MULTI-ROBOT COORDINATION PROTOCOL SPECIFICATION

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Classification: CONFIDENTIAL

Owner: NaviFloor Robotics, Inc.

1. INTRODUCTION

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1 This Multi-Robot Coordination Protocol Specification ("Protocol") defines

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2 This Protocol is a controlled document subject to NaviFloor Robotics' intel

2. DEFINITIONS

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1 "Coordination Zone" means any defined operational area where two or mo

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2 "Fleet Controller" means NaviFloor's centralized software system that man

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3 "Priority Level" means the hierarchical status assigned to each AMR task,

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4 "Safety Envelope" means the dynamic three-dimensional space surroundin

3. COORDINATION PARAMETERS

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1 Spatial Parameters

a) Minimum separation distance: 1.5 meters

b) Dynamic safety envelope radius: 0.8-2.0 meters (speed-dependent)

c) Vertical clearance requirement: 0.3 meters

d) Path intersection angle threshold: 15 degrees

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2 Temporal Parameters

a) Communication update frequency: 100ms

b) Path recalculation interval: 250ms

c) Collision prediction window: 3.0 seconds

d) Task reassignment threshold: 5.0 seconds

4. COORDINATION ALGORITHMS

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1 Path Planning

a) Primary algorithm: Modified A with dynamic constraints

b) Secondary algorithm: Rapidly-exploring Random Trees (RRT)

c) Fallback algorithm: Potential Field Method

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2 Collision Avoidance

a) Primary method: Velocity Obstacle approach

b) Secondary method: Time-scaled collision cones

c) Emergency protocol: Immediate stop with graduated deceleration

5. COMMUNICATION PROTOCOLS

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1 Inter-Robot Communication

a) Protocol: NaviFloor Secure Robot Communication Protocol (NSRCP)

b) Encryption: AES-256-GCM

c) Authentication: ED25519 signatures

d) Bandwidth allocation: 100 Kbps per AMR

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2 Fleet Controller Communication

a) Protocol: WebSocket Secure (WSS)

b) Heartbeat interval: 50ms

c) Reconnection attempts: 3 maximum

d) Timeout period: 500ms

6. PRIORITY MANAGEMENT

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1 Task Priority Levels

a) P1: Emergency operations

b) P2: Time-critical operations

c) P3: Standard operations

d) P4: Background operations

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2 Conflict Resolution

a) Higher priority tasks supersede lower priority tasks

b) Equal-priority conflicts resolved by timestamp

c) Deadlock prevention through task reassignment

d) Maximum wait time: 30 seconds

7. SAFETY REQUIREMENTS

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1 All AMRs must maintain active safety systems including:

a) LiDAR-based obstacle detection

b) Depth-sensing cameras

c) Emergency stop capabilities

d) Redundant communication systems

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2 Safety Override Conditions

a) Loss of communication > 1 second

b) Obstacle detection within 0.5 meters

c) System fault detection

d) Manual override signal

8. PERFORMANCE MONITORING

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1 Required Metrics

a) Path efficiency ratio

b) Collision avoidance events

c) Task completion times

d) Communication latency

2 Reporting Requirements

a) Real-time monitoring dashboard

b) Hourly performance logs

c) Daily summary reports

d) Monthly trend analysis

9. COMPLIANCE AND UPDATES

1 This Protocol must be implemented in full by all NaviFloor AMR systems.

2 Updates to this Protocol require approval from:

a) Chief Technology Officer

b) Chief Research Officer

c) Safety Compliance Officer

10. PROPRIETARY RIGHTS

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1 This Protocol and all implementing software, algorithms, and systems are t

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2 No part of this Protocol may be disclosed, copied, or implemented without

APPROVAL AND EXECUTION

APPROVED AND ADOPTED this 15th day of January, 2024.

NAVIFLOOR ROBOTICS, INC.

By:

Marcus Depth

Chief Technology Officer

By:

Dr. Elena Kovacs

Chief Research Officer