PATENT SPECIFICATION

United States Patent Application No. 16/789,432

Title: EXTREME WEATHER SENSOR CALIBRATION SYSTEM AND METHOD FOR AUTONOMOUS MOBILE ROBOTS

Inventors: Elena Frost, Marcus Chen, James Barrett

Assignee: Polar Dynamics Robotics, Inc.

Filed: March 15, 2023

ABSTRACT

A system and method for calibrating environmental sensors in autonomous mobile robots operating in extreme temperature conditions. The invention provides real-time adjustment of sensor parameters based on ambient temperature variations, enabling reliable navigation and operation in cold storage environments ranging from 0 C to -40 C. The system comprises temperature-compensated sensor arrays, thermal isolation modules, and an adaptive calibration algorithm that maintains sensor accuracy across extreme temperature gradients.

BACKGROUND

[0001] Autonomous mobile robots (AMRs) operating in cold storage environments face significant challenges related to sensor reliability and accuracy. Traditional sensor calibration methods fail to account for rapid temperature variations and condensation effects that occur in industrial freezer environments.

[0002] Existing solutions typically rely on static calibration parameters that become unreliable when exposed to extreme temperature differentials, leading to navigation errors and operational failures.

SUMMARY OF THE INVENTION

[0003] The present invention provides a dynamic sensor calibration system comprising:

(a) A temperature-hardened sensor array including LIDAR, infrared, and ultrasonic sensors;

(b) Thermal isolation modules protecting critical sensor components;

(c) An adaptive calibration algorithm that continuously adjusts sensor parameters based on environmental conditions;

(d) A machine learning model that predicts and compensates for temperature-induced sensor drift.

DETAILED DESCRIPTION

[0004] The system includes the following key components:

Temperature Compensation Module

[0005] A specialized thermal management system incorporating:

- Heated sensor housings maintaining optimal operating temperature
- Multi-layer thermal isolation barriers
- Temperature gradient monitoring arrays
- Active condensation prevention system

Adaptive Calibration Algorithm

[0006] The calibration algorithm performs:

- Real-time sensor drift analysis
- Environmental condition mapping
- Dynamic parameter adjustment
- Cross-sensor validation
- Error correction based on historical performance data

Machine Learning Integration

[0007] The system employs machine learning to:

- Predict sensor behavior under varying conditions
- Optimize calibration parameters
- Identify potential failure modes
- Generate compensatory adjustments

CLAIMS

A method for calibrating sensors in autonomous mobile robots operating in extreme temperature environments, comprising:

a) Monitoring ambient temperature conditions;

b) Adjusting sensor parameters based on temperature variations;

c) Applying machine learning-based compensation factors;

d) Validating sensor accuracy through cross-reference checking.

The method of claim 1, wherein the temperature monitoring includes:

a) Continuous measurement of ambient conditions;

b) Detection of temperature gradients;

c) Tracking of temporal temperature variations.

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

a) Temperature-hardened sensor arrays;

b) Thermal isolation modules;

c) Processing units executing the adaptive calibration algorithm;

d) Data storage containing historical calibration parameters.

DRAWINGS

[0008] FIG. 1 illustrates the overall system architecture

[0009] FIG. 2 shows the thermal isolation module components

[0010] FIG. 3 depicts the calibration algorithm workflow

[0011] FIG. 4 presents experimental validation results

INDUSTRIAL APPLICABILITY

[0012] This invention enables reliable autonomous robot operation in industrial cold storage environments, including:

- Pharmaceutical cold chain facilities
- Food processing plants
- Industrial freezer warehouses
- Temperature-controlled logistics centers

PRIOR ART REFERENCES

[0013] The following patents and publications are incorporated by reference:

- US Patent 10,234,567 - "Temperature Compensation in Sensor Systems"

- US Patent 10,876,543 - "Cold Environment Robot Navigation"
- International Journal of Robotics Research, Vol. 42, "Sensor Calibration in Extreme Environments"

DECLARATION

I hereby declare that all statements made herein 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 are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Respectfully submitted,

/s/ Elena Frost, Ph.D.

Elena Frost

Chief Executive Officer

Polar Dynamics Robotics, Inc.

Date: March 15, 2023