

POLAR ENVIRONMENT ADAPTATION SYSTEM PATENT

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United States Patent No. 11,287,459

Filed: June 15, 2019

Issued: March 22, 2021

Assignee: Polar Dynamics Robotics, Inc.

ABSTRACT

A system and method for enabling autonomous mobile robots to operate in e

cold environments through an integrated environmental adaptation system. The invention comprises a thermal management subsystem, cold-resistant sensors, and proprietary navigation algorithms specifically designed for sub-zero operations. The system maintains critical component temperatures while enabling precise mobility and navigation in temperatures as low as -40°C.

BACKGROUND OF INVENTION

[0001] Autonomous mobile robots (AMRs) face significant operational challenges in cold storage and freezer environments due to component sensitivity, battery performance degradation, and sensor interference from frost accumulation. Existing solutions fail to adequately address the combined challenges of thermal management, power efficiency, and navigation accuracy in extreme cold conditions.

[0002] There exists a need for an integrated system that enables reliable AMR

operation in industrial freezer environments while maintaining positioning accuracy and operational efficiency.

SUMMARY OF INVENTION

[0003] The present invention provides a comprehensive environmental adaptation system for autonomous mobile robots operating in extreme cold environments comprising:

- a) A multi-zone thermal management system utilizing phase-change materials and active heating elements to maintain optimal operating temperatures for critical components;
- b) Cold-resistant sensor arrays incorporating heated optical elements and redundant positioning systems;

c) Proprietary navigation algorithms optimized for operation on frozen surfaces and in conditions with potential frost accumulation;

d) An energy management system that optimizes power consumption while maintaining thermal stability.

DETAILED DESCRIPTION

Thermal Management Subsystem

[0004] The thermal management subsystem comprises:

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Vacuum-insulated component compartments

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Phase-change material (PCM) thermal buffer system

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Microprocessor-controlled heating elements

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Temperature monitoring array with 0.1°C precision

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Multi-zone thermal regulation system

Sensor Array Configuration

[0005] The cold-resistant sensor array includes:

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Heated LiDAR units with anti-frost coatings

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Redundant inertial measurement units (IMUs)

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Temperature-compensated wheel encoders

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Proximity sensors with thermal protection

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Vision systems with heated optical elements

Navigation System

[0006] The navigation system incorporates:

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Slip-detection algorithms for frozen surfaces

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Real-time surface condition analysis

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Dynamic path planning with thermal considerations

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Sensor fusion optimization for cold environments

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Adaptive speed control based on surface conditions

CLAIMS

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A system for enabling autonomous mobile robot operation in cold environments

a) A thermal management subsystem maintaining component temperatures at or above critical thresholds;

b) Cold-resistant sensor arrays providing redundant positioning data;

c) Navigation algorithms optimized for frozen surface operation.

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The system of claim 1, wherein the thermal management subsystem includes

- a) Vacuum-insulated compartments;
- b) Phase-change material thermal buffers;
- c) Active heating elements;
- d) Temperature monitoring systems.

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The system of claim 1, wherein the cold-resistant sensor arrays comprise:

- a) Heated optical sensors;
- b) Redundant positioning systems;
- c) Anti-frost protective coatings.

[Claims 4-20 omitted for brevity]

DRAWINGS

[Reference to attached technical drawings showing system components and configurations]

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ASSIGNMENT RECORD

All rights, title, and interest in this patent have been assigned to Polar Dynamics Robotics, Inc., a Delaware corporation, as recorded in the USPTO Assignment Database on April 15, 2021.

MAINTENANCE FEES

First maintenance fee due: September 22, 2024

Status: Pending

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