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Cloud Based Boiling Monitoring System App

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ABSTRACT— Beverages are taken by almost every home in the countries like India and USA. We can collect the beverage from a milk from cow or from any other animal needs to be boiled before use. Boiling helps to kills the bacteria in the milk which ferments it. Thus, boiling the milk helps to preserve it for longer time. Boiling of milk requires close and continuous supervision or we can say always requires a human intermission because as the milk is boiled in an open container, it starts oozing out after certain amount of time. Since milk boiling is a daily or routine activity for millions of people, in this work we have proposed a system that alerts the user when the milk is about to boil. The system is based on electronic hardware components that monitors the rate of temperature increase as the milk is boiled. Based on the observations, an algorithm was designed & a code was developed, to determine milk overflow and help automate the mil k boilingtask.The proposed system works very accurately ,alerting the user about the spilling of the milk 5-6 seconds in advance on average.Additionally,Arduino IDE is used for system operation based on which milk overflow can be avoided.

Keywords— Arduino, Boiling Point Detector, Water, Temperature Sensor, Flutter, Firebase, Spilling Detector

I. INTRODUCTION

Milk is a rich source of nutrients, especially in protein, vitamin B12 and phosphorus. Vitamin B12 is necessary for good mental health and red blood cells. Interestingly, this vitamin cannot be gained from any fruits or vegetables and only directly obtained from animals or animal derived products. So for people who not like to eat animal meat or fish meat ,the risk of vitamin B12 deficiency is very high , which can lead to gastrointestinal, neurological mental or other problems. Thus, Milk plays a very crucial role for the nutrition supplementation of Vitamin B12 for vegetarian people. Milk is also a rich source of vitamin D and phosphorus. Table 1 shows the different nutrition found the milk Ref. [1].

Milk can be obtained naturally from cow, goat, and sheep or synthetically from the soybeans.Raw milk obtained from the source must be boiled before use as there is a high risk of the presence of bacteria and pathogens. Boiling of milk includes placing the milk on to the vessels and lighting up the flame. The heat of the flame separates the fat, sugar and proteins as cream from the water (87%) present in the milk. When a certain boiling point is reached, the water vapor starts to push the cream to the top of the container. It is the point where the milk is said to boil and the flame needs to be turned off. If the flame is not turned off at this point, the milk cream will leak out, resulting in the loss of key nutrition. Currently, milk boiling is done under continuous monitoring to prevent spillage. Since the user is busy watching the milk boil continuously, he is not free to do other tasks.

TABLE 1
Nutrition per 100ml of the Milk. [1]

Nutrition	Quantity
Calories	61
Water	88%
Protein	3.2 g
Carbs	4.8 g
Sugar	5.1 g
Fiber	0 g
Fat	3.3 g
Monounsaturated	0.81 g
Polyunsaturated	0.2 g
Omega-3	0.08 g
Omega-6	0.12 g
Saturated	1.87 g

So there is a need for a system that can take care of this monitoring task and inform the user only when the milk is about to boil. Or more, if the system can provide the user with the expected milk boiling

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time, the user can schedule any other task for it in the meantime.

So we worked on these requirements and challenges to solve them for the automation of milk boiling. In our proposed system, with the help of low-cost sensors, milk boiling data is continuously monitored by the system and transmitted to the Android application via Bluetooth connection. The user is informed about the moment the milk is boiled even when starting, the user is informed about the time remaining until the start of the milk boiling. The user just needs to place the device over the milk boiling pot and install the customized app on their Android mobile. The operation of our device is shown in Fig. 1. The device is placed on a normal container for boiling milk. The milk is thus boiled in an open container. Once the device is turned on, it starts sending sensor data continuously to the user's Android phone, giving them information about the time it takes to boil the milk. As the picture shows, when the milk starts to boil, the device starts making a sound to alert the user to turn off the knob.

The simple design of the boiling point detector prevents spillage of beverages such as milk, water and more.

II. LITERATURE REVIEW

There have been attempts to build a system which can detect the boiling of liquid. Berge [2] has invented a system which has motor driven stirring and a boil over sensor. To keep the food from burning, his system keeps on stirring the food. The system also has a boil over point inside the pot. When the liquid is boiling and reaches the point, a float-actuated switch which hangs down from the lid into the pot connects to the electronic assembly, thus completing the circuit and sensing the boiling of the liquid. Rajendra [3], invented the system, which not only detects the boiling of the milk but also turns off the knob. In his work, a sensor is fixed in the boiling utensil. The moment the milk starts boiling, a signal is sent to a signal controlling circuit which in turn triggers the electro-mechanical system and turns off the knob.

It Rami et al. [4] applied acoustic emission (AE) in the detection of boiling of water. AE is transient elastic waves from within a material, when localized stress energy is rapidly released. These acoustic emissions can be detected in frequency ranges mostly under 1 kHz, but can go up to 100 MHz. In the boiling process it produces acoustic pressure waves of above 45 kHz which can be resulting from several mechanisms like bubble initiating, growth, and departure. On the basis of these mechanisms, it is assumed in the work, that boiling process involves sequences of pulses, having amplitude, length and time intervals varying randomly. Thus, with these AE technique different transient zones is detected before the boiling of the water. In another work by Harua et. al. [5] a type of water boiling detector is presented which uses temperature sensor readings over a period of type.

Over the years embedded devices have penetratsed every form of our life. The devices around us are getting smarter day by day. Electronic enthusiasms have grown into well developed community helping out each other and the newbies to get their work done. In the work by Hau et al. [6], with the help of microcontroller and gyroscope sensor, a self-balancing two wheeler is developed. Sebastian et al. [7] with the help of microcontroller and sensors implemented temperature monitoring system for a food items refrigerated vehicle. They used temperature sensor to get the vehicle's inside temperature and if it reaches certain level, the system transmits wireless signal to second module of the system situated near to the driver. The speaker of the system alarms the driver about the deviant temperature of the food items. In the work by Loup et. al. [8], they used microcontroller and temperature sensor to monitor the temperature of the servers and if it reaches any unsafe limit, the system informs the user wirelessly with the help of Bluetooth module, thus helping in remotely securing the systems without the need of actual physical continuous monitoring. In the work of Fuentes et. al. [9], low cost electronics is used to build a low cost autonomous data logger for PV systems and obtained reliable results with a prototype costing 60 Euro. The use of Android application over the phone have been explored by a number of researchers as a tool to visualize or output the result of their analysis or continuous data feed. In the work by Monika Mor et. al. [10], a number of sensor data like light sensor, motion sensor are commu nicated to the android application simultaneously in real time for graphical analysis of the data. In another work by Shilpa Mahajan [11], in order to assist persons who have met accidents, the position of the approaching vehicle is displayed on the google map of the android application with aim to depict the exact location of the device on the google map. Their work also focuses on avoiding accidents in the first place. Similar usage of android application can be found in [12], [13], [14], [15]. The use of sensors to automate the process in food based small scale industries have also gained significance in recent years.

III. METHODOLOGY

The tools used are covered in Section A, algorithm, code in Section B followed by Experimental set up is discussed in Section C.

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A. **Tools Used:**

1) **MLX90614 Temperature Sensor** – The MLX90614 is an infrared thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASIC are integrated in the same TO-39 can. Integrated into the MLX90614 are a low noise amplifier, 17-bit ADC and powerful DSP unit thus achieving high accuracy and resolution of the thermometer.

Figure 1 - MLX90614 Temperature Sensor

2) Node MCU – **NodeMCU** is a low-cost open source IoT platform.[4][5] It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which was based on the ESP-12 module.[6][7] Later, support for the ESP32 32-bit MCU was added.

Figure 2 – Node MCU

3) Arduino Uno – Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery.

Figure 3 - Arduino UNO

4) Arduino IDE - The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

5) Jumper Wires – A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

Figure 4 - Jumper Wires

6) LED – **light-emitting diode** (**LED**) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.

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Figure 5 - LED

7) Buzzer – A **buzzer** or **beeper** is an audio signaling device,[1] which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke.

Figure 6 – Buzzer

8) Breadbord – A **breadboard**, **solderless breadboard**, or **protoboard** is a construction base used to build semi-permanent prototypes of electronic circuits. Unlike a perfboard or stripboard, breadboards do not require soldering or destruction of tracks and are hence reusable. For this reason, breadboards are also popular with students and in technological education.

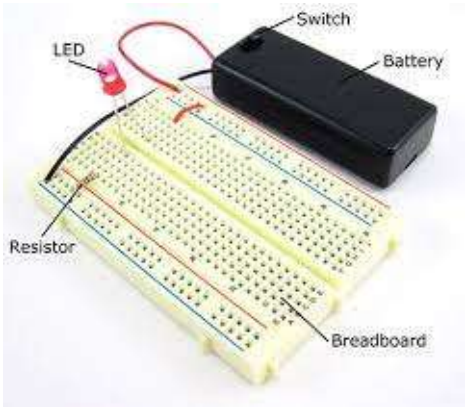

Figure 7 - Breadboard

B. Code, Algorithm:

```
#include <Wire.h>
#include <ESP8266WiFi.h>
#include <FirebaseESP8266.h>
#include <Adafruit_MLX90614.h>
Adafruit_MLX90614 mlx = Adafruit_MLX90614();

#define FIREBASE_HOST "https://heattransfercp-default-rtdb.firebaseio.com/"
#define FIREBASE_AUTH "jcCoJ0NM7tZXYwqf9cBLOfOJMFerlgwAfGwsbeHg"
#define WIFI_SSID "Rishikesh's iPhone"
#define WIFI_PASSWORD "12345678"

#define LED D0
double ambient_temp;
double object_temp;
int bPoint;
int ch;

FirebaseData firebaseData;
void setup() {
  Serial.begin(9600);
  Serial.println("Adafruit MLX90614 test");
  mlx.begin();
  pinMode(LED,OUTPUT);

  // connect to wifi.
  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print("connecting");
  while (WiFi.status() != WL_CONNECTED) {
    Serial.print(".");
    delay(500);
  }
```

```
    delay(500);
  }
  Serial.println();
  Serial.print("connected: ");
  Serial.println(WiFi.localIP());

  Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);

}

void loop() {
//  Serial.println("Enter the Process Number : ");
//  Serial.println("Press  : ");
//  Serial.println("1 : Boiling of Water ");
//  Serial.println("2 : Boiling of Milk ");
//  Serial.println("3 : Heating of Oil ");
//  while(Serial.available()==0){}
//  ch = Serial.parseInt();


  ambient_temp = mlx.readAmbientTempC();
  object_temp = mlx.readObjectTempC();
   if(Firebase.getString(firebaseData, "/tasks/TEMPERATURE")) {
      bPoint = (firebaseData.stringData()).toInt() ;

    Serial.println(bPoint);


    }

  Serial.print("Ambient = "); Serial.print(ambient_temp);
  Serial.print("°C\tObject = "); Serial.print(object_temp); Serial.println("°C");
  Serial.print("Ambient = "); Serial.print(mlx.readAmbientTempF());
```

Figure 8 - Code Written in Arduino IDE for functioning of Boiling Point Monitor System

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C. App Interface

Figure 9 – Application of System using Flutter and Firebase

This is the app of Boiling Point Monitor system which is built by using Flutter and Firebase as a database.

D. Setup

Figure 10 – Setup of the Boiling Point Monitor

This is the setup of Boiling Point Monitor system which would be mounted on the small liquid vessel.

IV. RESULTS & DISCUSSION

To test the accuracy of Boiling Monitor System, we were used water as liquid and conducted the experiment. We measured the different temperatures of water at different time from the top of the vessel for testing of IR sensor. It was observed that initially, temperature of water was rising slowly. The IR sensor continuously measuring the temperature of water. We plotted the graph between Ambient Temperature & Object Temperature, the time when the device started showing the alert message on screen and buzzing the alarm which was mounted on the system. As point of measurement of temperature which is the surface of the water increase, the buzzer senses the boiling quickly. It is also observed that if initially room temperature is higher, the boiling temperature measured is lower for same height at the surface. Also plotted the graph between Ambient Temperature & Object Temperature during monitoring, detecting boiling of water as shown in Fig. 10.

A. Figures and Tables

Sr No'	Ambient Temperature	Object Temperature
1	27.73 C	51.25 C
2	27.83 C	51.11 C
3	27.91 C	51.29 C
4	28.07 C	51.21 C
5	28.15 C	50.61 C
6	28.23 C	50.73 C
7	28.33 C	50.47 C
8	28.39 C	50.05 C
9	28.47 C	46.07 C
10	28.53 C	40.65 C
11	28.69 C	33.47 C
12	28.71 C	29.17 C
13	28.67 C	27.49 C
14	28.65 C	26.43 C

Table 2 - Table displaying the range of Ambient Temperature & Object Temperature during monitoring, detecting boiling of water.

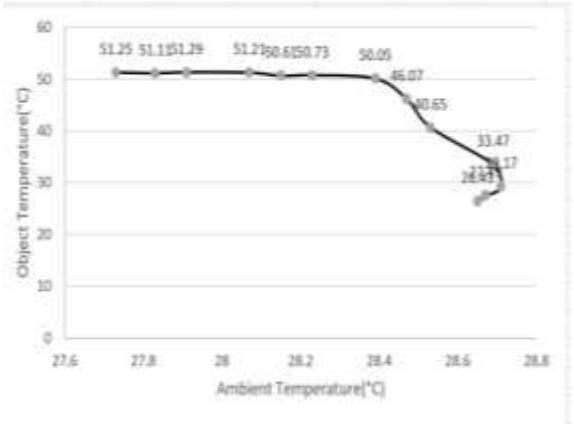

Figure 10 - Graph Showing Change in the Object Temperature w.r.t Ambient Temperature

V. CONCLUSION

By using Boiling Point Monitor System Using IR Heat Sensor, we detect the boiling point of the liquid to avoid spoiling. With the help of application that we made using flutter and firebase, user can select the liquid whose boiling point can be detect. Milk boiling point which currently involves close monitoring is presented in this work. The role of gradually increasing temperature on milk boiling is analyzed in detail and an algorithm taking it into consideration for milk boil detection is also presented. To free user completely from the monitoring of milk boil an application in the form of

android app is also proposed, which presents user time the milk is expected to take to boil.

FUTURE SCOPE

Currently, the system can detect boiling point of liquid and sends message and buzzed the alarm. When alarm is buzzed, we must manually switch off the gas button. But, in future we work on to do switching operations automatically.

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