PATENT SPECIFICATION

Arctic-Grade Communication System for Autonomous Mobile Robots

Patent No. PDR-2021-0147

ABSTRACT

A system and method for maintaining reliable wireless communication between autonomous mobile robots operating in extreme cold environments, comprising a thermally-insulated communication module, cold-resistant antenna array, and proprietary signal processing algorithms designed to compensate for temperature-induced signal degradation.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots operating in cold storage environments face significant challenges in maintaining reliable wireless communication due to extreme temperatures affecting electronic components and signal propagation. Traditional communication systems experience signal degradation, component failure, and increased latency when operating in sub-zero environments.

[0002] Existing solutions fail to adequately address the unique challenges of maintaining reliable robot-to-robot and robot-to-infrastructure communication in environments below -30 C, particularly in industrial freezer facilities where metal structures and ice formation create additional signal interference challenges.

SUMMARY OF THE INVENTION

[0003] The present invention provides a novel communication system specifically engineered for extreme cold environments, comprising:

a) A thermally-regulated communication module housing featuring:

- Multi-layer vacuum-insulated enclosure
- Phase-change material thermal buffer
- Micro-heating elements with intelligent power management
- Temperature-sensing feedback control system

b) Cold-resistant antenna array including:

- Cryogenically-rated materials and components
- Heated element integration

- Deicing capability
- Adaptive beam-forming technology

c) Signal processing system comprising:

- Temperature-compensating algorithms
- Dynamic power adjustment
- Multi-path signal optimization
- Interference rejection protocols

DETAILED DESCRIPTION

[0004] The communication system maintains operational integrity in temperatures ranging from -40 C to +25 C through the following mechanisms:

Thermal Management

[0005] The communication module employs a proprietary thermal regulation system that maintains internal electronic components within optimal operating temperatures while minimizing power consumption. The system utilizes:

- Vacuum-insulated housing with R-value >40
- Phase-change material buffer rated for 8 hours of thermal stability
- Microprocessor-controlled heating elements drawing <5W average power
- Temperature sensors with 0.1 C resolution

Signal Processing

[0006] The system implements advanced signal processing algorithms specifically designed for cold environment operation:

- Real-time temperature compensation
- Adaptive power management based on environmental conditions
- Multi-path signal optimization using proprietary IceNav(TM) technology
- Interference rejection specifically tuned for metal-rich freezer environments

CLAIMS

A communication system for autonomous mobile robots operating in cold environments comprising:

a) A thermally-regulated housing for electronic components

b) A cold-resistant antenna array

c) Temperature-compensating signal processing algorithms

The system of claim 1, wherein the thermally-regulated housing maintains internal temperature above -10 C while operating in ambient temperatures to -40 C.

The system of claim 1, wherein the cold-resistant antenna array includes active deicing capabilities.

The system of claim 1, wherein the signal processing algorithms dynamically adjust transmission parameters based on environmental conditions.

DRAWINGS

[0007] Figure 1: System Architecture Diagram

[0008] Figure 2: Thermal Management System Components

[0009] Figure 3: Signal Processing Flow Diagram

[0010] Figure 4: Performance Data in Various Temperature Conditions

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CERTIFICATION

I hereby certify that this patent application accurately describes the invention as developed by Polar Dynamics Robotics, Inc., and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true.

/s/ Katherine Wells

Chief Financial Officer

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