PATENT SPECIFICATION

Arctic-Grade Wireless Communication System

Patent No. PDR-2021-0147

Filing Date: March 15, 2021

ABSTRACT

A system and method for maintaining reliable wireless communication in extreme cold environments, specifically designed for autonomous mobile robots operating in sub-zero temperatures. The invention comprises a thermally-isolated communication module with redundant signal processing capabilities and cold-resistant components rated for operation at temperatures as low as -40 C.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots operating in cold storage and arctic environments face significant challenges maintaining reliable wireless communications due to component degradation and signal interference caused by extreme temperatures. Existing wireless systems frequently fail or experience significant performance degradation when exposed to sustained sub-zero temperatures.

[0002] Traditional wireless communication systems utilize components and materials that become unstable or cease functioning at temperatures below -20 C, creating critical vulnerabilities in automated logistics operations requiring consistent connectivity.

SUMMARY OF THE INVENTION

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

a) A thermally-isolated communication module housing incorporating vacuum-sealed chambers and proprietary insulation materials;

b) Cold-resistant circuit components rated for continuous operation at temperatures between -40 C and +25 C;

c) Redundant signal processing units with automated failover capabilities;

d) Proprietary firmware that dynamically adjusts transmission parameters based on environmental conditions;

e) Multi-band antenna array optimized for penetration through ice and frost accumulation.

DETAILED DESCRIPTION

Thermal Management System

[0004] The communication module employs a multi-layer thermal management system comprising:

- Outer shell constructed from cold-resistant composite materials
- Vacuum-sealed intermediate chamber providing thermal isolation
- Inner component chamber with active temperature regulation
- Proprietary phase-change material maintaining stable operating temperatures

Signal Processing Architecture

[0005] The system utilizes dual redundant signal processing units operating in active-standby configuration. Each unit incorporates:

- Cold-hardened processors rated for -40 C operation
- Error detection and correction algorithms optimized for cold-environment interference patterns
- Automated failover logic with <50ms switching time
- Self-diagnostic capabilities with predictive maintenance alerts

Antenna System

[0006] The multi-band antenna array features:

- Directional and omnidirectional elements optimized for sub-zero operation
- Anti-icing coating preventing signal degradation from frost accumulation
- Dynamic impedance matching compensating for temperature-induced changes
- Redundant elements ensuring continuous operation if primary components fail

CLAIMS

A wireless communication system for extreme cold environments comprising:

a) A thermally-isolated housing;

b) Redundant signal processing units;

c) Cold-resistant components rated for -40 C operation;

d) Environmental monitoring and adaptation capabilities.

The system of claim 1, wherein the thermal isolation system includes vacuum-sealed chambers and phase-change materials.

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

The system of claim 1, wherein the antenna system includes anti-icing capabilities and redundant elements.

DRAWINGS

[Reference is made to accompanying drawings PDR-2021-0147-D1 through D4]

INVENTORS

Dr. Marcus Chen

Chief Technology Officer

Polar Dynamics Robotics, Inc.

Dr. James Barrett

Chief Robotics Officer

Polar Dynamics Robotics, Inc.

ASSIGNMENT

The inventors hereby assign all right, title, and interest in this patent application to Polar Dynamics Robotics, Inc., a Delaware corporation having its principal place of business at 2100 Arctic Way, Suite 400, Minneapolis, MN 55401.

DECLARATION

I hereby declare that I am the original inventor of the subject matter which is claimed and for which a patent is sought; that I have reviewed and understand the contents of the above-identified

specification, including the claims; 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.

Executed on: March 15, 2021

/s/ Marcus Chen

Dr. Marcus Chen

/s/ James Barrett

Dr. James Barrett

LEGAL REPRESENTATION

Patent prosecution handled by:

Frost & Winters LLP

Patent Attorneys

One Technology Square

Boston, MA 02142

Attorney Docket No: PDR-PAT-2021-0147