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Track : Generative Ai

Topic : Seismic Detection

**Introduction**

Planetary missions like the Apollo and Mars InSight Lander gather extensive seismic data to study planetary interiors. However, sending all the collected data back to Earth is inefficient, as much of it consists of noise rather than scientifically valuable seismic events. This project proposes a solution by developing a computer program that identifies seismic quakes in the data and transmits only relevant information, thus optimizing power usage and data transmission.

**Steps for the Seismic Detection Program**

**Data Loading and Preprocessing**

The program begins by loading raw seismic data from planetary landers. This data may be vast and unprocessed.

Preprocessing includes normalizing the data, which ensures consistency and uniformity across different datasets, preparing it for further analysis.

**Noise Reduction (Filtering)**

Seismic data often contains noise from various environmental and instrumental sources. To isolate the seismic signals, the program applies filtering techniques:

High-pass filters remove low-frequency noise.

Low-pass filters eliminate high-frequency noise.

Band-pass filters focus on specific frequency ranges where seismic activity is expected.

This noise reduction step is crucial in improving the signal-to-noise ratio.

**Signal Detection**

The program then detects seismic signals using algorithms like Short-Term Average/Long-Term Average (STA/LTA). This method:

Compares the short-term average of the signal to the long-term average to identify sudden spikes in the data.

Detects seismic events by setting a threshold for significant changes in the signal.

This automated detection allows the lander to pick up only meaningful seismic events from the continuous data stream.

**Feature Extraction**

Once seismic signals are detected, the program extracts relevant features from the data:

Amplitude, frequency, and duration are some of the critical features.

These features allow further analysis and classification of the seismic events, determining their origin and magnitude.

**Classification**

A classification step distinguishes between actual seismic events (e.g., quakes, tectonic shifts) and noise (e.g., wind, lander movements).

Machine learning algorithms or rule-based systems can be applied to refine the classification process and minimize false positives.

**Data Transmission**

Only the filtered and classified data is prepared for transmission back to Earth, dramatically reducing the amount of unnecessary data.

This ensures that the spacecraft conserves power while focusing on sending only the scientifically valuable information.

**Summary**

The proposed project focuses on developing a robust seismic signal detection program that operates autonomously on planetary landers. By filtering out noise, detecting seismic events, and transmitting only relevant data, this approach will improve the efficiency of seismic data collection and communication on future planetary missions. The result will be better power management and more insightful seismic analysis with minimal data loss.