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

The primary electrical functionality will be performed on a 32-bit microcontroller which will process all of the commands sent from the computer. The microcontroller controls all three motors on the boat and sends back information regarding the GPS location coordinate, Compass direction, battery level, and capacity of storage room. Communications are done through Wi-Fi communication. The microcontroller manages the peripherals including SPI, UART, ADC, I2C and PWM(TIM). Other than what microcontroller handles, there are a voltage regulation circuit, a battery monitor circuit, and LDR sensing circuits.

2.0 Electrical Considerations

The operating voltage of the microcontroller will be 3.3V, the microcontroller used in this project has an operating voltage range of 1.71V to 3.6V [1]. The two brushless DC motors would be operated at 11.1V max, the ESC will take care of the voltage regulation for our brushless DC motors as the ESC is rated for 2s or 3s LiPo batteries[2], and the conveyor belt motor is driven in the voltage range of 3.7V to 6V. A 5V voltage will be provided to the Adafruit 746 GPS module [3] and the break beam sensing circuit. The ESP8266 WiFi module [4] and the SoC located on it is operated under 3.3V. The MLX90393 Triaxis Magnetic Compass provides 2.2V-3.6V supply for battery-powered applications, down to 1.8V IO voltage [5].

The LDR sensing circuits consist of PNP transistors that will light up the LED indicator when the LDR does not detect the light source. The microcontroller is constantly monitoring the analog voltage value of the LEDs. As the LED turns on indicating the light source is missing, the analog voltage value will change from about 1.6V to 0.32V.

For the power supply system, the battery unit will be outputting a voltage ranging from 9V to 12.6V[6], thus it is necessary to utilize multiple voltage regulator to step the high voltage value down to 5V and 3.3V since most of the components in the project operates at this voltage range.

Since the microcontroller's max Vin on the GPIO pins is 4V [1], we will be using a voltage divider when monitoring the voltage on our power supply ensuring that when our batteries are fully charged, the voltage on our GPIO pin is under 4V.

3.0 Interface Considerations

- PWM(TIM)
  To control the speed of the motors, the Electrical Speed Controls (ESC) will be utilized, and it communicates with the microcontroller through PWM, which uses the peripheral TIM. By modifying the clock cycle and changing the duty cycle of the PWM waveform, the ESCs adjusts the RPM of the motors to perform the assigned speed.

- ADC
  The storage unit capacity is monitored through a self-made laser break-beam circuit utilizing LDRs (light dependent resistors). The LDR changes its resistance based on the light source

illumination [7]. The whole LDR circuit outputs an analog voltage signal, which is monitored by the microcontroller through ADC. The battery monitor also gives an analog voltage signal and uses ADC peripheral. The There are 3 12-bit ADCs on STM32F407 board [1], which is powerful enough.

- SPI
  A GPS module communicates with the microcontroller through the SPI peripheral and is powered by the microcontroller. The GPS module supports UART, USB, SPI and DDC interface and SPI is selected in the project [3]. In SPI transmission, the maximum bandwidth is 100 kbit/s, the STM32F407 has 3 SPIs with up to 42 Mbits/s.

- I2C
  The Compass uses I2C to communicate and it uses 7-bit addressing mode, and it can use both I2C Standard-mode (up to 100 kHz) and Fast-mode (up to 400 kHz)[5]. The I2C peripheral of the STM32F407 board can support both modes. They support the 7/10-bit addressing mode. They can be served by DMA and they support SMBus 2.0/PMBus.

- UART/USART
  The WiFi module utilizes UART/USART to work with the microcontroller and the ESP8266 WiFi module could reach a maximum clock speed of 160MHZ[4]. The data transmission speed via UART interfaces with the microcontroller reaches 115200 x 40 (4.5 Mbps)[4].

4.0 Sources Cited:

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[4] Sparkfun. (2016) *Wi-Fi Module - ESP8266.* [Online]. Available:https://www.sparkfun.com/products/13678. [Accessed: 14-Sep-2018]

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Appendix 1: System Block Diagram