Component Analysis

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1.0 Component Analysis:

The core components of our design consist of the motion detection sensor, microcontroller, and motor drivers. The motion detection sensor is responsible for capturing data of surrounding movement to be processed by our software to trigger motion detection. This sensor interfaces with the microcontroller which is responsible for maintaining signals to and from the sensor, motors, and an external web server to process and execute the desired functionality for movement and detection. From the microcontroller output, the motor drivers are responsible for regulating the power and direction of wheel rotation to move the chassis.

1.1 Analysis of Component 1: Motion Detection Sensor

Feature	Sonar Sensor[1]	Ultrasonic Sensor[2]	360° Lidar Sensor[6]
Measurement Distance	7.65m	2cm - 4m	~12m
Angular View Area (degrees)	48°	15°	360°
Cost	$39.95	$4.50	$99.00
Chosen	Yes	No	Stretch Feature

Design constraints:
When selecting a mechanism for movement detection, we had to acquire a cost-effective yet also wide-range sensor with considerable reliability because they are core to the design of a surveillance robot.

Chosen Component: Sonar Sensor
Based on the specs shown in the table above, the sonar sensor provides a moderate-cost, moderate-distance solution for motion sensing. The 48 degree field of view allows for one of them to be placed on each side of our design, giving us strong coverage. In addition, 7.65 meters is surmised to be enough for our application since the distance of each measurement is aided by the MOUSE moving between each measurement, providing a much wider range for detection. The overall choice for selecting this component comes from its well-balanced range and cost.

Alternate Component 1: Ultrasonic Sensor
The ultrasonic sensor has a wide range in terms of measurement distance and comes in at a low price point. Based on our research, most of the ultrasonic sensors that we found did not support long-distance sensing and were designed to only sense objects a few centimeters in front of them. In addition, previous experiences with them were known to be inconsistent, not sufficient for robust motion-detection systems. For core functionality, it made sense to go for a higher-cost and more reliable part.

Alternate Component 2: Lidar Sensor
The lidar sensor is unique in the fact that it brings a 360 degree field of view. While it is more expensive to purchase one of them, it is able to be mounted on top of the divide and provide coverage in all directions. However, from a design standpoint, we wanted to mount a sensor device on all four sides of the MOUSE to perform data analysis on each side individually. It would not be cost-effective to do this with lidar sensors. For this reason, it seems effective as a cross-validation method that meets the need of being a stretch PSDR.

1.1 Analysis of Component 2: Microcontroller

The following hard design constraints for the MOUSE to function as specified in the functional specification assignment are as follows: WiFi communication capabilities, communication over I2C communication protocol, 4+ PWM channels, 7+ GPIO pins. Additionally, the clock frequency needs to be as fast as possible to allow for quick WiFi communication and low latency. [3] [4]

Feature	ESP32	ESP8266	STM32
WiFi	Yes	Yes	No
Operating Voltage (V)	3.3	3.3	2.4-3.6
GPIO Pins (Number)	34	17	39
Communication Protocols	SPI/I2C/UART/ADC/DAC	SPI/I2C/UART/ADC/DAC	SPI/I2C/UART/ADC/DAC
PWM Channel (Number)	16	8	6
Clock Frequency	Dual Core - 160 MHz & 240 MHz	Single Core - 80 MHz	Single Core - 48 MHz
Price	$6-$12	$4-$6	$1-$4
Chosen	Yes	No	No

From the table above, it can be seen that all three microcontrollers meet the hard requirements for PWM channels, communication protocols, and GPIO pins. However, the STM32 is missing WiFi capabilities. It also lacks the soft requirement of needing a high clock frequency as it has the lowest of the three options. In contrast, the ESP32 and ESP8266 meet all the hard requirements. Because the STM32 is lacking in these feature specifications, the choice is ultimately between the ESP32 and ESP8266.

The ESP8266 is actually the first iteration of the ESP32, so it makes sense that the obvious correct choice is the ESP32. Although the ESP32 is cheaper, it is negligible with the $450 budget. The ESP32 excels in its dual core clock that provides a much faster frequency. This is crucial in the decision between the two because WiFi latency is a big design concern, and the faster the frequency, the lower the latency is. Additionally, although unneeded with the current design plan, the ESP32 has twice as many PWM channels and GPIO pins.

1.1 Analysis of Component 3: Motor Drivers

The following hard design constraints for the MOUSE to function as specified in the functional specification assignment are as follows: Dual motor control, PWM controllable, 12V voltage input to allow direct connection from the battery, at least 6V output voltage, >1A peak current output per channel for motor stall current, and >0.5A continuous current output per channel. All motor controllers fulfill the 12V input voltage requirement. [5]

Feature	TB6612FNG	A4990	DRV8833
Number of Motor Channels	2	2	2
PWM controllable	Yes	Yes	Yes
Minimum Output Voltage (V)	4.5	6	2.7
Maximum Output Voltage (V)	13.5	32	10.8
Peak Current Output per Channel (A)	3	0.9	2
Max Continuous Current Output per Channel (A)	1	0.7	1.2
Price	$4.95	$7.95	$9.95
Chosen	Yes	No	No

From the table above, it is clear all motor controller options fulfill the requirements of dual motor control and PWM, 6V output voltage, and continuous current output per channel of 0.5A. However, the A4990 does not meet the requirement for 1A peak current as this motor driver can only output a maximum of 0.7A/channel. This will not allow the motor controller to output the current required to overcome the stall current of the motors being used. After all these basic considerations were met, we were deciding between the TB6612FNG and DRV8833.

The TB6612FNG has two distinct advantages over the DRV8833. First, the 477 lab had TB6612FNG in stock, allowing us to start testing with this motor controller already. From these tests, we know this motor driver works with our motors. Second, the TB6612FNG is approximately half the cost of DRV8833, which will save cost in the production of MOUSE.

2.0 Sources Cited:

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