جامعة الملك فهد للبترول والمعادن
King Fahd University of Petroleum & Minerals

Capstone 2.0
Term 241
Title: AI-Driven Thermal Imaging UAV for Pipeline Inspection
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About

Problem: Pipeline inspection in remote and high-risk areas is challenging, as human inspectors cannot be deployed safely.

Objective: To provide comprehensive pipeline inspections that cover larger areas quickly, ensuring accurate detection of defects while reducing costs across extensive networks.

Solution: A specialized drone equipped with a thermal camera and AI capabilities is designed to inspect pipes, detect leaks, and predict corrosion, enhancing safety and efficiency.

Elevator Pitch: Aramco faces challenges in detecting leaks and corrosion in pipelines. They need a reliable system for consistent detection. Unlike traditional systems, the AI-driven thermal imaging UAV is a mobile solution that captures thermal images and performs real-time AI analysis to identify pipeline issues.
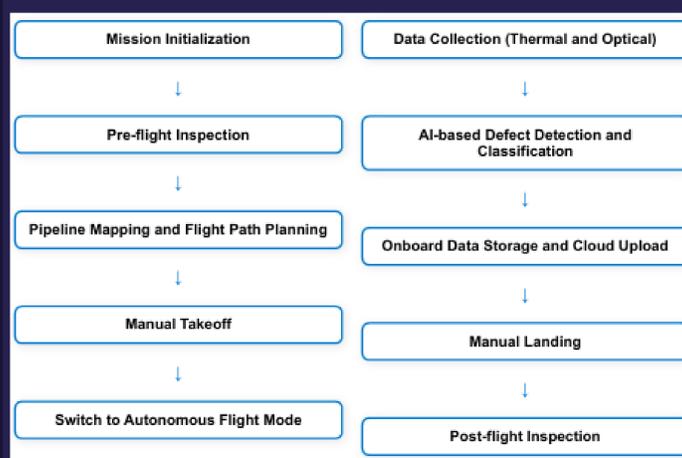

Constraints

Weather Impact
Flight Efficiency
Communication Range
Power Consumption
Altitude Compliance
Thermal Camera Precision
Navigation Reliability
Weight management
Humidity Control
Cavitation Prediction
Cost-Effectiveness
GPS Accuracy
Wi-Fi Connection

Specifications

Auto-Pilot Feature
Website Integration
Fail-safe features
Optimal Speed Range
High accuracy Thermal camera
Easy to control manually
Versatility in Pipeline Inspection
Operational Endurance
Optical Visuals
Easy Calibration
Robust Frame
Long-Range Telemetry Capability
Optimal Accuracy AI-Model

Process Flowchart

Mission Initialization	Data Collection (Thermal and Optical)
↓	↓
Pre-flight Inspection	AI-based Defect Detection and Classification
↓	↓
Pipeline Mapping and Flight Path Planning	Onboard Data Storage and Cloud Upload
↓	↓
Manual Takeoff	Manual Landing
↓	↓
Switch to Autonomous Flight Mode	Post-flight Inspection

Validation and Verification

\# We validated the accuracy of the AI model by testing it with multiple different thermal images
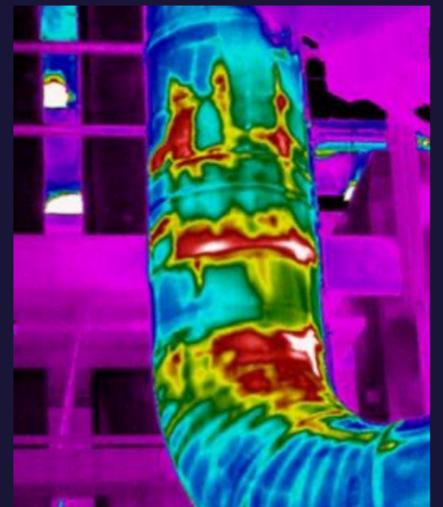
Predicted class : Corrosion

\# The test included thermal images of pipes with corrosion and pipes without any issues

Predicted class : No issue

Future developments:

·Use machine learning to predict future defects based on historical inspection data.

·Extend the drones' flight times and increase their range by using advanced battery technologies.

·Create a fully autonomous system where the drone handles everything from takeoff to landing without human intervention.

·Enhance the AI's ability to detect a wider range of pipeline defects using more advanced sensors and machine learning techniques.