Robotic Design Project
Power Requirement Analysis

Team Savitars

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1 Current requirements of each component

Component	Current Requirement	Qt.	Maximum	Operational	Notes
JGA 25-370 Motors	1800 mA (Stall Current) 450mA (Operational)	2	3600 mA	900mA	Motor specifications and current ratings
ESP32-S3 SoC (WiFi disabled mode)	110 mA	1	110 mA	110mA	This is the tested value for DevBoard. Datasheet mentioned that the modem-off mode with 80MHz clock should consume about 50mA. (Might be this when using the bare ESP SoC Module for the final robot)
TCS34725 Colour Sensor Module with 2 SMD White LEDs	4 mA	5	20 mA	20mA	Tested Value
VL530L0x ToF Sensor	20 mA	3	60mA	60mA	Tested and mentioned in the datasheet
Tower Pro MG90s Servo	800mA (Stall Current) 250mA (Operational)	1	800mA	250mA	Idle : 10mA, Operational: 120-250mA (Haven't verified as not in possession at the moment. Manufacturer datasheet doesn't mention current ratings)

Tower Pro SG90 Servo	300mA (Stall Current)	1	300mA	250mA	Idle : 10mA, Operational: 100-250mA (Haven't verified as not in possession at the moment. Manufacturer datasheet doesn't mention current ratings)
KK P20/15 2.5kg 5V DC Lifting Solenoid	220mA (Max)	1	220 mA	220mA	Digikey
TCA9548A I2C Multiplexer IC	20mA	1	20 mA	20mA	Texas Instruments
TB6612FNG Dual Motor Driver IC	2.2mA	1	2.2 mA	2.2mA	SparkFun
GY-271 Magnetometer Module (with QMC5883L)	3 μA	1	0	0	datasheet
Magnetic Encoders	3.5mA	2	7mA	7mA	Tested
Total			5200mA	1840mA	Absolute maximum possible current and operational maximum current that can be drawn

The power source should be capable of delivering a peak current of 5.2A at any given moment. However, it's important to note that under typical operating conditions, the actual current drawn by the motors and servos will not exceed approximately 1.9A . This design ensures a safety margin for sudden power demands while maintaining efficient operation during normal use.

2 Voltage requirements of the robot

All the sensors and control units can function with a voltage less 3.7 (Nominal voltage of Li-Po cell). But the actuators like servos require a typical voltage of 5V and the DC motor require a voltage higher than 6V to function in it's best performence. So a 2 series Li-Po or Lithium Ion battery cell configuration would be most suitable for our robot.

3 Suitability of acquired power source

As we already have a 2P CNHL 3S(11.1V) 100C Li-Po 1500mAh Battery pack we acquired for another application, we will analyze the suitability of that battery for our robot.

The maximum possible current the battery can supply ($I_{\max}$) is,

$$I_{\max} = C \times \text{Capacity} = 100 \times 1.5\,\text{A} = 150\,\text{A}$$

The maximum current requirement is satisfied since:

$$I_{\max} > 5.2\,\text{A}$$

The operational duration (T) of the battery, without discharging below 80% of its capacity is,

$$T = \frac{\text{Capacity} \times 0.8}{I_{\text{operational}}} = \frac{1500\,\text{mAh} \times 0.8}{1840\,\text{mA}} \approx 0.652\,\text{h} \approx 39\,\text{minutes}$$

As the supply voltage(11.1V) is higher than that of the highest required voltage(6V) this battery pack will be suitable for suppling power to the system via a voltage regulator or step down circuitry.

4 Power Source Alternatives

4.1 2S Lithium Polymer (Li-Po) Battery Pack(7.4

- Pros:
  - Possibility of being lighter in terms of weight compared to 3S
  - Lower voltage, potentially reducing the need for voltage regulation
  - Still provides sufficient voltage for most components
- Cons:
  - Might not provide enough voltage for optimal DC motor performance when discharged to some extent.
  - Expensive and most of the locally available 2S packs are heavier compared to the already available 3S pack.

4.2 Li-ion 18650 Battery Pack (2S2P or 3S2P configuration

- Pros:
  - Generally cheaper than Li-Po batteries
  - More stable and safer than Li-Po
  - Easy to replace individual cells if needed
- Cons:
  - Lower discharge rates compared to Li-Po
  - Heavier than equivalent capacity Li-Po packs
  - May require a custom battery holder or casing
  - Larger form factor will take much room from the robot

4.3 10-cell NiMH Pack (12V nominal)

- Pros:
  - Very safe and stable
  - Can handle high discharge rates
  - Often cheaper than Li-Po or Li-ion
- Cons:
  - Much heavier than Li-Po or Li-ion for equivalent capacity
  - Lower energy density, resulting in shorter run times or larger battery size
  - Prone to self-discharge and memory effect

4.4 20000mAh USB power bank with 5V output

- Pros:
  - Easily rechargeable with standard USB chargers
  - Safe to use
  - Can potentially power the system directly at 5V
- Cons:
  - May require additional circuitry to step up voltage for motors
  - Limited maximum current output compared to dedicated battery packs
  - Bulkier than a custom battery solution

5 Notes

Although the chosen battery pack somewhat exceeds the power requirements of our current application interms of the discharge rate, its integration offers several advantages:

- Minimal weight impact: At approximately 143g, the battery's lightweight design ensures negligible effect on the robot's overall functionality compared to other 2S Li-Po battery packs available on the market.
- Cost-effectiveness: Utilizing this existing resource allows for more efficient allocation of our budget.