A Mobile Support System to Assist DUI Offenders on Probation in Reducing DUI Relapse

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Figure 1: The portable breathalyzer and mobile app of the proposed system.

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Abstract
This paper proposes a mobile support system to assist DUI (Driving Under the Influence of Alcohol) offenders on probation in avoiding committing DUI again. A customizable portable breathalyzer is used in conjunction with the DUI offender's mobile phone to self-administer alcohol screening tests and send the results to a server. The system also transmits contextual information and momentary feedback to the server. Records pertaining to alcohol use are summarized on a server and a list of triggering events are inferred from the information sent from the phone. This data can then be used to characterize the difficulties faced by these individuals, monitor their compliance with their probation requirements, and gauge their progress.

Author Keywords
Driving Under the Influence (DUI); Mobile Support System.

ACM Classification Keywords
H.4.m [Information System Applications]: Miscellaneous

Introduction
Driving under the influences of alcohol (DUI) involves operating a vehicle while impaired by alcohol and thereby endangering the lives of themselves and others. In the United States, someone is killed by a drunk driver every 53 minutes [3] . To avoid overloading the prisons, prosecutors

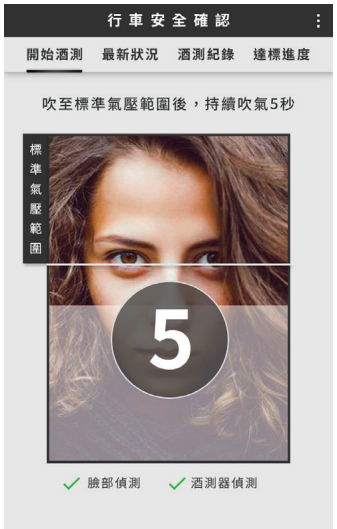

Figure 2: Directing the offender to continue to blow the air into the device for a sufficient long time. Because this study will be conducted by recruiting patients in Taiwan, all messages and instructions in the user interface in the current implementation are represented in Chinese characters; however, the messages can be easily translated to other languages for future applications.

commonly defer prosecution for this type of criminal misdemeanor, particularly when dealing with first-time offenders or non-repeat offenders [1]. Thus, the punishment for a routine DUI charge for first-time offenders or non-repeat offenders is typically a term of probation, which if completed successfully, results in the criminal charges being dropped. Unfortunately, many individuals commit additional DUIs while on probation. This is largely due to an inability to track and/or control alcohol use behavior. This paper outlines a novel strategy that uses mobile technology to assist probation officers and psychiatrists to monitor the alcohol use behavior of individuals on probation.

The method most commonly used to track offenders on probation involves having them check in with probation officers at a set frequency (e.g. every month). However, it is not uncommon for offenders to lie about their alcohol use behavior. Random unannounced visits to the offender's home or place of work are occasionally conducted by probation officers; however, this imposes enormous costs with regard to manpower and logistics. Electronic monitoring systems based on Global Positioning System or wearable devices [2] have been devised to facilitate the monitoring of alcohol use and keep track of offenders; however, these schemes [6] tend to suffer from some false positive detections, increase the stigma of confinement, and impose a financial burden on indigent families. Furthermore, offenders with alcohol use problems often attempt to cheat the system to prevent their alcohol use being detected. Offenders diagnosed with uncontrolled or serious alcohol use problems should receive alcohol withdrawal treatment or enter rehab centers; however, their alcohol use behavior must be monitored for extended periods in order to make a qualified diagnosis.

This study designed and prototyped a mobile support system (Figure 1) to assist probation officers and psychiatrist in the management of individuals with alcohol use problems. We devised a portable breathalyzer connected to the mobile phone of the offender via Bluetooth, thereby making it possible for authorities to continuously track alcohol use behavior. Alcohol test results as well as momentary feedback from the user and related contextual information is transmitted to a backend server. This data can then be viewed by probation officers and/or psychiatrist to verify alcohol use behavior and reveal the situations that commonly trigger alcohol use. Psychiatrists can also use the system to provide guidance informed by alcohol use logged in the system.

Pilot Study

Interviews were conducted with three probation officers (one male and two females; ages 37 $\sim$ 45) with more than ten years of experience dealing with DUI offenders. Affinity diagrams were drawn up from the transcripts of the interviews to assist in the grouping of observations. The following issues were identified as crucial to the task of monitoring alcohol use behavior.

Problematic alcohol use or alcohol dependence

All of the interviewees reported that most DUI offenders usually have alcohol use problems or alcohol dependence [7]. This has prompted the Taipei District Prosecutor's Office to collaborate with psychiatrists from Taipei City Psychiatric Center, and refer a large proportion of the DUI cases to outpatient alcohol withdrawal or maintenance programs (referred to as DUI offender treatment). Offenders diagnosed with alcohol use disorder are encouraged by probation officers to enter treatment programs to deal with withdrawal symptoms and obtain guidance in maintaining abstinence in daily life. Our previous work on the SoberDiary project [8] has demonstrated the feasibility of applying mobile technology to assist alcohol-dependent patients in their fight to abstain from alcohol use. This study sought to extend the scope of current treatment regimes by introducing

Figure 3: The interface to summarize the progress and compliance during the probation period. All instructions are currently presenting in Chinese Characters

the SoberDiary system while leveraging the power of law enforcement to deal more effectively with DUI offenders.

Identification of events likely to trigger DUI offenses
While on probation, offenders are expected to follow a set of rules outlined by probation officers, e.g., reporting back to the probation officer according to a set schedule. Many situations can trigger alcohol use; however, these trigger events cannot always be easily recalled and identified through such interviews. The ability to correlate the daily behavior with alcohol use could help to reveal events that cannot be surmised from simple interviews. In this study, we thought that the data logged by the mobile app could assist the offenders to actively make meaningful notes, and therefore share them with the psychiatrists to reduce their problematic alcohol use behaviors.

Preliminary System Design and Prototype

To improving issues identifying in the pilot study, we collaborated with probation officers and psychiatrists to develop a mobile support system, which comprises a smartphone app and a backend server.

Phone App Design
The app includes three modules: alcohol screening, contextual inference, and compliance with probation requirements.

Contextual inference. The app runs in the background to enable the continuous collection of data pertaining to the mobility of users (i.e., *walking*, using a *car*, taking a *bus*, and *other* modes of transport) [5] using GPS, WiFi signals, and the accelerometer on the smartphone.The face verification module recognizes the identity of users based on the Openface face recognition toolkit [4]. After the front camera on the smartphone captures the user's face, the app verifies the ID of the user by comparing it with a model trained offline and held in the SD storage of the phone. All of this contextual information (inferred and input manually) is sent back to the server for subsequent analysis.

Alcohol screening. We modified the design of the portable breathalyzer proposed in SoberDiary [8], by replacing the alcohol sensor with a fuel cell alcohol sensor in order to lower maintenance costs and improve the accuracy and reliability of alcohol screening results. Based on the fact that a few hours are required to metabolize alcohol, we divided the day into four time slots, (morning (3am to 9am), afternoon (9am to 3pm), night (3pm to 9am), and mid-night (9pm to 3am) slots). Our aim was to enhance screening frequency without putting too great a burden on the offenders by having them complete only one test during any three of the four time slots. The results can then be viewed by probation officers or psychiatrists on a webpage as describer later in this section. The face verification module is based on local binary patterns, which are trained offline and uploaded to the phone at the time of installation.

Figure 2 presents the user interface for the alcohol screening test. The use clicks the START button to initiate the test. The app then prompts the user to keep their face within a rectangle appearing on the screen through the front camera of the phone. The app verifies that this individual is indeed the intended user (specified at the time of app installation) and instructs the user to BLOW into the breathalyzer mouthpiece (for at least 5 seconds). The app counts down the time (the number in the center of Figure 2) while continuing to record the face of the user. When the blowing is completed, the app prompts the user to input momentary feedback (i.e., the triggers of their alcohol use). All of the test results, including the feedback and face verification results, are then uploaded to the server for analysis.

Probation progress and compliance feedback. Figure 3 displays alcohol screening results (in calendar view) to

encourage individuals to remain sober. Under the dates are four small rectangles indicating whether the user passed a test within a given time slot (green), failed to pass that test (red), or skipped the test (gray). Moreover, the app visualizes the rewards received by the user based on their compliance with the probation requirements and overall progress to encourage offenders. Finally, in the top card of the window, the app displays the days left until the next appointment with the probation officer or psychiatrist.

Monitoring Services

The web interface used to visualizing alcohol use behavior in calendar view. For each time slot, the webpage indicates whether face verification was passed and the results of alcohol testing and the results (i.e., passed, failed, or missed, and the associated breath alcohol concentration (BrAC) values) of each screening test. Probation officers or psychiatrists can review the webpage to quickly assess drinking behavior and verify that the designated individual actually took the test. Moreover, specific life events have been shown to trigger alcohol use. The web monitoring module also correlates alcohol use records, inferences concerning the mode of transport, aberrant alcohol use behavior, and situations in which the user failed face verification. Probation officers can use the web monitoring services to identify situations in which offenders are screened as drinking alcohol and then use a car (as indicated by the mode of transport). Further correlation with actual drinking activity would generate an alert for the probation officer.

Future Work

This paper outlines the design of a mobile support system capable of assisting DUI offenders in reducing DUI relapse while on probation. We are currently collaborating with probation officers and psychiatrists in prototyping the system in a small-scale study involving actual DUI offenders.

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