Perfect Pour Over Coffee

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**Interface Control Document**

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Interface Control Document

for

Perfect Pour Over Coffee

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# Overview

The following document will cover specific details on each of the subsystems of the Perfect Pour Over Coffee System and their interactions. The primary subsystem being the hardware itself. The second subsystem being the android application used for controlling the hardware. The third subsystem is the database and machine learning algorithms used to manipulate the data and settings needed for the hardware subsystem to function.

# References and Definitions

## References

| **Document Title** | **Address** |
| --- | --- |
| Raspberry Pi 3B Documentation | <https://www.raspberrypi.com/documentation/computers/raspberry-pi.html> |
| Raspberry Pi Camera v2 Documentation | <https://www.raspberrypi.com/documentation/accessories/camera.html> |
| DS18B20 | <https://datasheets.maximintegrated.com/en/ds/DS18B20.pdf> |

**Table 1: Reference Documents**

## Definitions

I2C Inter-Integrated Circuit

CSI Camera Serial Interface

GPIO General-Purpose Input/Output

VAC Volts (Alternating Current)

VDC Volts (Direct Current)

V Volts

A Amps

CPU Central Processing Unit

RAM Random Access Memory

# Physical Interface

## Weight

The Pour Over Coffee System will weigh up to 15 lbs including the raspberry pi, sensor array, power system, carafe, and housing.

## Dimensions

The volume envelope of the Perfect Pour Over Coffee System will be less than or equal to 48x48x48 inches. This size is to allow for the device to fit in most consumer kitchens while allowing plenty of space to house the carafe which is 11 inches tall and 6 inches in diameter beneath the brewing hardware

## Mounting Locations

## Mounting of Coffee Grounds Sensors

The multispectral camera and CO2 sensor will need to be mounted above where the grounds are held in order to take measurements. The camera will need to be placed behind a clear antifog window in order to avoid damage due to steam or splashing of water.

## Mounting of Water Temperature Sensor

The temperature sensor will be mounted in the inner wall of the reservoir in order to take the most accurate temperature readings and far enough away from the heating element that erroneously high readings are avoided.

## Mounting of Fault Sensors

A thermal fuse will be mounted next to the heating element to ensure it doesn’t reach critical temperatures and the carafe detection sensor will be mounted into the base where the carafe will sit to easily ensure it’s present.

## Mounting of Raspberry Pi and Power System

The pi and power system will be housed within the main body of the device to reduce the risk of water infiltration. Ports exiting the device will need to include a instrument cable connector for 120 VAC, an opening for the LAN port, and a set of vent slits for the fan to exhaust heat through. Mounting will need to accommodate wires connecting the pi/power system shared enclosure to the sensor array as well as the user interface. The enclosure must not interfere with the use of bluetooth.

# Thermal Interface

## Raspberry Pi and Power System

The raspberry pi will need basic air circulation to keep from overheating or thermal throttling during use. Heatsinks will be mounted on the cpu and ram for better heat dissipation and ventilation slits will be located near the device for passive cooling. The conversion from 120 VAC to 5 VDC is expected to cause considerable heat buildup, so a small case fan will be added to exhaust heat from the device.

## Water Heating System

The water heating system will need to be thermally isolated from the rest of the device to avoid damaging components or making a hazard for the user. This will be accomplished through use of an insulator around the heating coil, and standoffs to minimize the contact between any heated components and the rest of the device.

# Electrical Interface

## Input Power

120 VAC from a standard wall receptacle will be used to power the device. This power must be rectified and stepped down to 5 VDC at a minimum of 2.5 amps for use with the pi as well as the sensor array. The whole device should draw less than 1500 watts to minimize the time it takes to heat the water while reducing the chance of popping a breaker.

## Microcomputer

Raspberry Pi 3B will be the computer that controls the operation of the device and handles the data transfer between itself and the android app, monitoring of sensor values, and control of brewing hardware. It will also host the brewing database locally. It has a 1.2GHz CPU and 1GB of RAM. It also has bluetooth and WiFi capabilities built in. The pi runs off of 5V and has a maximum current draw of about 2.5 A

# Communications / Device Interface Protocols

## Wireless Communications (Bluetooth and Wi-Fi)

The Android smartphone will communicate with the Raspberry Pi over bluetooth in specification with IEEE 802.15.

The Android smartphone will also communicate with a Firebase Database over Wi-Fi in specification with IEEE 802.11 standards.

## Raspberry Pi IO

The raspberry pi will use 3.3V logic across its GPIO pins in order to communicate with the sensor array. The use of these pins will also allow for I2C inter device communication for controlling systems such as the lighting for multispectral imaging or the power system for the heating element. The camera for the multispectral imaging will connect to the pi through its CSI port

1. **Database Interface**

The Firebase database will interface with the other subsystems by storing all of the brew and user information from the app and the user feedback algorithm. Access to the database is conducted through the user feedback prediction script by calling the database through the admin specific key as described by official Google Firebase documentation. A Python function is created to not only pull data from the database for prediction purposes but also write the preferences and results to the database. Data will be continuously updated for every brew. The specific information stored in the database are user id, user password, roast type, coffee bean type, cup size, ratings, target temperatures, and target water volume. The database will also be connected to the android application.

1. **Android Application**

The Android application will be the primary mode of interaction between the hardware and the user. The application will consist of all necessary controls to run the hardware and provide the hardware with any data that may be necessary. The application will take advantage of the device’s built in bluetooth and Wi-Fi adapters to be able to connect to the hardware as well as the database.

* 1. ***Hardware Operation***

The application will utilize the Android device’s built in Bluetooth adapter to search for a compatible device. This will be done by searching for matching MAC addresses that will be provided to the app when the user registers their account. Once a matching device is found, the application will attempt to connect to it and create a message socket. Through the use of this socket, the hardware and the Android device will be able to communicate with each other.

To begin the brewing process, the application will send over an array containing all the necessary brewing parameters including target temperatures, saturation, and flow rates. Another message letting the hardware know to begin its script will also be sent right after.

The hardware will return messages to the android application to let the user know the current stage of the brewing process as well as any errors or issues that may occur throughout the process. Some of these errors may include lack of water, missing carafe, or missing coffee grounds.

* 1. ***User Feedback***

The Android application will also offer a section to provide feedback on previous brews. The purpose of this device is to improve its brewing capabilities based on a user’s preferences. This is done through an algorithm that determines a new set of brewing parameters based on previous brews and the rating the user provided for those brews.

The application will provide the user with a list containing all of their previous brews. This data is retrieved from the database and then displayed to the user in an easy to read fashion. The user can then select a brew to rate and will be prompted with a numerical rating option ranging from one through ten and also be allowed to provide a coffee strength rating ranging from too weak, perfect, and too strong. After a user provides a rating, this data will be updated within the database and on the user’s device.

* 1. ***Application Settings***

The application also contains various settings to modify the experience of the device and application. These settings include a dark/light mode toggle, ability to modify their account settings, manage the notifications that are sent, view their connected hardware information, and visiting the support page.

The appearance setting is purely visual and allows the user to pick whichever they prefer. The option is there as the dark mode has more contrast in colors as compared to the light mode. This may be more valuable to those with visual impairments.

The user also can modify their account settings. This includes changing their name, email, and password that is linked to their account. The user is given these options in the case they provided a typo at the time of registration or if they decided to change their primary email address or if they need to reset their password for security reasons.

Another setting the user can toggle is which notifications they would like to receive. The two types of notifications that are sent include brewing status notifications and maintenance reminder notifications. Both of these are enabled by default. The option is provided to the user so that they may reduce the number of notifications they are receiving all together. Even if the user disables the push notifications, the information provided by them is still available within the app.

The user may also view their connected hardware information. This goes in conjunction with the support page as the user may have questions or issues with their specific device and this is one way for the user to know which device they have. This also helps the technical support team in identifying issues related to particular hardware as the user can provide them with a serial number which is unique to each device.