

**AUTONOMOUS NAVIGATION IN LOW-VISIBILITY CONDITIONS PATENT**

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**UNITED STATES PATENT NO. 11,789,432**

**ABSTRACT**

A system and method for autonomous robot navigation in low-visibility environments utilizing multi-modal sensor fusion and adaptive environmental mapping. The invention comprises proprietary algorithms for real-time path planning and obstacle avoidance in conditions of reduced visibility, including fog, frost, condensation, and environmental interference common in cold storage facilities and temperature-controlled environments.

## **BACKGROUND OF THE INVENTION**

[0001] This invention relates to the field of autonomous mobile robots, specifically addressing the challenges of reliable navigation in extreme temperature environments where traditional vision and LiDAR systems may be compromised by environmental factors.

[0002] Conventional autonomous navigation systems often fail or demonstrate reduced effectiveness in cold storage environments due to sensor degradation, condensation formation, and ice crystal interference. This invention provides novel solutions for maintaining reliable autonomous operation in such conditions.

## **SUMMARY OF THE INVENTION**

[0003] The present invention provides systems and methods for autonomous

navigation in low-visibility conditions, comprising:

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Multi-modal sensor array incorporating temperature-hardened optical, infrared

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Proprietary sensor fusion algorithms optimized for sub-zero environments

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Real-time environmental condition compensation

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Adaptive path planning with dynamic obstacle avoidance

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Self-diagnostic capabilities for sensor performance monitoring

## **DETAILED DESCRIPTION**

[0004] The invention comprises the following key components and methods:

### **Sensor Array Configuration**

[0005] The primary sensor array includes:

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Dual redundant LiDAR units with heated optical surfaces

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Thermal imaging cameras with -40°C to +85°C operating range

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Ultrasonic sensor array with ice-detection capabilities

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Proprietary condensation-resistant optical sensors

### **Data Processing and Fusion**

[0006] The system employs proprietary algorithms for:

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Real-time sensor data validation and cross-referencing

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Environmental condition compensation

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Dynamic sensor weighting based on performance metrics

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Predictive failure detection

### **Navigation Control System**

[0007] The navigation control system features:

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Adaptive path planning with multiple redundancy levels

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Real-time obstacle detection and avoidance

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Dynamic speed adjustment based on visibility conditions

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Emergency stop protocols with fail-safe mechanisms

## **CLAIMS**

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A system for autonomous navigation in low-visibility conditions comprising

- a) A temperature-hardened multi-modal sensor array
- b) Proprietary sensor fusion algorithms
- c) Adaptive navigation control systems
- d) Environmental condition compensation mechanisms

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The system of claim 1, wherein the sensor array includes heated optical surface

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The system of claim 1, wherein the fusion algorithms dynamically adjust sensor

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## **PATENT DETAILS**

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## **LEGAL REPRESENTATION**

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## **GOVERNMENT INTERESTS**

[0008] This invention was made without government support.

## **FIELD OF THE INVENTION**

[0009] The present invention relates to autonomous mobile robot navigation systems, specifically addressing operation in low-visibility and extreme temperature conditions typical of cold storage and industrial freezer environments.

## **PRIOR ART REFERENCES**

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US Patent 10,234,567

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US Patent 10,876,543

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US Patent Application 2021/0234567

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EP Patent 3,456,789

## **CERTIFICATION**

I hereby certify that this patent document accurately represents the invention as described and claimed.

/s/ Victoria Wells

Chief Financial Officer

Polar Dynamics Robotics, Inc.

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[Patent drawings and detailed technical specifications omitted for brevity]

