AstraGuard AI: Autonomous Fault Detection & Recovery for Small Satellites

This presentation introduces AstraGuard AI, an innovative solution designed to address the critical issue of early failures in CubeSats. By leveraging machine learning for real-time telemetry monitoring, anomaly detection, and autonomous recovery actions, AstraGuard AI aims to significantly improve mission success rates, extend satellite lifespans, and reduce operator workload, ultimately contributing to a safer orbital environment.

Maximizing CubeSat Mission Success

Mission Resilience

Extended lifespan and reduced workload

Advanced AI Technology

Machine learning for anomaly detection

Autonomous Recovery Actions

Automated responses to detected failures

AstraGuard AI Security Framework

Proactive Monitoring

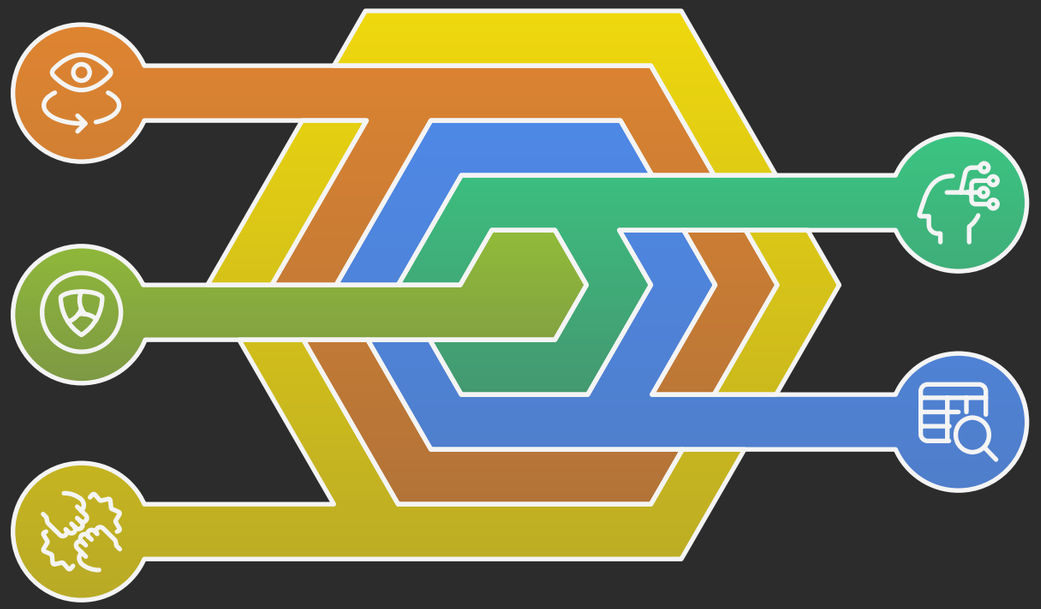
Prevents security breaches before they occur

AstraGuard AI

Core technology enhancing security

User Benefits

Peace of mind and operational integrity



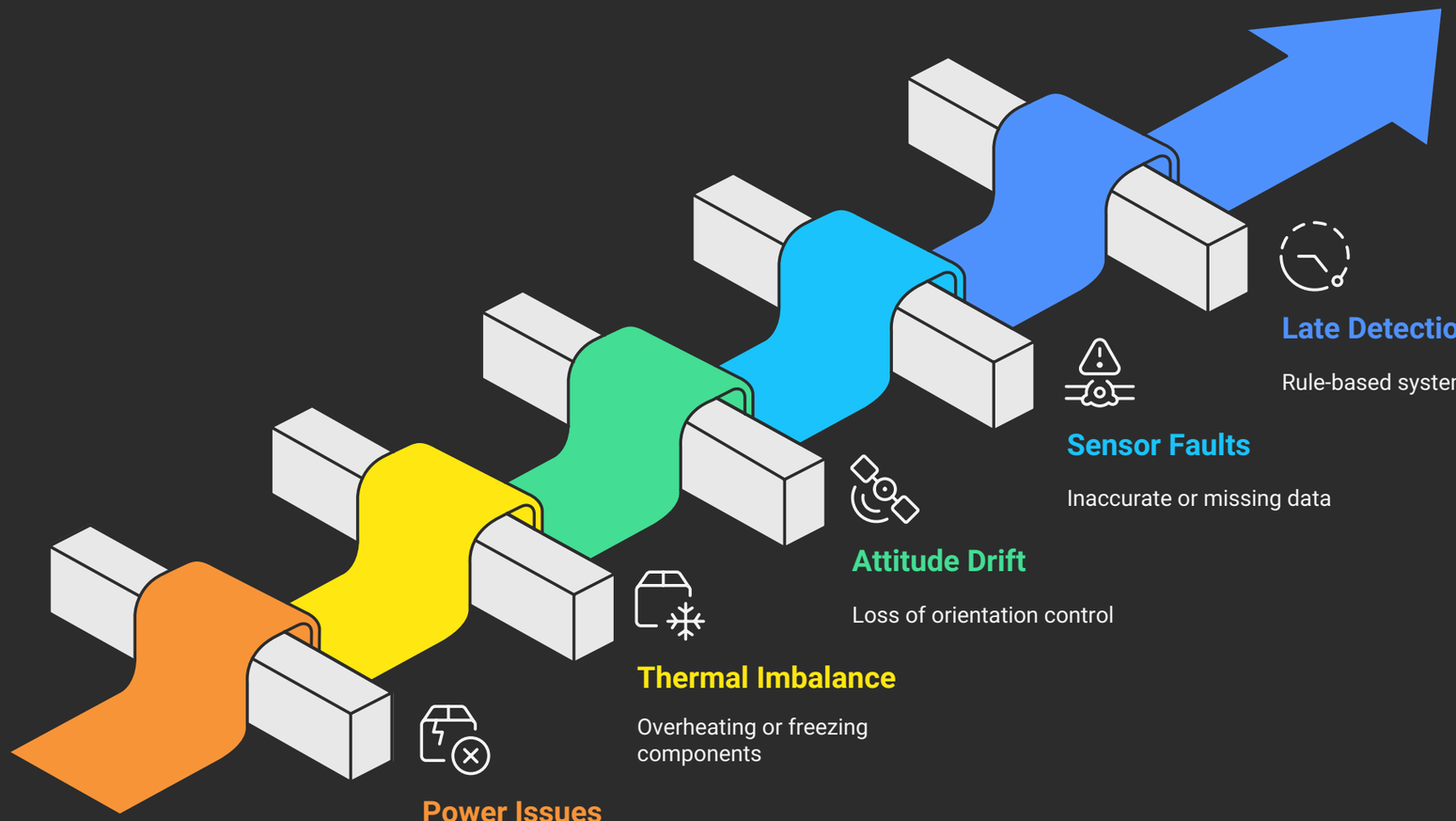
Machine Learning Algorithms

Foundation for data analysis and threat detection

Real-time Data Analysis

Enables immediate response to risks

CubeSat Early Failures



Power Issues

Insufficient power to operate

Thermal Imbalance

Overheating or freezing components

Attitude Drift

Loss of orientation control

Sensor Faults

Inaccurate or missing data

Late Detection

Rule-based systems react slowly

AstraGuard AI Solution

Fault Classification

Categorizes detected issues

AstraGuard AI

Core system for CubeSat management

Automatic Safe-mode + Recovery Actions

Immediate responses to faults

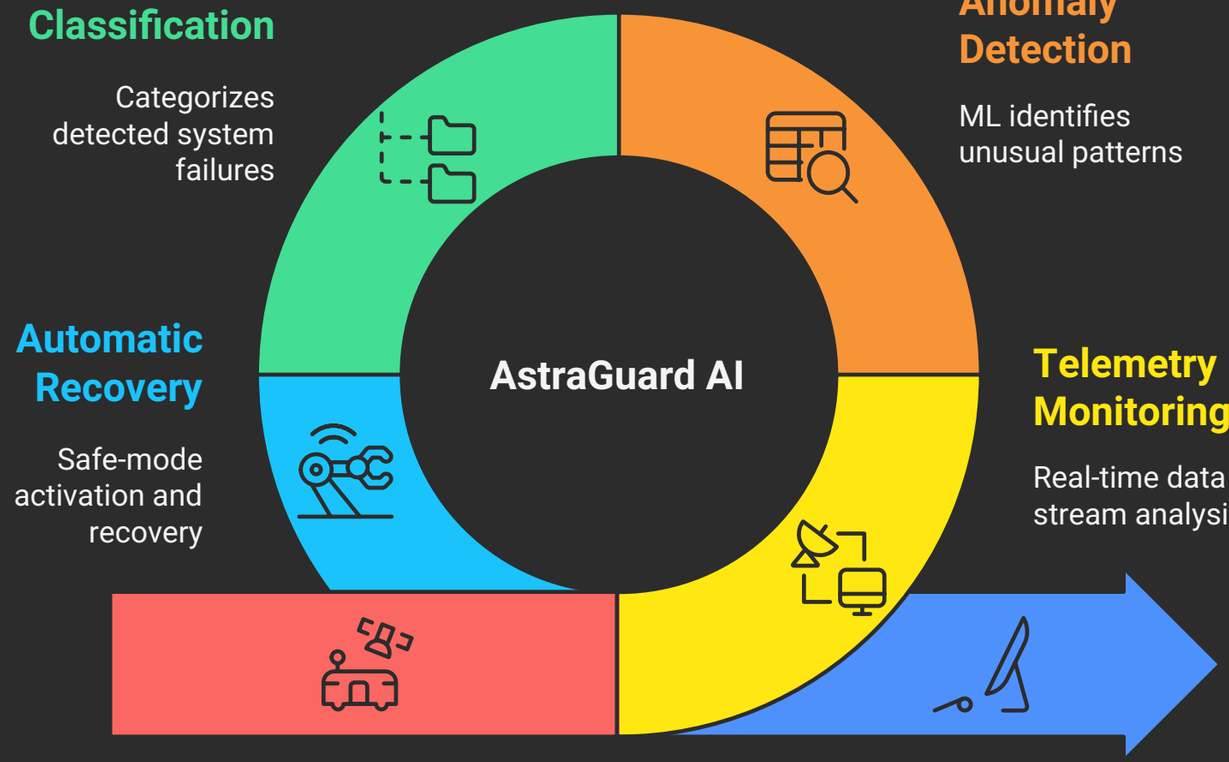
Real-time Telemetry Monitoring

Continuous data stream analysis

ML-based Anomaly Detection

Identifies unusual patterns

AstraGuard AI for CubeSat Protection



Fault Classification

Categorizes detected system failures

Anomaly Detection

ML identifies unusual patterns

Automatic Recovery

Safe-mode activation and recovery

Telemetry Monitoring

Real-time data stream analysis

CubeSat Vulnerability

Real-time monitoring is needed

CubeSat Protection

Autonomous fault detection and recovery

Autonomous Fault Recovery

Unidentified Satellite Fault

Unknown issue impacting performance

Telemetry

Continuous data stream from sensors

ML Detection

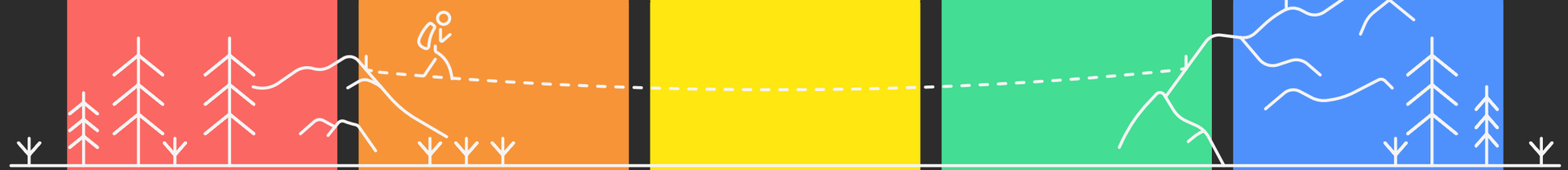
Algorithms identify anomalies

Fault Classification

AI categorizes fault type

Mitigated Satellite Fault

Autonomous response resolves issue



Feasibility of Nanosatellite ML

Limited Resources

Nanosatellites have limited resources

Efficient ML

Feasible ML

ML is feasible on nanosatellites

Utilize available nanosatellite data

Run ML on low-power hardware

Full demo via simulation

MVP Features

Telemetry Simulation

Simulating live telemetry data for testing.

Anomaly Detection

Identifying unusual patterns in the data stream.

Fault Identification

Pinpointing the source of errors or failures.

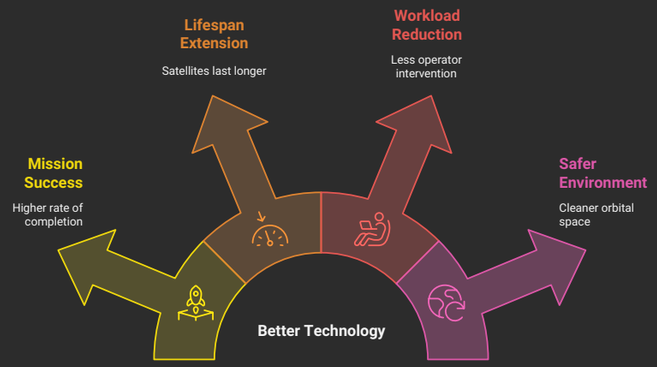
Autonomous Recovery

Automatically fixing issues without human intervention.

Dashboard Visualization

Displaying key metrics and alerts in a dashboard.

Improved Satellite Operations



Autonomous Health Monitoring for Satellites