Safe Squat
Mock Design Review

Group #5
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1 Block Diagram

Figure 1: High Level Block Diagram

Figure 2: Block Diagram for Knee Modules
2 Circuit Schematic

Figure 4: Voltage Regulator Circuit Schematic [3]
3 Calculation

Knee Sleeve Power Usage

We are planning to use an ATmega328 microprocessor, two MPU-600 IMUs, and a piezo buzzer in the knee sleeve. The ATmega328 operates at 1.8-5.5V with an operating current of 3.5mA [1]. Each IMU operates at 2.3-3.5V with an operating current of 3.9mA [2]. The piezo buzzer has an operating voltage of 1-30V and an operating current of 0.5mA [4].

Therefore the total input current to the circuit is:

\[ I_{total} = I_m + 2 \times I_i + I_p \]

\[ I_{total} = 3.5mA + 2 \times 3.9mA + 0.5mA = 11.8mA \]

We decided to go with 3V as our voltage because it is within all the operating voltages and can be stabilized from a 9V using a voltage regulator.

The total power is calculated by:

\[ P_{Total} = I_{Total} \times V_{Total} \]

\[ P_{Total} = 11.8mA \times 3V = 35.4mW \]

Therefore the total instantaneous power that is used by each knee sleeve is 35.4mW.
4  Plot of Angle Trajectories

![Angular Trajectories for Standard Squat](image)

Figure 5: Plot of Angle Trajectories

5  Sensor Block Description

The sensor portion of our design must be able to get data to help determine the angle of the back, the angle of the knees, and the lateral position of the knees. An IMU will be able to get us the necessary data about the angular and lateral position of the knees and send it to the microprocessor for our use. For our IMU, we have decided to use the MPU-6000 IMU. This chip will be able to get measurements accurately enough for our system to work. The IMU contains both an accelerometer and a gyroscope, each of which have 3 axes of motion. Together, these should allow us to calculate changes in angle from the calibrated values to check for any form issues. We will be placing one IMU in the back belt to measure the angle of the back. We will also have two IMUs on each knee, one above and one below the knee itself. These should work together to show the angle of the flex of the knee as well as any lateral motion in the knee. These sensors will be paramount in allowing the system to function properly.
6 Requirement and Verification

<table>
<thead>
<tr>
<th>IMU</th>
<th>1. Accurate normal angle measurements within 5 degrees</th>
<th>- Connect sensor to a setup mimicking a knee and compare IMU measured angle with manually measured angle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Accurate angular velocity measurements within 5 degrees/s</td>
<td>- Connect sensor to a setup mimicking a knee and compare the IMU measured angular velocity by sweeping the apparatus through 90 degrees of motion over a timed period</td>
</tr>
</tbody>
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7 Safety Statement

We are planning to use a 9V battery for our product as well as a voltage regulator to supply our circuit with 3V. In order to avoid any shock or injury to the user the battery will be stored in a waterproof compartment so that sweat does not hit the battery or the circuit protecting the user from any damage from the battery.

8 Citations


