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HOMURA: Development of mobile sensor for volcanic exploration

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Monitoring of phenomena near craters of active volcanoes is important to learn symptoms of volcanic eruptions and to understand eruption dynamics. At present, some devices such as crater camera, volcanic gas sensors, and seismographs that have been installed in a calm period of volcanic activity are monitoring volcanic phenomena near the craters. On the other hand, we cannot approach the crater and cannot install new devices after beginning of a volcanic eruption, even if we want to observe unexpected volcanic phenomena. Therefore, unmanned robots that observe them on an ad hoc basis are needed. Previously some projects have tried to develop robots for volcanic exploration. However, those projects which required large budgets ended before a practical application.

We hope to destroy the status quo and are trying to develop a practical unmanned-ground-vehicle-type robot for volcanic exploration that carries out monitoring near active craters. We named this system ”Homura”. Homura is controlled by wireless remote control, move in volcanic field, approach an active crater, monitor volcanic phenomena with sensors equipped in the vehicle, and send their data to the base stationin real time. In this presentation, we introduce a prototype of Homura and report a test campaign in Mihara-yama volcano, Izu-Ohshima.

Guidelines of development of Homura are two: (1) the vehicle does not readily become undrivable in volcanic fields, and (2) assemblage and use of Homura require low conts. We produced the prototype of Homura these guidelines. Homura is a six-wheeled vehicle with a vertically symmetric shape. Its size is 750 length x 430 width x height 310 height mm, its weight is about 12 kg. The power source is two-cell lithium polymer battery (7.4 V, about 250 Wh capacity). Some sensors such as camera, GPS, CO2 gas sensors are installed in the vehicle. Homura communicates with the base station by digital radio communication, and receives and send commands from base stations and data in real time. An installed small computer control all telecommunication, movement, and sensors. Production cost of vehicle is about 200,000 JPY, which is much lower than the robots developed in the previous projects.

Means of stable radio communication are needed for practical missions in volcanic field. Homura can use wireless transceiver modules that directly communicate with another module and Docomo FOMA modem using mobile phone network. The former wireless transceiver modules can be used in any volcanic field but distance between Homura and the base must be less than 1 km. The latter FOMA communication needs cell phone network. If the network is available, we can control Homura in any place.

We carried out a test campaign of Homura around Mihara-yama volcano, Izu-Ohshima in November, 2013 to examine remote control with FOMA communication. The base station was placed at Ohshima Spa Hotel which is about 2 km distant from the summit crater. Homura started Ohshima Spa Hotel. We controlled Homura only with information from sensors such as camera, GPS, and gyro. Homura moved on the mountain trail and reached the summit. Then, it climbed down on scoria slope without trail. This campaign result indicate that we can control Homura with remote control in volcanic fields. On the other hand, the radio communication with FOMA was not stable enough in Izu-Ohshima. At four areas where lava walls were barriers between Homura and a relay antenna of FOMA, the communication became unstable or disconnected. This indicates that we cannot move Homura to the summit only by remote control in Mihara-yama. When a UGV robot carries out missions in the volcanic field, we must obtain means of stable telecommunication before the missions. There are some cases where temporal stations of relay antenna are needed to use cell phone network.

Keywords: robot, Remote control, Telecommunication by cell phone, Izu-ohsima