Smart Mug

ECE445 Team#56
Hani Al Majed, Siqi Lu, Srishti Modgil
TEAM PRESENTATION

Srishti Modgil
Senior
Computer Engineering

Siqi Lu
Senior
Electrical Engineering

Hani Al Majed
Senior
Electrical Engineering
Agenda

- Problem, Solution
- Design Overview
- Performance Analysis
- Successes and Difficulties
- Conclusion
Problem 1
Problem

- Maintaining ideal temperature of beverages is challenging
- Impact on taste and enjoyment of the drink
- Existing solutions in the market are expensive, e.g., Ember Mug
- Accessibility issues for average consumers
Solution
Solution

- Advanced temperature control system to maintain desired temperature
- Intuitive app interface for setting temperature
- Affordable cost compared to existing solutions
- Eliminates the need for time-consuming and wasteful reheating
Ember Mug

4.5 (8216)  Write a review

$129.95 USD

Pay in 4 interest-free installments of $32.48 with shopify. Learn more.

Color

Size

14 OZ  10 OZ

Qty

ADD TO CART

Add product protection:

☐ 2-Year Protection Plan  $13.99

What’s Covered?

Designed for home or office, the new Ember Mug does more than simply keep your coffee hot. Our smart mug allows you to set an exact drinking temperature, so your coffee is never too hot, or too cold.

Ember then maintains your chosen temperature for up to 1.5 hours with the Ember Mug 10 oz and up to 80 minutes with the Ember Mug 14 oz - so your hot beverage stays perfect. Ember Mug is safe to hand wash and submersible up to 1 meter in water.
Design Overview
Recharged Battery/Heating Subsystem

Battery:
- two 2500 mAh Cells (4.8-5.2V)
- Qi Li-ion Charger
  Receiver (inductive charging)
- Universal Qi Charger Transmitter

Sensors & LEDs Subsystems

Temperature Sensor
- DS18B20 (5V)

Lighting System
- 19-C47/RSGHBHC-5V01/2T (5V)

Microcontroller SoC
- ESP32-WROVER-IE-N8R8

PTC Heating Element
- FIT0845 (5V)

Android App
- keeps temperature logs
- deploys ML model for recurrent
  time-series analysis
- visualizes trends
- sends notifications

Arrows Legend
- Blocks Legend
- Sensors/LEDs
- Battery/Heating
- Microcontroller
- Android App
- Data (wired)
- Data (wireless)
- Power (wired)
- Power (wireless)
Video Demonstration
## Cost Table

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturer</th>
<th>Quantity</th>
<th>Extended Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless power Li-ion charger Receiver compliant with Qi (WPC) with RT1660 Chip</td>
<td>Adafruit</td>
<td>1</td>
<td>$14.95</td>
</tr>
<tr>
<td>Universal Qi Wireless Charging Transmitter</td>
<td>Adafruit</td>
<td>1</td>
<td>$26.05</td>
</tr>
<tr>
<td>TP4056 Type-C USB 5V 1A Battery Charger Module Charging Board with Dual Protection Functions</td>
<td>Adafruit 1</td>
<td>2</td>
<td>$9.99</td>
</tr>
<tr>
<td>PTC HEATING ELEMENT - 5V 100C</td>
<td>DFRobot</td>
<td>2</td>
<td>$5.00</td>
</tr>
<tr>
<td>Panasonic NCR18650B 3400mAh 4.3A Battery</td>
<td>Panasonic</td>
<td>2</td>
<td>$8.00</td>
</tr>
<tr>
<td>Battery Holder (Open) 18650 2 Cell SMD (SMT) Tab</td>
<td>Exponent</td>
<td>1</td>
<td>$0.00</td>
</tr>
<tr>
<td>ESP32-WROVER-IE-NR8S</td>
<td>HiLetgo</td>
<td>1</td>
<td>$1.60</td>
</tr>
<tr>
<td>USB - micro B USB 2.0 Receptacle Connector &amp; Position Surface Mount, Right Angle Through Hole</td>
<td>Melex</td>
<td>1</td>
<td>$1.01</td>
</tr>
<tr>
<td>5V 12.5V 5V Bi-Directional SOD-523 ESD Protection Device: ROHS</td>
<td>LRC</td>
<td>3</td>
<td>$0.02</td>
</tr>
<tr>
<td>25V 300mA 110x100x1.8mm 1.8A NPN SOT-23 Bipolar Transistors - BJT ROHS</td>
<td>Jiangsu Charging Electronics Technology Co., Ltd.</td>
<td>2</td>
<td>$0.0197</td>
</tr>
<tr>
<td>LDO Voltage Regulator: 80mA &amp; 1A LDO</td>
<td>TexasInstruments</td>
<td>1</td>
<td>$2.07</td>
</tr>
<tr>
<td>USB Interface IC USBXpress - USB to UART Bridge QFN20</td>
<td>Silicon Labs</td>
<td>1</td>
<td>$4.66</td>
</tr>
<tr>
<td>Tactile Switches 6x0.5x83MM R/A 186G</td>
<td>E-Switch</td>
<td>2</td>
<td>$0.44</td>
</tr>
<tr>
<td>Programmable Resolution</td>
<td>Analog</td>
<td>1</td>
<td>$7.78</td>
</tr>
<tr>
<td>1-Wire Digital Thermometer</td>
<td>Devices Inc/Maxim Integrated</td>
<td>1</td>
<td>$0.92</td>
</tr>
<tr>
<td>Addressable Lighting - 1 LED Serial Red, Green, Blue (RGB), 1.46mm L x 1.8mm W</td>
<td>Everlight Electronic Co Ltd</td>
<td>4</td>
<td>$1.12</td>
</tr>
<tr>
<td>Red LED</td>
<td></td>
<td>4</td>
<td>$1.12</td>
</tr>
<tr>
<td>5.6V 18.5V 5V Bi-Directional SOD-523 ESD Protection Devices ROHS</td>
<td>LRC</td>
<td>3</td>
<td>$0.70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$97.30</strong></td>
</tr>
</tbody>
</table>

**$97.30 vs. $129.95**

**CHEAPER!**
Performance Analysis
Sensor Subsystem

Expected:
- Less than 2% difference with the actual temperature.
- Detected temperature send to ESP32

Achieved:
- Room temperature: 19.44 °C / 67 °F
- Detected temperature: ~20.50 °C
User input temperature: 25.00
Temp from sensor: 20.81
Heater turned ON
Heating Subsystem

Expected:

- Heating element controlled by a GPIO pin of ESP32
- Heating element heats up liquid in the mug
Achieved: output voltage from GPIO 5
voltage drop through the heating element

-20 -10 0 10 20

Voltage (V)

-25 -20 -15 -10 -5 0 5 10 15 20 25

±25V

-0.089 MIN
5.212 MAX
5.178 VDC
Successes and Difficulties
Schematics
Circuit Building: Successes

- Breadboard Circuit
- Most expectations achieved using the breadboard circuit:
  - Successfully controlled the on/off of the heating subsystem
  - Successfully detected the liquid temperature
Unable to power the heating element with MOSFET CD4007

- Incorrect calculation of the current required for the heating element (1 A vs 200 mA)
- Wrong MOSFET use of CD4007

Heating element heat up liquid slowly

Circuit Building: Difficulties
Software: Success

- Responsive and user-friendly front-end
- Integrated the front-end with a real-time NoSQL database
- Configured the ESP32 to connect to a Wi-Fi and database
- Program the ESP32 to receive temperature data from web app
- Communicates with the temperature control loop
Software: Difficulties

- Switch between a lot of microcontrollers
- Subsystems were not fully integrated
- Resolved most issues
Conclusion
Future Work
⦿ Implementation of the software design
⦿ Implementation of ML
⦿ Proper heating elements
⦿ Lower cost
What we learned this semester

- Program microcontroller
- Connect web app to a real time database
- Connect microcontroller to wifi and to real time database
- Soldering experience
- Got KiCad experience
What we learned this semester

- Real-World Problem Solving
- Interdisciplinary Collaboration
- Project Management
- Lifelong Learning
THANKS!

Any questions?