Development of a Penetrator Probe Dropping from a UAV for Disaster Prevention

*Satoshi Tanaka[1], Hiroaki Shiraishi[1], Kei Shirai[1], Yoshiaki Ishihara[1], Ken Goto[1], Masahiko Hayakawa[1], Masanobu Ozaki[1], Takahide Mizuno[1], Kazuhiko Yamada[1], Hideki Murakami[2], Ryuhei Yamada[3]

1.Institute of Space and Astronautical Science, 2.Kochi University, 3.National Astronomical Observatory of Japan

We are developing a probe, so called “penetrator”, which can make geophysical observations by dropping from a UAV and penetrating into the ground from a UAV. This basic idea was originally developed by the lunar exploration mission “LUNAR-A”, and we re-designed it to use for earth observations.
The penetrator is attached to the UAV and will be transported to a disastrous or a dangerous area such as an active volcanic area, a landslide area and so on. The penetrator will be released at a target position at an altitude of one to several hundred meters. The probe will be penetrated at the velocity of several tens meters per second and fixed tightly into the ground. The probe can observe seismic events, precision position, inclination and other required observations and transmit the data via IRIDIUM communication system. The concept of the system is schematically shown in Fig.1.
We developed 1/4 scale size probe launcher and deploy 1kg penetrator monitoring acceleration and attitude during flight. The probe was attached to B-3M type UAV (Fuji-imvac co. Ltd: http://www.fuji-imvac.jp/product/index.html) and brought to a performance test on August and September 2015(Fig.2). The flight route and releasing point were programmed before taking off. We successfully released the probe at the altitude of 100m 300m and 500m respectively and the landing position were within the error of 20-30 meters The error may be caused by delay of the detection of the target position, and by the effect of wind while dropping the probe.
At the time of penetration, shock level of 3000 -4000G will be loaded to the probe. In order to ensure the shock durability, we selected commercial base products which seem to have tough structures, and we made some modification and replaced some parts as necessary. In this study, we planed to make geophysical observation sensors such as seismometer, infrasound microphone, GPS, and tilt-meter. We have completed shock proof tests for all the sensors and bus system, then we are now designing an integrate model of the probe with the weight of 9kg which will enable us to transport it at a distance of 100km.
We will make further experiments using a real size probe in the near future, and after that, we are planning to use the probe for real-time seismic observation of Nishinoshina-Shintou island (27N, 140E) where is it is prohibited to enter at 4km area from the island. The UAV will take off from Chichijima island and fly at a distance of 130km to the target area. We consider this system useful for the initial response action in the earliest stages.
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Keywords: penetrator, geophysical observations, disaster prevention

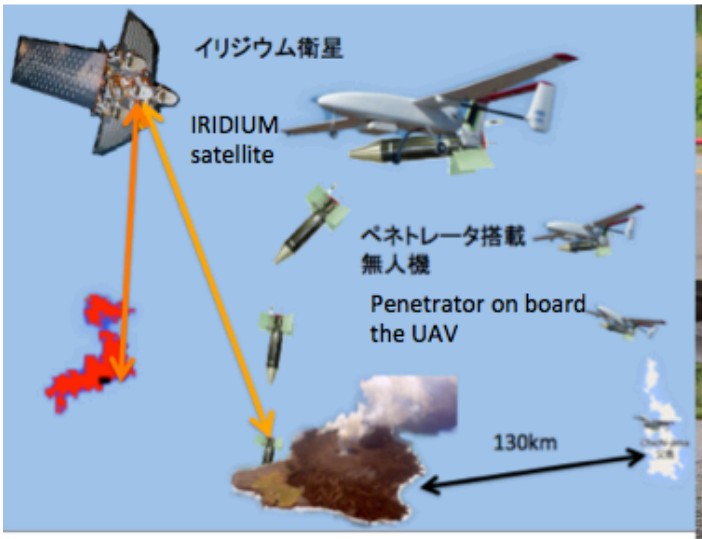

Fig.1

Fig.2

