THERMAL MANAGEMENT CONTROL SOFTWARE DOCUMENTATION

Polar Dynamics Robotics, Inc.

Document Version: 3.2

Last Updated: December 15, 2023

Classification: CONFIDENTIAL

1. PROPRIETARY SOFTWARE OVERVIEW

1 This documentation describes the proprietary thermal management control software (the "Software") developed by Polar Dynamics Robotics, Inc. ("Company") for use in its autonomous mobile robots operating in cold-environment applications.

2 The Software comprises the following core components:

a) ThermalCore(TM) Engine v4.2

b) CryoSense(TM) Monitoring System v3.1

c) TempGuard(TM) Control Interface v2.8

d) IceNav(TM) Environmental Adaptation Module v3.5

2. INTELLECTUAL PROPERTY RIGHTS

1 The Software, including all source code, object code, algorithms, architecture, and documentation, is protected under U.S. Copyright Registration Nos. TX-9-285-441, TX-9-287-652, and TX-9-290-773.

2 The following patent protection applies to the Software's core technologies:

- U.S. Patent No. 11,285,644: "System and Method for Thermal Management in Autonomous Robots"
- U.S. Patent No. 11,342,891: "Adaptive Control Systems for Cold-Environment Robotics"
- Patent Pending Application No. 17/825,991: "Machine Learning-Based Thermal Optimization in Mobile Robots"

3. TECHNICAL SPECIFICATIONS

1 Programming Languages and Frameworks:

- Primary: C++ (ISO/IEC 14882:2020 compliant)
- Secondary: Python 3.9+
- Framework: ROS2 Humble
- Runtime Environment: Linux Ubuntu 22.04 LTS

2 Performance Parameters:

- Operating Temperature Range: -40 C to +50 C
- Response Time: <50ms
- Memory Footprint: 256MB maximum
- CPU Utilization: <15% at idle, <45% under load

4. SECURITY MEASURES

1 The Software implements the following security protocols:

- AES-256 encryption for all data at rest
- TLS 1.3 for network communications
- Role-based access control (RBAC)
- Secure boot verification
- Real-time threat monitoring

2 Authentication Requirements:

- Multi-factor authentication for administrative access
- Hardware security module (HSM) integration
- Digital signatures for all software updates
- Automated session timeout after 30 minutes of inactivity

5. LICENSING AND USAGE RESTRICTIONS

1 The Software is licensed, not sold, under the terms of the Company's Enterprise License Agreement.

2 Usage Restrictions:

- No reverse engineering or decompilation
- No unauthorized modifications or derivative works
- No transfer or sublicensing without written consent

- Geographic restrictions per individual license terms

6. MAINTENANCE AND SUPPORT

1 Software updates are provided according to the following schedule:

- Security patches: Within 72 hours of identification
- Bug fixes: Monthly releases
- Feature updates: Quarterly releases
- Major version updates: Annually

2 Technical support is available through:

- 24/7 emergency support hotline
- Online ticket system
- Remote diagnostics and troubleshooting
- On-site support (as per service agreement)

7. COMPLIANCE AND CERTIFICATION

1 The Software has been certified compliant with:

- ISO/IEC 27001:2022 Information Security Management
- IEC 61508 Functional Safety Standard
- UL 1998 Software in Programmable Components
- CE marking requirements for robotics control systems

2 Regular compliance audits are conducted by:

- Internal audit team (quarterly)
- Third-party auditors (annually)
- Regulatory bodies (as required)

8. VERSION CONTROL AND DOCUMENTATION

1 All Software versions are maintained in GitLab Enterprise with:

- Comprehensive commit history
- Branch protection rules
- Code review requirements

- Automated testing protocols

2 Documentation is maintained in:

- Technical specification documents
- API documentation
- User manuals
- Implementation guides

9. CONFIDENTIALITY

1 This documentation contains confidential and proprietary information of Polar Dynamics Robotics, Inc. and is protected under applicable trade secret and copyright laws.

2 Disclosure, distribution, or reproduction without express written permission is strictly prohibited.

CERTIFICATION

The undersigned hereby certifies that this documentation is complete and accurate as of the date below.

/s/ Marcus Chen

Marcus Chen

Chief Technology Officer

Polar Dynamics Robotics, Inc.

Date: December 15, 2023