

PATENT APPLICATION

Extreme Cold Battery Management System

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ABSTRACT

A system and method for managing battery performance in extreme cold environments, specifically for autonomous mobile robots operating in sub-zero temperatures. The invention comprises an intelligent thermal regulation system that maintains optimal battery temperature and performance through a combination of active heating elements, passive insulation, and predictive power management algorithms.

BACKGROUND OF INVENTION

[0001] Autonomous mobile robots operating in cold storage and industrial freezer environments face significant challenges related to battery performance and longevity. Traditional lithium-ion batteries experience severely reduced capacity and performance in sub-zero temperatures, typically losing 50-80% of their effective capacity at -20 C.

[0002] Existing solutions rely primarily on passive insulation or basic heating elements, which are either insufficient for extended operation or energy-inefficient. There exists a need for an intelligent battery management system specifically designed for extreme cold environments.

SUMMARY OF INVENTION

[0003] The present invention provides a comprehensive battery management system comprising:

- An active thermal regulation subsystem
- Multi-layer smart insulation architecture
- Predictive power consumption algorithms
- Temperature-aware charging protocols
- Distributed heating element network

[0004] The system maintains optimal battery temperature between -5 C and 15 C while operating in ambient temperatures as low as -40 C, achieving up to 95% of nominal battery capacity.

DETAILED DESCRIPTION

[0005] The battery management system consists of the following core components:

Thermal Regulation Subsystem

[0006] A network of temperature sensors monitors battery cell temperatures at multiple points. The active heating system comprises carbon fiber heating elements integrated directly into the battery housing, controlled by a microprocessor running proprietary thermal management algorithms.

Smart Insulation Architecture

[0007] Multiple layers of advanced insulating materials, including:

- Outer layer: Impact-resistant aerogel composite
- Middle layer: Vacuum-insulated panels
- Inner layer: Phase-change material for thermal buffering

Predictive Power Management

[0008] Machine learning algorithms analyze:

- Historical power consumption patterns
- Environmental temperature data
- Robot mission parameters
- Battery thermal characteristics

[0009] The system optimizes heating power allocation based on predicted robot behavior and environmental conditions.

CLAIMS

A battery management system for extreme cold environments comprising:

- a) A battery assembly with integrated heating elements
- b) Multiple temperature sensors
- c) A thermal management controller
- d) Multi-layer insulation system
- e) Predictive power management software

The system of claim 1, wherein the thermal management controller maintains battery temperature between -5 C and 15 C in ambient temperatures as low as -40 C.

The system of claim 1, wherein the predictive power management software utilizes machine learning to optimize power allocation between battery heating and robot operation.

DRAWINGS

[0010] Figure 1: System architecture diagram

[0011] Figure 2: Thermal regulation flow chart

[0012] Figure 3: Insulation layer cross-section

[0013] Figure 4: Control system schematic

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ASSIGNMENT

The entire right, title, and interest in this patent application is assigned to:

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DECLARATION

I hereby declare that I am the original inventor of the subject matter which is claimed and for which a patent is sought. I have reviewed and understand the contents of this application and believe I am the original and first inventor of the subject matter which is claimed.

Executed on: March 15, 2022

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