PATENT SPECIFICATION

Ice Surface Analysis System

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ABSTRACT

A system and method for real-time analysis of ice and frost formation on surfaces in cold storage environments, comprising multiple sensor arrays, thermal imaging capabilities, and machine learning algorithms for detecting and characterizing ice accumulation patterns. The system enables autonomous mobile robots to navigate safely and efficiently in sub-zero industrial environments.

BACKGROUND OF THE INVENTION

[0001] In cold storage and industrial freezer environments, ice formation presents significant challenges for autonomous mobile robot navigation and operation. Traditional sensing systems often fail to accurately detect and characterize ice surfaces, leading to navigation errors and safety risks.

[0002] Existing solutions typically rely on single-mode sensing technologies that cannot reliably distinguish between ice formations and other surface conditions, particularly in dynamic industrial environments where temperature and humidity levels fluctuate.

SUMMARY OF THE INVENTION

[0003] The present invention provides an advanced ice surface analysis system comprising:

- Multi-spectral imaging sensors operating in visible and infrared spectrums
- Neural network-based pattern recognition algorithms
- Thermal conductivity sensors
- Real-time surface texture analysis capabilities
- Environmental condition monitoring subsystems

[0004] The system enables autonomous mobile robots to:

- Detect and classify various types of ice formations
- Generate real-time navigation path adjustments
- Predict potential ice formation zones

- Maintain operational safety in sub-zero environments

DETAILED DESCRIPTION

[0005] The ice surface analysis system includes:

Sensor Array Configuration

[0006] A primary sensor array comprising:

- High-resolution thermal imaging cameras (8-14 m spectral range)
- Short-wave infrared sensors (1.4-3 m range)
- Ultrasonic distance measurement units
- Surface conductivity probes

Processing Unit

[0007] A ruggedized computing module featuring:

- Dedicated neural network processor
- Real-time environmental data analysis engine
- Sensor fusion algorithms
- Predictive modeling capabilities

Machine Learning Implementation

[0008] The system employs proprietary machine learning algorithms to:

- Classify ice formation patterns
- Generate surface condition maps
- Predict environmental changes
- Optimize navigation parameters

CLAIMS

A system for analyzing ice surfaces in industrial environments, comprising:

a) Multiple sensor arrays configured to detect thermal, optical, and physical properties of surfaces

b) Processing units executing machine learning algorithms for ice pattern recognition

c) Environmental monitoring subsystems

d) Navigation optimization modules

The system of claim 1, wherein the sensor arrays include:

a) Thermal imaging cameras operating in the 8-14 m spectral range

b) Short-wave infrared sensors

c) Ultrasonic measurement units

d) Surface conductivity probes

A method for real-time ice surface analysis comprising:

a) Collecting multi-spectral sensor data

b) Processing environmental parameters

c) Generating surface condition maps

d) Implementing navigation adjustments

DRAWINGS

[0009] FIG. 1: System architecture diagram

[0010] FIG. 2: Sensor array configuration

[0011] FIG. 3: Data processing flow

[0012] FIG. 4: Ice pattern classification examples

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FOREIGN PRIORITY DATA

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The foregoing description is provided to enable any person skilled in the art to make and use the invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention.