Drunk Driving: Technologies To Measure The Concentration Of Alcohol

Drinking and driving is against the law. No adult can consume above 80mg of alcohol per 100ml of blood. The effects of alcohol to the brain, slows down a person's reaction time e.g. would take a longer period to respond to a hazard. The extra distance travelled in that time is called the 'thinking distance'. Each drink taken, can increase the thinking distance by 20%.

Drunk drivers underestimate the distance and speed of other vehicles on the road hence to why the rate of accidents has increased significantly over the past years. As when a person is drunk they are not in a suitable mindset to be driving a car as they put their own life as well as others lives in danger (Ref 2).

To decrease the number of accident caused due to drunk driving, there are many solutions such as;

- Breath-Based system fitted into the car.
- Touch-Based system fitted into the car (via engine button)
- Watch detecting alcohol (via Bluetooth)

Breath- Based system:

The breath based system is designed for drivers to exhale their breath into the sensor. This would measure the concentration of alcohol and carbon dioxide present. The known quantity of carbon dioxide in human breath serves as an indicator of the degree of dilution of the alcohol concentration in exhaled air.

Molecules of alcohol and other substances such as carbon dioxide absorb inferred radiation at different wavelengths. An Auto liv device directs infrared light beams on the breath sample and analyzes the wavelength returned to quickly and accurately calculates the alcohol concentration (Ref 3).

Prototype testing:

To test out some of the purposes of the design; DADSS research program has developed a wet gas simulator. The purpose of the simulator is to blend gases such as carbon dioxide, nitrogen and oxygen with moisture to create an "exhaled breath", to match the temperature and pressure of a natural human breath. Ethanol can then be added to the simulator at different times, to see if the prototype is able to detect the ethanol (Ref 3).

There are two types of tests for alcohol: direct or passive testing. A breath based system is known as a passive test, as a driver would not directly be breathing into the system. The advantages of passive testing are:

No mouth piece is required; the breath based system would be made as a sensor, which would

be attached just above the steering wheel. This would allow the breath based system to sensor within 20” of the steering wheel.

Quick Detection: The breath based system would be able to detect on whether the driver is in a suitable condition to drive or not, within the first 10 seconds of sitting in the drivers seat; only after that the driver would have access to turning his engine or then not being able to drive.

The disadvantages of passive testing (from previous results):

The breath based system may not be able to accurately detect the amount of alcohol is within the body. If so, the system would allow a driver to start the engine even if they are not in the set condition, or may not allow the driver to start the engine even if they are able to drive.

The system input would be expensive, which would prevent a lot of people from purchasing cars that have a breath based system installed (Ref 4).

Making of a similar project:

Alcohol Sensor MQ-3:

Evaluation: After evaluating the breath-based system. This process would not be used to help prevent drunk driving. Even though, there was many positive point and ideas with this process, they were a few major issues with this solution e.g. the breath intake can give out negative results, which can put a driver’s life at risk by allowing them to drive, the breath detector would be also be fooled as people can take other people (passengers) to take the test on behalf of them so that they are able to drive.

Bluetooth smart watch:

As we are aware that the percentage of drunk driving has increased significantly; one of the main reasons for this is because of the design of the vehicle. Current vehicles design does not mainly focus on the impacts of drunk driving and how they can help prevent the issue.

Another solution I have come up with to prevent drunk driving, is to work on a current ordinary watch alcohol detector, and to simply innovate the product so that the watch is automatically Bluetooth connected to the start/stop engine button on a car.

How Bluetooth works:

Bluetooth technology essentially works by using short-range wireless communication technology to connect two devices together. This eliminates the need for cables or wires. Bluetooth uses frequency-hopping spread spectrum, which is a radio technology. Frequency-hopping spread spectrum is a technique of transmitting radio signals by hopping or changing a carrier among many frequency channels, using some sequence which is known to both transmitter and receiver.

Using the same Bluetooth process, one of my solutions is to allow my car engine button to be connected via Bluetooth. By this I mean that my car engine button would also have a Bluetooth device built within it, which can be connected to any smart watch.

The purpose of this is so that the smart watch would be able to detect they top layer of the skin, whilst it rests on your skin; and if you want to start up the car, the smartwatch would already be connected to the car via Bluetooth, if the level of ethanol within the body is above 0.8mg/l the car will automatically switch off, whereas if it is below then the circuit would continue and the engine will turn on.

This idea also improves safety, as it would prevent theft. The people only insured on the car would be able to connect to the engine, meaning is someone was able to come into the car, there would not be able to start it.

Touched-Based system: (start engine button)

The aim of my project is to create a touch base start/engine button, that would be able to detect alcohol through finger print detection. This device would allow a significant decrease number of accidents due to drunk driving. This would also make the roads safer for other car drivers as well as any drunk drivers off the road.

The touch based system is designed to detect the amount of alcohol found beneath the skins surface (in the capillaries). Blood pressure is measured by shining infrared light on the driver's skin, which would flash onto the skin and into the tissues. A sample of light is then reflected onto the skins surface, where the information would be collected on a touchpad. The light would also contain information such as the concentration of alcohol with in the body, and from there the system would be able to detect on whether the engine would be started or not (Ref 6).

There is a specific wavelength, that signal the existence of alcohol. The touch base system would be designed, so that its only focus would be on the wavelengths where alcohol is presence, this would be done to ensure the speed and accuracy of the system. The wavelength needed to detect alcohol is called: Tissue Spectrometry System.

Tissue Spectrometry System:

The Tissue Spectrometry system is a noninvasive method that uses the near infrared region of the electromagnetic spectrum, to measure a substance (ethanol) within the body. The measurements are taken, by exposing the users skin to the NIR light, which would absorb into the tissue (circumstance: skin in contact with device). The wavelength could penetrate up to 5mm in to the skin, this would allow it to reach the dermal layer. This layer is where the alcohol is dissolved in water. A portion of light is then reflected on to the skins surface, where the information would be collected on an optical touch pad. The purpose of the light is to analyze the concentration of alcohol, as well as being able to detect the specific user at the time. This is so that when the system is built in to the car for the engine/start button, is would not be misused as the fingerprint would only be programmed to detect the drivers results.

Research has shown that the length of the wavelength can have an impact on the final reading, as when the wavelength is between 1.25?m – 2.5?m, it would give a higher sensitivity and selectivity for alcohol measurements; compared to when the wavelength is between 0.7?m – 1.25?m. The advantage of having the spectrum between 1.25?m – 2.5?m in comparison to 0.7?m – 1.25?m, the signals would be hundred times stronger, allowing there to be an accurate reading (Ref 7).

Does skin temperature effect the amount of alcohol detected within the body?

Alcohol dilates the arteries as well as increases the blood flow through the skin including the finger, hands, toes etc. This would allow your body temperature to do increase, but not by a significant amount. Which may not affect the results of the touch base sensor, when taking the reading. When a person is drunk they are impacted in many ways such as:

- A decreased perception and a sensation of cold, this means that when a person is drunk, they are not aware of how cold/warm their body may be, hence to why they would have no reaction to when the body is cold.
- A heavily drunk person, may have a decreased shiver rate, meaning there body would therefore produce less heat, compared to a person who has not had a lot of alcohol intake, but both ways the touch base system would be able to instantly recognize the amount of alcohol has been consumed, by using a stronger spectrum (Ref 8).

To confirm that the temperature does not affect the detection of alcohol in the body, some primary research would be done. As this would help improve my research as well as may or may not solve different problems with the existing design. Once the prototype for the touch base system has been made, I would like to use a random selection of people, where they have had the same amount of intake of alcohol but are placed in to different atmosphere e.g. placing someone in a room where the temperature in going to be higher then placing then in a cooler room where their body temperature would be lower. I would then compare the results to see on how much of an impact the temperature of the skin would have when detecting the amount of alcohol.

Another test to be conducted as part of my primary research, would be to measure the amount of alcohol detected within the body by using different wavelength spectrums. This would allow me to come to a judgement on whether a stronger spectrum has a better impact of detecting alcohol or if a lower level of spectrum would be better.

How long would the sensor take to detect the alcohol consumption within the body? The aim is to make the sensor so that it can detect the alcohol consumption within the first 10 seconds of the driver’s finger being in contact with the engine/start button. This would be done by programming the sensor, so that it would have an instant response on whether the circuit would be completed, and the engine would have access to be turned on or whether the circuit would not be completed, meaning that the alcohol intake is to much.

Problem:

Whilst doing my research I had come across a problem, that could affect my finished product. There are many different types of sensors, used for many different purposes. Having this into mind, a problem for me would be on how to connect the specific type of wire to the sensor, which would then allow the engine to start or not, as well as being able to give the sensor a timer of 10seconds to detect the alcohol level, as I am aware that being drunk can make a person frustrated or even make a normal person late for their plans, hence to why I want to resolve this issue.

How to resolve the problem?

The most suitable sensor for this project would be a resistive touch sensor. The advantages on using this sensor is: it is stylus versatility – meaning that you wouldn't need a specific type of stylus for the system to work (wider range of use), High sensor resolution – resistive sensors have a higher number of sensors per square inch, this means the sensor overall is more powerful when detecting information (Ref 9).

System Diagram:

Resistive Touch Sensor:

Resistive sensors are a form of touch sensor, which can be used for distance and pressured applications. They can be operated with finger touch or mechanical stylus. The sensor consists of having two layers which have a gap between them, and when the layers encounter each other the sensor would respond.

This sensor would be the most suitable sensor compared to many other sensors, as my project also consists of being a touch base system. Just the way this sensor is used for stylus/fingers, my engine/start button would also be designed to be touch screen, this is where it would detect the amount of ethanol (provided from research) in the capillaries.

A resistive touch screen is made of two transparent layers of glass or plastic, each coated with a conducting layer of Indium Tin Oxide (ITO). The conducting sides face one another and are separated by an air gap.

When pressure is applied by the user, the top layer bends and touches the bottom layer. This causes a small amount of current to flow at the point where they connect. The location of the touch event can then be measured by the sensors. Unlike most other types of touch screens (capacitive, infrared touchscreen technology) these screens have moving parts. Depending on how they are fabricated, these screens can be classified as:

- Analog 4 wire resistive – In this variant, if the top sheet has electrodes for the vertical direction (Y), the bottom sheet will have electrodes for the horizontal direction (X). The top and bottom sheets measure each others' voltages and based on that sensors can determine the location of the touch point.
- Analog 5 wire resistive -In this variant, the voltage of the bottom sheet is measured by the top sheet, with electrodes placed at four corners of the bottom sheet. The top sheet does not have any electrodes.
- Analog 8 wire resistive – These screens are similar to Analog 4 wire screens. The only difference is an extra set of electrodes, which automatically take care of alignment and recalibration issues that crop up in the 4 wire screens over long term use.

Pros of Resistive Touch Technology

- Inexpensive to make.
- Can accept an input from anything, including pens, gloved fingers etc.
- Can be easily assembled from the component parts; screens and
- sensors.
- Can work in rain or in the presence of other fluid.

Digital Sensor (Process):

What is Digital Signal Processing? Application of mathematical operations to digitally represented signals ƒ Signals represented digitally as sequences of samples ƒ Digital signals obtained from physical signals via transducers (e.g., microphones) and analogue-to- digital converters (ADC) ƒ Digital signals converted back to physical signals via digital-to-analogue converters (DAC) ƒ Digital Signal Processor (DSP): electronic system that processes digital signals.

Relay (output):

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it).One of the most common types of outputs available is the relay output. A relay can be used with both AC and DC loads. A load is simply a fancy word for whatever is connected to our outputs. We call it a load because we are 'loading the output' with something. If we connected no load to the output (i.e. just connect it directly to a power supply) we would certainly damage the outputs.

Advantages of Relay Output:

- Uses a small amount of power compared to other outputs to operate the relay coil.
- Relay can be used to control heaters, motors, lamps or AC circuits.

Cost:

- 0.5mm clear thin PETG plastic sheet : £7.49
- Transparent conductor 100mm x 100mm: £19.99
- Glass Fiber Tape: £3.99

Legalization:

- Data protection Act 1998:
- Health and Safety at work act 1974:

Feasibility Study:

As part of my project, one of the key point was to create a feasibility study. This was so that my end products meet all the required criteria. By making a table also allowed me to know what solution was most suitable for me.

Looking at the table my solution 3 had met all the above criteria as: the touch base system is an adaptable process, it isn’t dependent on technology because if the touch base screen does not work there is always an alternative method. There are no health and safety issues, that would prevent the touch base system to work but instead it increases the safety of the car as it would prevent it from theft. The main reason for this solution is because it meets the main criteria ‘Help to prevent drunk driving’. The manufacturing costs are going to be very cost effective as I will be using recycled materials, and also my product would be made to a very high-quality

standard, so that it would not need to be replaced often.

The reasons for not choosing solution 1 and 2 is because, the breath-based system would solely be independent on that one function, meaning if there was an issue with the wheels of the car, there would be no other alternative to turn it on. Similarly, solution 2 did not meet the criteria because, the Bluetooth watch was not adaptable to every type of car and was also only dependent on Bluetooth connections, which meant that if the smart watch is not able to connect to the car then there would be no other way on turning the car on. This is one of the reasons to why solution 3 is better than solution 1 and 2.

Evaluation:

After evaluating all three solutions, I have come to a conclusion of proceeding with solution 3. The reason for this is because solution three is the most realistic solution; solution 3 overall has a positive impact to the design of the car as well as the safety of passengers. As the current design of the engine/start button would only be accessed to the drivers insured on the car.