

# **COLD CLIMATE SENSOR FUSION ALGORITHM PATENT**

## **COLD CLIMATE SENSOR FUSION ALGORITHM**

**UNITED STATES PATENT APPLICATION NO. 16/78**

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### **ABSTRACT**

A system and method for sensor fusion in cold climate environments, multi-modal sensor array and processing architecture specifically designed to maintain accuracy and reliability in sub-zero temperatures. The invention enables robust autonomous navigation for mobile robots operating in

conditions through adaptive sensor calibration, temperature-compensation algorithms, sensor fusion, and environmental condition optimization algorithms.

## **BACKGROUND OF THE INVENTION**

[0001] Autonomous mobile robots operating in cold storage and industrial environments face significant challenges related to sensor performance degradation, signal interference, and navigation accuracy. Conventional sensor fusion algorithms fail to account for the unique characteristics of extreme cold environments, including frost accumulation, thermal gradients, and material property changes.

[0002] This invention addresses these challenges through a novel approach to sensor data integration and environmental compensation, enabling reliable autonomous navigation in temperatures as low as -40 C.

## DETAILED DESCRIPTION

### 1. System Architecture

[0003] The system comprises:

(a) A temperature-hardened sensor array including:

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LiDAR sensors with heated optical elements

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Thermal imaging cameras

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Ultrasonic sensors with cold-resistant piezoelectric elements

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Proprietary BlueCore(TM) environmental sensors

[0004]-The sensor array is integrated with a central processing unit for

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Real-time temperature compensation algorithms

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Multi-modal data fusion architecture

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Adaptive calibration systems

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Environmental condition monitoring and adjustment protocols

## **2. Sensor Fusion Algorithm**

[0005] The core algorithm implements:

(a) Temperature-dependent sensor weighting

(b) Dynamic recalibration based on environmental conditions

(c) Frost detection and compensation

(d) Signal processing optimized for cold-induced noise reduction

### **3. Environmental Compensation**

[0006] The system employs:

(a) Active thermal management for critical sensors

(b) Predictive maintenance protocols for cold-weather operation

(c) Automatic adjustment of sensor parameters based on temperature

(d) Real-time performance monitoring and adaptation

## **CLAIMS**

A method for sensor fusion in cold climate environments, comprising:

(a) Receiving input from multiple temperature-hardened sensors

- (b) Processing sensor data using adaptive environmental compensation
- (c) Implementing real-time calibration adjustments
- (d) Generating navigation commands based on fused sensor data

The method of claim 1, wherein the temperature-hardened sensors comprise:

- (a) Heated LiDAR systems
- (b) Cold-resistant ultrasonic arrays
- (c) Thermal imaging systems
- (d) Environmental condition sensors

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

- (a) A central processing unit
- (b) Multiple sensor interfaces
- (c) Environmental monitoring systems

(d) Navigation control outputs

## **INVENTORS**

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## **PRIORITY CLAIM**

This application claims priority to U.S. Provisional Application No. 63/198,752 filed March 15, 2021.

## **GOVERNMENT RIGHTS**

[0007] This invention was made with government support under Contract No. NIST-SBIR-2021-156789 awarded by the National Institute of Standards and Technology. The government has certain rights in the invention.

## **FIELD OF INVENTION**

[0008] The present invention relates to autonomous mobile robot navigation systems, specifically addressing sensor fusion algorithms optimized for



cold environments and industrial freezer applications.

## **PRIOR ART REFERENCES**

US Patent No. 10,234,567 - "Autonomous Navigation Systems"

US Patent No. 10,876,543 - "Cold Environment Robotics"

US Patent Application No. 15/789,432 - "Sensor Fusion Methods"

## **DECLARATION AND POWER OF ATTORNEY**

I hereby declare that I believe I am the original inventor of the subject matter herein, which is claimed and for which a patent is sought. I hereby appoint the undersigned, my registered patent attorneys of Record, Registration No. 65432, to prosecute this patent application and transact all business in the Patent and Trademark Office and all matters connected therewith.

Executed on: March 15, 2022

/s/ Dr. Elena Frost

Dr. Elena Frost, CEO & Co-founder

Polar Dynamics Robotics, Inc.

