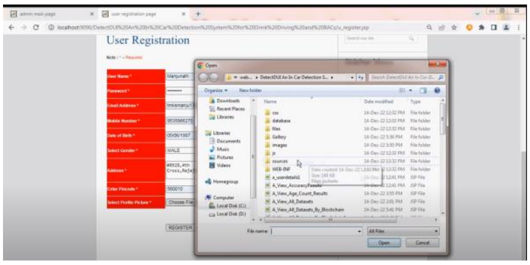


Fig.4. Dataset upload

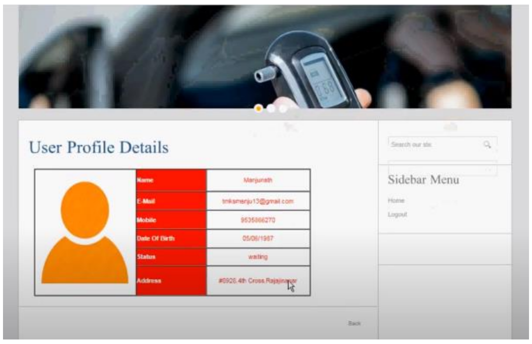
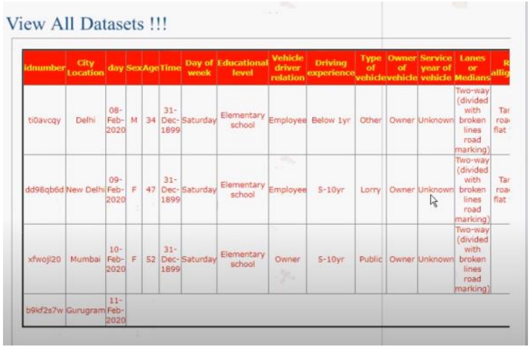


Fig.5. Profile details.



View All Datasets !!!

idnumber	City Location	day	Sex	Age	Time	Day of week	Educational level	Vehicle driver relation	Driving experience	Type of vehicle	Owner of vehicle	Service year of vehicle	Lanes or Medians	R allig
ti0avcqy	Delhi	08-Feb-2020	M	34	31-Dec-1899	Saturday	Elementary school	Employee	Below 1yr	Other	Owner	Unknown	Two-way (divided with broken lines road marking)	Tar roa flat
dd98qb6d	New Delhi	09-Feb-2020	F	47	31-Dec-1899	Saturday	Elementary school	Employee	5-10yr	Lorry	Owner	Unknown	Two-way (divided with broken lines road marking)	Tar roa flat
xfwojl20	Mumbai	10-Feb-2020	F	52	31-Dec-1899	Saturday	Elementary school	Owner	5-10yr	Public	Owner	Unknown	Two-way (divided with broken lines road marking)	
b9kf2s7w	Gurugram	11-Feb-2020												

Fig.6. Dataset details.

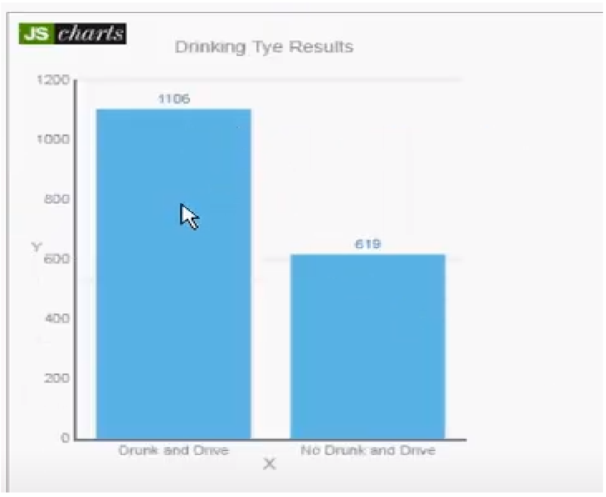


Fig.7. Output results.

CONCLUSION

In this paper, we presented Detect DUI, a non-intrusive, contactless, and continuous system of measuring and monitoring the side effects of alcohol on drivers. To develop Detect DUI to this stage, we have overcome two main challenges. The first is to eliminate interference in the WiFi signals caused by the motions of a moving vehicle. This problem was solved with a series of signal processing algorithms. The second is determining which specific features of alcohol's side effects best reflect driving under the influence of alcohol. We have addressed this challenge with a C-Attention network. The results of extensive experiments confirm that Detect DUI provides highly accurate drink driving detection and BAC prediction.

Apart from drinking alcohols, other factors may also affect vital signs and psychomotor coordination, e.g., catching a cold or other respiratory diseases. Respiratory diseases will change breathing patterns, which are expected to be different from the breathing patterns of drinking. However, it is difficult to collect training samples to help differentiate the breathing patterns under the two conditions. In the future, we intend to refine our drink driving detection model by considering other impact factors.

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