

PATENT SPECIFICATION

Condensation Prevention System for Electronic Components

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ABSTRACT

A system and method for preventing condensation formation on electronic components in autonomous mobile robots operating in temperature-variable environments. The system comprises a multi-layer thermal management architecture incorporating active humidity control, predictive temperature monitoring, and adaptive thermal barriers to maintain optimal operating conditions for sensitive electronic components during transitions between extreme temperature zones.

BACKGROUND

[0001] Autonomous mobile robots operating in cold storage environments face significant challenges related to condensation formation when moving between temperature zones. Traditional condensation prevention methods are inadequate for maintaining reliable operation of sensitive electronic components in environments with rapid temperature fluctuations.

[0002] Existing solutions typically rely on passive thermal management or basic heating elements, which fail to address the complex dynamics of moisture accumulation in variable-temperature industrial settings.

SUMMARY OF THE INVENTION

[0003] The present invention provides a comprehensive solution for preventing condensation formation on electronic components in autonomous robots operating across extreme temperature gradients. The system employs:

- a) An active thermal management subsystem
- b) Predictive environmental monitoring

- c) Multi-zone humidity control
- d) Adaptive thermal barrier deployment
- e) Real-time condensation risk assessment

DETAILED DESCRIPTION

Thermal Management Subsystem

[0004] The primary thermal management subsystem comprises:

- Multiple independently controlled thermal zones
- Precision temperature sensors with 0.1 C accuracy
- Solid-state cooling elements
- Variable-output heating elements
- Thermal isolation barriers

[0005] The system maintains optimal operating temperatures through:

Continuous monitoring of ambient conditions

Predictive temperature adjustment

Dynamic thermal zone isolation

Automated barrier deployment

Humidity Control System

[0006] The humidity control system includes:

- Distributed humidity sensors
- Active dehumidification elements
- Moisture-permeable membranes
- Condensation collection channels
- Automated moisture evacuation

[0007] Humidity levels are maintained within specified parameters through:

Real-time dewpoint calculation

Predictive humidity modeling

Active moisture removal

Automated ventilation control

CLAIMS

A system for preventing condensation on electronic components comprising:

- a) A sealed enclosure containing electronic components;
- b) Multiple thermal sensors distributed throughout said enclosure;
- c) At least one humidity sensor;
- d) A thermal management controller;
- e) Active heating and cooling elements;
- f) Automated thermal barriers.

The system of claim 1, wherein the thermal management controller:

- a) Monitors real-time temperature and humidity data;
- b) Calculates condensation risk factors;
- c) Controls thermal barrier deployment;
- d) Manages active heating and cooling elements.

A method for preventing condensation comprising:

- a) Monitoring ambient conditions;
- b) Predicting temperature gradients;
- c) Deploying thermal barriers;
- d) Activating heating/cooling elements;
- e) Managing humidity levels.

DRAWINGS

[0008] FIG. 1 illustrates the overall system architecture

[0009] FIG. 2 shows the thermal zone configuration

[0010] FIG. 3 depicts the humidity control system

[0011] FIG. 4 presents the control system flowchart

TECHNICAL FIELD

[0012] This invention relates to environmental control systems for electronic components, specifically addressing condensation prevention in autonomous mobile robots operating in variable temperature environments.

INDUSTRIAL APPLICABILITY

[0013] The invention has direct application in:

- Cold storage facilities
- Temperature-controlled warehouses
- Pharmaceutical manufacturing
- Food processing facilities
- Industrial freezer environments

CERTIFICATION

I hereby certify that I am authorized to execute this patent application on behalf of Polar Dynamics Robotics, Inc.

/s/ Marcus Chen

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Date: March 12, 2021

LEGAL REPRESENTATION

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