PATENT SPECIFICATION

United States Patent Application No. 16/789,432

Title: POLAR NAVIGATION DEAD RECKONING SYSTEM FOR AUTONOMOUS MOBILE ROBOTS IN LOW-TEMPERATURE ENVIRONMENTS

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ABSTRACT

A system and method for autonomous mobile robot navigation in extreme low-temperature environments using enhanced dead reckoning techniques. The system comprises temperature-hardened inertial measurement units, proprietary sensor fusion algorithms, and cold-resistant position tracking mechanisms that maintain accuracy in environments below -40 C. The invention enables reliable navigation when traditional visual and LiDAR-based systems are compromised by frost, condensation, or environmental interference.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots (AMRs) operating in cold storage and industrial freezer environments face unique challenges that compromise traditional navigation systems. Existing solutions rely heavily on visual and LiDAR sensors that become unreliable due to frost accumulation, condensation, and temperature-induced hardware failures.

[0002] Current dead reckoning systems exhibit significant drift in low-temperature environments due to thermal contraction of mechanical components and degraded sensor performance. This invention addresses these limitations through novel hardware and software solutions specifically engineered for extreme cold conditions.

SUMMARY OF THE INVENTION

[0003] The present invention provides a robust navigation system comprising:

- Temperature-compensated inertial measurement units (IMUs)

- Proprietary sensor fusion algorithms
- Cold-resistant wheel encoders
- Thermal management subsystems
- Advanced drift correction mechanisms

[0004] The system maintains positioning accuracy within 5cm over 1000m of travel in environments as cold as -40 C through novel sensor fusion and error correction techniques.

DETAILED DESCRIPTION

[0005] Hardware Components

The system includes:

- Dual redundant IMUs with operating range -50 C to +85 C
- Proprietary wheel encoder design with thermal compensation
- Temperature-hardened microprocessors
- Heated sensor enclosures with condensation prevention

[0006] Software Architecture

The navigation stack comprises:

- Real-time sensor fusion algorithm
- Temperature-adaptive Kalman filtering
- Dynamic drift compensation
- Machine learning-based error prediction
- Fault detection and recovery systems

[0007] Thermal Management

The invention incorporates:

- Active thermal regulation of critical sensors
- Temperature-dependent calibration adjustments
- Condensation prevention mechanisms
- Thermal expansion compensation algorithms

CLAIMS

A method for autonomous mobile robot navigation in low-temperature environments, comprising:

a) acquiring position data from temperature-hardened inertial sensors;

b) processing said data through proprietary fusion algorithms;

c) applying thermal compensation corrections;

d) generating navigation commands with accuracy maintained below -40 C.

The method of claim 1, wherein thermal compensation includes:

a) real-time temperature monitoring;

b) dynamic calibration adjustment;

c) mechanical expansion correction;

d) sensor fusion weight adaptation.

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

a) temperature-hardened IMUs;

b) cold-resistant wheel encoders;

c) thermal management subsystems;

d) sensor fusion processors.

[Claims 4-20 continued...]

DRAWINGS

[Fig. 1] System architecture diagram

[Fig. 2] Thermal management subsystem

[Fig. 3] Sensor fusion workflow

[Fig. 4] Error correction mechanism

[Figs. 5-12 continued...]

DECLARATION AND POWER OF ATTORNEY

I hereby declare that:

- I am the original inventor of the subject matter claimed
- I have reviewed and understand the contents of this application
- I acknowledge the duty to disclose material information
- All statements made herein are true and correct

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At: Wilmington, Delaware

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