PATENT SPECIFICATION

Snow and Ice Accumulation Prevention System for Autonomous Mobile Robots

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ABSTRACT

A system and method for preventing snow and ice accumulation on autonomous mobile robots operating in sub-zero environments. The system comprises a multi-layer thermal management architecture incorporating active heating elements, hydrophobic surface treatments, and intelligent thermal distribution controls to maintain optimal operating temperatures while preventing frozen precipitation buildup on critical robot components.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots operating in cold storage facilities, freezer warehouses, and other sub-zero environments face significant challenges from snow and ice accumulation. Such accumulation can impair sensor function, reduce mobility, and compromise overall system reliability.

[0002] Existing solutions typically rely on basic heating elements or mechanical removal methods, which prove inefficient and energy-intensive in sustained cold-environment operations.

SUMMARY OF THE INVENTION

[0003] The present invention provides a comprehensive system for preventing snow and ice accumulation on autonomous mobile robots through an integrated approach combining:

(a) Distributed thermal management zones

(b) Smart power allocation algorithms

(c) Surface modification technologies

(d) Predictive accumulation monitoring

(e) Zone-specific heating protocols

DETAILED DESCRIPTION

Thermal Management Architecture

[0004] The system comprises multiple independently controlled thermal zones, each monitored by

dedicated temperature and humidity sensors. Primary zones include:

- Sensor array housing
- Drive system components
- Battery compartment
- Navigation system elements
- External shell surfaces

[0005] Each zone incorporates thin-film heating elements capable of maintaining temperatures above the freezing point while minimizing power consumption.

Surface Treatment System

[0006] Critical surfaces are treated with a proprietary hydrophobic coating (Formula PDR-7) comprising:

- Fluoropolymer base layer
- Nano-textured intermediate layer
- Self-cleaning top coat
- Thermal-conductive additives

Control System

[0007] The thermal management control system employs:

Real-time temperature monitoring

Predictive weather modeling

Zone-specific heating protocols

Power optimization algorithms

Fail-safe override capabilities

CLAIMS

A system for preventing snow and ice accumulation on autonomous mobile robots comprising:

a) A plurality of independently controlled thermal zones;

b) Distributed temperature and humidity sensors;

c) Zone-specific heating elements;

d) Hydrophobic surface treatments;

e) Intelligent control algorithms.

The system of claim 1, wherein the thermal zones are configured to maintain temperatures above freezing while minimizing power consumption.

The system of claim 1, wherein the hydrophobic surface treatment comprises multiple layers including a fluoropolymer base and nano-textured intermediate layer.

A method for preventing snow and ice accumulation comprising:

a) Monitoring zone-specific temperatures;

b) Predictively activating heating elements;

c) Optimizing power distribution;

d) Maintaining surface treatment integrity.

DRAWINGS

[0008] Figure 1: System Architecture Diagram

[0009] Figure 2: Thermal Zone Layout

[0010] Figure 3: Surface Treatment Layers

[0011] Figure 4: Control System Flow Chart

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FOREIGN PRIORITY DATA

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FIELD OF INVENTION

[0012] This invention relates to thermal management systems for autonomous mobile robots, specifically addressing snow and ice prevention in sub-zero operating environments.

PRIOR ART REFERENCES

- US Patent 10,234,567
- US Patent 10,876,543
- EP Patent 3,456,789
- JP Patent 2020-123456

The foregoing description is provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed.

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