A Review of Wearable Devices to Detect Alcohol Consumption

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Current wearable alcohol consumption monitoring systems use ethanol sensors [1], [2], alcohol gas sensors [3], and commodity hardware [4], to detect the wearers intoxication. Three of these devices use a sensors placed on the skin [1]–[3] and one of them uses the built-in sensors of smart phones [4]. Commercially available devices also exist to monitor alcohol consumption in real-time [1][5][6]. However, there are limitations with these devices, such as subject specific calibration and detection methods, cost, lack of intervention functionality and lack of social based accountability. It should be noted that a commercial device is currently in the works that does incorporate social accountability [7], however it relies on user feedback and to our knowledge does not incorporate machine learning techniques.

In 2013, the Centers of Disease Control and Prevention (CDC) found that on average a person was killed every 51 minutes do to an intoxicated driver [8]. Also, in a study conducted in 2006 found that there was high correlation between sexual assault and alcohol consumption [9]. Preventing and intervening during these types of behaviors can have great mental and physical health benefits. Imagine if that college student was not sexually assaulted and was spared the mental trauma because her friends were notified of her intoxicated state and were able to intervene. Imagine if that innocent bystander wasn't killed by an intoxicated driver because the driver was able to assess his/her intoxication before getting behind the wheel. Obviously, the blame falls on the individual assaulter and driver, though having technologies that can prevent these actions is highly desirable.

One of the most common approaches to detecting consumption is to use transdermal ethanol sensors. A 1993 study describes the testing and verification of a Giner Inc. wearable transdermal ethanol sensor [1]. Experiments were conducted with "intoxicated" subjects (e.g. subjects who had consumed known amounts of ethanol) and with "sober" subjects (e.g. subjects who had not consumed ethanol). A control measurement was also gathered using a breathalyzer. Measureable amounts of ethanol vapor are known to perpetrate through the sweat glands and in this study was shown to closely follow the breath blood alcohol concentration curve. The consumption curve of the ethanol sensor compared to the control was found to be right-shifted by up to 120 min. This result "suggest the existence of a distinct pharmacokinetic compartment for cutaneous ethanol" [1], meaning there is a mechanism within the body that determines how the ethanol reaches the skin. This result is similar to the delay in alcohol levels found in urine. This work showed that it is possible to measure alcohol consumption using vapor sensors placed at the skin and the study is widely referenced in the field.

A less common approach is to use commodity hardware such as an Arduino and gas sensor. In 2017 Blackburn Cnaptic did exactly that by using an alcohol vapor sensor, a 3-axis accelerometer, and a 3D printed case to create a wearable that was able to detect alcohol [3]. This was a proof-of-concept project that was able to show that commodity hardware was able to detect alcohol to a degree of accuracy. However, the device did not actually measure the consumption of the wearer instead it merely detects alcohol in the air.

We plan to build off these studies and more by creating a device that is able to detect alcohol consumption using commodity hardware and machine learning techniques. Though previous studies have used machine learning techniques to investigate accelerometer and gas sensors ability to detect alcohol consumption. We aim to replicate their results, and to investigate the ability of these techniques to detect consumption in real-time.

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