Engineering Notebook

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BID4R EE421

Date: September 23, 2024

Tasks:

- Met with the project customer to discuss the scope of the BID4R Rover Model project.
- The customer outlined their expectations, including extending the robot's operational time to 60 minutes using a LiPo battery and integrating wireless charging.
- Clarified that the project would focus on a proof-of-concept for one robot, not the entire swarm of 50.

Meetings:

Attended an initial meeting with the customer to discuss the BID4R project's scope and objectives. Key areas of focus were on developing a distributed power management system, creating a wiring design, and integrating necessary components. The customer emphasized the importance of battery management, ensuring proper cooling during the charging process, and maintaining safe, efficient integration of all components. We also clarified that the project does not include autonomous docking for charging; instead, the operator will manually place the robot into the charging station when the battery is low.

New Ideas:

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- Began considering how to implement thermal monitoring for the charging, potentially using a temperature sensor.

Date: September 26, 2024

Tasks:

- Received detailed design documents from the customer, including the technical specifications of the robot and the required components for the project.

- The documents listed key components like the Arduino Nano 33 IoT, Pixy2 camera, and proximity sensors, and specified that the power system should be upgraded to use a 3000 mAh LiPo battery.

New Ideas:

- Evaluated the components for suitability and started considering alternative parts that might offer better performance or integration options.

Documents:

- Team received the robot design and component information from the customer.

Date: September 28, 2024

Tasks:

- Started drafting the project proposal, focusing on the problem statement and the proposed solution.
- Established a timeline for the project, assigning specific tasks to each team member. My task was to research LiPo battery safety and regulations.
- Began creating a backlog of tasks that would guide the project's progress over the semester.

Meetings:

- Team meeting to discuss how to distribute responsibilities and plan the project's major deadlines.
- Set internal deadlines for completing the initial power distribution design and wireless charging integration.

Date: September 29, 2024

Tasks:

- Finalized the project proposal, detailing the goals of upgrading a single rover with a LiPo battery and wireless charging.
- Completed the backlog, which outlined all the tasks and milestones for the project.

- Created a list of necessary components and linked them to their respective purchase sites to facilitate quick procurement.

Meetings:

- Met to review the project proposal and ensure all sections were complete.
- Finalized the backlog, ensuring it was comprehensive and included all expected tasks and deliverables.

Date: October 1, 2024

Tasks:

- We went to the lab to see the actual robot that we are upgrading. Took precise measurements of its dimensions to ensure the new components would fit correctly.
- Brought the robot back to start designing the power distribution system, keeping the measurements and space constraints in mind.

New Ideas:

- Noted that we might need to reduce the robot's 4-tier structure to a 3-tier structure to make room for the new battery and wireless charging receiver.

Date: October 4, 2024

Tasks:

- Finalized the team's individual tasks and responsibilities. My task is to research LiPo battery safety and wireless charging regulations. And Perform calculation with Mohammed.
- Completed calculations for the power requirements of the system, ensuring the LiPo battery would supply enough power to all components without overloading the system.

Meetings:

Collaborated with Mohammed to calculate the robot's operating time under both normal and stall conditions. Using the formula $P=V \times I$ we determined the power consumption of each component. The motors, under normal conditions, draw 0.3A each, consuming a

total of 2.22W. During stall conditions, this current draw increases to 1.5A per motor, resulting in 11.1W.

Other components such as the Pixy2 Camera, VCNL4010 Proximity Sensor, Arduino Nano 33 IoT, and APA600 LEDs, powered by the PowerBoost 1000C, consume 1.72W. For normal operation, total power consumption was 3.94W, rising to 12.82W in stall conditions.

We estimated the robot's runtime using the LiPo battery's energy (11.1Wh). For normal conditions, the robot can run for approximately 2.82 hours (169 minutes), while in stall conditions, the runtime decreases to 0.87 hours (52 minutes).
To optimize power management, we applied a detailed formula to estimate total operating time based on different load scenarios. For example, if the robot operates under heavy load 10% of the time and normal load 90%, this formula allows us to predict the battery's total runtime under these mixed conditions.

Formula:

$$T_{\text{operation}} = \frac{E_{\text{battery}}}{(f_{\text{heavy}} \times P_{\text{heavy}}) + (f_{\text{normal}} \times P_{\text{normal}})}$$

New Ideas:

- Proposed include a thermal cutoff mechanism that would stop charging if the battery temperature exceeded 113°F (45°C).

Documents :

LiPo Battery Safety and Wireless Charging Mechanism
This guide outlines essential safety protocols for LiPo batteries, including proper storage, handling, charging, and disposal to prevent risks like overheating and fire hazards. Key highlights include the importance of using certified LiPo chargers, avoiding overcharging, and implementing thermal cutoff mechanisms in wireless chargers to prevent overheating. Florida-specific regulations prohibit the disposal of LiPo batteries in regular waste and recommend recycling through certified centers. Safety measures like regular health monitoring and ensuring the battery doesn’t exceed 113°F (45°C) during wireless charging are vital for safe operation. (Full document provided on jira and Github)

Date: October 17, 2024

Tasks:

- Met with the stakeholder to review the charging station design and discuss the required components, such as the Qi wireless charging transmitter and receiver.
- Worked on preparing the presentation slides, outlining the goals, design challenges, and proposed solutions for the charging system.

Meetings:

During a stakeholder meeting, we reviewed the charging station design, and the additional components list provided on October 15. The discussion focused on the necessity of a Battery Management System (BMS) and fuses. The stakeholders agreed to supply the BMS, acknowledging its critical role in ensuring the safe operation of the LiPo battery by managing overcharging, over-discharging, and short circuits.

Also,

- Finalized the presentation slides with the team for the upcoming review.

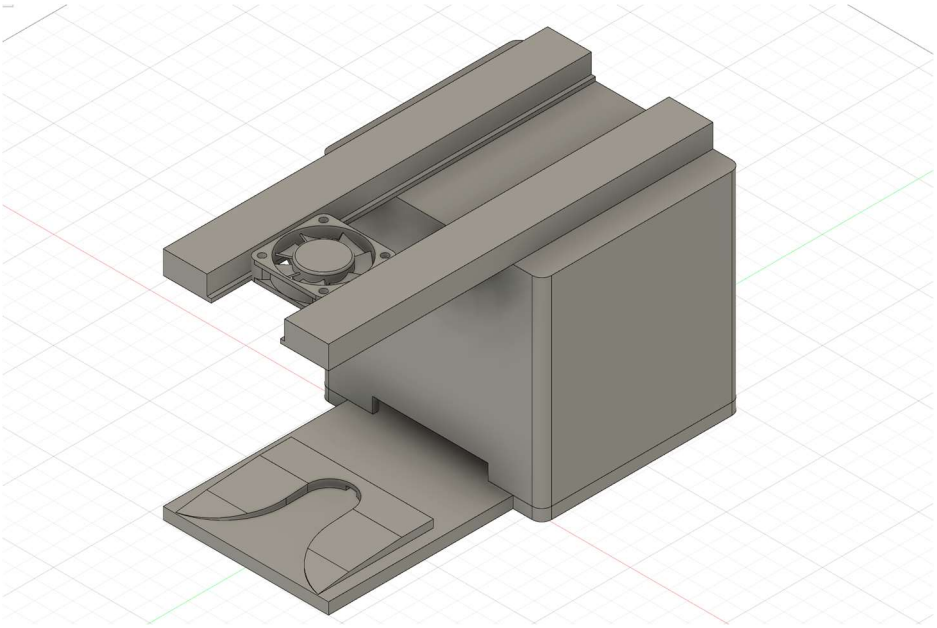
Date: October 17, 2024

Tasks:

Met with the customer to review the charging station design and ensure all necessary components were included in the design.

Meetings:

During this meeting, we conducted a detailed review of the charging station design and the components required for the project, which had been provided on October 15. The discussion focused heavily on the importance of including a Battery Management System (BMS) for safety and long-term functionality. We emphasized the role of the BMS in preventing issues like overcharging, over-discharging, and potential short circuits. There was also discussion about fuses, though the final decision was not to order them. The stakeholders agreed to provide the BMS but were unsure about the fuses' necessity. The meeting allowed us to finalize a clear path forward regarding the components needed for safe and efficient power management.



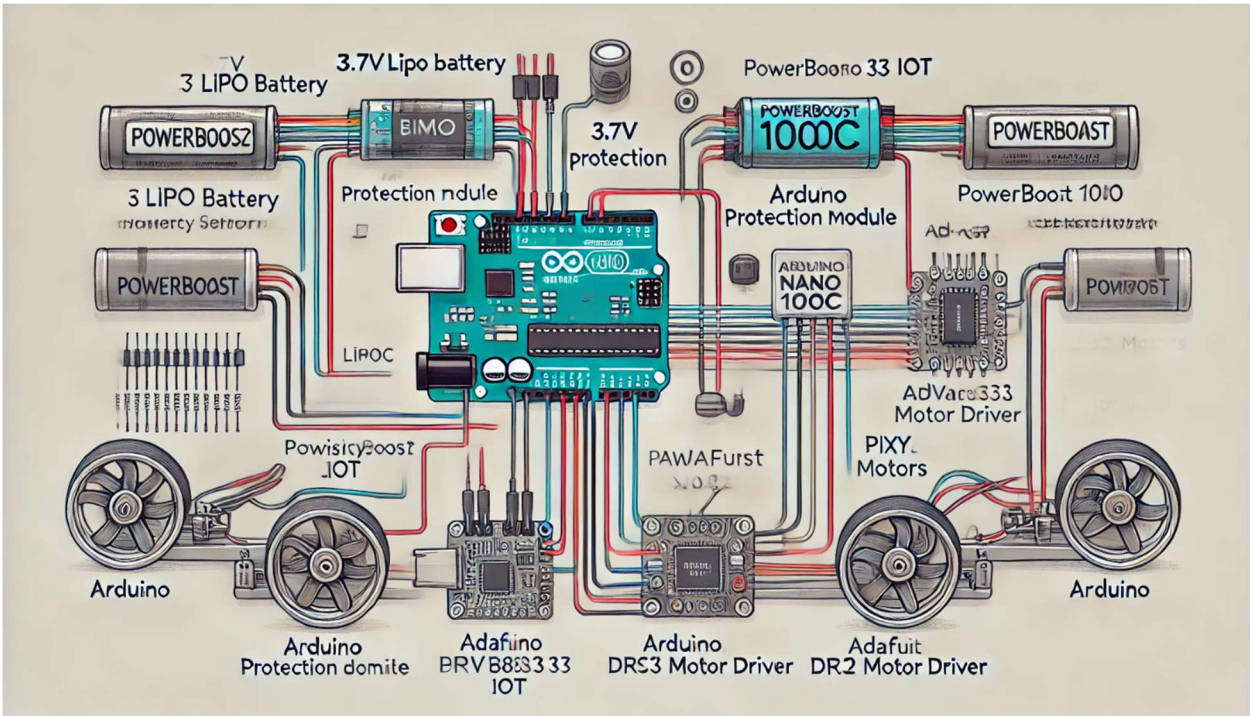
Date: October 23, 2024

Tasks:

Reviewed the current wiring diagram and made necessary updates based on the latest project developments. Adjusted the Jira backlog to ensure tasks were properly organized.

Meetings:

We conducted an internal team review of the wiring diagram to ensure all components were connected accurately and in line with the manufacturer's specifications. After reviewing the diagram, we made some minor adjustments, particularly focusing on ensuring proper power distribution. Following the wiring review, we revisited our Jira backlog, reassigning and refining tasks to reflect the updated timeline and any new developments in the wiring design. This allowed us to better track progress and ensure that upcoming tasks related to power and wiring would stay on schedule.



Date: October 24, 2024

Tasks:

Met with the stakeholder TAs in the lab to review the charging station after printing and to verify measurements. Discussed the missing components and the need for further design adjustments.

Meetings:

Today, we met in the lab with the stakeholder TAs to review the charging station design after it was printed. We carefully examined the measurements, ensuring that the station fits the dimensions of our robot and meets the design requirements. Unfortunately, we encountered some discrepancies with the space allocated for the transmitter, which will need to be revised. Additionally, there were issues with the embedded nails due to a printer malfunction. We also discussed the status of the other components we had requested earlier. Not all components have arrived yet, which means we will need to delay the final integration of the charging station. Based on these observations, we will make the necessary design adjustments before proceeding with reprinting the station to ensure it functions as intended and accommodates all components.