**2. Design Requirements/Constraints**

ALLDET will provide a way for keg owners to determine the amount of liquid in their containers without having to move them, weigh them, or spill any liquid. Our product will provide a non-invasive, hands-free method for level monitoring that requires no new taps or lines, all while maintaining a lower price point than our main competitors. This document will outline technical and practical constraints that need to be met to achieve this goal.

* 1. **Technical Design Constraints**

**Table 2.1. Technical Design Constraints**

|  |  |
| --- | --- |
| **Name** | **Description** |
| Temperature | Our device needs to be able to operate down to 0℃. |
| Accuracy | The device needs to determine the liquid level with an accuracy of +/- 5% of actual amount. |
| Wireless Transmission Distance | The Bluetooth connection must reach up to 9 m. |
| Battery Life | The device must continuously run for 16 hours using a battery. |
| Noisy Environment | The readings of our sensor must be accurate within an environment of 80 dB. |

**2.1.1. Temperature**

ALLDET will need to operate at any range of temperatures that a keg would be exposed to. Kegs would likely be refrigerated or kept in storage. The ideal temperature for a beer keg is 3.3℃ so make sure that the foam is not too cold which causes the beer to taste flat and not too hot which causes it to foam up too much [7]. Therefore, the device would need to be able to operate at a temperature range of room temperature (20-25℃) down to freezing (0℃).

**2.1.2. Accuracy**

ALLDET will need to report the liquid level of a keg to the user. Although our method of measurement will be convenient and not require lifting, it will not be as accurate as weighing the keg. However, our customers will likely not care about the level being reported to them being accurate down to the single percent. It is more likely that they would care more about having a general idea of how much liquid is left in the keg, especially considering some people that we have talked to had been just guessing the level based on lifting the keg with one finger. Therefore we have chosen a constraint for our device to report the liquid level with an accuracy of +/- 5% of the actual amount.

**2.1.3. Wireless Transmission Distance**

ALLDET will send recorded data to a smartphone application for display and processing. This data will be sent wirelessly through Bluetooth and should be accessible from a short distance away to ensure that the user does not have to go into the refrigerator holding the kegs to get the data. Preferably this distance would cover a large portion of the restaurant or bar so that the users can access this data at their convenience. The coverage area of Bluetooth Class 2 devices is about 10 meters, so we added a design constraint of Bluetooth connectivity up to 9 meters to account for the kegs needing to be inside an enclosure or needing to be connected through a wall [8].

**2.1.4. Battery Life**

ALLDET’s battery life must match the expected life of a keg in use. If customers must change or recharge the battery before the container has been fully used, that will greatly decrease the value of our product. The benefit of our device is that it is a hands-free, automated method for inventory tracking. If the battery must be recharged or changed before the keg must be replaced, that is taking time away from our customers. The device can be removed when the keg is dry and the battery recharged before being attached to the next container.

**2.1.5.** **Noisy Environment**

ALLDET will need to be able to reliably measure the level of a keg within an environment that is typical of a bar or a restaurant. A noisy restaurant is approximately 85 dB loud, and since a keg will be contained in a refrigerated casing, we are aiming to be able to measure within a background noise of 80 dB [11]. In the case where measuring is done outside of the container, it can be assumed that it will be during non-peak hours in a less noisy environment.

**2.2. Practical Design Constraints**

**Table 2.2. Practical Design Constraints**

|  |  |  |
| --- | --- | --- |
| Type | Name | Description |
| Economic | Cost | To ensure our customers a short ROI, ALLDET will keep the device cost less than $200. |
| Manufacturability | Size | The device must fit on the keg inside the storage station. |
| Environmental | Water Tolerance | The device should be able to work in accordance with the IP52 standard. |
| Social | Application enabled | The device will be connected to an application that the user will be able to customize. |
| Sustainability | Hands-free usage | The device will not need user intervention to operate. |

**2.2.1. Economic**

The ALLDET device will be priced under $200 not only to ensure a quick return on investment (ROI) for our customers, but also to be competitive within the marketplace. Using inexpensive yet quality components, we can drive production costs down. Given an average restaurant manager salary of $50,000 per year, the per diem cost of paying a manager is roughly is $192 [10]. If an estimated 3 days are spent on inventory each year, customers can achieve an ROI within 4 months.

**2.2.2. Manufacturability**

The size of the device must be small enough to attach to the side of the keg and fit inside the serving station. Because kegs are round, even when kegs are placed side by side there will still be some space available. The case must easily attach to the container and be small enough not to impact the storage method.

**2.2.3. Environmental**

The device will be able to withstand some precipitation from the keg and possible beer leakage. The casing shall prevent any liquid from damaging the device in accordance with the IP52 standard [8].

**2.2.4. Social**

ALLDET will have an application paired with the hardware provided. The application will allow the user to track and monitor the liquid level inside of the keg. Also, the app will notify the user when the keg nearly is empty. The app will be easy-to-use and will not require a technical background.

**2.2.5. Sustainability**

ALLDET will have a device that does not require the user to fully interact with it for operations. The hardware will need the user to attach and remove it from the keg, but after that, the device will be self-sufficient via the application. The application will be able to provide you with the readings from the device’s sensors.

**2.3. Appropriate Engineering Standards**

|  |  |  |
| --- | --- | --- |
| Specific Standard | Standard Document | Specification/application |
| IP52 | IP Rating Chart (IEC 60529) | Protects from water spray less than 15 degrees from vertical |
| Bluetooth 5.1 | Bluetooth Core  Specification 5.1 | Used for sending and receiving data from the host device and a smartphone |

**2.3.1. IP52**

The IP52 standard for liquids is to protect from vertically dripping water onto the enclosure tilted up to 15 degrees from its normal position [9].

**2.3.2. Bluetooth 5.1**

ALLDET must comply with Bluetooth 5.1 to ensure connectivity to any smart phone.

**References**

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