**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. The product will provide a non-invasive, hands-free method for liquid level monitoring that does not require new taps or lines, all while maintaining a lower price point than the competition. This document outlines technical and practical constraints required to achieve this goal.

* 1. **Technical Design Constraints**

The following table lists five technical constraints that must be adhered to upon completion of this product.

**Table 2.1. Technical Design Constraints**

|  |  |
| --- | --- |
| **Name** | **Description** |
| Temperature | The device must operate at a temperature of 0℃. |
| Accuracy | The device must 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 run continuously for 16 hours using a battery. |
| Noisy Environment | The readings of the sensor must be accurate within an environment of 80 dB. |

**2.1.1. Temperature**

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

**2.1.2. Accuracy**

ALLDET will report the liquid level of a keg to the user. Although the selected method of measurement will be convenient and not require lifting, it will not be as accurate as weighing the keg. However, 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 potential customers that we have talked to estimate the liquid content by lifting the keg with one finger. Therefore, the constraint for the device to report the liquid level with an accuracy of ±5%, or about two pints, of the actual amount is necessary.

**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. The effective transmission distance must cover a large portion of the restaurant or bar so that the users can access this data at their convenience. Nine meters will certainly accomplish this goal, and is achievable using Bluetooth Class 2 [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, it will greatly decrease the value of the product. The benefit of the 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, it takes time away from the users. The device must be active until the keg is dry, when it can be removed and the battery recharged before being attached to the next container.

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

ALLDET must 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, measuring with background noise of 80 dB will be sufficient to make the product usable [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 lists five additional constraints that must be adhered to for the product to be considered complete.

**Table 2.2. Practical Design Constraints**

|  |  |  |
| --- | --- | --- |
| Type | Name | Description |
| Economic | Cost | To ensure the customers a short ROI, ALLDET will keep the device cost less than $200. |
| Manufacturability | Size | The physical dimensions should be less than or equal to 30 cm high, 10 cm wide, and 10 cm deep. |
| Environmental | Water tolerance | The device must work in accordance with the IP52 standard. |
| Social | Application enabled | The device will be connected to an application that the user can use for liquid level tracking. |
| Sustainability | Hands-free usage | The device will not need user intervention to operate, but need the user to charge it. |

**2.2.1. Economic**

The ALLDET device will be priced under $200 not only to ensure a quick return on investment (ROI) for the users, but also to be competitive within the marketplace. Using inexpensive yet quality components, we can lower production costs. 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 not be greater than 30 cm high, 10 cm wide, and 10 cm deep, based on the dimensions of commercial kegerators and one-sixth barrel kegs [12], [13]. Since kegs are round, even when kegs are placed side by side there will 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 [9].

**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 is within 5%, or about two pints, of being 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 interact with it directly for operations. The hardware will need the user to attach and remove it from the keg, but afterward the device will be self-sufficient via the application. The application will be able to provide the user 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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