PATENT APPLICATION

Self-Heating Actuator Housing Design

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ABSTRACT

A self-heating actuator housing system for robotic applications in sub-zero environments, comprising a thermally-regulated enclosure with integrated heating elements and temperature sensors. The housing incorporates a multi-layer thermal management system with active temperature control and power-efficient heat distribution, enabling consistent actuator performance in environments ranging from -40 C to +50 C.

BACKGROUND

[0001] Autonomous mobile robots operating in cold storage environments face significant challenges related to actuator performance and reliability. Traditional actuator housings suffer from thermal inefficiency, leading to reduced functionality and increased power consumption in sub-zero conditions.

[0002] Existing solutions typically rely on external heating systems or require significant power overhead to maintain operational temperatures, resulting in reduced battery life and decreased operational efficiency.

SUMMARY OF THE INVENTION

[0003] The present invention provides a novel actuator housing design that incorporates self-heating capabilities while maintaining optimal power efficiency. The system comprises:

a) A multi-layer thermal isolation chamber

b) Integrated microscale heating elements

c) Distributed temperature sensing array

d) Active thermal management controller

e) Power-optimized heat distribution channels

DETAILED DESCRIPTION

Thermal Isolation Chamber

[0004] The primary housing structure consists of three concentric layers:

- Outer layer: Impact-resistant composite material (0.8mm thickness)
- Middle layer: Vacuum-sealed thermal barrier (1.2mm thickness)
- Inner layer: Heat-conductive aluminum alloy (1.5mm thickness)

Heating Element Configuration

[0005] The system employs proprietary micro-heating elements:

- Power rating: 0.5W - 2.5W per element
- Spacing: 8mm intervals along critical thermal paths
- Response time: <50ms temperature adjustment
- Operating voltage: 12V DC nominal

Temperature Sensing System

[0006] An array of high-precision temperature sensors:

- Accuracy: 0.1 C
- Sampling rate: 100Hz
- Operating range: -50 C to +85 C
- Power consumption: 0.8mW per sensor

Control Architecture

[0007] The thermal management system utilizes:

- Adaptive PID control algorithm
- Real-time temperature mapping
- Predictive heating optimization
- Power consumption monitoring
- Fault detection capabilities

CLAIMS

A self-heating actuator housing system comprising:

a) A thermally-isolated enclosure with multiple concentric layers

b) Integrated heating elements distributed within the inner layer

c) Temperature sensors arranged in a monitoring array

d) A control system for managing thermal distribution

The system of claim 1, wherein the heating elements are configured to:

a) Operate independently or in synchronized groups

b) Maintain temperature differentials within 0.5 C

c) Achieve thermal stability within 60 seconds of activation

The system of claim 1, further comprising:

a) Power management subsystem

b) Thermal pathway optimization

c) Predictive temperature control

d) Emergency thermal protection protocols

DRAWINGS

[0008] Figure 1: Cross-sectional view of actuator housing

[0009] Figure 2: Heating element distribution diagram

[0010] Figure 3: Temperature sensor placement schematic

[0011] Figure 4: Control system architecture

DECLARATION AND POWER OF ATTORNEY

I hereby declare that:

(1) Each inventor's residence is as stated below their name;

(2) I believe the inventors named to be the original and first inventors;

(3) I hereby appoint the registered patent attorneys of WILSON PATENT LAW GROUP, Registration No. 56,789, to prosecute this application;

(4) All statements made herein are true and correct to the best of my knowledge.

Executed on: March 15, 2023

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