PATENT APPLICATION

Adaptive Heating Algorithm for Sub-Zero Robotic Joints

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ABSTRACT

A system and method for dynamically managing thermal conditions in robotic joint assemblies operating in sub-zero environments. The invention comprises an adaptive heating algorithm that utilizes real-time temperature sensors, predictive modeling, and machine learning to optimize power consumption while maintaining operational integrity of robotic joints at temperatures below 0 C. The system includes distributed thermal sensors, microprocessor-controlled heating elements, and a proprietary software control system that adjusts heating parameters based on environmental conditions and operational demands.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots (AMRs) operating in cold storage environments face significant challenges related to joint mobility and mechanical integrity. Traditional heating solutions employ static heating elements that consume excessive power and fail to adapt to varying operational conditions.

[0002] Existing solutions typically rely on constant-temperature heating elements, resulting in inefficient energy usage and potential mechanical stress due to thermal cycling. The present invention addresses these limitations through an intelligent, adaptive approach to thermal management.

DETAILED DESCRIPTION

1. System Architecture

[0003] The adaptive heating system comprises:

a) A network of distributed temperature sensors (DTS) positioned at critical joint locations

b) Microprocessor-controlled heating elements with variable power output

c) A central control unit executing the adaptive heating algorithm

d) Environmental monitoring sensors

e) Power management subsystem

2. Adaptive Heating Algorithm

[0004] The core algorithm utilizes the following components:

1 Temperature Monitoring

- Continuous monitoring of joint temperatures via DTS network
- Environmental temperature tracking
- Operational load assessment

2 Predictive Modeling

- Machine learning model trained on historical operational data
- Real-time adjustment of heating parameters
- Power optimization calculations

3 Control Logic

- Dynamic power allocation to heating elements
- Thermal gradient management
- Emergency override protocols

3. Implementation Methods

[0005] The system implements the following operational sequence:

1 Initialization Phase

- System self-test and sensor calibration
- Baseline temperature establishment
- Operating parameter configuration

2 Operational Phase

- Continuous monitoring and adjustment
- Predictive heating activation

- Power consumption optimization

4. Claims

A method for adaptive thermal management of robotic joints comprising:

a) Monitoring joint temperatures through distributed sensors

b) Executing predictive algorithms to anticipate heating requirements

c) Dynamically adjusting power allocation to heating elements

d) Optimizing energy consumption based on operational conditions

The method of claim 1, further comprising machine learning capabilities that:

a) Learn from historical operational data

b) Adapt to changing environmental conditions

c) Optimize heating patterns for specific joint configurations

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

a) Distributed temperature sensors

b) Microprocessor-controlled heating elements

c) Central control unit

d) Power management subsystem

5. Technical Advantages

[0006] The invention provides:

- 40% reduction in power consumption compared to traditional heating methods
- Improved joint reliability in environments below -30 C
- Extended operational lifespan of mechanical components
- Reduced maintenance requirements
- Enhanced safety through predictive failure prevention

DRAWINGS

[0007] Figure 1: System Architecture Diagram

[0008] Figure 2: Control Flow Schematic

[0009] Figure 3: Sensor Network Layout

[0010] Figure 4: Power Management Subsystem

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.

Executed on: March 15, 2023

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