Electrical Overview

Year: 2022 Semester: Spring Team: 8 Project: Gimbal Vehicle

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Assignment Evaluation:

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| --- | --- | --- | --- | --- |
| **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. Electrical Overview

Our project has two computational components.

* 1. Electrical Overview of controller part

The controller part will use STM32F091RCT6, a 32-bit microcontroller, which will handle the reading of two joysticks, and the operation of NRF24L01 wireless transceiver. The input and output device for the controller part will be a single pole double throw switch for mode selection (SPDT switch), two joysticks for controlling the movement of the vehicle, and a wireless transceiver for sending information to the vehicle.

1.2 Electrical Overview of vehicle part

The Vehicle part will use STM32F407VGT6, a 32-bit microcontroller, which will handle the operation of NRF24L01 wireless transceiver, control of four motors, and two servos, and the communication of an IMU(MPU6050) and an OLED screen.

The input and output device for the vehicle part will be a wireless transceiver for receiving information from the controller, an OLED screen for display the real time information of the vehicle, two motor driver chip for controlling motor, and an IMU for gimble control.

2.0 Electrical Considerations

2.1 Operation Voltage

The operation voltage of the controller and vehicle part will be 3.3V. Both the STM32F091RCT6 and STM32F407VGT6 allow the Maximum 5V power supply. All the component except motor controller chip(L298n) can work properly between 2.6V to 3.8V.

The motor controller chip (L298n, Dual full-bridge driver) needs a 12V input to function correctly. This component will connect to 12V battery directly. Also, this chip can endure maximum 50V input.

2.2 Operation Frequency

The main constrain of the operation frequency will be determined by the ADC sampling frequency (controller part), SPI Bard Rate (controller part), and PWM output frequency (vehicle part).

For the controller part, STM32F091RCT6 only has one ADC unit, and we need to use up to 4 channels to get the real-time joystick sampling information. Therefore, the MCU should run at 48Mhz. Also, the maximum transfer speed of the transceiver is 8Mbps. When the MCU runs under 48Mhz, it can satisfy the requirement of the transceiver.

For the Vehicle part, we need to use five timers to fully control (including using hall sensor encoders) the chassis. The PWM output should go above 5Khz to prevent oscillation of the motor. Therefore, we will run the STM32F407VGT6 at 84Mhz (the maximum speed is 168Mhz) so that we can set the Prescaler register (TIMx\_PSC) and counter period register (TIMx\_ARR) to an integer value, and the output frequency can be 10Khz as we want.

2.3 Power Supply

For controller part, we will use a 9V alkaline battery for power supply.

The current requirements of controller part are included in following table:

|  |  |
| --- | --- |
| Device | Current (Maximum) |
| Microcontroller | 100mA |
| Wireless transceiver | 12mA |
| LED | 10mA |
| Total | 122mA |

For vehicle part, we will use a 12V robotic battery for power supply, the maximum current endurance for this battery is 30A. For safety reason, we have a 20A fuse connect it in series.

The current requirements of vehicle part are included in following table:

|  |  |
| --- | --- |
| Device | Current (Maximum) |
| Microcontroller | 200mA |
| OLED | 5mA |
| IMU | 3.9mA |
| Motor \* 4 | 2A \* 4(stall current) |
| Wireless transceiver | 12mA |
| Servo \* 2 | 700mA \* 2(stall current) |
| Total | 9.62A |

图示

描述已自动生成

Figure 1 Power supply circuit

3.0 Interface Considerations

3.1 Interface Consideration for Controller Part

The first interface is SPI which is responsible for transmitting the data between the wireless transmitter and receiver module. The read/write data rate is 2Mbps. 5 Bytes for the TX/RX address. The data package handled by SPI has a size of 10bytes, which contains the ADC input from the two joysticks and current state of the switch.

For the ADC, we mainly use it to get analog data from the joysticks. We defined the ADC resolution to 12 bits and had Continuous Conversion Mode enable. The data that we read from ADC will be stored in a length of 4 of uint16\_t array. Regarding the status of the switch, we read directly from the GPIOC pin0 and GPIOC pin 1. The data structure of the status will be uint8\_t.

3.2 Interface Consideration for Vehicle Part

We interfaced OLED display with microcontroller using I2C due to the nature of the display module we are using which has one SDA pin and one SCL pin. It will be transmitting data of Yaw, Roll, and Pitch angle of the IMU to display them on the display. We are using I2C channel 2 for the OLED display which has a speed frequency of 400 KHz.

We also used I2C for the interfacing between the IMU and the microcontroller. We use I2C channel 1 of the microcontroller to read gyroscope and accelerometer data from the IMU. The data is used for the calculation of the angle of the chassis in order to control the movement of the gimbal, keeping the camera focusing on the same direction. We used I2C due to the nature of the IMU we used which is MPU6050. It has one SCL pin and one SDA pin. The I2C speed frequency is 100 KHz for data transmission between the IMU and the microcontroller.

4.0 Sources Cited:

[1] STMicroelectronics, “Adjustable and fixed low drop positive voltage regulator,” 04-Feb-2020. [Online]. Available: https://www.st.com/resource/en/datasheet/ld1117.pdf. [Accessed: 04-Feb-2022].

[2] L. Huan, “Using voltage regulator to convert 5-12V range to 3 - 41j.com,” 02-Apr-2010. [Online]. Available: http://41j.com/blog/wp-content/uploads/2014/08/HuanLin480ApplicationNote.pdf. [Accessed: 04-Feb-2022].

[3] Energizer, “Energizer Max 9V.” [Online]. Available: https://data.energizer.com/pdfs/max-eu-9v.pdf. [Accessed: 04-Feb-2022].

[4] NORDIC semiconductor, “NRF24L01 product Specification V2 - mouser.com.” [Online]. Available: https://www.mouser.com/datasheet/2/297/nRF24L01\_Product\_Specification\_v2\_0-9199.pdf. [Accessed: 04-Feb-2022].

Appendix 1: System Block Diagram

电脑屏幕截图

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