

# **PATENT SPECIFICATION**

## **Cold-Weather Power Distribution Architecture for Autonomous Mobile Robots**

Patent No. PDR-2021-0147

### **ABSTRACT**

A system and method for distributing power in autonomous mobile robots operating in extreme cold environments, comprising a thermally-isolated power distribution network, smart thermal management controllers, and redundant power routing capabilities. The architecture enables sustained robot operation in sub-zero environments while maintaining optimal battery performance and protecting sensitive electronic components.

### **BACKGROUND OF THE INVENTION**

[0001] Autonomous mobile robots operating in cold storage and industrial freezer environments face significant challenges related to power distribution and battery performance. Traditional power systems experience reduced efficiency and potential failure when exposed to sustained low temperatures.

[0002] Existing solutions typically rely on basic thermal insulation or heating elements, which are energy-inefficient and provide inadequate protection for mission-critical power distribution components.

### **SUMMARY OF THE INVENTION**

[0003] The present invention provides a novel power distribution architecture specifically designed for autonomous mobile robots operating in environments between -40 C and +25 C. The system comprises:

- a) A multi-layer thermal isolation subsystem
- b) Smart power routing controllers with temperature-aware load balancing
- c) Redundant power distribution pathways
- d) Active thermal management zones
- e) Self-diagnostic capability for power efficiency optimization

### **DETAILED DESCRIPTION**

## **Thermal Isolation Subsystem**

[0004] The thermal isolation subsystem utilizes a proprietary multi-layer approach:

- Layer 1: Vacuum-sealed power distribution channels
- Layer 2: Phase-change material thermal buffer
- Layer 3: Active thermal regulation membrane
- Layer 4: Composite insulation barrier

[0005] These layers work in concert to maintain optimal operating temperature for power distribution components while minimizing energy expenditure for thermal management.

## **Smart Power Routing**

[0006] The invention implements an intelligent power routing system that:

- Monitors real-time temperature across all power distribution nodes
- Dynamically adjusts power flow based on thermal conditions
- Implements predictive load balancing algorithms
- Maintains redundant power pathways for critical systems

## **Active Thermal Management**

[0007] The system incorporates zone-based thermal management:

- Independent thermal control for high-sensitivity components
- Adaptive heating/cooling based on operational demands
- Energy recovery from waste heat
- Thermal load sharing between adjacent zones

## **CLAIMS**

A power distribution system for cold-environment autonomous mobile robots comprising:

- a) A multi-layer thermal isolation subsystem
- b) Temperature-aware power routing controllers
- c) Redundant power distribution pathways
- d) Active thermal management zones
- e) Self-diagnostic capabilities

The system of claim 1, wherein the thermal isolation subsystem comprises four distinct layers providing progressive thermal protection.

The system of claim 1, wherein the power routing controllers dynamically adjust power distribution based on real-time temperature monitoring.

A method for maintaining optimal power distribution in cold environments comprising:

- a) Continuous monitoring of thermal conditions
- b) Dynamic adjustment of power routing
- c) Predictive load balancing
- d) Active thermal zone management

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## **FILING INFORMATION**

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## **CERTIFICATION**

I hereby certify that this patent application accurately describes the invention as developed by Polar Dynamics Robotics, Inc., and contains no known prior art conflicts as of the filing date.

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