Cypress Robot Kit
Mock Design Review

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1 Block Diagram

Figure 1: Block diagram showing how the different modules are connected.
2 Circuit Schematic of Power System

Figure 2: Schematic of step-down converter from 7.4V LiPo Battery to 5V based off of example schematic [1].
3 Motor Control Calculations

We are using SparkFun’s Micro Gearmotor with gear ratio 298:1. The motor operates 6-12V with no-load current of 30mA at 6V [2]. To calculate power consumption of the motors, load torque applied to the motors will be assumed to be maximum for this calculation, meaning the load torque will be equal to stall torque, $T_s = 282.5 \text{ mN-m}$ and stall current, $I_s = 360mA$ rated. Therefore total motor input current is,

$$I_{total} = I_{noLoad} + I_s = 30mA + 360mA = 390mA$$

(1)

Our robot will continuously stop and start based on sensor readings, and it is safe to assume each motor will constantly draw a stall current a 390mA each as the worst case scenario. For selecting the motor driver circuit and voltage regulators, each motor will be connected to their own H-bridge and voltage regulator. Since each motor draws 390mA of maximum current with 6V, each component is chosen so that they have maximum current output of 1A.

The maximum electrical power, $P$, input required to drive the two motor is the product of the applied voltage, $V$, and total current, $I$.

$$P = V \times I = (6V \times 390mA) \times (2\text{motors}) = 4,680mW$$

(2)

Therefore, total instantaneous power consumed by the two motors is 4,680mW.
4 Plot of Max Current Draw vs Load

Figure 3: Plot of max current draw across both motors depending on the robot load

For this experiment, we measured the max current of the robot moving across a distance of 1 foot using the Tamiya 70097 Twin-Motor Gearbox Kit motors. On the worst case load, the motors draw a combined current of over 1.55A. This has shown us that even during normal operation, we need to make sure our motor driver parts are all rated to be able to handle this much current.
5 Ultrasonic Sensor Block Diagram Description

The HC SR-04 sensor will provide us with information about the distance of possible obstacles in front of the robot with a range of 2cm to 400cm [3]. It will be powered by 5V and communicate with the PSoC through two I/O pins interfaced through the shield. To get a distance reading, the trigger pin will be sent a high signal of 5V for at least 10us. Upon reading high pulse of 5V from the echo pin, a counter will be started to measure how long the echo pin is held high. This time measurement will then be converted into cm based off of constants found in the datasheet. Upon sensing an obstacle, the motor control should turn away to avoid it. The data from this sensor will be utilized when the obstacle avoiding mode is selected from the phone application through Bluetooth.
## 6 Requirements and Verifications

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
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<tbody>
<tr>
<td><strong>Power System</strong></td>
<td></td>
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<tr>
<td>1. 7.4V to 5V linear voltage regulator provides microcontroller with constant DC voltage of 5V +/- 5%</td>
<td>1. Measure the microcontroller output of the power module using digital multimeter to ensure the voltage is between 4.75V to 5.25V</td>
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<tr>
<td>2. 7.4V to 6V linear voltage regulator provides motor control with constant DC voltage of 6V +/- 5%</td>
<td>2. Measure the motor output of the power module using digital multimeter to ensure the voltage is between 5.7V to 6.3V</td>
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7 Safety Statement

The robot kit uses a 7.4V LiPo battery as its power supply. LiPo batteries need to be handled more carefully than regular batteries. More specifically, the user needs to ensure that the batteries remain at room temperate so they should not be stored in a hot garage or cold basement in the winter. For charging, keeping the batteries in a fire proof bag is advised and should not be overcharged. To address the dangers of using a LiPo battery, the battery will be placed as far as possible from the voltage regulator and h-bridge circuits. This is because both these components generate heat so the LiPo should not be placed near them.
8 Citations

References

