Component Analysis

Year: 2022 Semester: 2 Team: 2 Project: VRms

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Assignment Evaluation:

| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| --- | --- | --- | --- | --- |
| **Assignment-Specific Items** | | | | |
| **Analysis of Component 1** |  | x2 |  |  |
| **Analysis of Component 2** |  | x2 |  |  |
| **Analysis of Component 3** |  | x2 |  |  |
| **Bill of Materials** |  | x6 |  |  |
| **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:

1.0 Component Analysis:

The primary components of our design are the Microcontroller, Raspberry-Pi, Robotic Arm, Servo Driver, and Buzzer. The microcontroller will translate angular position data from the unity server to the servo position and then will send that data to the servo driver. The Raspberry-Pi will send the angular position data from the server to the microcontroller while also sending camera data to the server. The servo driver is responsible for controlling all of the servo movements on the robot arm. The robot arm is the interface to the physical world that the user will be controlling through the VR headset and controllers. The buzzer component will be used to signal that the connection to the server has been lost and that the robot has returned to the home position.

1.1 Analysis of Component 1: Microcontroller

The choice of microcontroller came down between the STM32F091 and the STM32F051. The microcontroller needed to have UART, SPI, and PWM capabilities to interface with the other components. The STM32F091RC [1] and STM32F051 [2] satisfies all of these requirements, but have different computing speeds. Our microcontroller needs to be able to handle quite a bit of incoming and outgoing data with data parsing in the middle, so this is an important requirement. We only need 1 UART channel, 2 PWM channels, and 1 SPI channel.

|  | STM32F091 | STM32F051 |
| --- | --- | --- |
| Operating Frequency | 48 MHz | 48 MHz |
| I/O pins | 52 | 39 |
| RAM | 32KB | 8KB |
| Flash Memory | 256KB | 16KB |
| Operating Voltage | 2V - 3.6V | 2V - 3.6V |
| UART module | 8 | 2 |
| SPI module | 2 | 2 |
| I2C | 2 | 2 |
| PWM | 6 | 6 |
| Price | $3.48 | $6.29 |

Both of these microcontrollers would work for our project, but due to the chip shortage, we decided to go with the STM32F091 since it is available in lab. The STM32F051 would have been a more bare bones choice for our project, but since it was not available we were unable to go with that option.

1.2 Analysis of Component 2: Raspberry Pi

The choice for our Raspberry Pi came down to price and simplicity. We know that the raspberry pi is capable of performing the actions we need the pi to do; the pi needs to collect data from the internet, and send data to individual components like the robotic arm or our PCB board. Both Pi contains PINs that we can use in order to transmit data between different components. In addition, they both have wifi capability so they should be able to communicate remotely. We compare the difference between the two pi below [7][8][9].

|  | Raspberry Pi 4 | Raspberry Pi 3 |
| --- | --- | --- |
| Number of USB | 4 | 3 |
| Clock Speed | 1.5GHz | 1.4GHz |
| RAM | 2 GB LPDDR4 | 1 GB LPDDR2 |
| Wifi | 2.4 GHz and 5.0 GHz IEEE 802.11 ac wireless | 2.4 GHz and 5.0 GHz IEEE 802.11 ac wireless |
| Cost | $45 | $35 |

What made us choose Raspberry Pi 4 over Raspberry Pi 3 is the RAM. A high RAM means it has more of a capacity to run multithreaded programs, which will require more easily accessible memory allocations. In addition, the RAM gives us more flexibility on how much we want the Raspberry Pi to perform, because at this moment, we are not entirely confident on the full constraints that the Pi will only retrieve data from the Pi, and send and receive data via UART via their ports; we might have it do some extra computations.

1.3 Analysis of Component 3: Robotic Arm

The choice for our robot arm came down to two arms, [3] and [4], both made by the same company. What we were looking for was an affordable arm with a high degree of freedom. These both have six degrees of freedom, which is one less than what we wanted, but the most these types of arms go up to online. While [4] is more expensive, it has a more premium build quality and better quality servo motors. We also needed to consider the operating voltage since we are powering this with a wall outlet, and ease of use since there are 7 different servos we need to control at once.

|  | Hiwonder Bus Servo Arm | HiWonder Robot Arm Kit |
| --- | --- | --- |
| Power Supply | 7.5V 3A Power Adapter | 7.5V 6A DC Power Adapter |
| Degrees of Freedom | 5DOF + Gripper | 5DOF + Gripper |
| Package Weight | 2.2kg | 1.68Kg |
| Dimensions | 18.31 x 4.7 x 11.22 inches | 6x5.5x16.8 inches |

While there were slight tradeoffs between the two arms, they both would be completely usable for our project. The main factor contributing to which one we chose was the fact that [3] was available for free from a team that bought it the previous semester, so that arm is the one we went with.

1.4 Analysis of Component 4: Buzzer

One of our main components is the auditory feedback system we have in place to let the user know that the Raspberry-Pi has been disconnected from the server. We need a buzzer that will change tone under a pwm signal, so our only option is to go with a passive buzzer. Our two options were the MLT-8530 buzzer module [5] or the PS1240 Piezo buzzer [6]. The audible frequency range is from 20 Hz to 20kHz, so anything in the middle with a loud enough volume would work for our project.

|  | PS1240 Piezo Buzzer | MLT-8530 Module |
| --- | --- | --- |
| Frequency Range | 2KHz to 10KHz (~70dB) | 2.7 KHz (~80dB) |
| Operating Voltage | 3V-5V | 2.5V - 4.5V |
| Price | $1.50 | $6.29 |

Since both buzzers are within an audible range and appropriate decible level, we could have gone with either one. We decided to go with the PS1240 Piezo Buzzer because it wasn’t a module but just the buzzer alone, and because its price was much lower than the MLT-8530.

2.0 Sources Cited:

[1]“STM32F091RC.” *STMicroelectronics*, <https://www.st.com/en/microcontrollers-microprocessors/stm32f091rc.html>.

[2]“STM32F051C4.” *STMicroelectronics*, <https://www.st.com/content/st_com/en/products/microcontrollers-microprocessors/stm32-32-bit-arm-cortex-mcus/stm32-mainstream-mcus/stm32f0-series/stm32f0x1/stm32f051c4.html>.

[3] *Amazon.com: Robotic Arm Kit 6dof Programming Robot Arm ...* <https://www.amazon.com/LewanSoul-Robotic-Arduino-Software-Tutorial/dp/B074T6DPKX>.

[4] *Amazon.com: Robotic xArm 6DOF Full Metal Programmable Arm …*

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[5]“107020109.” *DigiKey*, <https://www.digikey.com/en/products/detail/seeed-technology-co-ltd/107020109/12086988>.

[6] Industries, Adafruit. “Piezo Buzzer.” *Adafruit Industries Blog RSS*, <https://www.adafruit.com/product/160>.

[7]Hattersley, Lucy, and Lucy is Editor of The MagPi. “Raspberry Pi 4 vs Raspberry Pi 3B+.” *The MagPi Magazine*, <https://magpi.raspberrypi.com/articles/raspberry-pi-4-vs-raspberry-pi-3b-plus>.

[8] “Raspberry Pi 3 Model B+.” *OKdo*, 12 Feb. 2022, <https://www.okdo.com/us/p/raspberry-pi-3-model-b/>.

[9] “Raspberry Pi 4 Model B - 2GB.” *OKdo*, 9 Feb. 2022, <https://www.okdo.com/us/p/raspberry-pi-4-model-b-2gb-2/?src=raspberrypi>.