PATENT SPECIFICATION

Arctic Robot Shell Design and Construction

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ABSTRACT

A thermally-optimized robotic shell design and construction method for autonomous mobile robots operating in extreme cold environments, comprising a multi-layer composite structure with integrated thermal management channels and cold-resistant joint assemblies. The design enables reliable robotic operation in temperatures ranging from -40 C to +30 C while maintaining critical internal component temperatures within operational parameters.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots operating in cold storage and arctic environments face significant challenges related to thermal management, material performance, and mechanical reliability. Conventional robot chassis designs fail to adequately protect sensitive electronic components and mechanical systems from extreme cold conditions, leading to reduced performance and potential system failures.

[0002] This invention addresses these challenges through a novel shell construction methodology that combines advanced composite materials with an active thermal management system integrated directly into the robot's structural elements.

SUMMARY OF THE INVENTION

[0003] The present invention provides a robotic shell construction comprising:

- A primary structural layer formed from cold-resistant carbon fiber composite
- An intermediate thermal management layer with integrated heating channels
- An outer protective layer incorporating self-healing polymer technology
- Thermally-isolated joint assemblies with proprietary lubricant retention systems
- Modular access panels with redundant environmental sealing

DETAILED DESCRIPTION

Shell Construction

[0004] The primary structural layer utilizes a proprietary carbon fiber weave pattern (Fig. 1) optimized for thermal isolation while maintaining structural integrity under dynamic loads. The fiber orientation provides maximum strength along primary stress vectors while minimizing thermal conductivity paths.

[0005] The intermediate layer incorporates a network of heating channels (Fig. 2) that:

- Maintain critical component temperatures within 2 C of target values
- Utilize waste heat from drive motors and computing systems
- Enable zone-specific temperature control based on component requirements
- Feature redundant flow paths for system reliability

Thermal Management System

[0006] The integrated thermal management system comprises:

- Microprocessor-controlled heat distribution network
- Temperature sensors with 0.1 C resolution
- Adaptive flow control valves
- Emergency backup heating elements
- Thermal expansion compensation joints

Joint Assembly Design

[0007] Critical joint assemblies feature:

- Ceramic-composite bearing surfaces
- Double-sealed lubricant chambers
- Thermal expansion compensation mechanisms
- Replaceable wear components
- Integration with shell thermal management system

CLAIMS

A thermally-optimized robotic shell comprising:

a. A multi-layer composite structure

b. Integrated thermal management channels

c. Cold-resistant joint assemblies

d. Modular access panels

e. Environmental sealing system

The thermal management system of claim 1, wherein:

a. Temperature control is maintained within 2 C

b. Multiple redundant heating paths are provided

c. Waste heat is captured and redistributed

d. Zone-specific temperature control is enabled

The joint assembly design of claim 1, comprising:

a. Ceramic-composite bearing surfaces

b. Double-sealed lubricant chambers

c. Thermal expansion compensation

d. Integration with shell thermal management

DRAWINGS

[0008] The following drawings form part of this specification:

- Figure 1: Composite Layer Structure
- Figure 2: Thermal Management Channel Layout
- Figure 3: Joint Assembly Cross-Section
- Figure 4: Access Panel Detail
- Figure 5: System Integration Diagram

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