PATENT SPECIFICATION

Ice Detection and Avoidance System for Autonomous Robots

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ABSTRACT

A system and method for detecting and avoiding ice formations in autonomous robot operations, comprising sensors, processors, and control systems that enable mobile robots to identify, classify, and navigate around hazardous ice conditions in cold environment operations. The system utilizes multi-modal sensing, machine learning algorithms, and adaptive path planning to ensure safe and efficient robot mobility in sub-zero environments.

BACKGROUND OF THE INVENTION

[0001] Autonomous mobile robots operating in cold storage facilities, freezer warehouses, and other sub-zero environments face significant challenges related to ice formation and accumulation. Traditional navigation and obstacle avoidance systems are often inadequate for detecting and responding to ice-related hazards.

[0002] Existing solutions typically rely on single-mode sensing systems that cannot reliably distinguish between ice and other surface conditions, leading to reduced operational efficiency and increased safety risks.

SUMMARY OF THE INVENTION

[0003] The present invention provides an advanced ice detection and avoidance system specifically designed for autonomous mobile robots operating in cold environments. The system comprises:

a) A multi-modal sensor array incorporating:

- Infrared thermography sensors

- Surface texture analysis cameras

- Pressure-sensitive contact sensors

- Spectral reflectance analyzers

b) An artificial intelligence processing unit that:

- Fuses data from multiple sensor inputs

- Classifies surface conditions in real-time

- Generates risk assessment scores

- Updates navigation parameters

c) An adaptive navigation control system that:

- Modifies robot movement patterns

- Adjusts speed and acceleration profiles

- Implements alternative path planning

- Maintains operational safety margins

DETAILED DESCRIPTION

[0004] The ice detection system utilizes proprietary sensor fusion algorithms to create detailed environmental maps incorporating temperature gradients, surface texture characteristics, and reflectivity patterns. The system employs machine learning models trained on extensive datasets of ice formation patterns in industrial cold storage environments.

[0005] The primary components include:

Sensor Array Configuration

- Forward-looking infrared (FLIR) cameras operating in the 8-14 m range

- High-resolution texture mapping cameras with LED illumination

- Distributed pressure sensors in robot contact points

- Multi-spectral reflectance sensors with custom wavelength selection

Processing Architecture

- Edge computing units with dedicated neural network processors

- Real-time sensor fusion algorithms

- Dynamic risk assessment models

- Adaptive path planning optimization

Control Integration

- Variable speed drive systems

- Torque-limited actuator controls

- Emergency stop protocols

- Thermal management systems

CLAIMS

A method for autonomous robot ice detection and avoidance comprising:

a) Collecting multi-modal sensor data about surface conditions

b) Processing sensor data through machine learning algorithms

c) Generating real-time surface condition maps

d) Implementing adaptive navigation protocols

The method of claim 1, wherein the multi-modal sensor data includes:

a) Infrared thermal signatures

b) Visual texture patterns

c) Contact pressure measurements

d) Spectral reflectance characteristics

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

a) Sensor arrays mounted on autonomous mobile robots

b) Processing units executing proprietary algorithms

c) Control systems for navigation modification

d) Safety override mechanisms

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GOVERNMENT INTERESTS

PRIOR ART REFERENCES

US Patent 10,789,XXX

US Patent Application 2020/0123XXX

EP Patent 3,456,XXX

The foregoing description of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed.