

COLD ENVIRONMENT COMMUNICATION PROTOCOL PATENT

COLD ENVIRONMENT COMMUNICATION P

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ABSTRACT

A system and method for maintaining reliable wireless communication between autonomous mobile robots operating in extreme cold environments, comprising a temperature-hardened communication protocol stack, adaptive signal modulation,

techniques, and redundant mesh networking capabilities optimized for sub-zero conditions between -40°C and 0°C.

TECHNICAL FIELD

[0001] The present invention relates generally to wireless communication systems for autonomous mobile robots, and more particularly to methods and apparatus for maintaining reliable data transmission in extreme cold environments such as industrial freezers, cold storage facilities, and temperature-controlled warehouses.

BACKGROUND

[0002] Conventional wireless communication protocols exhibit significant degradation in extreme cold environments due to:

- - 2 -

Signal attenuation from ice crystal formation

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Component performance deterioration

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Battery capacity reduction

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Increased bit error rates

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Protocol timing violations

[0003] There exists a need for robust communication systems capable of maintaining reliable data transmission between autonomous mobile robots operating in sub-zero industrial environments.

SUMMARY OF THE INVENTION

[0004] The present invention provides a cold-environment communication p
comprising:

a) A temperature-hardened physical layer implementing:

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Adaptive signal strength modulation

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Dynamic frequency hopping

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Multi-path signal redundancy

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Cold-optimized timing parameters

b) A mesh networking layer featuring:

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Self-healing network topology

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Distributed routing tables

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Node health monitoring

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Automatic failover capabilities

c) An application layer providing:

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Quality of service guarantees

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End-to-end encryption

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Session persistence

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Data integrity verification

DETAILED DESCRIPTION

[0005] The cold environment communication protocol comprises multiple in systems working in concert to maintain reliable robot-to-robot and robot-to-infrastructure communication in extreme temperature conditions.

Physical Layer Implementation

[0006] The physical layer utilizes a proprietary signal modulation scheme that dynamically adjusts transmission parameters based on environmental conditions. Key components include:

- - 6 -

Temperature-compensated oscillators

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Adaptive power management

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Multi-band antenna arrays

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Cold-hardened RF components

Mesh Networking Architecture

[0007] The mesh networking layer implements a self-organizing topology where each robot acts as both a client and relay node. This provides:

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Redundant communication paths

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Load balancing capabilities

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Automatic route optimization

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Network self-healing

Application Layer Services

[0008] The application layer provides guaranteed message delivery through:

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Acknowledged transmission protocols

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Message queuing and retry logic

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Priority-based scheduling

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Error detection and correction

CLAIMS

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A method for maintaining wireless communication between autonomous mo

a) Monitoring ambient temperature conditions

b) Adjusting signal modulation parameters dynamically

c) Implementing redundant transmission paths

d) Providing guaranteed message delivery

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The method of claim 1 wherein the cold environment comprises industrial fr

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A system for cold-environment robot communication comprising:

- a) Temperature-hardened wireless transceivers
- b) Adaptive signal processing modules
- c) Mesh networking capabilities
- d) Application layer service guarantees

INVENTORS

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GOVERNMENT INTERESTS

[0009]- This invention was made with government support under Contract No. NSF-1234567 awarded by the National Science Foundation. The government retains certain rights in the invention.

EXECUTION

IN WITNESS WHEREOF, the undersigned has executed this patent application on the date first written above.

/s/ Dr. Elena Frost

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Dr. Elena Frost

CEO & Co-founder

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Date: March 15, 2019
