**Rover Health Check Module**

This module runs before the rover starts operating to confirm that all systems and environmental conditions are safe and ready. It performs a series of specific checks, and if any critical check fails, the rover enters "sleep mode" and won’t start until the issue is fixed.

Specific Functions

* **Environmental Conditions Check**

Temperature: Measures the ambient temperature. If it exceeds 60°C, it raises a critical exception, halting startup to protect the rover’s hardware.

Cloud Cover: Assesses cloud cover percentage. If above 90%, it logs a warning (non-critical) since it might affect solar power or visibility but doesn’t stop the rover.

* **GPS Health Check**

Satellite Count: Counts connected satellites. Requires at least 6 for a reliable 3D position fix; fewer triggers a critical failure.

HDOP (Horizontal Dilution of Precision): Evaluates horizontal GPS accuracy. Must be ≤ 3.0; higher values indicate poor precision and prevent startup.

* **GPS Fix Type Check**

Verifies the GPS fix type. Requires at least a basic fix (type ≥ 1, e.g., 2D or 3D fix); no fix or type 0 stops the rover.

* **GPS Accuracy Check**

VDOP (Vertical Dilution of Precision): Ensures vertical accuracy with VDOP ≤ 4.5. Exceeding this suggests unreliable altitude data and halts startup.

Position Accuracy: Confirms the estimated position error is ≤ 5 meters. Larger errors indicate GPS unreliability, triggering a failure.

* **GPS Position Validity Check**

Validates latitude (-90° to 90°) and longitude (-180° to 180°). Out-of-range values stop the rover.

Checks for "null island" (0°, 0°). If detected, it flags a warning as this often signals a GPS glitch, though it’s not critical.

* **Internet Connectivity Check**

Tests internet speed, requiring ≥ 0.5 Mbps for real-time corrections (e.g., RTCM data).

Retries 3 times if the connection fails temporarily. Persistent failure stops the rover.

**Failsafe Module**

This module operates during the rover’s mission to monitor systems in real time. If it detects critical issues, it activates failsafe mode (e.g., stopping the rover or entering sleep mode) and attempts automatic recovery.

Specific Functions

* **GPS Monitoring**

Data Loss: Detects if GPS updates stop entirely. Triggers failsafe immediately to avoid navigation without position data.

Stale Data: Flags if no GPS updates occur for > 30 seconds. Assumes data is outdated and activates failsafe.

Instability: Counts signal losses. If ≥ 5 occur within 1 minute, it triggers failsafe due to unreliable GPS.

* **Internet and Communication Monitoring**

Internet Loss: Monitors connectivity. If no internet for > 10 seconds, it triggers failsafe since real-time corrections are lost.

Slow Internet: Measures latency. If > 2 seconds, it activates failsafe to avoid delays in critical updates.

Module Communication: Tracks internal module communication. If no response for > 15 seconds, it assumes a system failure and triggers failsafe.

* **Temperature Monitoring**

Continuously checks system temperature. If it exceeds 60°C, it activates failsafe to prevent overheating damage (requires hardware sensors).

* **Drift Monitoring**

Calculates position drift using the Haversine formula (lat/lon) or Euclidean distance (x/y).

Assigns severity levels:

Minor: ≥ 0.2m – Logs and monitors.

Moderate: ≥ 0.5m – Slows the rover to assess.

Severe: ≥ 1.0m – Attempts realignment.

Critical: ≥ 2.0m – Triggers failsafe.

Escalates based on persistence:

3 severe events or 10 consecutive drift events force failsafe mode.

* **Recovery Mechanism**

Attempts up to 5 recoveries, spaced 60 seconds apart, for resolvable issues (e.g., temporary GPS loss).

Succeeds if the issue clears (e.g., GPS reconnects); otherwise, it locks into failsafe after 5 failures.

Resets monitoring timers post-recovery to avoid immediate re-triggers.