IoT Freezer Project – Machine Learning Roadmap

Overview

This document describes the Machine Learning (ML) and Computer Vision roadmap for the IoT-based freezer system. The goal is to implement predictive maintenance, refrigeration cycle optimization, and ice-cream detection using sensor and image data.

PHASE 1: Data Preparation & Feature Engineering

• Input data collected from sensors (temperature, evaporator temperature, humidity, power, RPM, vibration).
• Generate derived features such as Superheat (Temperature – Evaporator Temperature).
• Calculate trends, gradients, and efficiency-related parameters.
• Prepare ML-ready CSV dataset.

PHASE 2: Predictive Maintenance & Anomaly Detection

• Apply unsupervised or semi-supervised ML models such as Isolation Forest or Autoencoders.
• Detect abnormal behavior in compressor, fan, and power consumption.
• Identify early signs of mechanical or electrical failure.
• Output anomaly score or normal/abnormal classification.

PHASE 3: Refrigeration Cycle Optimization

• Use ML insights combined with rule-based logic for safe control.
• Optimize Electronic Expansion Valve (EEV) opening based on superheat.
• Adjust compressor RPM and condenser fan speed to improve efficiency.
• Reduce energy consumption while maintaining temperature stability.

PHASE 4: Ice-Cream Detection using Computer Vision

• Use ESP32-CAM or external camera module.
• Apply YOLO or lightweight CNN models for object detection.
• Detect presence or absence of ice-cream packages.
• Enable inventory monitoring and alert generation.

PHASE 5: System Integration & Deployment

• Integrate ML predictions with Node-RED dashboard.
• Generate alerts for anomalies and maintenance warnings.
• Display optimization suggestions for operators.
• Prepare system for real-time and cloud-based deployment.

Conclusion

This phased ML roadmap enables an end-to-end intelligent freezer system capable of self-monitoring, optimization, and predictive maintenance. The approach is scalable,

industry-relevant, and suitable for academic and internship evaluations.