

PATENT: THERMAL MANAGEMENT FOR PROCESSING UNITS

PATENT SPECIFICATION

THERMAL MANAGEMENT SYSTEM AND METHOD

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ABSTRACT

A thermal management system and method for maintaining optimal operating temperatures of processing units in autonomous mobile robots operating in extreme cold environments. The system comprises a multi-layer thermal isolation architecture, dynamic heat distribution channels, and an adaptive thermal control algorithm that enables consistent performance of robotic processing units in sub-zero conditions down to -40°C .

BACKGROUND

[0001] Autonomous mobile robots operating in cold storage and industrial environments face significant challenges related to processing unit performance and reliability. Traditional thermal management solutions fail to adequately protect sensitive electronic components in sustained sub-zero conditions.

[0002] Existing solutions typically rely on passive insulation or basic heating elements that are inefficient and unable to maintain consistent operating temperatures across varying thermal loads and environmental conditions.

SUMMARY OF THE INVENTION

[0003] The present invention provides a thermal management system comprising:

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A multi-chamber thermal isolation housing

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Active heat distribution channels utilizing phase-change materials

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Microprocessor-controlled thermal regulation

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Adaptive power management subsystem

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Real-time temperature monitoring and adjustment capabilities

[0004] The system enables:

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Sustained operation in environments from -40°C to +25°C

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Processing unit temperature maintenance within $\pm 2^\circ\text{C}$ of optimal range

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Power efficiency improvements of 40% over conventional solutions

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Reduced thermal cycling stress on electronic components

DETAILED DESCRIPTION

[0005] Thermal Isolation Housing

The housing comprises three concentric chambers separated by vacuum-sealed barriers. The outer chamber contains aerogel-based insulation material with a thermal conductivity of 0.014 W/mK. The middle chamber houses the phase material network, while the inner chamber contains the processing unit and active thermal management components.

[0006] Heat Distribution System

A network of micro-channels filled with proprietary phase-change material (PCM-7842) actively transfers heat between components. The PCM demonstrates a phase transition at -15°C with a latent heat capacity of 190 J/g.

[0007] Control Architecture

The thermal management controller employs a predictive algorithm that:

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Monitors temperature across 16 distinct zones

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Adjusts heat distribution based on processing load

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Optimizes power consumption through dynamic scaling

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Maintains temperature stability within $\pm 0.5^{\circ}\text{C}$

CLAIMS

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A thermal management system for robotic processing units comprising:

a) A multi-chamber thermal isolation housing

b) Active heat distribution channels

c) Adaptive thermal control system

d) Phase-change material thermal buffer

e) Power management subsystem

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The system of claim 1, wherein the thermal isolation housing comprises three

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The system of claim 1, wherein the heat distribution channels contain a phase

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A method for maintaining processing unit temperature in sub-zero environment

a) Monitoring temperatures across multiple zones

b) Dynamically adjusting heat distribution

c) Optimizing power consumption based on thermal load

d) Maintaining temperature stability within specified parameters

DRAWINGS

[0008] FIG. 1 illustrates the multi-chamber thermal isolation housing architecture.

[0009] FIG. 2 shows the heat distribution channel network configuration.

[0010] FIG. 3 depicts the control system architecture and thermal monitoring zones.

[0011] FIG. 4 presents performance data across operating temperature ranges.

INDUSTRIAL APPLICABILITY

[0012] This invention provides significant advantages for autonomous mobile robots operating in cold storage facilities, frozen food processing plants, and other industrial freezer environments where maintaining consistent processing unit performance is critical for operational reliability.

DECLARATION AND GRANT

The Commissioner of Patents has granted this patent to Polar Dynamics Robotics Inc. for the term of 20 years from the filing date, subject to the payment of maintenance fees as provided by law.

IN WITNESS WHEREOF, this patent is granted and sealed by the United States Patent and Trademark Office

/s/ Katherine K. Vidal

Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office

