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Denoising Ambient Temperature Sensor data in Mars

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The Red Planet has generated an enormous curiosity among the scientific community around the world. Since the sixties, many space missions have been trying to reach Mars. Unfortunately, not all the missions have successfully landed on the planet but the lucky ones who have succeeded have offered incalculable information that have helped us discover many things and get to know our neighbor planet better.
Among all data received from the different missions, our study is focused on the Rover Environmental Monitoring Station, REMS, located in the Curiosity rover, from NASA. We have decided to study data from this mission because this rover has provided measurements for such a wide period of time with very few gaps of data: it started almost 10 years ago, and it continues properly working and their sensors still provide data with high temporal resolution.

After having worked for almost 10 years with data from these sensors, we have realized that data arrive on Earth with lot of noise while the REMS sensors are not using the appropriate algorithm to denoise the samples.

It is to be noted that bringing environmental data from Mars to Earth for their processing and further study requires a tremendous effort, so that it may not make sense to radically smooth the received data, thus removing some potential information content that could effectively cooperate with other sensors and measurements.

We have decided to analyze data from two temperature sensors from REMS. Temperature measurements received from the rover are very noisy and must be processed and validated before being delivered to the scientific community.

The algorithm that has been traditionally used is a moving average filter and we propose two new methods for denoising: Wavelets and Empirical Mode Decomposition. We can ascertain an improvement in signal-to-noise ratio when using the proposed methods.

We also present a procedure to validate the different methods' performance based on the comparison of the estimated standard deviation of the noise when using a test data performed on Earth with the sensors, as a reference against the Martian temperature sensor data, which is subject to a variety of external perturbations.

We concluded that the proposed methods allow a better fitting for all the realistic scenarios, while providing the possibility to identify and analyze other interesting signal features and artifacts that could subject of future research. Lots of meteorological features might be masked if we smooth data too much.
The present proposal can be also easily adapted to other REMS sensors.