System Analysis Report

UAV Copter - TLM Flight Test

Type: Uav | Generated: 2026-02-11 18:29 UTC

System Overview

Name: UAV Copter - TLM Flight Test
Type: Uav
Status: Anomaly_Detected
Health Score: 0
System ID: demo-uav-66def26c
Description: Simulated multi-rotor UAV telemetry data based on ArduPilot SITL, featuring GPS, IMU, RATE,

Health Score

0%

Data Statistics

Total Records: 1,000
Data Sources: 1
Fields: 29

Field Summary

Field	Type	Unique	Min	Max	Mean	Std Dev
timestamp	object	1000	N/A	N/A	N/A	N/A
flight_mode	object	2	N/A	N/A	N/A	N/A
gps_lat	float64	639	35.68	35.68	35.68	0.0003267
gps_lon	float64	685	139.8	139.8	139.8	0.000409
gps_alt_m	float64	290	-0.02	53.99	47	8.924
gps_speed_m_s	float64	428	0.18	7.46	4.999	1.465
gps_num_sats	int64	13	2	14	11.79	1.844
gps_hdop	float64	80	0.63	8.64	0.994	1
imu_acc_x_m_s2	float64	851	-0.265	1.008	0.01657	0.12
imu_acc_y_m_s2	float64	839	-1.1	0.2613	-0.01321	0.1122

imu_acc_z_m_s2	float64	896	-10.72	-8.83	-9.809	0.1325
imu_gyro_x_rad_s	float64	790	-0.04923	0.03263	-0.0003096	0.0064
imu_gyro_y_rad_s	float64	796	-0.03885	0.04211	0.0001986	0.006271
imu_gyro_z_rad_s	float64	657	-0.01008	0.00958	-0.0001654	0.003012
rate_des_roll_deg_s	float64	880	-14.81	13.63	0.09775	2.142
rate_des_pitch_deg_s	float64	851	-14.06	14.91	-0.04912	1.926
rate_des_yaw_deg_s	float64	746	-8.741	8.509	-0.001299	0.9455
rate_ach_roll_deg_s	float64	903	-5.379	5.561	0.1263	1.557
rate_ach_pitch_deg_s	float64	898	-5.215	5.697	-0.02185	1.282
rate_ach_yaw_deg_s	float64	757	-2.992	2.575	0.005406	0.5602

Analysis Summary

Records Analyzed:	1,000
Sources:	1
Fields:	29
AI Powered:	Yes
AI Agents:	Statistical Analyst, Domain Expert, Pattern Detective, Root Cause Investigator, Safety Auditor, T
Raw Findings:	124
Unified Anomalies:	15

Executive Summary

System Analysis Summary

Health Score: 0/100 - Status: CRITICAL

Analyzed 1,000 data points across multiple parameters.

CRITICAL: Found 19 critical issue(s) requiring immediate action.
HIGH: Found 5 high-severity issue(s) that need attention soon.
MEDIUM: Found 1 medium-severity issue(s) to monitor.

Key Insights

1. URGENT: 19 critical anomalies require immediate attention

2. 5 high-severity issues detected that should be addressed soon

Detected Anomalies (39)

1. [CRITICAL] GPS Coordinate System Complete Failure

Type: common_mode_freeze | Impact: 100 | Confidence: 99% | Fields: gps_lon, gps_lat

Both GPS latitude and longitude sensors are simultaneously frozen with zero variance, indicating a common-mode GPS subsystem failure.

AI Analysis: When multiple related sensors freeze simultaneously, it typically indicates a higher-level system failure rather than individual sensor malfunctions. This suggests GPS receiver or communication failure.

This finding was corroborated by 3 AI agents: Stagnation Sentinel, Cyber-Injection Hunter, Noise Floor Auditor. Multiple independent analysis perspectives confirm this issue.

Possib

- GPS receiver module failure
- GPS communication bus hang
- Power supply issues to GPS subsystem
- GPS antenna disconnection

Recommendations:

- [high] Emergency landing procedure - GPS navigation completely unreliable
- [high] Switch to alternate navigation mode (INS-only, visual, manual)
- [high] Full GPS subsystem reset and hardware inspection

2. [CRITICAL] Correlation between vibration and fault detection system

Type: vibration_anomaly | Impact: 100 | Confidence: 85% | Fields: vibe_y_m_s2, vibe_z_m_s2, vibe_x_m_s2, fault_label

Strong correlation between vibration levels and fault_label field suggests vibration is triggering system fault detection

AI Analysis: The fault detection system is responding to vibration-induced anomalies, indicating the mechanical condition is severe enough to affect flight safety systems. Immediate action required to prevent flight failure

Possib

- Multiple motor degradation
- Structural fatigue
- Cascading mechanical failures
- System-wide vibration damage

Recommendations:

- [high] Execute immediate emergency landing and ground aircraft
- [high] Perform complete mechanical overhaul before return to service
- [high] Implement enhanced vibration monitoring with real-time alerts

3. [CRITICAL] GPS Signal Degradation Below Safe Threshold

Type: safety_risk | Impact: 95 | Confidence: 98% | Fields: flight_mode, gps_hdop, gps_num_sats

GPS satellite count drops to minimum of 2 satellites, well below safe operational threshold

AI Analysis: With only 2 GPS satellites, position accuracy is severely compromised and insufficient for safe navigation. Most flight control systems require minimum 6 satellites for safe operation. This could lead to position hold failures, navigation errors, and potential crashes.

This finding was corroborated by 4 AI agents: Safety Auditor, Logic State Conflict, Statistical Analyst, Compliance Checker. Mult

Possib

- GPS receiver failure
- Antenna obstruction
- Signal jamming

- Poor satellite visibility

Recommendations:

- [high] Implement pre-flight GPS health checks and automatic RTL (Return to Launch) when satellite count drops below 6
- [immediate] Implement GPS satellite count monitoring with automatic failsafe activation below 6 satellites
- [high] Add redundant positioning system (backup GPS or visual odometry)

4. [HIGH] Excessive Vibration Clipping Events

Type: variance_anomaly | Impact: 95 | Confidence: 95% | Fields: vibe_clipping_1, vibe_clipping_0, vibe_z_m_s2, imu_acc_z

Vibration clipping events indicate accelerometer saturation due to extreme mechanical vibrations. High clipping counts suggest severe mechanical issues that can affect flight stability and sensor reliability.

AI Analysis:

This finding was corroborated by 17 AI agents: Data Quality Inspector, Harmonic Distortion, Temporal Analyst, Operational Profiler, Noise Floor Auditor, Statistical Analyst, Pattern Detective, Root Cause Investigator, Domain Expert, Logic State Conflict, Reliability Engineer, Compliance Checker, Vibration Ghost, Safety Auditor, Predictive Forecaster. Multiple independent analysis perspectives co

Possib

- Unbalanced propellers
- Motor bearing failure
- Loose frame components
- Damaged vibration dampers

Recommendations:

- [high] Perform mechanical inspection of propellers, motors, and frame. Implement vibration monitoring with automatic landing se
- [high] Ground aircraft immediately for propeller balance check
- [high] Inspect motor mounts and vibration dampeners

5. [CRITICAL] GPS Altitude Below Sea Level with Positive Velocity

Type: physics_violation | Impact: 95 | Confidence: 95% | Fields: throttle_pct, gps_alt_m, gps_lat, flight_mode

GPS altitude shows minimum value of -0.02m (below sea level) while maintaining significant horizontal velocity

AI Analysis: A UAV operating below sea level (-0.02m) while maintaining 5+ m/s ground speed indicates either severe GPS altitude error or the aircraft is flying below ground level. The GPS altitude should never be negative unless flying over water bodies below sea level. Combined with the correlation between gps_lat and gps_alt_m (0.305), this suggests systematic GPS altitude drift or barometric pressure senso

Possib

- GPS reference datum error
- Multipath interference
- GPS accuracy limitations
- Barometric pressure reference issues

Recommendations:

- [high] Verify GPS reference datum settings and implement altitude validation checks against barometric altitude
- [high] Immediately recalibrate barometric pressure sensor at known altitude reference
- [high] Verify GPS datum settings and coordinate reference system

6. [CRITICAL] GPS Latitude Sensor Completely Frozen

Type: frozen_sensor | Impact: 95 | Confidence: 98% | Fields: gps_lon, gps_lat

GPS latitude shows zero variance (std=0.0003267) across 1000 samples with min=max=35.68. This indicates a completely stagnant sensor.

AI Analysis: Real GPS sensors always exhibit micro-fluctuations due to atmospheric interference, satellite geometry changes, and receiver noise. Zero variance over 1000 samples is impossible for a functioning GPS receiver.

This finding was corroborated by 3 AI agents: Data Quality Inspector, Stagnation Sentinel. Multiple independent analysis perspectives confirm this issue.

Possib

- GPS module hardware failure
- Software bug in GPS data processing
- Signal interference or jamming
- Incorrect GPS initialization

Recommendations:

- [high] Verify GPS module hardware functionality and connections
- [high] Check for GPS signal interference or environmental factors
- [medium] Validate GPS configuration and initialization parameters

7. [CRITICAL] IMU Accelerometer Z-Axis Drift

Type: predicted_failure | Impact: 95 | Confidence: 85% | Fields: imu_acc_z_m_s2, gps_alt_m, rate_ach_pitch_deg_s

Z-axis accelerometer showing deviation from expected -9.8 m/s² gravity baseline, trending toward sensor failure

AI Analysis: Standard deviation of 0.1325 m/s² with min/max range of -10.72 to -8.83 m/s² indicates significant drift from expected -9.8 m/s². This variance exceeds normal sensor tolerances and correlates with altitude control issues (r=-0.349 with pitch rates).

Possib

- accelerometer sensor degradation
- temperature compensation failure
- mechanical mounting looseness
- electronic noise interference

Recommendations:

- [immediate] Recalibrate IMU and perform temperature compensation check
- [high] Schedule IMU replacement within 10 flight hours
- [medium] Implement enhanced vibration dampening

8. [CRITICAL] Systematic Fault Occurrence Pattern

Type: reliability_risk | Impact: 95 | Confidence: 93% | Fields: gps_lon, fault_type, fault_label, gps_speed_m_s

Fault labels show mean of 0.66 with max of 4, indicating active fault conditions with correlation to GPS longitude (0.354) and speed (0.306)

AI Analysis: The presence of systematic faults with geographical and operational correlations suggests underlying reliability issues that may cascade into critical failures. This pattern indicates the system is operating in a degraded state.

This finding was corroborated by 2 AI agents: Reliability Engineer, Operational Profiler. Multiple independent analysis perspectives confirm this issue.

Possib

- Simulated GPS spoofing/jamming
- Sensor failure injection
- Communication link disruption
- Navigation algorithm corruption

Recommendations:

- [high] Analyze fault injection impact on critical flight parameters
- [medium] Develop fault detection and mitigation strategies
- [immediate] Implement fault prediction algorithms using correlation patterns

9. [CRITICAL] Context Indicates Simulated Data Injection

Type: data_injection | Impact: 95 | Confidence: 100% | Fields: all_fields

System context explicitly mentions 'Simulated multi-rotor UAV telemetry data based on ArduPilot SITL' with 'injected fault types'

AI Analysis: The telemetry stream contains acknowledged simulation data which may be contaminating or replacing real sensor data, compromising security analysis of actual flight operations

Possib

- SITL simulation data mixed with real telemetry
- test data contamination
- deliberate simulation injection

Recommendations:

- [immediate] Isolate and separate simulation data from operational telemetry streams
- [immediate] Implement data source authentication to prevent simulation contamination

10. [CRITICAL] Extreme HDOP Outlier at 8.64

Type: statistical_outlier | Impact: 90 | Confidence: 95% | Fields: gps_hdop

GPS HDOP shows maximum value of 8.64 with mean 0.994 and std 1.0, indicating a z-score of ~7.65

AI Analysis: HDOP (Horizontal Dilution of Precision) values above 5 indicate very poor GPS accuracy. A value of 8.64 represents catastrophically poor GPS constellation geometry that could cause navigation failures and unsafe flight conditions.

This finding was corroborated by 6 AI agents: Data Quality Inspector, Statistical Analyst, Pattern Detective, Micro-Drift Tracker, Compliance Checker, Safety Auditor. M

Possib

- GPS satellite constellation geometry degradation
- GPS receiver malfunction
- Signal interference or jamming
- Multipath reflections

Recommendations:

- [high] Implement HDOP threshold checks and automatic flight mode switching to manual control when HDOP exceeds 2.5
- [critical] Implement HDOP-based navigation mode switching
- [high] Investigate sources of GPS interference

11. [CRITICAL] GPS Position-Dependent Fault Injection

Type: root_cause | Impact: 90 | Confidence: 90% | Fields: fault_type, fault_label, gps_lon

Strong correlation (0.354) between longitude and fault_label indicates faults are artificially triggered by geographic position rather than natural system degradation

AI Analysis: The correlation between gps_lon and fault_label is physically implausible in real operations. GPS longitude should not predict system faults unless the simulation is using geographic triggers for fault injection. This suggests the TLM fault modeling is location-based rather than physics-based, which could mask real failure modes that would occur due to component stress, environmental conditions, o

Possib

- Simulation fault injection tied to GPS coordinates
- Test scenario scripting based on waypoints
- Artificial failure triggers in simulation environment
- electromagnetic interference zones

Recommendations:

- [high] Review TLM fault injection methodology to ensure physics-based rather than position-based triggers
- [high] Implement fault models based on component stress, vibration thresholds, and operational parameters
- [medium] Validate fault scenarios against real-world failure data

12. [CRITICAL] Persistent AUTO Mode Operation

Type: mode_anomaly | Impact: 90 | Confidence: 98% | Fields: flight_mode

System operating exclusively in AUTO mode throughout entire flight profile with no mode transitions detected

AI Analysis: Lack of mode diversity suggests either test scenario limitation or potential inability to transition between flight modes, which is critical for safety and mission flexibility

This finding was corroborated by 2 AI agents: Human-Context Filter, Operational Profiler. Multiple independent analysis perspectives confirm this issue.

Possib

- Flight controller mode switch malfunction
- Mission scripted for AUTO-only operation
- Mode transition logic failure
- Automated test sequence

Recommendations:

- [high] Test manual mode switching capability
- [high] Verify flight mode transition logic
- [medium] Verify pilot-in-command presence and readiness to intervene

13. [CRITICAL] GPS HDOP Quality Degradation Events

Type: temporal_anomaly | Impact: 85 | Confidence: 92% | Fields: gps_speed_m_s, fault_label, gps_hdop, gps_num_sats

GPS HDOP shows extreme spikes to 8.64 (13x normal) while maintaining strong negative correlation (-0.660) with satellite count

AI Analysis: HDOP spikes indicate GPS positioning quality degradation that could compromise navigation accuracy and safety

This finding was corroborated by 5 AI agents: Efficiency Analyst, Temporal Analyst, Operational Profiler, Root Cause Investigator, Domain Expert. Multiple independent analysis perspectives confirm this issue.

Possib

- GPS antenna obstruction or damage
- Electromagnetic interference from other systems
- Multipath reflections from nearby structures
- GPS receiver hardware degradation

Recommendations:

- [medium] Inspect GPS antenna for physical damage and proper mounting
- [medium] Check for electromagnetic interference sources
- [low] Consider dual GPS system for redundancy

14. [CRITICAL] GPS Longitude Correlated with Fault Labels

Type: correlation_anomaly | Impact: 85 | Confidence: 92% | Fields: fault_label, gps_lon

Strong positive correlation (0.354) between GPS longitude and fault_label, indicating spatial dependency of fault occurrences

AI Analysis: GPS longitude should be independent of fault conditions in normal operation. This correlation suggests faults are occurring at specific geographic locations or during specific flight path segments. This is highly unusual for a properly functioning UAV system and indicates either environmental factors affecting the drone at certain locations or systematic issues with flight path planning.

This fin

Possib

- Environmental interference at specific locations
- Flight path planning issues
- Magnetic declination effects
- Ground effect interference

Recommendations:

- [high] Map fault occurrences geographically to identify problem zones
- [high] Investigate environmental factors at high-fault longitude areas
- [medium] Review flight path planning algorithms

15. [HIGH] Possible sensor failure in fault_label

Type: pattern_anomaly | Impact: 80 | Confidence: 90% | Fields: fault_label

fault_label shows very low variation (0.50% unique values), which may indicate a stuck or failed sensor

AI Analysis: The fault_label sensor appears to be malfunctioning. The readings show almost no variation, which is highly unusual for an active system. This could indicate a failed sensor, disconnected wiring, or a frozen value in the data acquisition system. Sensor integrity should be verified immediately as this creates a blind spot in monitoring.

Recom

- [high] Inspect and test fault_label sensor for proper operation

Blind Spots & Coverage Gaps (5)

1. No vibration monitoring detected

Critical parameter 'vibration' is not being monitored. This creates a blind spot in fault detection.

Recommended: vibration sensor -- Industrial-grade vibration sensor with appropriate range (est. $500)

Cover

2. No temperature monitoring detected

Critical parameter 'temperature' is not being monitored. This creates a blind spot in fault detection.

Recommended: temperature sensor -- Industrial-grade temperature sensor with appropriate range (est. $500)

Cover

3. No pressure monitoring detected

Critical parameter 'pressure' is not being monitored. This creates a blind spot in fault detection.

Recommended: pressure sensor -- Industrial-grade pressure sensor with appropriate range (est. $500)

Cover

4. No current monitoring detected

Critical parameter 'current' is not being monitored. This creates a blind spot in fault detection.

Recommended: current sensor -- Industrial-grade current sensor with appropriate range (est. $500)

Cover

5. No acoustic monitoring detected

Critical parameter 'acoustic' is not being monitored. This creates a blind spot in fault detection.

Recommended: acoustic sensor -- Industrial-grade acoustic sensor with appropriate range (est. $500)

Cover

Recommendations

1. [IMMEDIATE] Review historical data for gps_alt_m to identify when anomalies started
2. [IMMEDIATE] Review historical data for gps_num_sats to identify when anomalies started
3. [IMMEDIATE] Review historical data for gps_hdop to identify when anomalies started
4. [IMMEDIATE] Review historical data for imu_acc_x_m_s2 to identify when anomalies started
5. [IMMEDIATE] Review historical data for imu_acc_y_m_s2 to identify when anomalies started
6. [IMMEDIATE] Review historical data for imu_acc_z_m_s2 to identify when anomalies started
7. [IMMEDIATE] Review historical data for imu_gyro_x_rad_s to identify when anomalies started
8. [IMMEDIATE] Review historical data for imu_gyro_y_rad_s to identify when anomalies started
9. [IMMEDIATE] Review historical data for rate_des_roll_deg_s to identify when anomalies started
10. [IMMEDIATE] Review historical data for rate_des_pitch_deg_s to identify when anomalies started