# **ALLDET**

Fall 2019 ECE Senior Design Team

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**Project description**

The goal of this project is to design a non-invasive system that will determine the level of liquid remaining in a container, such as a beer keg. The detection systems that exist now require invasive procedures that call for either new lines from the kegs to the taps or entirely new taps altogether. This creates an issue for businesses that either do not have the revenue to install new lines and taps or cannot afford the downtime or headache of new tap, or line, assembly. Our team will design a small, easy-to-use system that is entirely non-invasive, easily installed, and affordable.

We will use a small rotary or stepper motor, controlled by a microcontroller, to activate a small mechanical arm with a metal ball on the end, to act as a “bopper.” Once the motor swiftly spins the arm, causing the mechanism to strike the side of the container, vibration sensors strategically placed on the keg will pick up the signal. We will have taken prior measurements from containers that were empty, full, and at other intermittent levels that will be used to compare the signal response. These sensors will communicate with our microcontroller so that we can display the data via mobile application. This mobile application will have a simple interface that will provide useful information to the user, such as estimated liquid level, alerts, usage history, and intermittent measuring options including by weight, ounce, or time. Our project will provide a simple, inexpensive, and non-invasive solution to a major issue within many fields, including the restaurant, bar, and beer-brewing industries.

In the case that the above method is inaccurate, we will design a proprietary smart scale to determine the level of liquid remaining in the keg. The scale will be placed under the container and the measured weight will be used to determine how much is left in the keg by percentage and ounce. Using a microcontroller, the scale will be integrated with a mobile application that will allow notifications regarding keg level and even intermittent measuring options. This method is not preferred because it requires the container to be set on the device, rather than the device be attached to the side as with the bopper, which would make it much more portable.

## **Background**

The following link is to a keg scale already on the market. This source shows the limited capabilities of existing products in the market.

“Keg Scale.” alcoholcontrols.com.

<https://alcoholcontrols.com/noname.html> (accessed July 2019).

The following article outlines numerous methods for vibration analysis and specifies which algorithms are most useful for different environments:

S. Handley. “Vibration Measurements: Vibration Analysis Basics”. blog.mide.com.

<https://blog.mide.com/vibration-measurements-vibration-analysis-basics> (accessed July 2019).

The following article discusses the frequency responses of a container with varying amounts of liquid:

Farid, M., Levy, N., Gendelman, “Vibration mitigation in partially liquid-filled vessel using passive energy absorbers,” *Journal of Sound and Vibration* vol. 406, pp. 21–22, Oct. 2017.

## **Context**

### **Ethical**

The ethical responsibilities behind this project are primarily associated with information security. We must ensure the accurate and secure transfer of data from the sensor to the app, without the data being intercepted or altered. In addition, our device must not affect the liquid in any negative way. Utilizing vibration sensing from outside the container will ensure that the liquid is unaffected by the measurements.

### **Professional**

Professional responsibilities are to ensure an effective, accurate system for monitoring liquid levels through vibration sensing.

**Global**

Our product will allow any restaurant or bar or home brewer to serve its customers or guests more efficiently.

### **Economic**

Our product will allow for beverage use tracking throughout the day, giving the users a more exact understanding of consumption patterns. This will help to prevent under/overstocking, as well as identify heavy usage times, allowing for appropriate preparations to be made. It will also be a major benefit when logging inventory. Rather than a restaurant manager having to enter information about his or her inventory manually, our system will keep track of all the information he or she would need to know. Although price points have not been established, we have spoken with consumers who say they would be very interested in our product. The benefit of making our product inexpensive to build is that we can mimic any price market that would allow our product to sell while still being profitable.

### **Environmental**

The operating environment of the device could vary from user to user. The device will likely be placed inside a cooler, creating a cold, noisy environment. Our design will use properly rated parts for cold environments, and our program will ignore peripheral noise. Since the device will be exposed to condensation from the side of the container, appropriate waterproofing will allow the device to operate if it comes into contact with a small amount of moisture. Should the product be struck by another keg, it will not affect the readings because the sensors will only activate on movement of the arm. The casing will provide durability, but we strongly suggest against rigorous collision with the product, as it does consist of electronics.

### **Societal**

Providing an inexpensive level monitoring system will improve the social experience both out at a restaurant/bar and for the home brewer at in-house gatherings by allowing the host to monitor keg levels and have replacements on hand and readily available.

## **Detailed design**

**Hardware:**

* **5.2 gallon beer keg**
* **Microcontroller**
* **Vibration sensor**
* **Rotary motor**
* **Battery**

**Software:**

* **Smartphone app**
* **Signal analysis software**
* **Server communication (for linking multiple devices)**

This project will use a combination of vibration or rotary motor(s) and vibration sensor(s) to determine the level of liquid remaining in a ⅙ barrel (5.2 gallons) beer keg. Since beer kegs are metal containers, striking them will create resonances that will vary depending on if they are full, empty, or anywhere in between. Knowing this, we will use a vibration or rotary motor to send an impulse through the metal container in order to give our vibration sensor usable data. We will measure the vibration frequencies generated by the keg at regular intervals from full to empty. These results will then be used as a baseline to determine how much liquid is remaining inside the barrel. Using a microcontroller to control the motors and gather feedback from the sensors, we will be able to make the information accessible to the consumer through a mobile

application. Since these motors and sensors are very cheap, our application will provide an inexpensive and non-invasive solution for an extremely large market.

The device will be battery powered. The battery will be selected to provide the longest amount of life on a single charge without causing the device to be too bulky for easy placement. Because there will not be many parts, the battery will be large enough to allow for several weeks of use without causing the device to be too large to be usable. We will also use either Wi-Fi or Bluetooth capability to link several devices, depending on which application appears to be less difficult to use.

During our rudimentary tests to determine if this method was feasible, our vibration sensor output approximately 750 mV when the container was struck while empty, and never more than 300 mV when it was full. When the striking of the container is automated, this range should be sufficient to determine the current volume of liquid in the container with accuracy.

If, however, the vibration detection method should prove infeasible, we will design a proprietary smart scale to determine the level of liquid remaining in the keg. The scale will be placed under the container and use the measured weight to determine how much is left in the keg by percentage and ounce. Using a microcontroller, the scale will be integrated with a mobile application that will allow notifications regarding keg level and even intermittent measuring options.

## **Responsibilities**

**Jesse Tutor - Embedded development/web development**

**Zach Fauver - Signal processing/development**

**Khara Robinson - Web development/electrical & mechanical design**

**Andrew Bullington - Application & embedded development**

**Ryan Ladd - Team lead/electrical & mechanical design**

**Everyone - Research/documentation**

## **Schedule**

August - Finalize design and order parts

September - Build prototype and begin phone app development

October - Finish programming, test, and debug

November - Deliver final design