



AUTOMATIC VACUUM CLEANING ROBOT WITH WEAR PREDICTION

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Abstract - Keeping an automatic vacuum cleaning robot in top shape can be challenging, especially when its parts wear out over time. This paper introduces a smart system that predicts when key components, like brushes and filters, need maintenance or replacement. By using built-in sensors and simple algorithms, the robot can monitor its usage and let users know when action is needed. This feature helps avoid surprises, reduces downtime, and keeps the robot running smoothly. Real-world tests show that this wear prediction system works effectively, making it a practical upgrade for any robot vacuum.

INTRODUCTION

Automatic vacuum cleaning robots have made cleaning easier than ever. They handle daily messes and save us time. But like any device, their parts can wear out, which affects their performance. Most robots today rely on fixed schedules or the user's judgment to decide when to clean or replace parts. This approach can lead to issues—parts might be replaced too late or too early, wasting time and money.

To solve this, we've developed a wear prediction system for robot vacuums. This system tracks the condition of components like brushes, filters, and wheels and alerts users before any problems arise. It's like having a smart assistant that ensures the robot is always ready to perform at its best. In this paper, we'll explain how it works and share results from our testing.



Figure 1: Working flowchart of vacuum cleaner

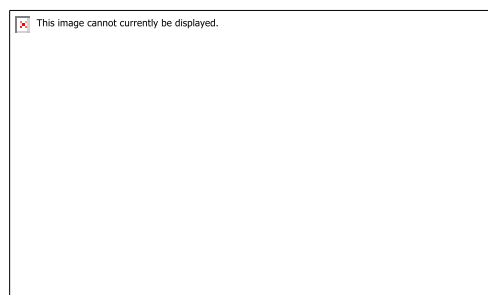


Figure 2: shell and hardware

CLASSIFICATION OF WEAR PREDICTION SYSTEM

Our wear prediction system has four main parts:

- 1. **Sensors:** Tiny devices inside the robot that track how much parts are used.
- 2. **Data Collection:** The robot gathers information during cleaning, like how long it runs and how hard it works.
- 3. **Wear Prediction:** A simple program that figures out when a part is getting close to wearing out.
- 4. **User Notifications:** Alerts sent to the user, usually through a mobile app, when maintenance is needed

• GROUND TRUTH

To make sure the system is accurate, we tested it under controlled conditions. Here’s what we did:

- 1. Ran the robot on different surfaces, like carpets and hardwood floors, and tracked how quickly parts wore out.
- 2. Measured things like brush speed, dustbin usage, and airflow in the filter.
- 3. Set thresholds, like “replace the brush after 50 hours of use,” based on real-world data and manufacturer guidelines.

This testing gave us a solid foundation to train the system and ensure it gives helpful maintenance alerts.

• WORKING:

The wear prediction system is like a health tracker for the robot. Sensors inside the robot measure things like:

- 1. How fast the brushes are spinning.
- 2. Whether the filter is getting clogged.
- 3. How often the wheels are turning.

This data is sent to a program that looks for signs of wear. If a part is nearing the end of its lifespan, the robot sends a notification, so the user knows to clean or replace it.

• MAKING PREDICITON:

The system uses simple patterns to predict when parts will wear out. For example:

- 1. If the brushes spin slower over time, it means they’re wearing down.
- 2. If the airflow through the filter decreases, it’s time for cleaning.

By monitoring these trends, the system can predict maintenance needs before problems occur.

TABLE

Here’s a summary of the parts we monitor and how the system tracks their wear:

Part	Sensor Used	What It Tracks	Alert Given
Brush	Rotation Sensor	Speed and usage time	"Replace brush soon"
Filter	Airflow Sensor	Clogging level	"Clean or replace filter"
Wheels	Movement Sensor	Rotations and wear	"Check wheels for wear"
Battery	Voltage Sensor	Charge cycles and temperature	"Battery needs replacement"

CONCLUSION

By adding a wear prediction system, we’ve made robot vacuums smarter and easier to maintain. Users no longer need to guess when parts need attention—the robot will tell them. This keeps the vacuum performing at its best while reducing unnecessary maintenance. Our tests show that this system works well and makes a great addition to any automatic vacuum. In the future, we’ll work on expanding the system to monitor even more components and fine-tune its accuracy.

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