Electrical Overview

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Assignment Evaluation:

Item	Score (0-5)	Weight	Points	Notes
Assignment-Specific Items				
Electrical Overview		x3		
Electrical Considerations		x3		
Interface Considerations		x3		
System Block Diagram		x3		
Writing-Specific Items				
Spelling and Grammar		x2		
Formatting and Citations		x1		
Figures and Graphs		x2		
Technical Writing Style		x3		
Total Score				

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:
Relevant overall comments about the paper will be included here

1.0 Electrical Overview

The Super Susan uses a number of electrical components that together allow it to function as a smart lazy Susan which assists users in locating and taking inventory of spices. A 32-bit, 64-pin microcontroller will be the central component which processes the input signals and controls output signals. It will communicate with a variety of components, including a stepper motor, LCD screen, NFC reader, weight sensors, and a wireless module.

Input to the Super Susan will be received either through an on-unit interface or a phone app. The physical interface will consist of a rotary dial and button which allow the user to specify the desired behavior of the Super Susan (deliver spice, add new spice, measure spice). When using the phone app, the wireless module will facilitate the communication between the user and the Super Susan. Additional inputs to the Super Susan include the weight measured by the weight sensor as well as the NFC tag information read by the NFC reader.

The Super Susan will have two outputs: motor rotation to deliver the spice, and a message regarding the inventory. Based on the requested spice, the microcontroller will send a signal to the stepper motor to rotate it the appropriate number of degrees to present the spice to the user. Inventory information will be displayed on an LCD screen or through the phone app via wireless communication.

2.0 Electrical Considerations

2.1 Operating Frequency

The microcontroller chosen, the STM32F410, has a maximum clock speed of 100 MHz [1]. Since it is available, we will operate the Super Susan at 100 MHz, which will provide enough speed to multitask. This is particularly important in regards to the LCD display - the operating frequency needs to be fast enough to update the screen almost instantaneously while still taking inputs and giving outputs to the other components. This frequency may be excessive, but power usage is not a major concern since the Super Susan will be powered from the wall.

2.2 Power Requirements

The Super Susan will require 3 different voltage levels - 12 V, 5 V, and 3.3 V. The main power supply will therefore provide 12 V, and the other levels will be stepped down to the appropriate level.

The stepper motor [2] is the only component which requires a power supply of 12 V. The current per phase winding is 350 mA, and since the motor is a 2-phase motor, we need to be able to supply a maximum of 2 x 350 mA = 700 mA. This requires a maximum power of 8.4 W (see Table 1).

Device	Voltage	Current
Stepper Motor	12 V	350 mA x 2 windings = 700 mA
	Power	8.4 W (700 mA)

Table 1: 12 V Power Supply Requirements

Several components require an input voltage of 5 V, including the LCD display and the RGB LED indicator lights. The LCD screen requires a supply current of 3.0 mA, as well as a backlight supply current of 60 - 80 mA [3]. This gives a maximum current of 83 mA. The RGB LED indicator lights draw a variable amount of current depending on the color, ranging from 2 - 20 mA [4]. Thus, as shown in Table 2, the maximum power required at 5 V is 0.615 W.

Device	Voltage	Current
LCD Display	5 V	3 mA + 80 mA = 83 mA
RGB LEDs	5 V	20 mA x 2 LEDs = 40 mA
	Power	0.615 W (123 mA)

Table 2: 5 V Power Supply Requirements

The remaining components will operate with a power supply of 3.3 V since this is a common supply voltage within the ranges of all the components. These components include the STM32 microcontroller [1], NFC reader [5], wireless module [6], weight sensor [7], Hall Effect sensor [8], rotary dial [9], and input button [10]. As seen in Table 3, many of these components have a range between approximately 2 - 5 V, but since they are all inputs to the microcontroller, we will operate them all using 3.3 V. Thus, the maximum power required from the 3.3 V power supply is 2.81 W.

Device	Number	Voltage	Current
STM32 Micro	1	1.7 - 3.6 V	max 200 mA
NFC Reader	2	2.2 - 3.6 V	max 100 mA
WiFi Module	1	2.5 - 3.6 V	80 - 300 mA
Weight Sensor	2	2.6 - 5.5 V	max 1.5 mA
Hall Effect Sensor	24	2.8 - 5.5 V	3 - 12 mA
Rotary Dial	1	3.3 V	max 10 mA
Pushbutton	1	max 24 V	10 uA - 50 mA
		Power	2.81 W (851 mA)

Table 3: 3.3 V Power Supply Requirements

Originally, our plan was to power the Super Susan with a USB-C cable, but after evaluating our power needs as well as the capabilities of USB power, we realized this would not be possible. We need a power supply which can provide at least 11.83 W at all times. Therefore, we will be using a 12 V wall adapter which has the capability to provide 3 A, or 36 W. A DC-DC regulator will step down the 12 V to 5 V for the 5 V supply, and then we will use a linear regulator to further step from 5 V to 3.3 V.

3.0 Interface Considerations

The Super Susan will use SPI, PWM, and GPIO to interface with the various components. SPI will be used to interface between the microcontroller (master) with the wireless module (slave), NFC reader (slave), and the weight sensor (slave). The microcontroller has a maximum SPI rate of 50 MHz, and since this exceeds the SPI rates of the slave devices, the SPI rate for each device will be determined by the component. The SPI rate for the wireless module is still being determined, but it will not exceed 50 MHz. The SPI rate for the NFC reader has a maximum of 10 MHz, and the weight sensor has an SPI rate maximum of 5 MHz. We plan to operate as close to these values as possible to maximize the performance of the Super Susan.

The LCD screen will interface to the microcontroller through a parallel interface with 7 pins, as well as a PWM clock signal. The PWM clock signal will be 2 kHz.

The LEDs and stepper motor will also interface with the microcontroller using PWM. The LEDs will have a 1 kHz PWM signal with the duty cycle adjusted for the desired light color. The stepper motor will have a PWM signal determined based on the desired speed. This will be specified in more detail after the gearing system is developed.

4.0 Sources Cited:

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Appendix 1: System Block Diagram

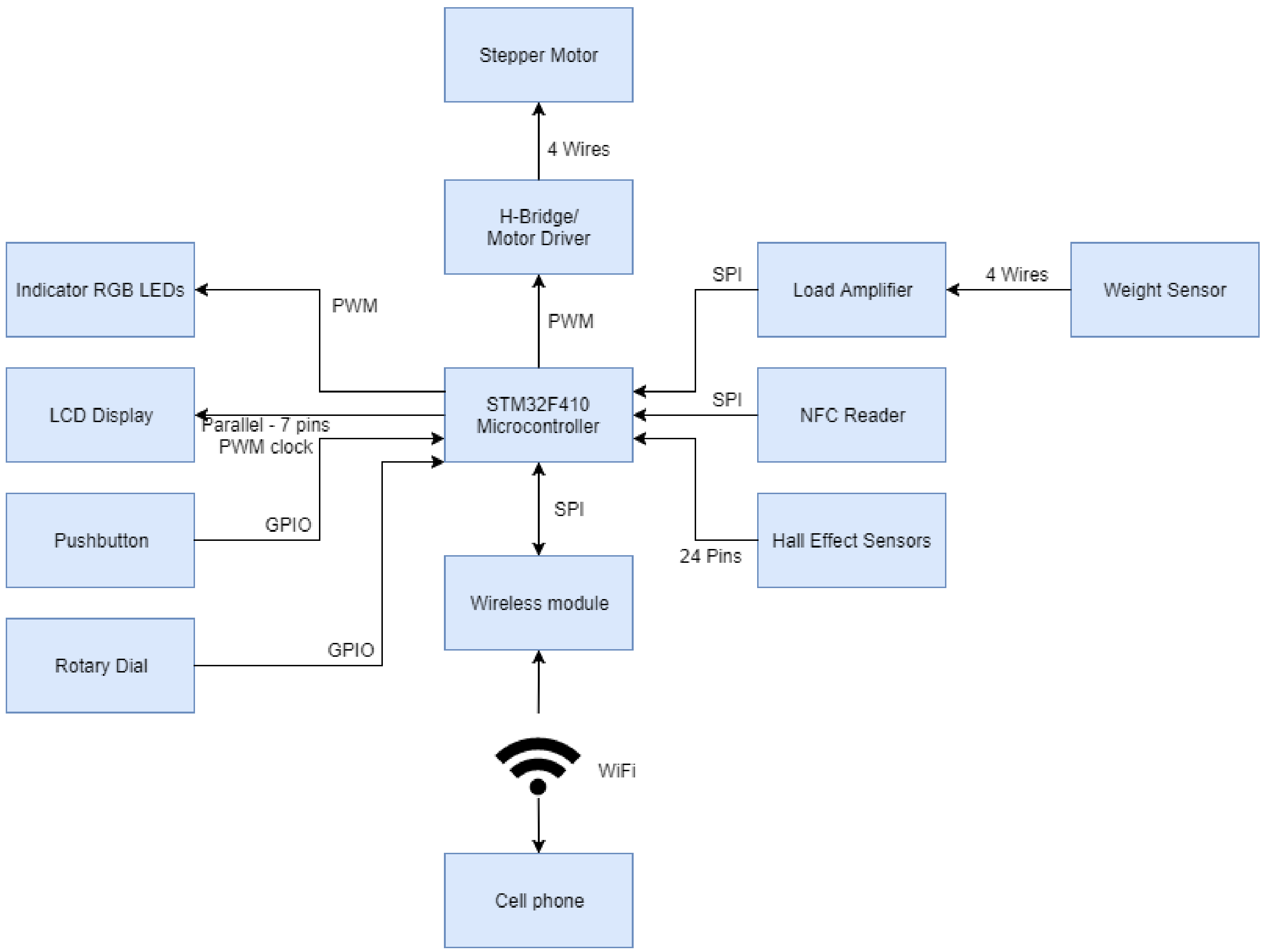

Figure 1: Electrical System Block Diagram