Lid Lad: Thermally Regulated/Spill Resistant Lid

CAD Lads
UCSB ME153 – Spring 2019

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Problem: Scalding Drinks and Spilled Mugs

Travel mugs can keep your drink hot for hours. However, if a user wants to cool their drink, the only way to conveniently do this is to remove the mug lid. This presents several hazards. Firstly, the user could easily spill their entire drink all over the surrounding area. Secondly, if that drink is hot, they could also burn themselves in the process.

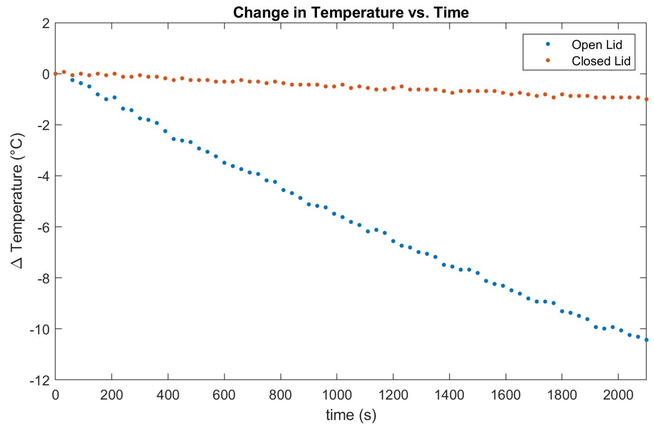

Figure 1. Cooling with closed lid vs. natural convection

Solution

The Lid Lad is a simple solution to both of these problems. It utilizes free convective cooling in a controlled and safe manner to keep a drink at any temperature. An actuated servo can open or close the lid to allow cooling through free convection. This lid will close when it falls and is controlled by an easy-to-use phone app.

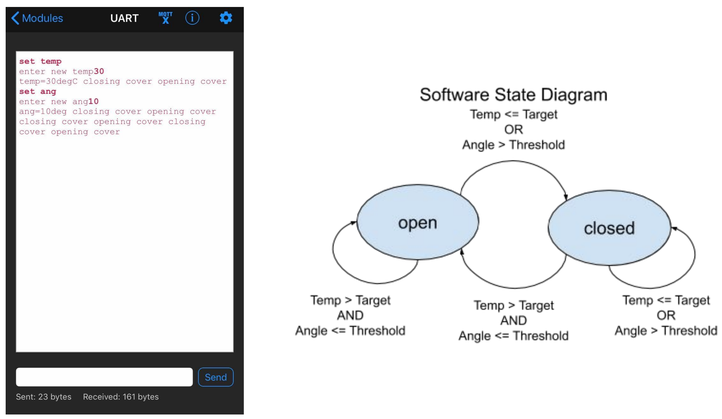

Figure 2. Bluetooth user interface through Bluefruit app and software state diagram.

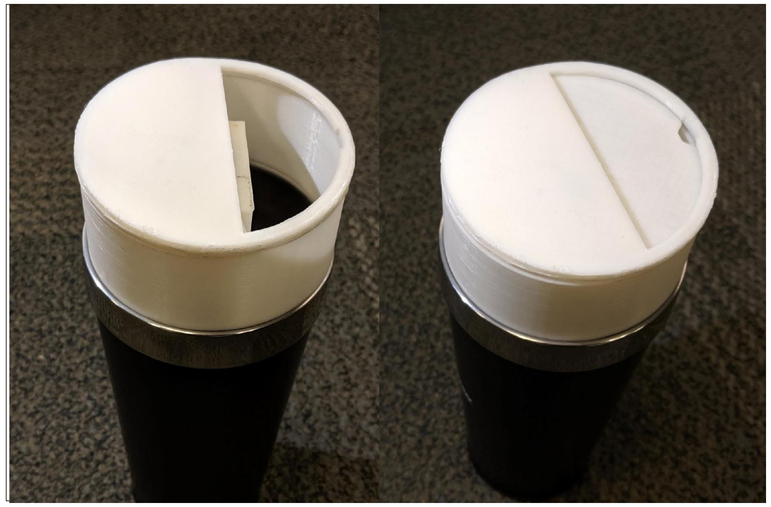

Figure 3. Assembled prototype (Version 5)

Analysis of Design

The sub-micro servo delivers 6.6 kg/cm which is sufficient for the lid closing mechanism as the body is light and supplies little resistance. The thermistor pulls 1.72mA of current which lies within the capabilities of the LiPo power supply in tandem with the other components requiring power. The Bluetooth app connects wirelessly with lid, allowing user to alter tilt response angle and temperature threshold.

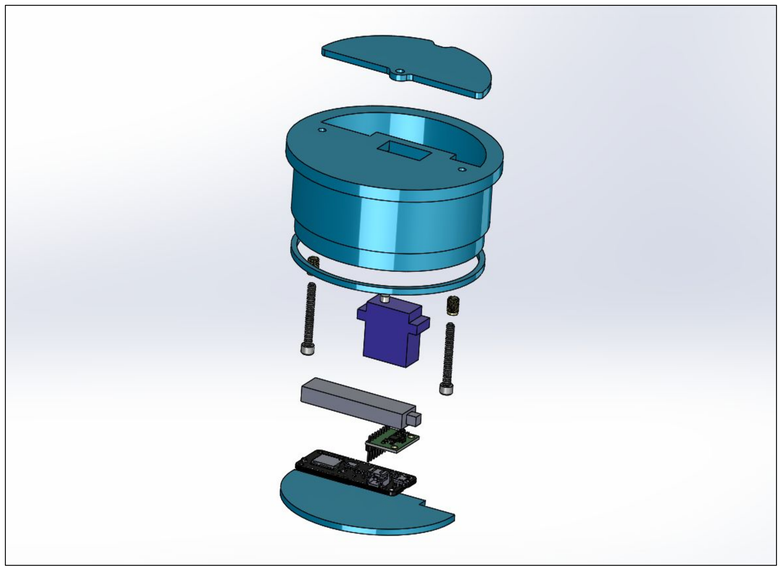

Figure 4. Exploded view of complete CAD model

Testing Results

Tests demonstrate the response time of the lid closing mechanism and the thermistor temperature readout. The lid is capable of responding to disruptions in approximately 0.12 seconds. The thermistor is accurate with noise of 0.1°C.

Multiple iterations of the design were made to improve robustness, waterproofing capabilities and integration of the power on/off switch.

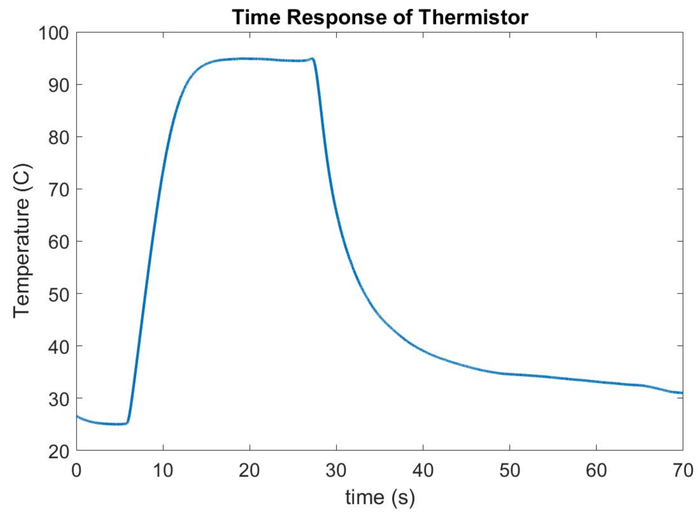

Figure 5. Response time of thermistor when heating in water and subsequently cooling in air.

Future Improvements to the Design

- Sleeker design for user experience
- Spring actuated closing mechanism to improve response time of closing feature
- Laser temperature sensor

Acknowledgments

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References

Adafruit, "Bluefruit nRF52 Feather Learning Guide", Kevin Townsend, April 2019