

PATENT APPLICATION

Arctic Mission Planning Algorithm for Autonomous Mobile Robots in Sub-Zero Environments

USPTO Patent Application No. 16/789,432

ABSTRACT

A system and method for autonomous mission planning and navigation of mobile robots in extreme cold environments, comprising a multi-layered decision architecture that accounts for thermal constraints, surface conditions, and dynamic obstacle avoidance in sub-zero temperatures. The invention enables reliable autonomous navigation in industrial freezer and cold storage environments through proprietary sensor fusion and path optimization techniques.

BACKGROUND OF INVENTION

[0001] Autonomous mobile robots (AMRs) operating in cold storage and industrial freezer environments face unique challenges related to mechanical performance, sensor reliability, and navigation accuracy. Existing solutions fail to adequately address the combined effects of condensation, ice formation, and thermal stress on robot operation and path planning.

[0002] Traditional AMR navigation systems rely on environmental assumptions that break down in extreme cold conditions, particularly below -20 C. These limitations create significant operational constraints for cold chain logistics and frozen storage applications.

SUMMARY OF INVENTION

[0003] The present invention provides a novel approach to mission planning and execution for AMRs operating in extreme cold environments. The system comprises:

- a) A thermal-aware path planning algorithm that incorporates real-time temperature mapping
- b) Multi-modal sensor fusion architecture optimized for sub-zero conditions
- c) Dynamic trajectory adjustment based on surface friction coefficients
- d) Predictive maintenance scheduling accounting for cold-induced stress
- e) Adaptive power management system for extended battery life in low temperatures

DETAILED DESCRIPTION

[0004] The Arctic Mission Planning Algorithm ("AMPA") utilizes a hierarchical decision framework comprising:

Primary Control Layer

- Real-time temperature mapping using distributed thermal sensors
- Surface condition classification using proprietary imaging algorithms
- Dynamic obstacle detection with cold-compensated LIDAR
- Battery performance optimization based on thermal conditions

Navigation Layer

- Path planning incorporating thermal zones and surface conditions
- Dynamic speed adjustment based on environmental factors
- Collision avoidance with thermal consideration
- Multi-robot coordination in confined cold spaces

Operation Layer

- Mission priority scheduling based on thermal constraints
- Power consumption optimization for cold environments
- Predictive maintenance scheduling
- Emergency protocol management

[0005] The system employs proprietary sensor fusion techniques to maintain reliable operation in temperatures as low as -40 C, utilizing:

- Thermal-hardened actuators
- Cold-resistant sensor arrays
- Proprietary condensation management
- Advanced thermal management systems

CLAIMS

A method for autonomous mobile robot navigation in sub-zero environments comprising:

- a) Generating real-time thermal maps of the operating environment
- b) Calculating optimal paths considering thermal constraints
- c) Implementing dynamic trajectory adjustments based on surface conditions

d) Managing power consumption according to thermal zones

The method of claim 1, further comprising:

- a) Multi-robot coordination in confined cold spaces
- b) Predictive maintenance scheduling based on thermal stress
- c) Emergency protocol management for extreme cold conditions

A system for implementing the method of claim 1, comprising:

- a) Thermal-hardened sensors and actuators
- b) Proprietary sensor fusion algorithms
- c) Cold-environment navigation software
- d) Adaptive power management systems

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PRIORITY CLAIM

This application claims priority to U.S. Provisional Application No. 62/789,432 filed March 15, 2023.

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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements

were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

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/s/ Dr. Elena Frost

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