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# IllumiMug: Revealing Imperceptible Characteristics of Drinks

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**Abstract**

Drinking is vital, but certain drinks can also harm human health and well-being. In this paper, we present IllumiMug, a concept for a content-aware, interactive cup. The IllumiMug concept is able to measure the temperature and the level of a liquid in a cup and can represent helpful information through ambient light. We discuss some initial design thoughts and illustrate the potential benefits of IllumiMug in two scenarios, i.e., the preparation of proper alcoholic drinks, where the alcohol concentration is measured and shown, and the brewing of safe tea, where the drink's temperature is indicated.

**Author Keywords**

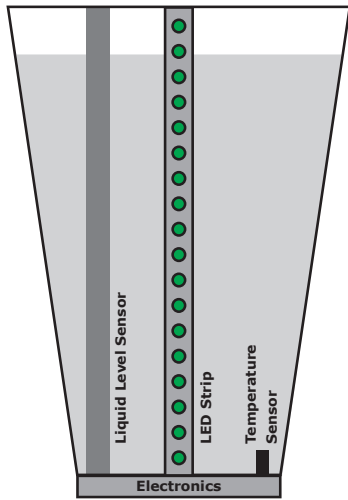
Design; Prototyping; Ambient; Wearable; Light; Display

**ACM Classification Keywords**

H.5.2. Information interfaces and presentation: User Interfaces—*Prototyping*.

**Introduction**

Drinking is extremely important for human beings. A regular intake of water or other drinks is required to ensure a normal physiological functioning of the human body. Unfortunately, not all drinks are healthy, and specific drinks can even harm human health and well-being.



**Figure 1.** The IllumiMug concept is using an Arduino, a temperature sensor, a liquid level sensor, and a LED strip.

For example, an extensive consumption of alcoholic beverages can lead to severe intoxications and is considered to be a major public health issue. Even for moderate drinkers it would be valuable to assess the consumed amount of alcohol, e.g., to self-estimate the remaining driving skills. Less known, but still risky, is the preparation of tea with non-boiling water, which is unable to kill microorganisms and which can lead to, e.g., nausea, diarrhoea, and vomiting. Overall, many beverages come with certain risks, which are hard to assess with human senses only.

In this paper, we propose a concept for a content-aware cup, named *IllumiMug*, which provides the consumer with additional information about a drink's contents or its preparation. This information is presented through decorative, ambient light and clarifies about potential risks, which makes drinking safer than it is today. In the following, we summarize related work, illustrate our conceptual design, and sketch two applications: AlcAware and SafeTea.

### Related Work

Ambient displays are well suited to realise aesthetic, abstract visualizations that are effective and efficient [5, 2]. Particularly *light* offers a huge range of encodings, and can easily be displayed in an ambient way. Tarasewich et al. [6] showed that single LED display is useful for supporting information awareness on mobile devices. They suggested using colours to distinguish between different types or levels of information, e.g., red for "danger".

Indeed, single light sources are often used to raise awareness, warn, or remind a person by, e.g., lighting up or changing their colour. However, in general,

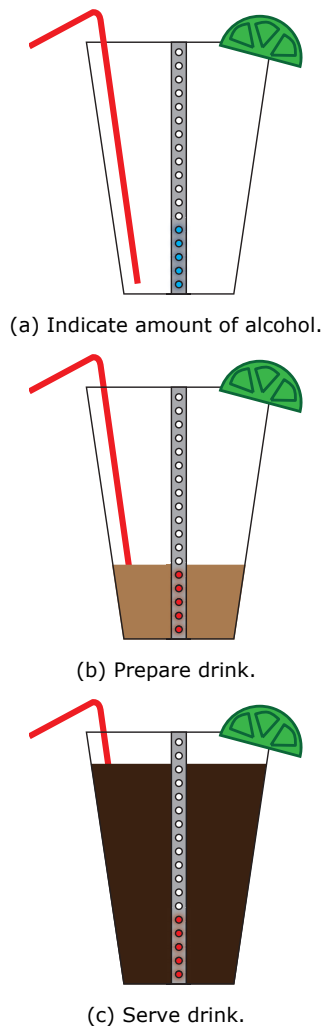
ambient light allows for much broader applications, e.g., in navigation settings or in a health context [3]. Although there are efforts to enhance kitchen appliances [4], ambient light did not yet find its way into a mug.

### IllumiMug Concept

We began the creative process with the identification of common problems with today's drinks and beverages. We found that particularly a drink's alcohol concentration and its temperature are key parameters, which frequently are hard to assess and could potentially harm the personal health and well-being. Further, we identified which are the crucial parts of the preparation process and how these aspects can be measured with nowadays commercially available sensors. During the whole design process we kept in mind that liquids and electronics don't go well together, which motivated us to keep our designs and solutions as robust and reliable as possible.

For alcohol preparation we identified that the alcohol concentration of a drink would be good to know. However, we were unable to find a commercially available sensor, which can provide us with this value. Consequently, we identified a more abstract measure, i.e., level of a liquid, which allows us to draw conclusions on the alcohol concentration. Temperature is a very important aspect for tea preparation. A tea needs to be prepared at certain temperatures to be safe and needs to brew for a certain amount of time. Consequently, the IllumiMug concept should come with a temperature sensor.

We conceptually based our system on the Arduino platform to emphasize the mobile character. We



**Figure 2.** IllumiMug can assist a bartender in preparing a tasty Cuba Libre or any other long drink.

envison to use an Arduino Lilypad or Nano as a core component, which would allow an assembly below the bottom of the cup, similar to the Mediacup [1]. The IllumiMug concept comes with two sensors (see Figure 1). The temperature sensor measures the temperature of a liquid, and the liquid level sensor measures the level of a liquid within the glass. Here we identified the MAXIM DS18B20 digital thermometer to be a good component, providing a range from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . To measure the liquid level we identified the eTape Liquid Level sensor to be most suited, as it comes with a reasonable sensor length of 213 mm and has an almost linear sensor output. For visualization purposes we made good experiences with RGB lighting strips and therefore also plan to use it for IllumiMug.

We have not implemented the IllumiMug concept, yet, although we plan to do so in the near future. Thus, we cannot say anything about the appropriateness of the mentioned components, but would like to illustrate and discuss some potential applications and use cases.

### **AlcAware: Be Aware of Alcohol Intake**

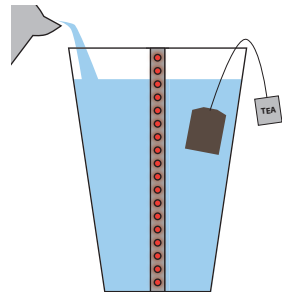
If not self-made, it will be hard to assess the alcohol concentration of long drinks or cocktails. Typically, bartenders often prepare these drinks in a rush and mostly rely on their intention to pour the correct amounts of ingredients into the glass. In consequence, recipes are often not exactly matched, which affects the taste of the drink. If too little alcohol is poured, the consumer might be disappointed because the drink tastes too soft and wonders what the premium is paid for. If too much alcohol is poured, the drink might taste too strong and could lead to intoxication or even mental blackouts.

We envision that the IllumiMug can be programmed for certain drinks, e.g., a long drink typically contains 4 cl of alcohol. Thus, it can give the bartender visual indications how much alcohol should be poured into the glass (see Figure 2a). The IllumiMug concept comes with a sensor that is capable to measure the fluid level within the glass. Thus, it can measure and display how much alcohol was actually poured into the drink (see Figure 2b). This information could remain active when the drink is served to the consumer (see Figure 2c), allowing for a proper assessment of the alcohol concentration. Further, the indicator could serve as a warning for children or reformed alcoholics that this drink might be harmful.

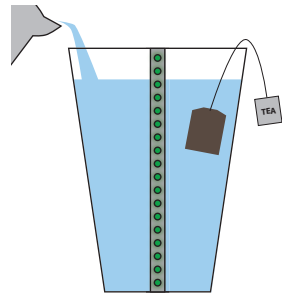
While designing this concept we came across several issues that need to be addressed. First, the data sheet of the liquid level sensor states that the sensor is unsuited to measure solvents or corrosive liquids. It is unclear if and for how long the sensor will withstand alcoholic liquids. Further, the sensor provides a measure for the height of the liquid inside the glass. This needs to be matched to standard *cl*-units that are used in cocktail or long drink recipes. Another problem is that the IllumiMug needs to differentiate between alcoholic and non-alcoholic liquids. We imagine that this can be done through button presses or intelligent sensors. Regarding the interaction concept it is unclear if and how various alcoholic liquids are considered, e.g., if strong rum gets the same presentation as wine.

### **SafeTea: Preparing Safe Teas**

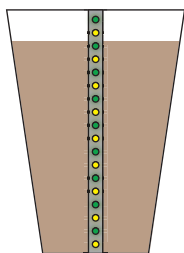
During growth tealeaves are often treated with insecticides and other chemicals to kill various microorganisms. Nevertheless, some microorganisms survive these treatments and find their way into the



(a) Unsafe tea.



(b) Safe tea.



(c) Serve drink.

**Figure 3.** IllumiMug can assist in the preparation of safe tea.

final tea products. If they also survive the brewing process, most likely because non-boiling water is used to prepare the tea, they can cause nausea, diarrhoea, and vomiting when consumed. Consequently, most tea bags state that they have to be prepared with boiling water to get a safe product. This, however, leads to another problem with tea preparation, i.e., that tea is consumed too hot which leads to painful scalds.

This second use case can also be handled by our IllumiMug concept. Because it comes with an integrated temperature sensor it can measure whether the water is hot enough or not. This information can be displayed in an ambient way immediately while the tea is prepared. Our initial ideas use a red colour to indicate that the water was not hot enough to safely kill all microorganisms (see Figure 3a); green illumination indicates that the water was hot enough and drinking the tea is safe (see Figure 3b). The latter visualization can adapt over time, e.g., by reducing its brightness or changing colours, to indicate that the water has cooled and the tea is ready for consumption (see Figure 3c).

Before further prototype development some more aspects should be considered. Most importantly, there exist a variety of different teas, of which some should be prepared with hot, but non-boiling water of a certain temperature. IllumiMug should be able to handle this requirement technically, but somehow needs to be aware which tea will be prepared. From a hardware perspective it would be difficult to implement both design concepts, AlcAware and SafeTea, in one cup as the liquid level sensor is not suited to exceed temperatures of 65°C (150°F). However, in practise nobody would likely enjoy teas and long drinks from the same cup.

## Conclusions

In this paper, we propose the IllumiMug concept, a cup with sensors and ambient light output, which can make otherwise imperceptible characteristics of a drink visible. We sketch how the IllumiMug might be implemented and illustrate two scenarios how the cup can be used in relevant settings. We discussed potential interaction flows and highlighted key technical limitations that need to be addressed in the realisation of this concept. We argue that this paper can inspire fellow designers and developers and can provoke discussions on new domains and future applications.

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