SpyderSense

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Project Description:

In response to Regina's pressing challenge with hoarder houses hindering emergency responders, our project addresses the need for efficient fire detection. We propose developing a prototype spider bot equipped with thermal sensing capabilities to detect and relay thermal hotspots, facilitating strategic resource allocation. The project also incorporates a camera for navigation purposes. The spider-bot will be remotely controlled, ensuring user convenience in navigating cluttered environments. Our goals encompass cost-effectiveness, compact size, manageable weight, good battery life, regulatory compliance and a commitment to minimizing environmental impact. The spider bot aims to be a versatile and effective solution for enhancing safety and rescue operations in challenging environments.

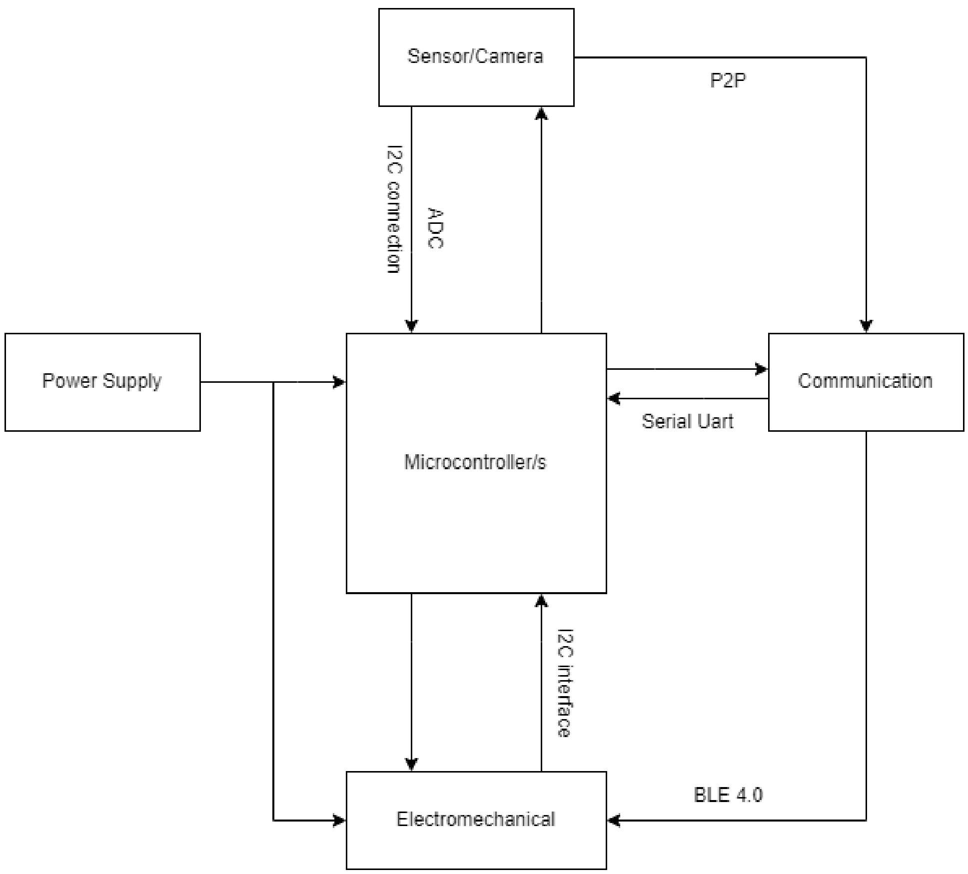


Fig 1. Block Diagram Hexapod

The block diagram above shows the basic components that are needed to set up the Spider Bot. The microcontroller is the base control for the robot. The power supply component gives power to the microcontroller and the electromechanical (Robot) part separately to avoid damaging the microcontroller. The communication module communicates using BLE 4.0 and Serial uart. The Electromechanical (Robot) part has servo drivers which will use I2C interface to communicate with the microcontroller. For the camera and sensors, we plan to use I2C (camera), P2P (wifi) and ADC (sensor) protocols.

Project Specifications

As a team working on this project together, we need to consider various specifications that apply to different parts of our overall goal. Here's a starting list of specifications that will guide the development of the hexapod.

Physical specifications:

- Weight:
    - Overall weight needs to be as light as possible considering the heavy servos in order to make the robot movement as smooth as possible. By previous estimations we are aiming for the robot to be around 3-3.5KG
- Material:
    - Use lighter but durable material Such as ABA for design with a 50-60 infill for durability.
- Legs DOF:
    - Considering the heavy build a 6-legged spider bot with 3 DOF (Degrees of Freedom) per leg would be a better choice than a 4-legged version as if rough terrain is to be navigated the bot might need to be up on 2 legs at a time and being a 6-legged design the extra two legs should provide stability to the robot.
- LM35:
    - Temperature range of –55°C to 150°C.
- Camera module (0v7670):
    - 0.3MP resolution, VGA (640 x 480)

Performance specifications:

- Servo power consumption:
    - According to the MG996r datasheet and initial testing calculations the operating current of the servo is in the range of 500-900mA with current spikes reaching 1.1A on moderate load. Operating voltage for the servos is 4.8-7V.
- Battery life:
    - The final aim of the prototype is to aim for a battery life of 15-30 min.
- Image Transmission:
    - Minimum Bandwidth requirement of 0.407 bits per second
- Range:
    - Aiming to achieve 30-50m Range (HM-10 module has open space range of 100m according to datasheet)

Protocol Specifications:

- Communication protocols:
  - The PCA9685 Servo driver uses I2C communication. (pin 20-21)
  - HM10 Bluetooth module needs uart and BLE 4.0. (pin 0-1)
- Control interface:
  - Android 4.0 application.
- LM35:
  - Uses ADC to communicate with microcontroller
- ESP8266:
  - Uses TCP/IP networking
- Camera Module (0v7670):
  - Uses Serial camera control bus (SCCB) which is an I2C protocol.

Workload

The workload distribution for our group is as follow:

Yash: -Responsible for hexapod design and construction and Bluetooth functionality

-Integration of final components.

Selam: -Responsible for Circuit building and designing for camera and thermal sensor module.

Testing plan

Based on the workload distribution the testing plan of each individual team member is as follows:

Yash (Electromechanical, communication, power supply):

- **Servo Motor Testing**:
  - Connect servo motors to PCA9685 and control multiple servos. **(√)**
  - Measuring operating, peak and hold current for servos. **(√ - except hold current)**
  - Calibrate each servo to a 0° angle to make it easier for testing leg movement.
- **Power Supply Testing**:
  - Connect 9 servo motors to the same power supply.
  - Confirm that the power supply can handle the load of all connected servos.
  - Monitor for any fluctuations or issues in servo movements during simultaneous operation.
  - Check to see if bench supply is good or is it better to use a buck converter. (Find old buck convertor from previous toolbox)
- **Initial Robot Build and Code Testing (Start before Fall Break)**:
  - Begin the physical construction of the hexapod robot during the Fall break. **(√ - leg design submitted and waiting on reply from workshop)**
  - Test the code implementation on the microcontroller for basic functionalities.
  - Identify and address any early issues with the build or code.
- **Robot Mobility Testing without Bluetooth**:
  - Test the movement of the robot without the Bluetooth module.
  - Ensure that the servos can handle the load and move the robot effectively.
  - Check for any mechanical issues or constraints affecting mobility.
- **Communication Module Testing**:
  - Verify the reliability of communication between the microcontroller and the Bluetooth module.

- **Bluetooth Implementation and Controller/Android Application Decision**:
  - Implement the code to utilize the Bluetooth module for robot movement.
  - Test the movement using a controller (if chosen) or an Android application.

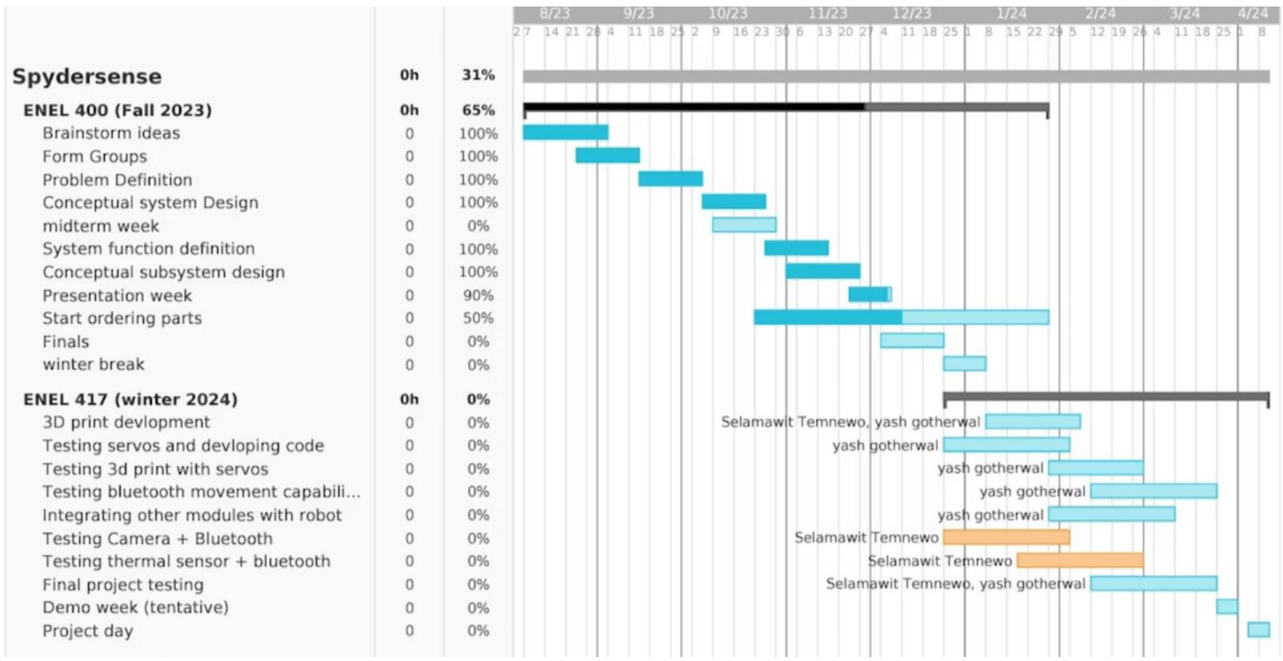
Selam: (Camera, Sensor, Communication, Power supply)

- **Camera Integration and Image Transmission:**
  - Connect the camera to the microcontroller.
  - Write code to capture an image using the camera.
  - Measure the time taken for the entire process of capturing and sending the image.

- **Temperature Sensor Integration and Reading:**
  - Connect the temperature sensor to the microcontroller.
  - Develop a small program to read temperature data from the sensor.
  - Display the temperature information on the microcontroller.
- **Wi-Fi Communication Setup:**
  - Connect a Wi-Fi module to the microcontroller.
  - Write code to enable communication between the microcontroller, camera, and temperature sensor through Wi-Fi.
  - Ensure the microcontroller can send both the picture and temperature information to an app or cloud-based system.
- **Computer Display Check:**
  - Set up a remote-control system for the project on your computer.
  - Verify that the microcontroller sends the captured picture and temperature information to the computer screen.
- **Power Consumption Check:**
  - Verify that the camera, temperature sensor, and microcontroller are adequately powered.
  - Measure the power consumption of each component during operation.
- **Integration Test:**
  - Combine the camera, temperature sensor, and Wi-Fi modules into one integrated system.
  - Test the overall functionality, ensuring smooth operation when all components are working together.

Gantt Chart:

Below is an attached gantt chart that was created for ENEL 400. So Far, we look to be on the correct track.



Budget:

As this is a self-funded project the budget options were discussed with Dr. Paul Laforge. Upon discussion we concluded that the budget would be around $200 per person (cost of 2 textbooks per semester) so the overall budget is $400.