

UAV, UGV AIMING AT THE MOON AND MARS AIMING FOR ATMOSPHERIC OBSERVATIONS ON MARS

1stWataru Okamoto
 Institute for Space-Earth Environmental
 Research, Nagoya University
 Mars Society of Japan Moon Mobius

2ndTatsuki Horii
 AeroFlex Tsukuba University

Abstract- In recent years, there has been a growing interest in space development all over the world. Nearby stars such as the Moon and Mars will have manned spaceflights in the near future. Robotic exploration and construction will take place before humans actually go. Many shafts have been found on the Moon and Mars, and the first bases and cities will be built underground. Demonstration experiments will be conducted on Earth for robots that are active on the Moon and Mars.

MDRS (MARS DESERT RESEARCH STATION)

MDRS is a Mars simulation facility built in the desert of Utah, USA. Scientists and engineers from all over the world gather and stay for two weeks. Experiments of each theme, and exploration of the desert by the rover are carried out.

MDRS (Mars Desert Research Station)

MDRS is located about 11 km northwest of the city of Hanksville in Utah, USA, and it takes about 3-4 hours by car from the Grand Junction airport through the desert. It's right there. It has been operated by the American NPO "Mars Society" since around 2006, and research teams from various countries come every two weeks. We are conducting experiments on the theme that is an extension of our usual research.

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Okamoto and Venzha Christ, Director of the Indonesian Space Association, participated in the 2018 CREW191 Team Asia. Okamoto is conducting exploration by drone.

group with Japanese participants

Japanese have participated in MDRS several times in the past. Among them, Okamoto participated in CREW137 and CREW191. In CREW191, a film crew from the Japanese TV station NHK is also participating.

- 2014 "Team Nippon Crew 137"
- 2015 "Crew165"
- 2017 "Crew182"
- 2018 "Crew188"
- 2018 "Team Asia Crew191"

火星移住実験で過酷な生活 7人のリアルドキュメント

火星移住実験！クルー7人のリアルドキュメント

NHK 1.5チャンネル

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COLLECTION OF AEROSOLS BY DRONE

Mars has an atmosphere. 0.7% of Earth's atmospheric pressure. Measuring atmospheric conditions is essential for working on Mars.

Drone-mounted aerosol collector

The air is aspirated with an aerosol and passed through a sealed and sterilized filter (medical cleaning cotton) to collect fine particles. At this time, a suction device that achieves a large flow rate so as not to lose to the airflow of the drone is important.

Motor, Washing cotton Filter, Servomotor, Electric shutter (To prevent extra particles from entering during flight), Air, Suction device, Exhaust

A centrifugal fan with a diameter of 30 mm and 8 blades is rotated by a small BL motor (14000 rpm) to create powerful negative pressure.

Advanced UAV Research Project AeroFlex Representative Tatsuki Horii

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We used drones to collect aerosols. The collected aerosol was subjected to XAFS measurement at a synchrotron radiation facility (in this study, the Aichi Synchrotron Light Facility was used).

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AeroFlex 堀井樹代表とエアロゾル収集装置

AeroFlex公式ホームページ <https://horiiatatsuki.wixsite.com/webside>

This collection device can remotely control the collection time of the aerosol. Aerosol collection was performed at the "field burning site" conducted on January 23, 2022, in the vicinity of the Kogai River (downstream of Yamato Bridge, Joso City, Ibaraki Prefecture).



Two collection heights, ``15-20 ft'' and ``300 ft'' above the ground, were selected, and the aerosol collection was performed for 3 minutes at these positions. A cotton puff was used as a collection filter to collect the aerosol.

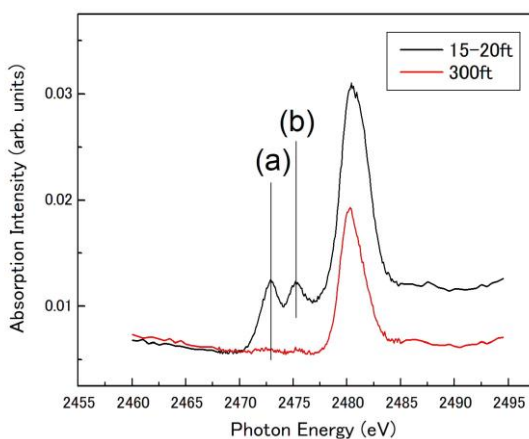
XAFS measurement @ Aichi SR_BL6N1 (He-path system)

Fluorescent X-ray
 Incident X-ray
 Measure the intensity of Fluorescent X-rays
 ↓
 Calculate absorption spectrum

- ◆ Attach up to 12 strip-shaped rubber samples
- ◆ Measured at atmospheric pressure with He path
- ◆ In-situ measurement by using a heating device

Capable of analyzing insulating samples and liquid samples:
 Capable of analyzing the chemical state of aerosols

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MARS DRONE

On April 19, 2021, NASA successfully flew a drone on a planet other than Earth for the first time in human

history. Ingenuity is the drone that arrived on Mars in the Perseverance rover.

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At the University of Tsukuba venture company AeroFlex, we received an order from JAXA in Japan and produced a Mars drone. Equipped with 6 propellers, the middle propeller is placed upside down.

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CAVES ON THE MOON AND MARS

In recent years, many vertical holes have been discovered on the Moon and Mars. Drones and rovers will be deployed to explore these holes.

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Shafts found on Mars Credit:

Vertical hole of Marius Hill- Vertical hole first discovered by KAGUYA (SELENE) -

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Since the moon has no atmosphere, either a rover-only probe or a rocket-powered UAV is conceivable.

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Trends in Mars Exploration

- Explore Mars and Moon shafts with UAVs and robots→ The world's first trial
- Mars exploration UAV researched by JAXA also aims to explore pits on Mars

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Demonstration experiments are being conducted by actually operating drones and rovers in vertical holes in various parts of Japan.

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Japan has many underground caves. We are exploring various caves for experimental purposes.

- 秋吉台国定公園 - UAV測量
- 大谷資料館 - UAV探査, UGV探査
- 石切山脈 - UAV測量
- 片島魚雷発射跡地 - UAV測量
- 千代ヶ崎砲台跡地 - UAV測量, UGV地下探査
- 野島砲台壕 - UAV探査, UGV探査

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STATE OF EXPERIMENT IN A CAVE

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 Wataru Okamoto, Tatsuki Horii

We are conducting experiments using drones and rovers in various parts of Japan. We are testing both standalone and coordinated exploration.

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Examples of UAVs and UGVs used in experiments

Ibis NEO
 Equipped with night vision camera

Cave Cat
 Small unmanned six-wheeled survey vehicle

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The Nojima Bunker in Yokohama has been tested many times this year.

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Joint UAV and UGV Exploration

- Exploration system that can "explore broadly and shallowly" at low cost is important
- Acquisition of topographical and surface environment data that cannot be obtained from the Mars Orbiter
- Mark the exploration location in advance

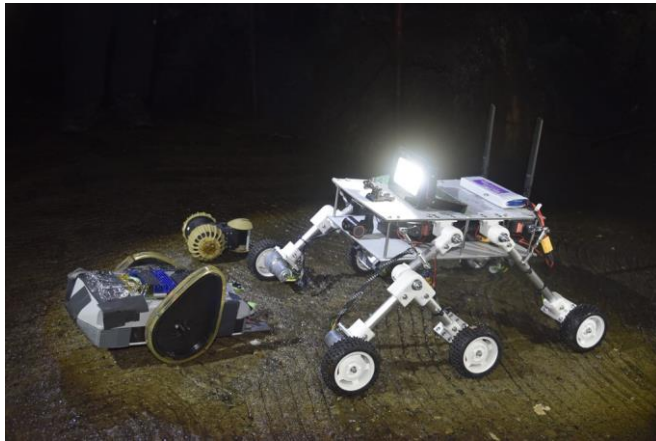
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Cave exploration flying robot [Colibri]
 Output of each motor when approaching the wall.
 Back calculation from this data to find the force acting on the airframe

- A rotor guard is installed as a safety device preparation
- For the purpose of floodlighting and ensuring visibility in the cave. Equipped with white blue high-brightness LEDs on the front and rear
- In the next stage, in a non-GPS environment inside the cave it performs RTL (autonomous cave exploration flying robot dynamic return) and autopilot only with a vision sensor.

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Rover Daimon Yaoki, which is participating in the experiment, will be launched this month. It will be Japan's first rover to go to the moon.

LANDING GEAR ON MARS

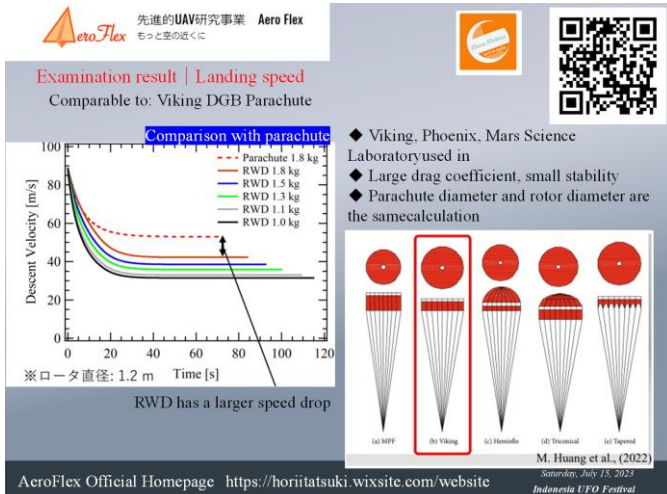
Here, we introduce a new landing gear that AeroFlex is developing.

Until now, landers have generally used parachutes.

Horii is developing a landing gear that applies the principle of helicopter autorotation.

It is easy to control the speed and position of the landing point.

In addition, there are scenes where the deceleration effect is more than the parachute.



On Earth, we are thinking of applying it to a probe that is dropped into a typhoon.

ACKNOWLEDGMENTS

We received a lot of support from JAXA and other universities and research institutes in Japan, as well as from the Indonesian Space Association. Thank you for your continued support. Let's go to space together.

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Hosted by the Former Naval Port City Japan Heritage Utilization Promotion Council

Former Naval Port Four Cities Naval Base Japan Heritage Symposium in Sasebo (Sasebo Civic Cultural Hall) March 20, 2023

• AGU 2022 iPoster

Air pollution collection and XAFS analysis by drone

Wataru Okamoto, Shinya Yagi 1), Tatsuki Horii 2)

1) Nagoya University 2) AeroFlex

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