PATENT SPECIFICATION

Power Management System for Arctic-Environment Robotic Systems

Patent No. PDR-2021-0147

ABSTRACT

A power management system for autonomous mobile robots operating in extreme cold environments, comprising an intelligent thermal regulation subsystem, cold-resistant power cells, and adaptive power distribution controls. The system enables sustained robotic operation in sub-zero environments through dynamic power allocation and thermal protection mechanisms.

BACKGROUND OF THE INVENTION

[001] Autonomous mobile robots operating in cold environments face significant challenges related to power management and battery performance. Traditional lithium-ion power systems experience severely degraded performance in sub-zero temperatures, limiting operational capabilities and reliability.

[002] Existing solutions fail to adequately address the combined challenges of power efficiency, thermal management, and system reliability in extreme cold conditions, particularly in industrial automation applications below -30 C.

SUMMARY OF THE INVENTION

[003] The present invention provides a comprehensive power management system specifically designed for arctic-environment robotic systems, comprising:

- Thermally-regulated power cell arrays with active temperature maintenance
- Intelligent power distribution controllers with cold-optimized algorithms
- Redundant backup power systems with rapid switchover capabilities
- Adaptive thermal management subsystems for critical components

[004] The system enables sustained robotic operation in environments ranging from -40 C to +25 C while maintaining optimal power efficiency and component protection.

DETAILED DESCRIPTION

Power Cell Configuration

[005] The primary power array comprises multiple cold-resistant lithium iron phosphate (LiFePO4) cells arranged in a redundant matrix configuration. Each cell incorporates:

- Proprietary thermal insulation coating (Composition A-117)
- Internal heating elements with PTC control
- Temperature sensors at 12 monitoring points
- Rapid-discharge protection circuitry

[006] Cell arrays are organized in independently-monitored zones with automatic isolation capabilities.

Thermal Management System

[007] The thermal regulation subsystem maintains optimal operating temperatures through:

- Active heating elements with proportional control
- Multi-layer insulation barriers
- Thermally-conductive pathways for controlled heat distribution
- Microprocessor-controlled temperature monitoring and adjustment

[008] System employs predictive thermal modeling to anticipate and prevent cold-related power degradation.

Power Distribution Control

[009] The intelligent power distribution controller implements:

- Dynamic load balancing across cell arrays
- Predictive power allocation based on operational parameters
- Automatic failover to redundant power paths
- Real-time monitoring of cell health and performance

[010] Controller firmware adapts power distribution patterns based on environmental conditions and operational demands.

CLAIMS

A power management system for arctic-environment robots comprising:

a) Thermally-regulated power cell arrays

b) Intelligent power distribution controllers

c) Adaptive thermal management subsystems

d) Redundant backup power systems

The power management system of claim 1, wherein the power cell arrays incorporate:

a) Cold-resistant LiFePO4 cells

b) Proprietary thermal insulation coating

c) Internal heating elements

d) Temperature monitoring sensors

The power management system of claim 1, wherein the thermal management system comprises:

a) Active heating elements

b) Multi-layer insulation barriers

c) Controlled heat distribution pathways

d) Predictive thermal modeling capabilities

[Claims 4-12 continued...]

DRAWINGS

[Reference to attached technical drawings PDR-2021-0147-D1 through D8]

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