Precision Controlled Bytes (PCB) Smoker: A Senior Design Project

Department of Electrical and Computer Engineering

Gabriel Boicu, Trenton Cathcart, Parker Widmeyer, and Dr. Rohit Dua

Abstract

This project aims to convert a simple, generic smoker to an automated smoker with Internet of Things (IoT). Devices such as servo motors, fans, a microcontroller, and a temperature sensor were added to the smoker, which will all be controlled automatically in response to a set temperature by the operator. The operator can set this temperature on a mounted touch-screen, as well as control the individual devices for troubleshooting purposes and control the devices from a users remote internet connected device. To determine the components that were added, a requirements matrix was created that established goals that, if met, would be deemed a successful conversion to an automated smoker. These requirements will be the tests that the smoker must pass, like maintaining a set temperature within ±20°F.

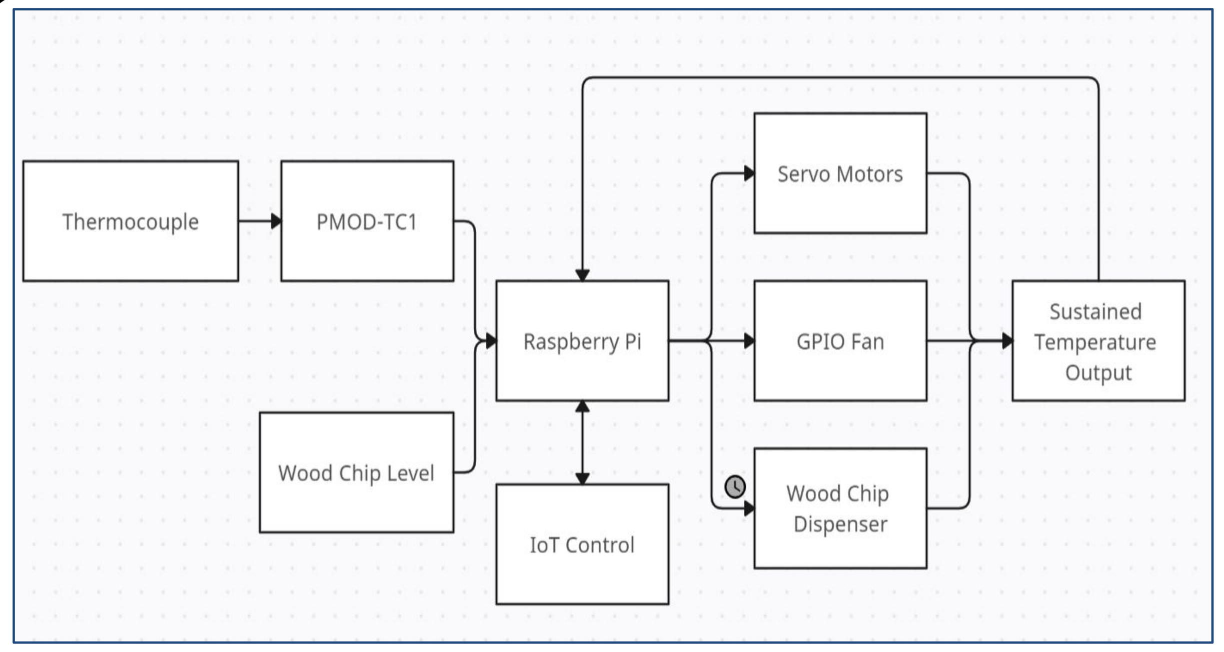
Requirements Matrix

REQUIREMENT	TITLE	DESCRIPTION	VERIFICATION
1	AUTOMATED TEMPERATURE CONTROL	The system must maintain a user set internal temperature within ±10° F.	The microcontroller will adjust servo motors and fans according to the most recent temperature from the PMOD and in turn adjust the temperature. The PMOD relays the current temperature reading. If the internal temperature can indefinititly maintain the user set temperature within ±10° F then this is requirement will be passed.
2	WOOD CHIP DISPENSING	The system will dispense wood chips from the hopper, into the fire box, at regular intervals using a servo motor and auger configuration.	The microcontroller will have a set dispense time and will dispense at this time expiration. If the fire is able to stay lit for the entirety of the cooking process. Then this requirement will be passed.
3	REMOTE OPERATION AND IOT INTEGRATION	The smokers data and accessibility will be accessible from devices in other locations.	One will be able to use their phone to set an operating temperature, and look at live data feedback from the smoker system. If these specifications are met, then this requirement will be passed.
4	FRIENDLY UI AND ACCESSIBILITY	The User Interface will be user friendly, of which amatuer culinists will beable to navigate.	Usability testing will be conducted with a group of users to assess the intuitiveness of the UI. Success will be measured by the ability of at least 90% of participants to complete a set of standard operations without assistance or reference to a manual within a designated timeframe.
5	MECHANICALLY AND ELECTRICALLY SOUND	The smoker must be robustly constructed, ensuring all mechanical and electrical components are reliable, have a low failure rate, and comply with industry standards for safety and performance.	The smoker will undergo a series of mechanical and electrical safety tests, including stress testing to simulate extended usage and inspections to ensure compliance with safety standards. A successful outcome will be demonstrated by a pass in all regulatory safety inspections and the absence of mechanical or electrical failures during testing periods.

IOT

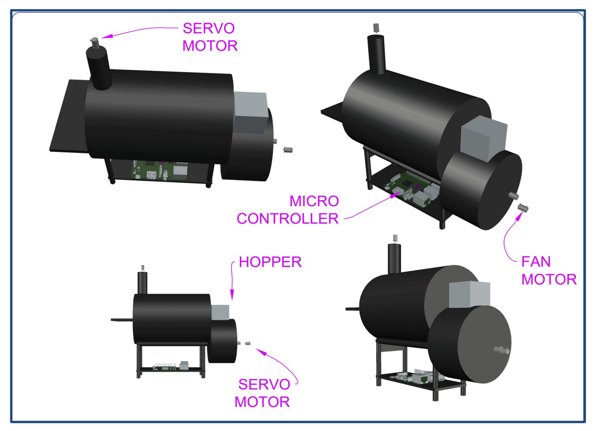
The IoT give users complete access to all features of the PCB Smoker from any device that can connect to the internet. The user friendly UI (shown to the right) allows users to simply set their desired temperature and the smoker will maintain the set temperature. The user may also manually open/close and start/stop any of the automated process for more control of the smoker through the IOT or physical display. The manual controls were implemented as a safety feature in case of an accident.

Block Diagram



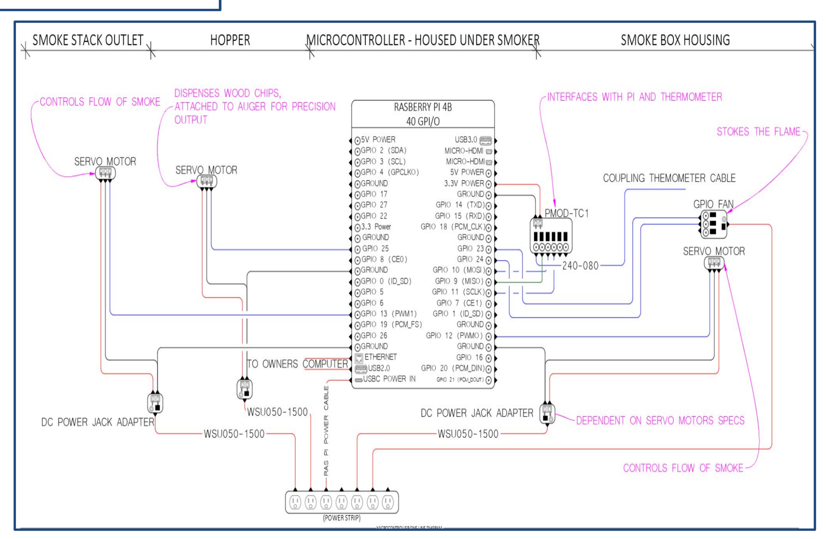
This block diagram gives a high level illustration of how all systems interact with each other. The heart of the system is the Raspberry Pi Microcontroller and all subsequent systems feed information into it. The three main components controlled by the Microcontroller are the Servo Motor, GPIO Fan, and Wood Chip Dispenser. Through these, sustained temperature output is maintained.

Machine Design: Hardware



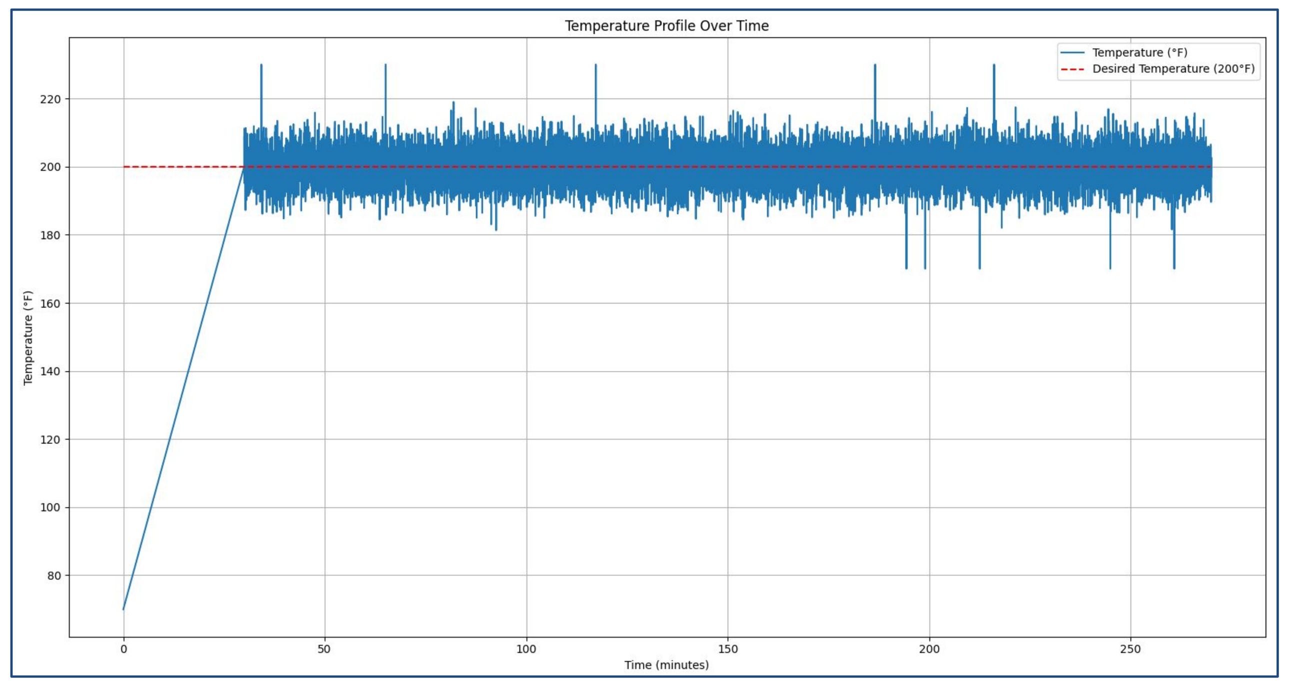
The Microcontroller is mounted and housed away from any moving parts and the heat from the main smoker. This position is also centralized for running wires to each of the components.

This Diagram was made before any components were ordered, to ensure that the design could be implemented with all each component's required connection being available on the Raspberry Pi Microcontroller.



Results/Output

This graph depicts a user entering a smoker temperature operating point of 200 degrees (red dashed line). The actual temperature readings over a period of 4 hours can be observed in the blue tracer. Where the temperature fluctuates continuously between 220 and 180 for 4 hours.



Machine Design: Reality

The machine design in reality looks much different than our initial drawings. The biggest change was that the smoke stack and fan were added on the side of the smoker rather than the top to avoid heat damaging the fan.

Conclusion

In conclusion, our automated smoker system, adept at sustaining user-defined temperatures through microcontroller control of a fan, wood chip dispenser, and servo motors, represents the culmination of months of dedication, creativity, and teamwork. Beyond its technical prowess, it holds the potential to revolutionize the culinary landscape, offering enthusiasts and professionals a reliable solution for perfect smoked dishes. While proud of our achievements, we acknowledge room for future enhancement, envisioning advanced automation,improved remote monitoring, and expanded features.

Acknowledgments

The Designers are grateful to Dr. Dua for his constant mentorship throughout the design and creation of this project.

Cooperative Engineering Program

Missouri University of Science and Technology/Missouri State University

Designers

Gabriel Boicu, Trenton Cathcart, Parker Widmeyer

Electrical Engineering