Analysis of microphones operating characteristics under harsh environment in order to develop a sound detector in Martian atomosphere

*Hiroaki Fujitsu[1], Masa-yuki Yamamoto[1]

1.Kochi University of Technology

Introduction: In 2020s, launches of a Japanese Mars explores are planned by Japan Aerospace Exploration Agency (JAXA), and realization of the series-like Mars explorations is expected. As of 2016, the sonic wave observation in Martian atmosphere has never been carried out. Not only measuring Martian atmospheric sound with the dust events but also sensing of physical parameters in Martian atmosphere could be realized if a few small microphones are equipped on a Rover for exploration based on an appropriate design and development.
Purpose: We perform microphone testing experiments under simulated severe Martian environment by using vacuum chambers in order to select one from two kinds of microphone Breadboard models (BBM), capacitor type microphones and Micro Electro Mechanical Systems (MEMS) type ones experimentally. Under the assessment process, enhancement of detection performance with applying the microphone array is evaluated under the simulated Martian atmospheric conditions.
Experiment outline: An atmospheric condition with 95% of CO_2 component occupies with its atmospheric pressure level of 7 hPa as well as temperature level of -120 degree Celsius like nighttime Martian surface was used for simulating severe environment in the experiment at Chiba Institute ok Technology in January, 2015. Furthermore, We performed a calibration experiment of microphone BBMs in Kochi University of Technology. We call the sound less than 20 Hz that is the lowest limit of the audible sound as the infrasound. Aiming at successful detection of the infrasound signal in the Martian atmosphere in future, we input simulated infrasound signal with audible range sound into the experimental space as calibration basis. Here, we use a vacuum chamber as an rigid container for performing repeated compression/absorption with a small syringe as a small volume with periodically creating slight atmospheric pressure waves as an exact wave pattern. We assumed this process can make a wave pattern of infrasound for calibrating the microphone BBMs. Evaluation of a Chaparral Physics Model25 infrasound sensor and microphone BBMs was carried out with simulating 0.1 Hz infrasound with 1 Pa amplitude.
Experimental result: The result of a measurement using the simulated infrasound signal provided a clear spectrum peak of 0.1 Hz frequency with the both sensors. The capacitor type microphone have effective precision better than the infrasound sensor at the 0.1 Hz range. We compared the MEMS microphones with the capacitor microphones under the same condition. The capacitor microphones could clearly detect infrasound of 0.1 Hz, but seldom detectabilities for the MEMS microphones.
Conclusion: Under the simulated severe Martian atmospheric environment, we compared the performance of capacitor and MEMS microphones, resulting in an advantage of the capacitor type microphones suitable for sensing in the Martian atmosphere. We conclude that the capacitor type microphones should be selected for detecting infrasound signal at around 0.1 Hz for Martian exploration.

Keywords: Mars, Infrasound

