BID4R Charging Station

Design Documentation

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Abstract

This document outlines the design and implementation of the BID4R wireless charging station using Qi technology. The charging station was designed to ensure efficient power transfer, precise docking alignment, and adequate thermal management. The design process involved addressing several challenges, such as limited height clearance and repositioning of components to accommodate the robot's unique configuration.

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1. Introduction

The BID4R charging station is designed to facilitate wireless charging using Qi technology. This system consists of a base for housing the Qi transmitter and a chassis on the robot for the Qi receiver. The goal of this design is to ensure precise alignment, efficient power transfer, and thermal management during charging while addressing physical constraints imposed by the robot's structure.

The initial design concept was found on GitHub, and modifications were made to suit the specific needs of the BID4R project.

2. Design Requirements and Specifications

- Functional Requirements:
    - Wireless Charging: The charging station must enable efficient wireless charging through the Qi transmitter and receiver.
    - Docking Alignment: The robot should dock securely to ensure optimal charging.
    - Thermal Management: A fan should be incorporated to cool the PowerBoost 1000C charger during the charging process.
- Non-Functional Requirements:
    - Easy Assembly/Disassembly: The station should be simple to assemble and disassemble for maintenance.
    - Wire Management: All wires and circuit boards must be housed inside a dedicated box to ensure neat organization.
    - Maintenance Hatch: A hatch must be provided in the box for easy access to components during maintenance.
    - Adjustable Fan Position: The fan's position must be adjustable to ensure efficient cooling.
    - Accommodation of Robot Height: The station must be designed to account for the 16mm ground clearance of the robot.

3. Design Approach

3.1 Conceptual Design

       The initial design for the charging station, sourced from GitHub, featured a two-layer base. The lower layer was intended to house the Qi transmitter, while the upper layer would accommodate docking. The conceptual design also included wire management with wires exiting from the front of the station.

3.2 Final Design

Due to height limitations and functional challenges, the two-layer system was eliminated. Here is the final design description:

- Base: The Qi transmitter is placed visibly on the surface of the base for direct alignment with the Qi receiver, ensuring efficient power transfer. The base includes a rising edge and block system that guides the robot into the correct docking position, securing it in place during the charging process. A dedicated rectangular box at the back houses the wiring and circuit boards, keeping them organized and protected.
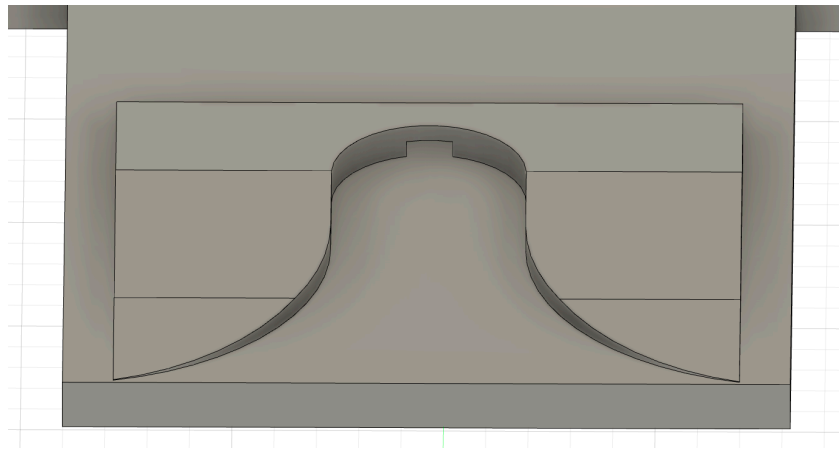

Figure 1: Rising Edge and Block for Precise Docking here

- Chassis: The robot's chassis incorporates a circular docking feature that integrates smoothly with the rising edge and block on the base. This ensures precise alignment with the transmitter for effective wireless charging.
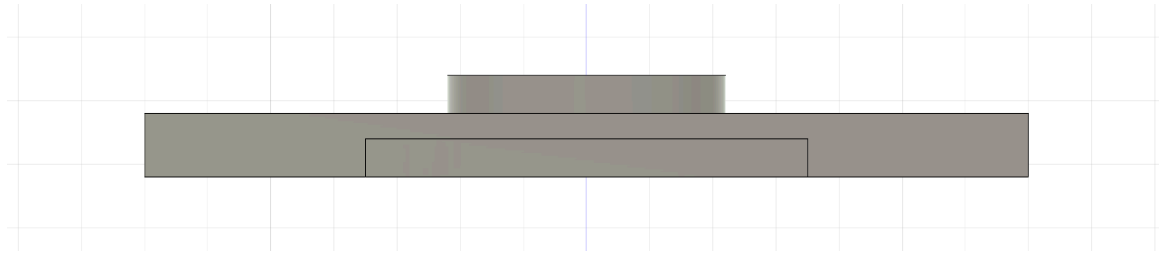
Figure 2: Circular Docking Feature

- Fan: The fan mount is positioned above the robot to regulate the temperature during charging. Its adjustable design allows for precise positioning over heat-sensitive areas, providing optimal cooling for the PowerBoost 1000C charger.
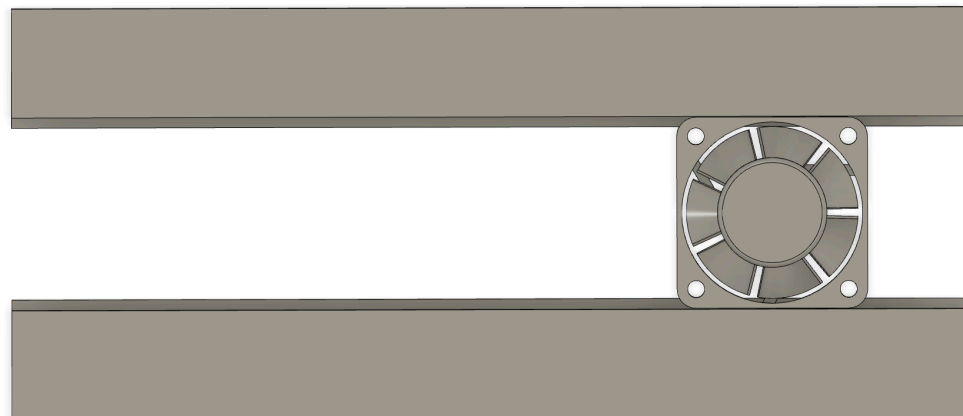

Figure 3: Fan Mount for Cooling the Charger

4. Challenges and Revisions

- Challenge 1: Height Limitation for Base Layers
  The initial design included two layers for the base, with the Qi transmitter housed in the bottom layer. However, the robot's 16mm ground clearance was insufficient for this design. To resolve this, the bottom layer was removed, and the Qi transmitter was placed directly on the base floor.

- Challenge 2: Wire Placement

  In the initial design, wires exited from the front of the charging station, where the robot docks. This caused interference during docking, as the robot would come into contact with the wires. To solve this, the wires were rerouted to the back of the station, keeping them clear of the robot's docking path.

- Challenge 3: Robot Configuration

  The initial design assumed a two-wheel robot. However, the BID4R robot has two wheels and a stabilizer in the middle, which limited its ability to dock fully. To accommodate this, the transmitter was moved to the front of the station, allowing the robot to dock properly, with all wires and components positioned at the back.

5. Testing and Validation

- Docking Tests: Tests will ensure the robot docks accurately and maintains a stable connection for charging. The design's alignment features, such as the rising edge and block system, will be tested for precision.

- Charging Efficiency Tests: The Qi transmitter and receiver will be evaluated for consistent power transfer, ensuring the robot can charge effectively without interruptions.

- Thermal Tests: Temperature sensors will be used to monitor the PowerBoost 1000C during charging, ensuring the fan maintains safe operating temperatures. The adjustable fan will be tested to optimize its cooling effectiveness.

6. Conclusion

The BID4R charging station design successfully addresses both functional and physical constraints. The design ensures efficient wireless charging through the precise alignment of the Qi transmitter and receiver while providing thermal management

through an adjustable fan. Key revisions, such as repositioning the transmitter and rerouting wires, resolved issues related to height and docking. Future improvements could focus on optimizing the charging distance and further refining the thermal management system.

7. References

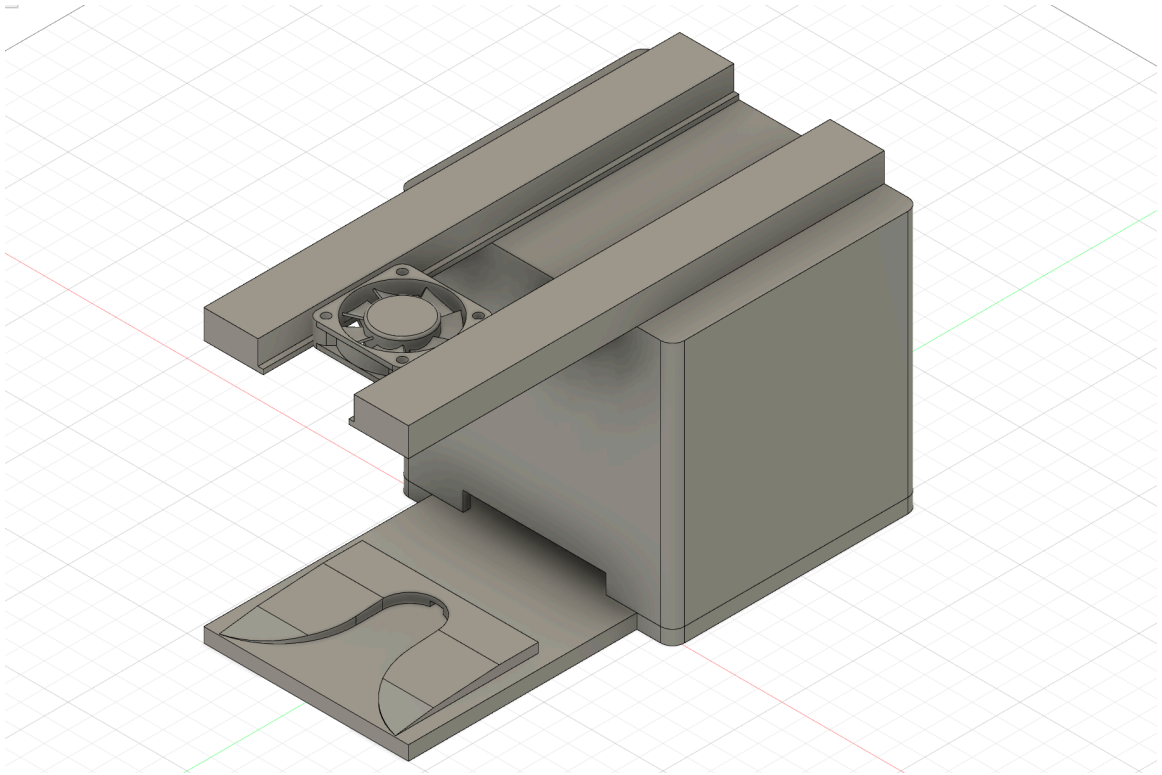- GitHub Repository: https://github.com/kevinmcaleer/Wireless-Charging-STLs

8. Appendix

Figure 4: Full Design