Component Analysis

Year: 2019 Semester: Fall Team: 10 Project: Gesture controlled smart home

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Assignment Evaluation:

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| --- | --- | --- | --- | --- |
| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Analysis of Component 1** | 5 | x2 | 10 | Please add a justification for choosing the particular sensor. I am not deducting point as you have stated justifications for the other components, and they are > 3. |
| **Analysis of Component 2** | 5 | x2 | 10 |  |
| **Analysis of Component 3** | 5 | x2 | 10 |  |
| **Bill of Materials** | 3 | x6 | 18 |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 5 | x2 | 10 |  |
| **Formatting and Citations** | 5 | x1 | 5 |  |
| **Figures and Graphs** | 5 | x2 | 10 |  |
| **Technical Writing Style** | 5 | x3 | 15 |  |
| **Total Score** | 88 | | |  |

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*

IMPORTANT NOTE: The Bill of Materials is a separate document and should be downloaded and filled out for another assignment. The Bill of Materials is to be submitted separately, per the course calendar (possibly on a different week), and will graded collectively with this assignment.

BoM needs a lot of work. The packaging of the components on the PCB needs to be added. Also, the passive components are missing. While choosing the passives, it is advisable to select 0805 or 1206 as your package. For other components it is advisable to use surface mount components. Please make sure all the components can be integrated easily.

1.0 Component Analysis:

The primary components for our design include the Gesture Sensor, Microcontroller, LCD Screen, WiFi module, and rechargeable battery. Gesture Sensors sense the user’s gesture and send it to the microcontroller. Microcontroller decodes the gesture command from the sensor and sends it to the WiFi module. The LCD screen displays the status report to the user. WiFi module this the interface that communicates to the API and microcontroller. Since our device is portable, rechargeable batteries will be required.

1.1 Analysis of Component 1: Sensor

Gesture sensors received and send user’s gesture command to the microcontroller. Due to a large number of possible sensors available that meet the design’s requirement, this analysis compares a few popular sensors and makes appropriate selections.

APDS-9960 Optical Gesture sensor , with an operating range of 10-20 cm, offers ambient light and RGB color sensing, proximity detection, and touchless gesture sensing [1]. The RGB and ambient light sensing feature detects light intensity under various lighting conditions and various attenuation materials including darkened glass. APDS-9960 can sensor both complex gestures accurately [2]. The internal state machine allows the device to stay in a low power state between RGBC, proximity, and gesture measurement. In fact, it is the same sensor that is used in the Samsung Galaxy S5.

SEN-13162 ZX Distance and Gesture Sensor is a touchless sensor looking for simple gestures [3]. In addition, it can also sense the distance, using IR beam, of an object away from itself up to about 30 cm.

APDS-9930 RGB Infrared Gesture Sensor has high sensitivity that allows the device to operate behind a darkened glass. The operating range of this sensor is 10 cm [4]. One feature of this sensor is the internal state machine that has the ability to put the device into a low power mode.

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| --- | --- | --- | --- |
|  | APDS-9960 | SEN-13162 | APDS-9930 |
| voltage range | 2.4-3.6V | 3.3-5V | 2.2-3.6V |
| Proximity detection | Yes | N/A | Yes |
| Output type | I2C | I2C/UART | I2C |
| Operating Temp | -30C to 85C | N/A | -40C to 85C |
| Optical/IR | Optical | IR | IR |
| Operating range | 10-20cm | 30cm | under 10cm |
| Price | 2.72/unit | 24.95/board | 2.05/unit |
|  | CHOSEN |  |  |

1.1 Analysis of Component 2: Microcontroller

In our device, most components communicate with microcontroller using I2C (sensors, EEPROM, rechargeable battery), so the microcontroller used in this device will need to have at least 3 I2C channels. Our team is more familiar with the STM family, therefore we will compare and analyze among the STM microcontroller. We are choosing between STM32F4 series and STM32L4 series.

The STM32F4 series reaches to the industry’s highest benchmark scores for Cortex-M-based microcontrollers. It has high FCPU speed and meet the requirement on the number of I2C channels. The STM32L4 series, though has operating speed around 80MHz, provides great energy efficiency for applications. Due to the high operation speed of STM32F4, our team choose STM32F407IGT6 as the microcontroller of our device.

|  |  |  |
| --- | --- | --- |
|  | STM32F407IGT6[7] | STM32L496[8] |
| Speed | 168MHz | 80MHz |
| RAM | 192K \* 8 | 320K \* 8 |
| Program Memory | Flash 1MB | Flash 1MB |
| Operating Voltage | 1.8 - 3.6V | 1.71-3.6V |
| UART | 4USART/2UART | 5 |
| SPI | 3 | 3 |
| I2C | 3 | 4 |
| Price | 12.13/unit | 11.32/unit |
|  | CHOSEN |  |

1.1 Analysis of Component 3: LCD Screen

For the LCD screen, we decided to purchase the Adafruit TFT 320x480 3.5” Touchscreen after comparing with the Adafruit TFT 160x80 0.96” Display. One of the main reasons is that, despite Adafruit TFT 160x80 0.96” Display being $20 cheaper, the Adafruit TFT 320x480 3.5” Touchscreen has way larger viewing area. Furthermore, the Adafruit TFT 320x480 3.5” is a touchscreen that could allow us to add more features to it in the future if we want.

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| --- | --- | --- |
|  | [9]Adafruit TFT 320x480 3.5” Touchscreen | [10] Adafruit TFT 160x80 0.96” Display |
| Viewing Area | 50.66mm W x 75.09mm H | 33.02mm W x 27.94mm H |
| Touchscreen | Resistive | x |
| Diagonal Screen Size | 3.5” (88.90mm) | 0.96” (24.38mm) |
| Display Type | TFT - Color | TFT - Color |
| Display Mode | Transmissive | x |
| Dot Pixels | 320x480 | 160 x 80 |
| Interface | Parallel/Serial | SPI |
| Graphics Color | RGB | RGB |
| Price | $39.95/unit | $19.99 |
|  | CHOSEN |  |

1.1 Analysis of Component 4: WiFi module

The two candidates of the WiFi module are ESP8266 and ESP32. They are both self-contained SOC with integrated TCP/IP protocol stack that gives microcontroller access to the WiFi network.

WiFi Module - esp8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor [12]. ESP-8266 has powerful on-board processing and storage that allows it to be integrated with the sensors and other devices through GPIO pins.

WiFi Module - esp32 has more features than esp8266 contains [13]. It supports Bluetooth low-energy and has nearly 30 I/O pins. Moreover, ESP32 has lower current leakage and higher memory storage. However, it has higher power consumption and a very high price.

Since the current leakage and the memory storage of ESP8266 is acceptable, and ESP-8266 has all the features we need for the design, our team chooses ESP-8266 as the WiFi module used in Gesture Control Smart Home.

|  |  |  |
| --- | --- | --- |
|  | ESP-8266 | ESP32[14] |
| power down leakage current | <10uA | 2.5uA |
| Operating Voltage | 3.3 V | 3.0-3.6 V |
| Flash Memory | 1MB | 4MB |
| Standby power consumption | <1.0mW | <3.0mW |
| wake up and transmit time | < 2ms | N/A |
| Price | 6.95 | 21.95 |
|  | CHOSEN |  |

1.1 Analysis of Component: Battery

Since our device is designed to be portable, we need a large-capacity rechargeable battery as a power supply. 18650 batteries are known for the rechargeable battery, so we looked up candidates from the 18650 series.

Samsung 30Q 18650 3000mAh 15A Battery has a high battery capacity. The feature of this battery is that it has a smaller size compared to the other [15].

18650 Protected 3100mAh Li-ion Rechargeable Orbtronic-Panasonic Battery has a high battery capacity [16]. One feature of this battery is that there is a built-in IC to protect current overflow and short and over-charge/discharge. Though the price is higher, due to the user’s safety, this one is chosen.

|  |  |  |
| --- | --- | --- |
|  | Samsung 30Q 18650 | 18650 Li-ion Battery |
| Voltage | 3.6 | 3.7V (4.2V at max) |
| Capacity | 3000mAh | 3100mAh |
| Dimensions | 18.33mm \* 64.85mm | 18.6mm \* 68mm |
| Current overflow protection | No | yes (5A - 6A) |
| IC protection | No | Yes |
| Price | 4.5 | 9.99 |
|  |  | CHOSEN |

2.0 Sources Cited:

[1]Digi-Key(2019) APDS-9960. Available:<https://www.digikey.com/product-detail/en/broadcom-limited/APDS-9960/516-3480-1-ND/6677150>

[2]BROADCOM(2019) APDS-9960 Digital RGB, Ambient Light, Proximity and Gesture Sensor. Available: <https://www.broadcom.com/products/optical-sensors/integrated-ambient-light-and-proximity-sensors/apds-9960>

[3]Sparkfun (2019) ZX Distance and Gesture Sensor SEN-13162.

Available: <https://www.sparkfun.com/products/13162>

[4] Digi-Key(2019) APDS-9930 RGB Infrared Gesture Sensor.

Available: <https://www.digikey.com/product-detail/en/broadcom-limited/APDS-9930/516-3479-1-ND/6677149>

[5] Digi-Key(2019) STM32F407IGT6. Available: <https://www.digikey.com/product-detail/en/stmicroelectronics/STM32F407IGT6/497-11604-ND/2747118>

[6]Digi-Key(2019) STM32L4. Available: <https://www.digikey.com/product-detail/en/stmicroelectronics/STM32L496ZGT6/497-17178-ND/6709883>

[7]STM32F407 Datasheet(2016). STM32F405xx STM32F407xx Datasheet. Available: <https://www.st.com/content/ccc/resource/technical/document/datasheet/ef/92/76/6d/bb/c2/4f/f7/DM00037051.pdf/files/DM00037051.pdf/jcr:content/translations/en.DM00037051.pdf>

[8] STM32L496 Datasheet(2018). STM32L496xx Datasheet. Available:

<https://www.st.com/resource/en/datasheet/stm32l496ae.pdf>

[9] Digi-Key (2019) *3.5” TFT 320x480 + Touchscreen Breakout Board with MicroSD Socket* Available:

<https://www.digikey.com/catalog/en/partgroup/3-5-tft-320-x-480-touchscreen-breakout-board-with-microsd-socket/60158?mpart=2050&vendor=1528>

[10] Digi-Key (2019) *0.96” 160x80 Color TFT Display With MicroSD Card Breakout - ST7735* Available: <https://www.digikey.com/catalog/en/partgroup/0-96-160-x-80-color-tft-display-with-microsd-card-breakout-st7735/70103?mpart=3533&vendor=1528>

[12] Sparkfun (2019). WiFi module - ESP8266. Available: <https://www.sparkfun.com/products/13678>

[13]Sparkfun (2019). WiFi module - ESP32. Available: <https://www.sparkfun.com/products/13907>

[14] ESP-32 Datasheet.(2018) Available: <https://cdn.sparkfun.com/datasheets/IoT/esp32_datasheet_en.pdf>

[15]18650batterystore.(2019)Samsung 30Q 3000mAh 15A Battery. Available: <https://www.18650batterystore.com/Samsung-18650-p/samsung-30q.htm>

[16] ORBTRONIC(2019). 18650 Protected 3100mAh Li-ion Rechargeable Orbtronic-Panasonic Battery. Available: <https://www.orbtronic.com/batteries-chargers/protected-3100mah-18650-li-ion-battery-cell-is-panasonic-ncr18650a-protection-ic-made-in-japan-top-button>