Cheap and Versatile Breathalyzer Box

Fig 1. Sample Metal Box [1]

Team 1 - ECE 445 - Project Proposal - Fall 2019
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1. Introduction

1.1 Objective

Driving under the influence is one of the deadliest problems still faced by the modern world. In 2017, 10,874 people died on roads in the United States in crashes related to blood alcohol content being above legal limits. That year, those deaths made up 29% of all deaths involving roads in the United States. [2] Additionally, alcoholism is one of the most common drug addictions, with an estimated 15 million people in the United States suffering from an alcohol use disorder. [3] These statistics support the fact that avoiding driving under the influence is a problem that many face. The problem is current systems to prevent drunk driving are tied to someone's car rather than the user themselves and are expensive.

Our proposed solution involves building an RFID-blocking box that can hold someone's car keys. That box will consist of three main mechanisms, the breathalyzer mechanism, blood alcohol content display mechanism, and locking mechanism. The breathalyzer mechanism will consist of an alcohol gas sensor to detect the user's blood alcohol content. The blood alcohol content display mechanism will display the user's current blood alcohol content so they can know how far they are from the legal limit. Lastly, the locking mechanism will have a passcode input, and will be able to be locked by anybody, but will only unlock once a correct pass code is entered and the breathalyzer has detected an alcohol level below the legal limit. Our focus is to create a portable and low-cost solution for those seeking to drive safely.

1.2 Background

People rarely plan, while they're sober, to drive drunk. However, drunk driving is common and current systems to prevent drunk driving are expensive. Bars and restaurants rely on noticing drunk customers and being able to take away their keys. Ignition lock systems are tied to one's car rather than the user themselves and can cost ~$900. [4] We plan to give customers a low cost, car key focused solution. Our solution will allow the user, or customers of an institution with our device, such as a bar, to lock away car keys. These keys can then only be retrieved when the user has entered the correct passcode and safely blown a blood alcohol content that's below the legal limit. This device should make it noticeably easier to prevent driving under the influence.

1.3 High-level Requirements List

1. Breathalyzer box should be able to accurately measure and display the user's blood alcohol content on an LED display.

2. The passcode can interface with the alcohol gas sensor such that the breathalyzer box needs a value below the legal limit and the passcode needs to be set correctly to open the container.

3. The breathalyzer box should be able to prevent a push-to-start key from being used while it is inside and as an all-encompassing solution cost less than $50.

2. Design

2.1 Block Diagram

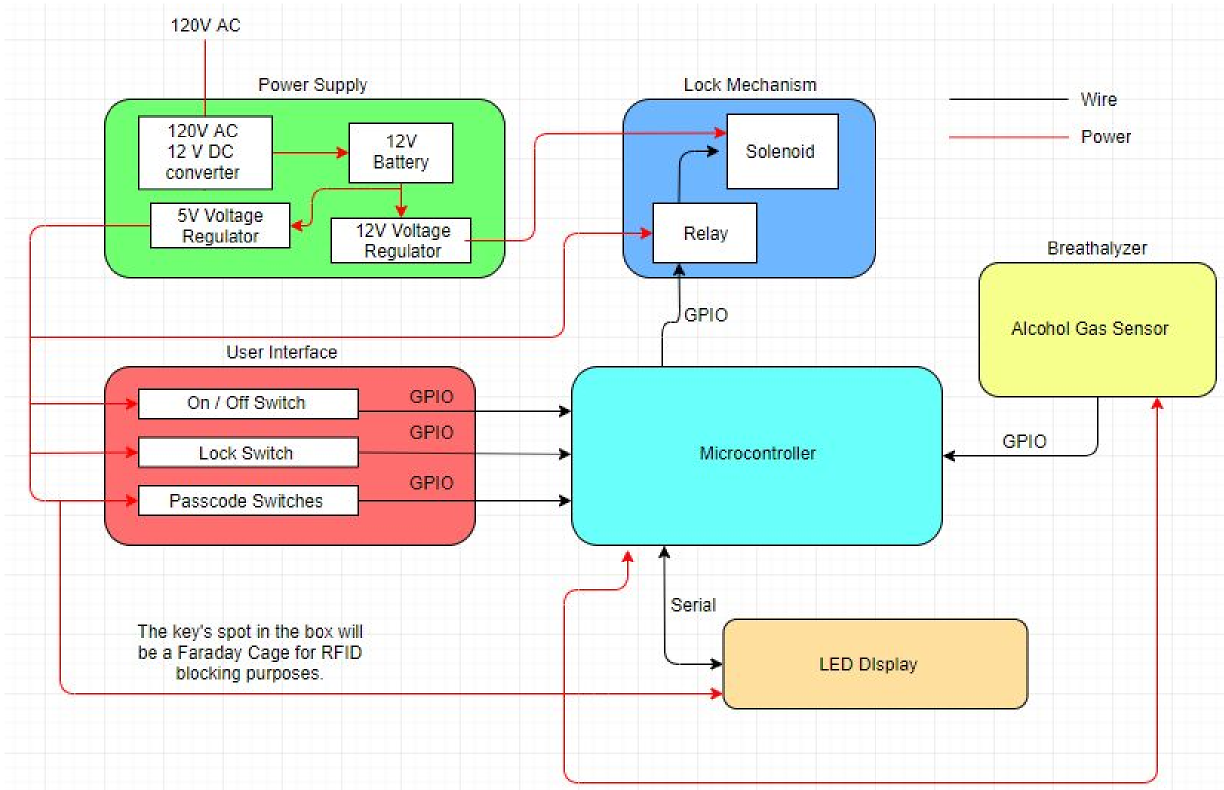

Fig 2. Project Block Diagram

2.2 Physical Design

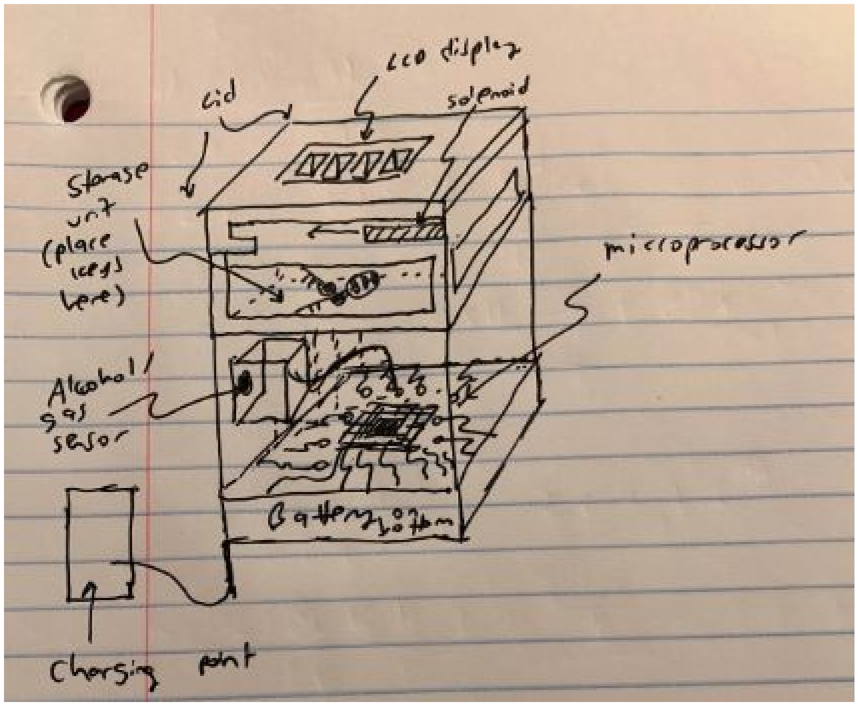

Fig 3. Physical Design

Above is a 3D hand drawing of our design. It contains cross-sectional views of each of the parts of the design. On the bottom is our rechargeable 12V battery. The microprocessor and PCB that we'll be using are on top of that. The alcohol gas sensor comes out of the side of the box and has connections to the microprocessor / PCB. On the lid is the LED display, which provides users their blood alcohol content information. The solenoid is to one side of the container and locks by extending into a notch on the side of the container. Lastly, in the middle of the box are the keys. The container is RFID proof.

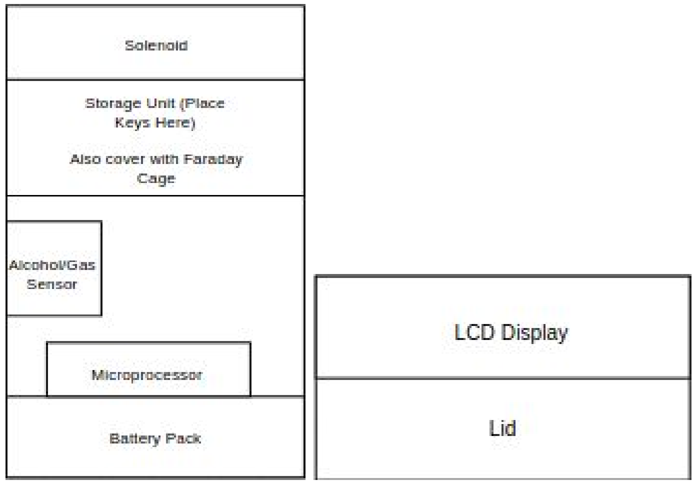

Fig 4. Top down view without lid (left) and with lid (right)

The top-down view both with and without the LID are shown above.

The battery pack is at the bottom and sitting on top of it is the microprocessor. They will be secured to help prevent any possible damage. The alcohol gas sensor is located on the side of the box, with a hole to allow the user to blow in. The key storage unit is located on the other side, covered with a Faraday cage as to prevent electrical interference. Finally, the solenoid is positioned on the far side to prevent the lid from opening when engaged.

The LCD display sits on top of the lid. It is a seven-segment display that is only able to show numbers, but that is all we will need. The LCD will show the user their current blood alcohol content.

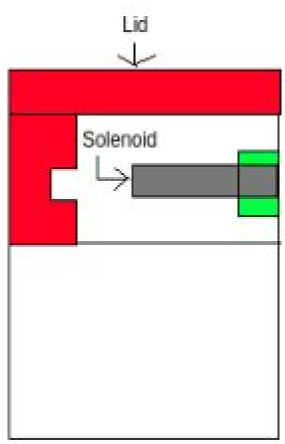

Fig 5. Side View

Above is a side view diagram of the solenoid as part of the lid-locking mechanism. The gray solenoid extends until it fits the groove making it impossible for a person to pull open the lid of the box. The logic for whether the solenoid extends is dictated by the microprocessor which in turn obtains inputs from the BAC readings as well as the passcode combination.

2.3 Functional Overview

This project has a pretty straightforward sequence of events. Our current design has a form of two factor authentication in which the user needs to breathe into the alcohol gas sensor as well as enter the right passcode. If both of these pass, then the lock will open and allow the person to retrieve their keys from the box. To lock the box, the user places their keys into the box, closes the lid, and flips the lock switch to lock the box. This is the general purpose of the box. The box will also be a Faraday cage to make sure that it is RFID blocking.

In order to reduce the cost of the project and work with the LED display, we plan to use an Arduino mini to handle the logic of connecting to the alcohol gas sensor and sending an output to the LEDs. We plan to use a printed PCB board with associated chips and logic to handle verifying whether the inputted passcode is correct and separately handle the lock logic based on the output from the microcontroller.

2.4 Block Requirements

Power Supply

Must be able to convert 120V AC from the wall to charge a 12V battery. Must be able to take output from battery and convert to both 12V and 5V DC. Must be able to provide enough current to support device for a long night out (minimum 8 hours).

Requirement 1: Provide 12V +/- 0.5V and 5V +/- 0.5V after the voltage regulators.

Requirement 2: Provide sufficient current for the box to remain locked for 8 hours.

Requirement 3: Battery can be fully recharged from a standard wall outlet (can use a wall to USB converter if necessary).

User Interface

The user interface consists of the lock switch, the passcode switch, and the on/off switch. The lock switch must be able to lock the box when the lock switch is flipped. The passcode switch must be able to receive the appropriate passcode from the user. The on/off switch must be able to unlock the box assuming appropriate input from the user, however, the default for the device will be locked when the device is off.

Requirement 1: Securely lock the box when the lock switch is toggled.

Requirement 2: Receive the password input from the user.

Requirement 3: Turn on the device to allow the user to attempt to unlock the box with the breathalyzer and the passcode.

Processor

Must be able to take the input from the passcode switch and the alcohol gas sensor, calculate the appropriate BAC and then send the values to both the LED display and the lock.

Requirement 1: Accurately calculate the BAC based on the resistive measurement sent from the alcohol gas sensor.

Requirement 2: Accurately send the BAC to the LED display.

Requirement 3: Verify the passcode switch, and in combination with the BAC send the appropriate action to the lock switch. Prevent a locked box from being unlocked without receiving the appropriate action.

LED Display

Must be capable of accurately displaying the BAC.

Requirement 1: Receive the BAC from the processor unit and display it on the screen.

Breathalyzer

This is the main component of the device and is for testing blood alcohol content. It must be able to accurately calculate the BAC from the user vs. a commercially available BAC device. Must be able to accurately send the BAC to the microcontroller.

Requirement 1: Calculate a user's BAC to within 0.02% vs. a commercially available BAC.

Requirement 2: Accurately send user's blood alcohol content to the microcontroller.

Faraday Cage

Must be able to prevent car with keyless ignition from turning on with the key in the box.

Requirement 1: With the key inside and the box locked, a car with a keyless ignition system must not be able to start.

2.5 Risk Analysis

A significant risk of this design is the blood alcohol content detection. The sensor must pick up the BAC reading accurately and only if the levels are below a certain threshold can the solenoid release. Since the premise of our entire project hinges on whether this part works properly, it is important that the sensor is able to pick up accurate information. Otherwise, the box will function as merely an ordinary safe. Or it may just prevent the user from obtaining their belongings.

As an extension to this, since the user must breathe into the box, we must carry out tests to determine how variance in the angle and distance the user breathes from affects the readings by the sensor. A more intoxicated person is less likely to be able to accurately breathe into the box, however, if that affects the readings, they might be more likely to be able to retrieve their keys.

A more niche and less likely risk would be the positioning of the solenoid with regards to the groove. If in the unlikely case the solenoid is pointed widely off target, or it shifts as the user carries it, it may damage the internal internal components of the design. It's not very likely that this will cause much damage but it is still a potential problem to look out for.

2.6 Extension Goal

We feel that in the long-term our project has significant potential, and that a part of this potential can be realized through additional features. As a result, we have come up with an extension goal for our project, should time permit.

Our extension goal for our project is to provide users with a way to calculate whether or not they can have another drink based on the time they want to travel home. For example, a user can enter their weight, height, age, and gender. They can then blow into the breathalyzer and see that based on their current blood alcohol content, and if they want to travel home in 2 hours, see that they can have 2 more standard drinks.

The requirements for this project would be a number pad, and some sort of memory system, potentially attached to the Arduino. The LED display, and a series of buttons, would allow the user to decide if they want to save information. They could then decide if they want to use the next breathalyzer reading to count the number of drinks left rather than use it to unlock the container.

There is a major potential ethical issue with this in that it could potentially advocate someone getting as close as the legal limit as possible before driving home. Even a blood alcohol content below the legal limit has noticeable effects on someone's psychology and reaction time, over a blood alcohol content of zero.

Another ethical consideration is that by implementing this extension goal, we will be collecting personal information (height / weight / gender) from users. Pursuant to the ACM Code of Ethics, "Honor confidentiality", should we collect this personal information about users we will make sure to securely store it and not send it anywhere outside of the device.

3. Ethics and Safety

As with any consumer product, there needs to be some safety considerations with our product. The first is that we need to make the breathing module easy to clean as well as safe to put in one's mouth. A dirty module could mean inaccurate readings or cause damage to the components. Cleanliness helps prevent other potential health issues that could come from bacterial growth. We need to use a safe material for the breathing module so that we can prevent any issues.

This product is meant to be taken out to places where drinking may occur, so it may be exposed to harsh elements like water or sugar/salt. We need to make sure that all sensitive electronic components are enclosed such that these elements don't damage the product. And in the case that there are spills on or near the box, we need to make sure that it is easy to clean.

On a similar note as the last point, we are using a battery to power the product, and such we need to make sure that the battery module is safe to use and has no risk of damage to the product or the person using it. This is by ensuring we take precautions when routing power to the various components. We will make sure to conduct thorough testing to ensure that this product will have no issues regarding power consumption.

One of the ACM Code of Ethics is to "Honor confidentiality."[5] We are making sure to abide by this by keeping all the information about blood alcohol content only available to the user of the product and not shared outside of the scope of the product. All of the data that is being used to help the consumer make a smarter choice should be confidential to the user of the product.

Another of the ACM Code of Ethics is to "Avoid harm."[5] Since our device involves providing users with the ability to operate heavy machinery, by allowing them to get access to their keys, along with the usage of electrical equipment when charging, we will make sure to provide users with the appropriate warnings and information. We will also exhaustively test the accuracy of our alcohol gas sensor. In the event of uncertainty in the alcohol gas sensor's detected value, we will err on the side of caution in terms of letting users access their keys.

4. Citations

[1] *Small Gray Combination Lock Box*, WFCDN. Available at: https://secure.img2-fg.wfcdn.com/im/53242573/resize-h800-w800%5Ecompr-r85/6553/6553667/Small+Gray+Combination+Lock+Box.jpg

[2] *Impaired Driving: Get the Facts*, Center for Disease Control and Prevention, 2019. Available at: https://www.cdc.gov/motorvehiclesafety/impaired_driving/impaired-drv_factsheet.html

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