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

Virtual Queue will be implemented using a 32-bit microcontroller, which will carry out general processing and basic algorithms/computations. The microcontroller will manage interfacing with all other components and assume responsibility for all necessary peripherals. All sensor input data will be analyzed by the microcontroller and applied in conjunction with data from the web application to produce intended data outputs in the form of a display and instructions to the user of Virtual Queue. Specifically, the microcontroller will read data from various sensors, communicate queue information to the web application and read back instructions, operate a speaker for customer service, and output queue data onto a display. The web application does the actual software of the queue.

A WiFi module interfaced with the microcontroller will act as the link between the physical product and the complimenting software used to manage the virtual queue. It will be in charge of maintaining communication between the on-site hardware and employed web application. As a result QR-code scans can be properly implemented to secure a customer's spot in line, the display can be continuously populated with information about the queue, and instructions for customers attempting to enter the place of business can be sent to the physical station.

A QR-code scanner will read QR-codes off of smart phones/smart devices in order to place the customer into the queue. Once the customer is notified that it is their turn to enter the place of business, they will scan their QR-code again to begin the entry process for the store/restaurant. The temperature of each customer/user will be taken with a thermopile sensor. It will convert the amount of IR energy it reads into a voltage value via the ADC to be compared with the acceptable range indicative of an asymptomatic and "healthy" customer. PIR sensors will be placed on the entryway/exitway. They will communicate to the microcontroller and indicate when an entity passes through the doorway.

A display will output information from the Virtual Queue web application, including current capacity statistics, groups/individuals near the top of the queue, and instructions to enter the place of business. The display will be driven by a TFT driver to ensure 60 Hz refresh rate and 4 MHz clocking does not bog down the microcontroller. A speaker will utilize the DAC from the microcontroller to inform users if customer service needs to get involved. A class-D audio amplifier will be implemented.

2.0 Electrical Considerations

The microcontroller that Team 4 has determined will fit the needs of Virtual Queue operates with a maximum operating frequency of 80 MHz. However, the used operating frequency will be 26 MHz. This decision is based on the desire to conserve energy while maximizing processing power. 26 MHz allows the microcontroller to handle all of its designated computing processes without using unnecessary amounts of power. The Wifi Module operates within a range of 24-52 MHz, but will be set to 24 MHz in order to minimize consumed power (just like the MCU). The display will be refreshed at 60 Hz with 4 MHz clocking, but the TFT driver will account for this, freeing up the MCU to do other tasks.

Table 1 shows pertinent electrical characteristics of all considered components that will comprise Virtual Queue. The total current consumed by Virtual Queue will cap at 845 mA if all components draw maximum current at once. However, many components will remain in low power/sleep mode to preserve power during hours of business.

Table 1: Power Budget

Part	Operating Voltage	Minimum - Maximum Voltage	Operating Current	Maximum Current	Power (based on Maximum Current)
Microcontroller	3.3 V (1.7 - 3.6 V)	-0.3 - 4 V	---	150 mA	495 mW
WiFi Module	3.3 V	2.5 - 3.6 V	80 mA	170 mA	561 mW
QR-Code Scanner	5 V	4.2 - 6 V	3 - 160 mA	160 mA	800 mW
Display	3.3 V (3 - 3.6 V)	-0.3 - 5 V	120 mA	180 mA	594 mW
TFT Driver	3.3 V (3 - 3.6 V)	-0.3 - 4 V	20 - 50 mA	50 mA	165 mW
PIR Motion Sensor	3.6 V	-0.6 - 4.6 V	-10 - 10 mA	10 mA	36 mW
Speaker	1 V	0 - 4 V	125 mA	---	2 W (Maximum)

Due to the nature of this product, Virtual Queue will be battery powered. Battery life needs to last a minimum of 10 hours due to standard business practices (i.e. how long businesses are open during the day). If the device draws full current for these 10 hours, a capacity of 8450 mAh would be needed to last the full day on one charge. To meet this criteria, we have selected to use two 3.7 V Lithium-Ion batteries with a 6600 mAh capacity each [8], giving us a total of 13200 mAh. Two buck converters will be used to drop to 5 V and 3.3 V in order to provide the required supply voltages for the different components.

No loading concerns from external sources exist.

3.0 Interface Considerations

Virtual Queue will utilize the SPI, I2C, and UART interfaces. The SPI interface will be used to communicate with the LCD display chosen for this product. 5 SPI pins from the microcontroller will interface to a TFT driver which will then drive the display. 4-pin SPI clocks between 100 kHz and ⅓ the system clock, which would be ~13 MHz for the maximum clock rate and 433 KHz for the 26 MHz rate. It is estimated that a clock frequency of 400 kHz will be used as it accounts for any dip in performance but meets our needs electrically: the display will not require frame changes at optimal speeds.

I2C will be used for the AK9753 PIR IR sensors. It will be used to read the data collected by the PIR sensors to determine whether or not an entity has passed through a doorway. It communicates with 16 bits at a time, up to 400 KHz.

Both the Wifi Module and the QR-code scanner will utilize UART. The WiFi module can reach speeds of 4.5 MBs. Due to the chosen frequency (26 MHz), the baud rate will be 74880. The QR-code scanner will have a baud rate of 9600.

4.0 Sources Cited:

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Appendix 1: System Block Diagram