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Development of mobile sensor for volcanic observation "HOMURA" and reports of test campaigns

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Monitoring of volcano near or inside active craters is very important in order to detect precursors of volcanic eruptions and understandings of eruption dynamics. At present, observations of active volcanoes, for example, by remote-controlled camera and some geophysical monitoring are carrying out. On the other hand, robots for volcanic exploration are also useful for flexible observation of volcanic activity that changes every moment.

We have been developed "mobile sensor for volcanic observation", which is a new robotic system that has been designed to observe volcanic phenomena inside active volcanic craters. We named it "HOMURA", which means flame in an old Japanese. HOMURA should be a practical robot for exploration of volcanic phenomena inside active vents. Then, we planned to develop a simple robot rather than an advanced robot with high technology. At present, we have completed a prototype of HOMURA. In this presentation, we show concepts and specification of HOMURA and results of test campaigns in volcanic fields.

We determined what HOMURA does for volcanic exploration as follows; HOMRA is controlled by a person from a rim of crater where we can safely approach, climb down the crater wall to the floor of the crater, and observe volcanic phenomena there by some sensors in it. We investigated some report of some robots that previously developed and recognize two important points to develop HOMURA. One is that HOMURA must not readily become immovable by trouble during a mission. Because a volcanic field is very harsh environment for a robot only to move there, the robot may fall down in climbing up and down a rough surface. Even in that case, the robot should be controllable. The other is that HOMURA can be made, transported to mission field, and used for volcanic exploration at small costs. The previous robots require high costs and have not been used for actual volcanic exploration. We developed HOMURA as a small unmanned ground vehicle on two lines "die-hard" and "cheap".

Specification of HOMURA is shown in the following. HOMURA with six wheels driven by electric motors is approx. 780 x 560 x 300 mm in dimension and 10 kg in weight. It can move for 1.5 hours with maximum velocity of 2 km/h and climb up and down a rough surface with slope angle of 30 degree. HOMURA has unique shapes of vehicle body and wheel. The vehicle body of aluminum with 2 mm thick has a shape with a horizontal symmetry plane. This body shape allows HOMURA to move even in overturning. The wheels of plywood with 9 mm have cog-like shape, which have good performance to move on a rough surface. HOMURA is operated by wireless remote control from a base station at a distance of more than 1 km. At the base station, we send commands of moving and measurement by sensors in HOMURA. Data measured by the sensors are sent back in real time. At present, sensors of camera, GPS, thermometer, infrared thermometer, and audio microphone are available. Expense of making HOMURA without sensors is less than 200, 000 yen. These allow us to make a new vehicle even if HOMURA should be lost by accident during missions. In addition, HOMURA can be transported by public traffic facilities

by one person. This contributes utility of HOMURA.

In test campaigns at Aso volcano and Izu-Oshima volcano, we examined abilities of HOMURA on climbing up and down rough surfaces, wireless remote control, and real-time sampling of data by sensors. As result, we confirmed that HOMURA has the above abilities in natural volcanic fields. We plan a further test campaign at Miyake-jima in March, 2010. Then, we will examine climbing up rough surface at a long distance (> 2 km) and climbing down from a rim of crater to inside of the crater.

Keywords: robot for volcanic observation, exploration inside crators, UGV, volcanic monitoring