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Design Project User and Product Manual

Wheelchair Aid Product Manual

Submitted by:

Wheelchair Aid 5.4

Pamir Habib, 300284009

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University of Ottawa

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
BOM	Bill of Materials
BMS	Battery Management System

Table 2. Glossary

Term	Acronym	Definition
n/a	n/a	n/a

1 Introduction

This User and Product Manual (UPM) provides the information necessary for wheelchair users and professionals to effectively use the Wheelchair Aid (WA) Prototype and for prototype documentation.

The context of our work revolves around the development of a wheelchair slush cleaner prototype, aimed at addressing the issue of slush and salt buildup faced by wheelchair users during winter conditions. The prototype is designed to be user-friendly, efficient, and accessible to a wide range of users.

Assumptions:

1. We assume that the prototype is designed for manual operation, with features like an electric hand drill attachment for cleaning.
2. The prototype includes safety mechanisms to prevent any harm to users during operation.
3. It is assumed that the prototype has been tested for efficiency and safety.

Document Overview:

The document overview serves as the introductory section, providing crucial context and guidance for the entire document. It begins by establishing the fundamental context within which the document is created, offering insights into the background and circumstances that led to the development of the wheelchair slush cleaner prototype. The section also highlights any key assumptions made during the project, setting the foundational expectations for the prototype's operation.

Purpose and Scope:

The purpose of this document is to provide comprehensive guidance on the safe and effective use of the wheelchair slush cleaner prototype. It aims to ensure that users can utilize the device efficiently while maintaining safety standards. The document also reflects on the project's goals, achievements, and future directions.

Intended Audience:

The intended audience for this document includes:

- Wheelchair users and their caregivers who will use the prototype.
- Healthcare professionals who may recommend or assist in using the device.
- Project team members and designers involved in the development.
- Anyone interested in understanding the project's objectives and outcomes.

Security/Safety and Privacy Considerations:

- Safety is a paramount consideration in the use of the User and Product Manual. Users are advised to follow all safety guidelines and recommendations to prevent accidents and injuries.
- Privacy considerations are minimal since the document primarily focuses on user instructions and product details. However, it's essential to protect user data and ensure the confidentiality of any information collected during the project.
- The device itself should include safety mechanisms to prevent any harm to users during operation, as mentioned in the assumptions.

2 Overview

Problem:

The core requirements from users include the need for a cleaning device that is simple to operate, effective in different weather conditions, and compatible with various wheelchair models. Solving this problem is crucial for wheelchair users who wish to maintain their autonomy and for healthcare providers who aim to ensure the safety and well-being of their patients. Current solutions may involve manual cleaning, which is labor-intensive, or avoiding going out altogether, which is not viable. Therefore, our device offers a more accessible and proactive alternative.

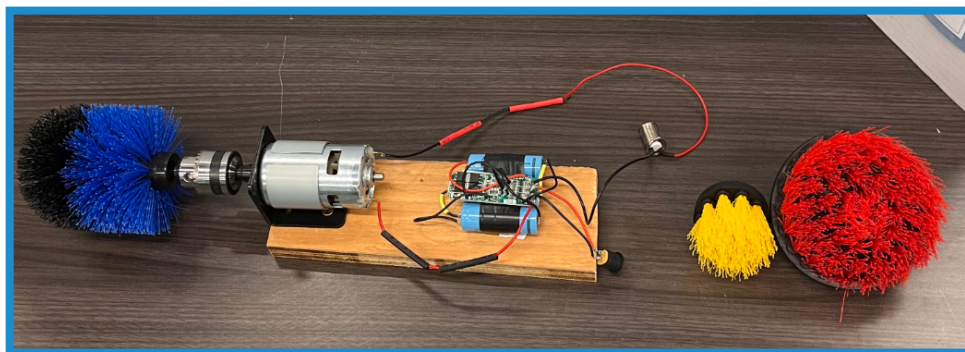
User Needs:

This attachment is designed to effectively remove slush and debris from wheelchair surfaces. Our client requested a device that was:

- 1: Handheld**
- 2: Rechargeable**
- 3: Battery Powered/Electric**
- 4: User Independent.**

Why Our Product:

Our wheelchair slush cleaner stands out because it is specifically engineered to be user-friendly, with an ergonomic design that is easy to handle and operate. Our solution is tailormade to our clients' requirements and expectations. Our client asked for the product to be battery powered, rechargeable, handheld, and durable. It's also versatile, capable of cleaning multiple wheelchair models effectively. Unlike other solutions that might be bulky, complex, or not designed for all wheelchair types, our device is compact, intuitive, and inclusive in design, ensuring that it meets the varied needs of our users.



Keeping these requirements in mind our device features a user-friendly push-button operation for convenience, making it accessible to a wide range of users, a battery management system to ensure efficient power usage and longevity, and a female charging port for easy recharging.

2.1 Conventions

An action is required on the part of the reader, it is indicated by a line beginning with the word 'Action'.

2.2 Cautions & Warnings

Some cautions and warnings that users should be aware of before using the wheelchair slush cleaner prototype:

1. Electrical Safety: The prototype is powered by a battery and contains electrical components. Users should exercise caution to avoid electrical hazards. Do not open the device or attempt to repair electrical components without proper training.

2. Operating Environment: The prototype is designed for use in outdoor conditions where slush and salt may be present. Users should be cautious and avoid using it in extreme weather conditions, such as heavy rain, thunderstorms, or severe cold, which may affect its performance and safety.

3. Proper Usage: Users should only use the device for its intended purpose, which is to remove slush and salt buildup from wheelchairs. Using it for other purposes may result in damage to the device or improper cleaning.

4. Maintenance: Regular maintenance and cleaning of the prototype are necessary to ensure its continued safe and efficient operation. Follow the maintenance instructions provided in the user manual.

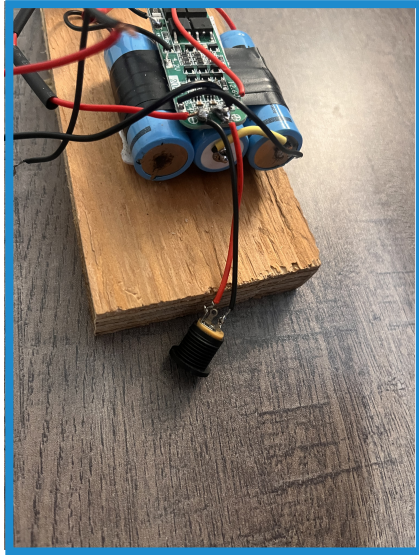
5. Battery Charging: When recharging the battery, use only the provided charging equipment and follow the manufacturer's instructions. Overcharging or using incompatible chargers may pose safety risks.

6. Safety Gear: Users should consider wearing appropriate personal protective equipment, such as gloves and safety goggles, especially when using the prototype in messy conditions.

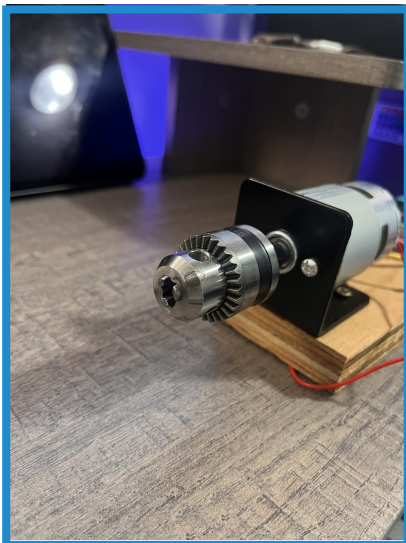
3 Getting started

The general use of the product is extremely straight forward.

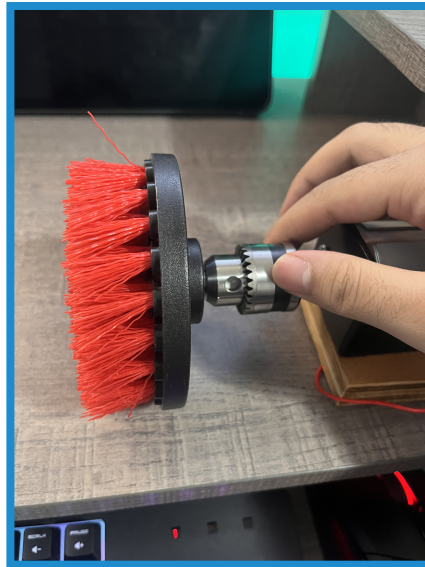
Step 1: Action - Charge the batteries through the female 12V DC charging port if the batteries are dead.



Step 2: Action - Attach desired brush attachments by loosening the the drill chuck with the chuck key.



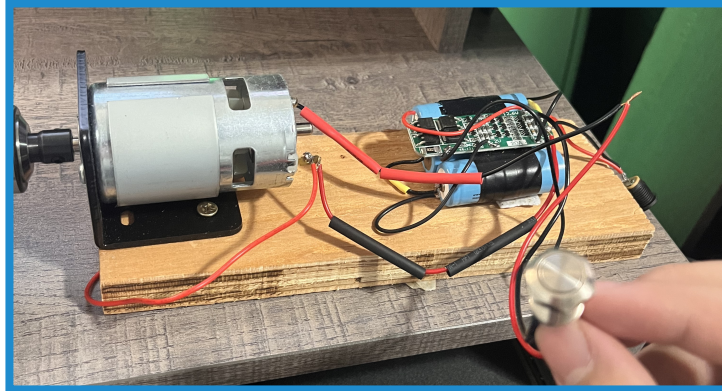
Step 3: Action - Insert brush attachment and align with drill chuck teeth.



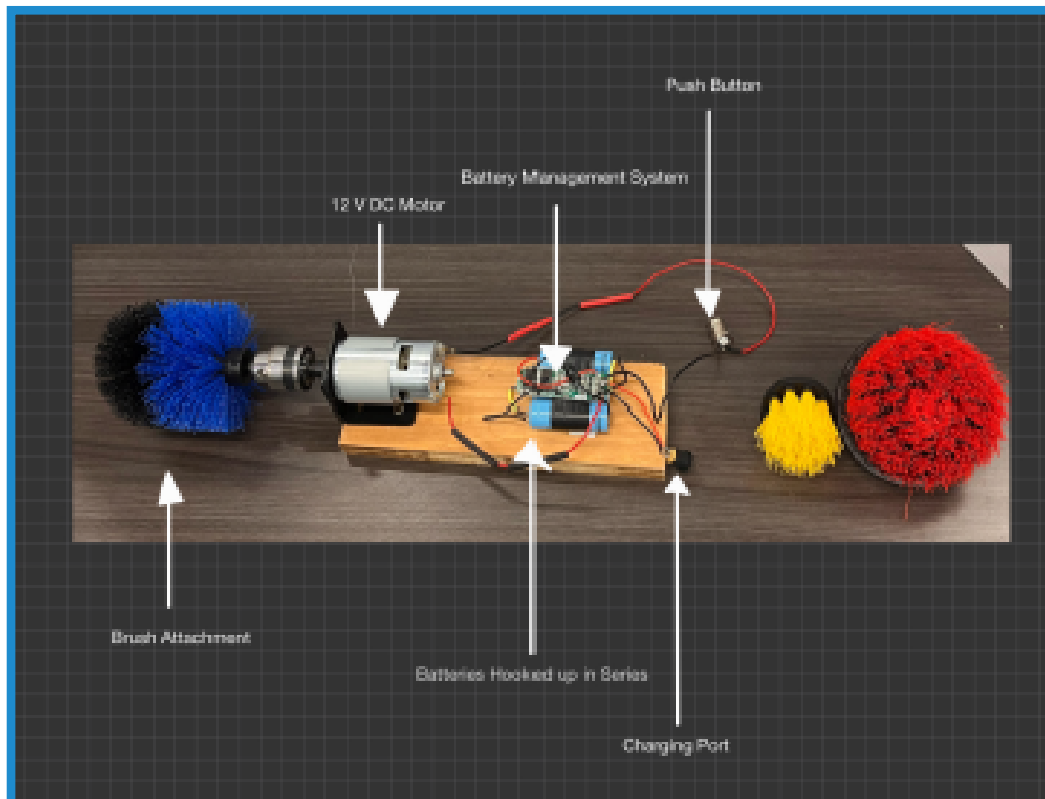
Step 4: Action - Tighten drill chuck either by hand or with drill chuck key.



Step 5: Action - Press push button to operate.



3.1 Configuration Considerations



Parts Configuration

3.2 User Access Considerations

The wheelchair slush cleaner prototype can have various user groups, each with specific needs and restrictions on accessibility or use:

1. Individual Wheelchair Users:

Accessibility: The primary users are individual wheelchair users with mobility challenges. Accessibility is crucial, and the device should be easy to use with their wheelchairs.

Restrictions: There should be minimal restrictions on accessibility for individual users. The device should be designed for easy operation, with safety features to prevent misuse.

2. Healthcare Professionals:

Accessibility: Healthcare professionals may use the prototype to assist wheelchair users in healthcare facilities.

Restrictions: While accessibility should be available to healthcare professionals, it may be restricted to trained personnel to ensure safe and effective use.

3. Care Facilities (Nursing Homes, Hospitals)

Accessibility: Care facilities may employ the prototype for the benefit of their residents or patients.

Restrictions: Accessibility within care facilities should be controlled and restricted to authorized staff members who have received training on the device's operation.

5. General Public (Retail Customers)

Accessibility: If the prototype is available for retail purchase, it should be designed for easy setup and use by the general public.

Restrictions: There should be no significant restrictions on accessibility for retail customers, except for safety-related instructions and age restrictions for safe use.

6. Government Regulatory Authorities

Accessibility: Regulatory authorities may need access to the prototype for certification, safety inspections, or compliance assessments.

Restrictions: Accessibility for regulatory authorities should be provided as required by law or regulations, and restrictions may apply only to authorized inspectors or auditors.

In summary, the key is the prototype caters to the specific needs and safety considerations of each user group. Accessibility should be balanced with necessary restrictions to ensure safe and effective use, compliance with regulations, and protection of intellectual property rights.

3.3 Accessing/setting up the System

The Wheelchair Aid prototype is fully plug and play. Operational straight out the box. 1 key feature to note is the interchangeable brush attachments. The brushes can be changed by following the procedure in section 3.

3.4 System Organization & Navigation

1. Drill Chuck and DC Motor: This combination is a smart choice for the core mechanism. The drill chuck allows for easy attachment and detachment of various brushes, catering to different cleaning needs. The DC motor provides the necessary power, making the device efficient in removing snow and slush.

2. Push Button: The inclusion of a push button for operation simplifies the user experience. It's intuitive and accessible, ensuring that users can easily operate the cleaner without needing to fiddle with complicated controls.

3. Battery Management System and Batteries: The BMS is vital for safely managing the power supply from the batteries. It ensures longevity and efficiency of battery life, which is crucial for a device meant for outdoor use in potentially harsh conditions.

4. Charging Port: Including a charging port adds to the convenience, making it easy to recharge the device. This feature is essential for maintaining the cleaner's readiness and reliability.

5. Interchangeable Brushes: This feature takes into consideration the varied user needs. Different brushes can be tailored for different types of debris and snow conditions, enhancing the cleaner's versatility and effectiveness.

3.5 Exiting the System

To properly put away the physical wheelchair slush cleaner prototype, follow these actions:

1. Cleaning and Maintenance:

- Clean any residual slush, salt, or debris from the cleaning brush and other components. Use a brush or cloth to wipe down any surfaces that may have encountered slush or dirt.
- Check the condition of the brush attachment and replace it if it shows signs of wear or damage.
- Ensure that the brush attachment is properly secured or stored in its designated place.

2.2. Inspect Casing/Components Examine the casing and all components of the prototype for any damage or wear and tear. If any issues are identified, address them promptly to maintain the prototype's functionality.

3. Secure Loose Parts: If there are any loose parts, such as cables, connectors, or accessories, secure them in a designated storage area or compartment to prevent loss or damage.

4. Store in a Dry Location: Place the prototype and its components in a dry and secure location, away from moisture or extreme temperatures. It's essential to protect the prototype from environmental factors that could cause damage.

5. Charging: Ensure that it is stored with an adequate charge level to prevent battery depletion. Follow the guidelines for long-term storage of rechargeable batteries.

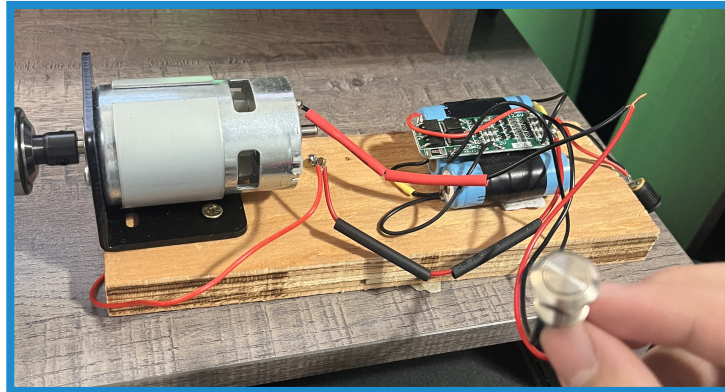
6. Documentation: Keep any user manuals, maintenance logs, or documentation related to the prototype in a safe and accessible place for future reference.

By following these steps, you can properly put away the wheelchair slush cleaner prototype, ensuring its longevity and readiness for future use while maintaining safety and functionality.

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the Wheelchair Aid prototype.

4.1 Push Button



Function Description:

The operation of this wheelchair slush cleaner prototype is straightforward. It features a single push-button operation. To activate the cleaning process, press and hold the push button, which is conveniently located on the device. As you press the button, the connected DC motor engages, causing the brush attachment in the drill chuck to rotate. This rotation allows the brush to effectively remove slush and salt buildup from the wheelchair's wheels. When you release the push button, the motor stops, ending the cleaning process. The simplicity of this design ensures user-friendliness and ease of operation, making it accessible for various users.

Characteristics of Input:

The input for this function involves pressing and holding the push button, which requires a straightforward push-action to operate.

System-Produced Output:

The system-produced output is the rotation of the brush attachment when the push button is pressed and held. This action effectively cleans the wheelchair's wheels, providing the desired cleaning functionality.

4.1.1 Interchanging Brushes



Function Description:

The wheelchair slush cleaner prototype allows for the easy interchange of different brush attachments using a drill chuck key. To swap out brush attachments, follow these steps:

1. Locate the drill chuck on the device, which holds the brush attachment.
2. Insert the drill chuck key into the chuck's keyhole.
3. Turn the drill chuck key counterclockwise to release the current brush attachment. This action will loosen the chuck and allow the attachment to be removed.
4. Once the chuck is sufficiently loosened, carefully remove the current brush attachment.
5. Select the desired brush attachment for the specific cleaning task.
6. Insert the chosen brush attachment into the chuck.
7. Use the drill chuck key to turn it clockwise, tightening the chuck securely around the new brush attachment.

Characteristics of Input:

Interchanging brush attachments involves using the drill chuck key to turn it counterclockwise for removal and clockwise for attachment. This action requires a firm but controlled force on the key.

System-Produced Output:

When the chosen brush attachment is securely tightened in the chuck using the drill chuck key, the system ensures that it's firmly in place and ready for use. You'll feel the resistance decrease as the attachment is tightened, indicating that it's properly secured.

5 Troubleshooting & Support

Recovery and Error Correction Procedures

Battery Management System (BMS)

- Error Condition: If the battery management system detects an overcharge or over-discharge error.
- Corrective Action: If the BMS detects an error, disconnect the charger immediately if overcharging is detected. If over-discharging is detected, recharge the batteries promptly. In both cases, ensure the batteries are in good condition.

Batteries in Series

- Error Condition: If one of the batteries in the series fails to charge or discharge properly.
- Corrective Action: If a battery issue is suspected, check each battery's voltage individually. Replace any malfunctioning batteries to ensure the series remains operational.

Push Button Operation

- Error Condition: If the push button fails to operate or becomes unresponsive.
- Corrective Action: Check for any debris or obstructions around the push button. If unresponsive, inspect the button's wiring and connections for damage. Replace the button if necessary.

Charging Port

- Error Condition: If the charging port does not charge the batteries or connection issues arise.
- Corrective Action: Ensure the charging port is clean and free from debris. Check the charger and cable for faults. If issues persist, inspect the charging port's wiring and connections. Replace components if needed.

DC Motor with Drill Chuck

- Error Condition: If the DC motor fails to rotate the drill chuck or exhibits irregular operation.
- Corrective Action: Inspect the motor's connections and wiring. Ensure the chuck is free from obstructions. If the motor continues to malfunction, consider motor replacement.

5.1 Error Messages or Behaviors

The wheelchair slush cleaner prototype may encounter errors such as battery management system warnings, unresponsive push button, charging port issues, or motor malfunctions. These errors may arise due to overcharge, component damage, or connectivity problems. Users should refer to the provided appendix for a comprehensive list of error messages and corrective actions.

5.2 Special Considerations

1 key component that may halt the usage of the device is the disconnection of Sauder from the batteries. If this problem arises simply re-saude the wire to the battery while using flux to ensure this problem does not occur in the future. Apart from this tiny issue in the prototype no other known issues are present.

5.3 Maintenance

To ensure the continued performance of the prototype and prevent failures, regular maintenance should include:

- Checking battery condition and charging as needed.
- Inspecting and cleaning the brush attachments.
- Verifying the condition of the drill chuck key.
- Ensuring the charging port remains clean and functional.
- Periodically inspecting all wiring and connections for damage.
- Lubricating moving parts of the DC motor if necessary.

By performing these routine checks and maintenance tasks, users can help extend the lifespan of the prototype and minimize the risk of failures.

5.4 Support

For emergency assistance and system support, please contact Pamir Habib:

- Name: Pamir Habib
- Phone: 343-297-9945
- Email: phabi014@uottawa.ca

If you encounter any issues with the prototype or need assistance, don't hesitate to reach out to Pamir for prompt support. To report problems or seek help, send an email or call the provided contact information. Security incidents, if applicable, should also be reported to the same contact for appropriate handling.

6 Product Documentation

6.1 Building the Prototype

6.1.1 BOM (Bill of Materials)

Item	Material	Price	website/ resource
1	telescopic stick	\$14.87	link
2	rotating motor	\$22.34	link
3	wire	free	use the wire in lab section
4	nylon brush	\$10.36	link
5	DC Motor	\$29.79	link
Total estimated cost		\$77.36 (before tax)	

6.1.2 Equipment list

To build this prototype very few pieces of equipment were needed. Sauder was required to wire the batteries in series and for the BMS (battery management system) as well as the push button and charging port. A drill was required to mount the mounting plate of the 12V Dc motor into the wood plank. A bandsaw may be necessary to cut the wooden plank to size, and screws are required to secure the mounting plate into the plank.

1 – Sauder

2 – Drill

3 – Bandsaw

4 – Screws

6.1.3 Step 1 - Main Frame: Wood plank, L bracket



Screw (with hardware included in kit into the L bracket to securely hold DC motor and Drill Chuck.

6.1.4 Step 2 Battery System:

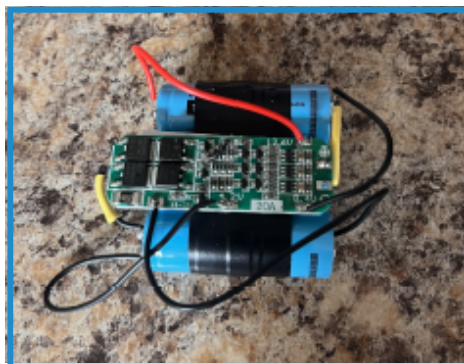


Figure 1

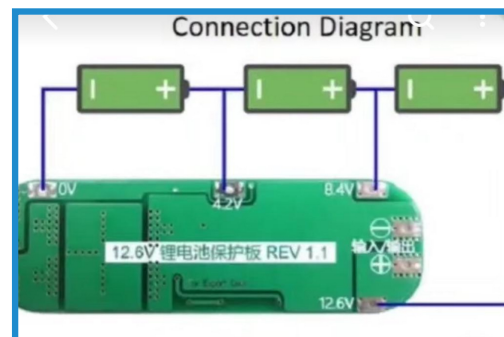
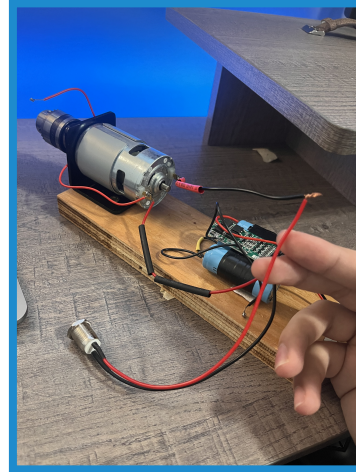
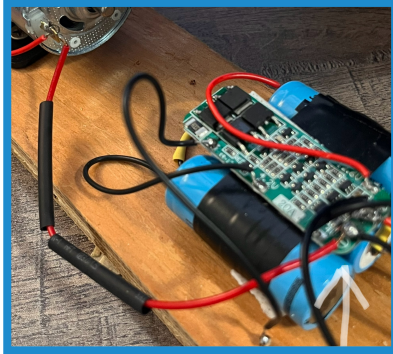


Figure 2

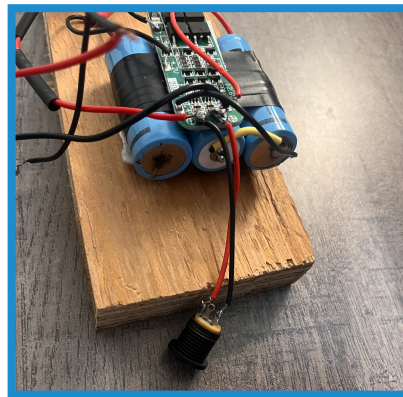
The battery management system is configured and soldered as depicted in figure 2. The batteries themselves are configured in series

6.1.5 Step 3 - Motor/Push Button:

The positive end of the motor is connected to the push button. While the negative end is connected to the BMS.



6.1.6 Step 4 - Charging Port:



The charging port is also configured to the BMS via the negative and positive terminals and wires.

6.2 Testing & Validation

Push Button Endurance Test

Purpose: Assess the reliability of the push button under extended use.

Procedure: The push button was continuously engaged for a period of 20 minutes to mimic a rigorous workday.

Findings: The button showed consistent performance throughout the test, with no failure to activate the drill.

Post-Test Condition: Examination revealed slight wear on the button's surface, suggesting material fatigue may occur over time.

Action Items: Periodic monitoring of the button's condition is recommended during future tests to evaluate long-term durability.

Drill Chuck Tensile Test

Purpose: Determine the maximum torque the drill chuck can withstand before bit slippage occurs.

Procedure: A controlled amount of torque was gradually applied to the chuck while it held a standard-sized drill bit, measuring the point of torque where the bit began to slip.

Findings: The chuck maintained a firm grip up to an impressive torque level, surpassing typical operational needs.

Post-Test Condition: Inspection showed no deformation on the gripping surface of the chuck jaws.

Action Items: Consideration for using a higher-grade chuck could be made to ensure longevity, especially for users who may require the drill for heavy-duty cleaning tasks.

Overall Conclusion:

The prototype drill has demonstrated satisfactory performance in endurance, and strength. While the button and chuck exhibited minor wear, they remained fully functional. Long-term durability could be improved with material enhancements and user guidelines for maintenance and operational breaks. Future tests should focus on repetitive stress and real-world usage scenarios to gather more data on the prototype's performance.

7 Conclusions and Recommendations for Future Work

During the development of the wheelchair slush cleaner prototype, several valuable lessons were learned and key areas for future work were identified. It became evident that prioritizing user-centric design and durability features is crucial, ensuring that the device is user-friendly and safe for wheelchair users. Regulatory compliance is paramount, and staying informed about industry standards is essential. Future work should focus on completing the casing for the prototype and adding an ergonomic handle to enhance portability and ease of use. Comprehensive user testing is necessary to gather feedback for iterative design improvements. Additionally, manufacturability refinements are essential for scalability and affordability. Thorough market research should inform product positioning and marketing strategies, and ensuring accessibility to a wide range of wheelchair models is vital. These efforts will contribute to the development of an effective and user-friendly wheelchair slush cleaner prototype, addressing the challenges faced by wheelchair users during winter conditions.

8 Bibliography

[Drill Key Chuck Image](#)

[BMS Schematic](#)

APPENDICES

9 APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Casing Piece 1	https://makerepo.com/tthai074/1879.wheelchair-aid	2023-12-12
Casing Piece 2	https://makerepo.com/tthai074/1879.wheelchair-aid	2023-12-12
Casing Piece 3	https://makerepo.com/tthai074/1879.wheelchair-aid	2023-12-12

10 APPENDIX II: Other Appendices

[Maker Repo Link](#)