Improved of Smart Vacuum Flask with Beverage Identifier and Temperature Indicator

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Abstract. Vacuum flask has been an essential part of the everyday life of a working person. Nowadays, vacuum flask is not the only function as a liquid carrier but also has been equipped with technology to diversify its function from the essential function. This paper proposes to create a smart vacuum flask that able to classify the beverage type and indicate the temperature range of the beverage. This is attempted to address the user difficulty in remembering the type and temperature of the beverage inside the vacuum flask. This project is built using Arduino as the microcontroller, while LM35 is used to read the temperature sensor. A simple concept of tomography using LDRs and LEDs is used to determine the beverage type. The flask is tested to test nine scenarios: 1) cold and clear beverage; 2) warm and clear beverage; 3) hot and clear beverage; 4) cold and juice beverage; 5) warm and juice beverage; 6) hot and juice beverage; 7) cold and milk beverage; 8) warm and milk beverage; 9) hot and milk beverage. The result obtained indicates that the prototype able to classify all nine scenarios correctly.

1. Introduction

Basically, vacuum flask is a container that has a vacuum space which we called as thermal insulator to prevent thermal losses. As we want to keep the temperature remains in the container, thermal insulation is the most ideal insulator. The vacuum part normally made by the industry nearly vacuum and this shows that industries are mostly agree that the heat cannot travel through vacuum. For the structure of the vacuum flask, mostly vacuum flask has an inner chamber and an outer plastic or metal case which will separate the glass with a vacuum in between. Sometimes, the layer it coated with reflective metal and nowadays lot of durable vacuum flask created which is using two stainless steels with vacuum layer and a reflective layer. For the stopper part, usually the industries prefer to use screw down stopper as it will close the outlet part tightly.

In our daily life, the application of vacuum flask has been implemented in many types of products which make our life more convenient. Example of application of vacuum flask is vacuum flask with heater, ice box, hot milk container, etc. There are lot of companies such as Bakelite (Thermos 1925 Ltd),...
British Vacuum Flask Company and many more. Recently, there is a shift in the vacuum flask manufacturing where the vacuum flask created is no longer serve the function as beverage carrier but also equipped with technology in order to differentiate the product. The introduction of additional feature like temperature indicator [1], automatic stirrer [2], braille [3], tea thermos timer [4], and drink remainder [5] that encourages the existing consumer to purchase additional vacuum flask for these new features.

For this project, the authors attempt to include two new features: 1) temperature indicator; 2) beverage indicator. The temperature indicator proposed in the prototype should able to classify the three ranges of temperatures which are hot, warm and cold. The reason behind this idea is to avoid user accidentally burns their lips when they drink their beverage by knowing the temperature of the beverage in advance. The second feature proposed in this project is a simple beverage identifier that able to classify three type of beverage: 1) clear beverage; 2) juice beverage; 3) milky beverage.

The remaining of this project will explain the methodology of the project, the result and discussion of the project, and conclusion of this project.

2. Methodology

Figure 1 is the block diagram of the proposed prototype which have three inputs which are 1) Light Dependent Resistor (LDR); 2) push button; 3) temperature sensor LM35. The LDR is used to capture the light produce by the light emitted diode (LED) inside the vacuum flask. Using basic tomography concept where it is commonly known that liquid with greater substance will block more light through it compared to liquid with less substance. The temperature sensor is used to determine the temperature of the beverage. This project use LM35 sensor which are installed at the inner metal container (in the vacuum area). The push button is used in this project is as feedback for Arduino to determine the user request. When the user wants to know the temperature and the beverage type, the user is required to press the pushbutton, then the Arduino will process the user request and provide the suitable feedback based on the two sensors mentioned.

Arduino UNO is used as the microcontroller for this project. Arduino microcontroller is known to be programmer friendly and cost effective where the success of the use of Arduino-based microcontroller can be seen in several applications: educational kit [6] [7] [8], electronic game board [9] [10], can crusher [11], etc. The use of Arduino UNO in this project rather than the smaller Arduino Nano because the library of Arduino Nano is not available in the Proteus simulator during the project.
development. There are two electronic components used in this project which are: 1) LED; and 2) Red-Green-Blue (RGB) LEDs. As stated earlier, the LED which is monochrome color is used to provide light for the tomography process in the vacuum flask in order to identify the type of the beverage. While the RGB LEDs are used as indicator for both features proposed by this project.

Figure 2 shows the flow chart of the project, after Arduino detect the user pressed the push button, the LED inside the vacuum flask will turn ON and the LDR will takes several readings until the reading stabilize within the margin of error of 5%. This operation usually takes less than a second. Then, Arduino will decide the respective RGB LED that will be activated which depending on the reading value obtained by the LDR. Next, the LM35 value will start to read the temperature value of the inner metal container of the vacuum flask for several times until the reading stabilize to +/- 1°C. Based on that information, the activated RGB LED just now will turn ON appropriate color based on the temperature range.

3. Result and Discussion

As the proposed prototype is non-invasive sensor where the temperature sensor and LDR sensor is place in the vacuum area of the inner side of the vacuum flask, calibration of the LM11 is deemed necessary. This calibration needs to be done as it necessary to find the linear correlation between the temperature of the liquid and the relationship with the temperature of the inner container. Table 1 shows the relationship between these two parameters and clearly it can be seen that the difference between these two parameters are +/- 5°C and this has been taken into account in the program algorithm.

Table 1: Temperature Testing Result

| Condition | Inside Container (°C) | Outside Container (°C) | Differences (°C) |
|-----------|-----------------------|------------------------|-----------------|
| Cold      | 6                     | 11                     | 5               |
|           | 5                     | 10                     | 5               |
|           | 4                     | 9                      | 5               |
|           | 29                    | 25                     | 4               |
| Warm      | 28                    | 24                     | 4               |
|           | 29                    | 24                     | 5               |
|           | 50                    | 44                     | 4               |
| Hot       | 49                    | 44                     | 5               |
|           | 41                    | 36                     | 5               |
Figure 2: Flowchart of the proposed prototype
Table 2: Tomography Testing Result

| Beverage Type        | Reading 1 | Reading 2 | Reading 3 | Average |
|----------------------|-----------|-----------|-----------|---------|
| Clean Beverage       |           |           |           |         |
| Mineral water        | 96        | 97        | 96        | 96.33   |
| Reverse Osmosis water| 104       | 102       | 103       | 103     |
| Pipe water           | 102       | 102       | 103       | 101.67  |
| Miranda Strawberry   | 5         | 4         | 6         | 5       |
| Fanta Oren           | 1         | 2         | 1         | 1.3     |
| Sunquick Blackcurrant| 4         | 5         | 6         | 5       |
| Juices               |           |           |           |         |
| Milly Base/Dark Beverage |       |           |           |         |
| Nestum               | 0         | 0         | 0         | 0       |
| Fanta Oren           | 1         | 2         | 1         | 1.3     |
| Sunquick Blackcurrant| 4         | 5         | 6         | 5       |
| Milky Beverage       |           |           |           |         |
| Coffee               | 0         | 0         | 0         | 0       |

Table 2 shows the readings taken from several types of beverage for each category to be classified in the vacuum flask. This result used as prove to the range to be set in the vacuum flask is suitable. The calibration shows that the value of these three categories differ a lot which is easy for this project to classify them accordingly. This justify the selection of the value of 0 to represent milk-based beverage, 1 to 19 to represent juice beverage, and remaining as the clear water.

Figure 3 shows three types of beverage from different category which are Cold Plain Water (Clear Beverage), Mountain Dew (Juice) and Milo (Milk Base/Dark Beverage). These testers will be tested in three conditions which are hot, cold and warm. The result will appear as the LED which represents the beverage type will light up with the temperature condition color indicator.

![Figure 3: Beverage used for testing (a) Dasani mineral water (b) Mountain Dew Blue Spark (c) Milo](image)

Figure 4 shows the result of the testing with plain water which light up the correct LED that represents clear beverage. The clear beverage is in three conditions which are hot, warm and cold. The red LED indicates that the vacuum flask contains clear beverage is hot, while blue LED indicates that the clear beverage is cold, and the green LED indicates warm clear beverage.
Figure 5 shows the result of the testing with Mountain Dew Blue Sparkle which light up the middle LED that represents juice beverage. The juice beverage is in three conditions which are hot, warm and cold. The red LED indicates that the vacuum flask contains hot beverage, while blue LED indicates that the juice beverage is cold, and the green LED indicates warm juice beverage.

Figure 6 shows the result of the testing with plain water which light up the left LED that represents milk-based beverage. The milk-based beverage totally blocks the light to pass through beverage. The clear beverage is in three conditions which are hot, warm and cold. The red LED indicates that the vacuum flask contains hot milk base beverage, while blue LED indicates that the milk base/dark beverage is cold and the green LED indicates warm milk base/dark beverage.
Figure 6: Result for Milo in (a) cold condition (b) hot condition (c) warm condition

Table 3: Overall Result for the proposed prototype

| Scenarios          | Temperature Value (°C) | LDR Reacting (light intensity) | Expected Results | Actual Results |
|--------------------|------------------------|--------------------------------|------------------|----------------|
| Cold Water Plain   | x < 20                 | y > 15                         | Right            | Right          |
| Warm Water Plain   | 21 < x < 34            | y > 15                         | Right            | Right          |
| Hot Water Plain    | x > 35                 | y > 15                         | Right            | Right          |
| Cold Mountain Dew  | x < 20                 | 1 < y < 14                     | Middle           | Middle         |
| Warm Mountain Dew  | 21 < x < 34            | 1 < y < 14                     | Middle           | Middle         |
| Hot Mountain Dew   | x > 35                 | 1 < y < 14                     | Middle           | Middle         |
| Cold Milo          | x < 20                 | y = 0                          | Left             | Left           |
| Warm Milo          | 21 < x < 34            | y = 0                          | Left             | Left           |
| Hot Milo           | x > 35                 | y = 0                          | Left             | Left           |

Table 3 summarizes the overall result shown in the previous three figures. The prototype tested on three types of beverages which are Milo (milk base/dark beverage), Mountain Dew (juice beverage) and Plain Water (clear beverage). These beverages tested in three conditions which are hot, warm and cold.

4. Conclusion

This paper presented the prototype of the proposed smart vacuum flask that able to determine the beverage type and beverage temperature. The proposed project is operates using Arduino UNO as controller, a push button as input, two sensors: LDR and LM35, and the RGB LEDs as the outputs. For the temperature this will be +/- 5°C of temperature value as it due to material loss. The proposed prototype tested using three kind of beverage and the result shows it able to detect all the beverage correctly.
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