Autonomous Telemetering System by using Mobile Networks for a Long-term Seismic Observation

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INTRODUCTION

When a large earthquake occurs, it is important to know the detailed distribution of aftershocks immediately after the main shock for the estimation of the fault plane. The large amount of seismic data is also required to determine the three-dimensional seismic velocity structure around the focal area. We have developed an autonomous telemetry system using mobile networks, which is specialized for aftershock observations.

FEATURES

Because the newly developed system enables a quick installation and real-time data transmission by using mobile networks, we can construct a dense online seismic network even in mountain areas where conventional wired networks are not available. This system is equipped with solar panels that charge lead-acid battery, and enables a long-term seismic observation without maintenance. Furthermore, this system enables a continuous observation at low costs with flat-rate or prepaid Internet access. We have tried to expand coverage areas of mobile communication and back up Internet access by configuring plural mobile carriers.

SPECIFICATIONS

A micro server embedded with Linux consists of automatic control programs of the Internet connection and data transmission. A status monitoring and remote maintenance are available via the Internet. In case of a communication failure, an internal storage can back up data for two years.

The power consumption of communication device ranges from 2.5 to 4.0 W. With a 50 Ah lead-acid battery, this system continues to record data for four days if the battery charging by solar panels is temporarily unavailable.

Table 1. Armadillo-420 (Atmark Techno)

CPU	Freescale i.MX257 400MHz
Memory	64MB LPDDR SDRAM, 16MB NOR FLASH
OS	Linux (Kernel 2.6)
Distribution	Debian/GNU Linux, Atmark Dist
Clock	RTC with backup battery
Storage Media	microSD (4GB - 32GB)
Interface	Ethernet(100BASE-T), RS-232C, USB2.0×2
Power	DC3.1 - 5.25V (1.2W)
Temperature	-20 - +70 C
Size / Weight	88 x 58 x 24.3mm / 66.47g

Table 2. LS-7000XT (Hakusan)

Channel	6
Input Range	±10V, ±1V
Sampling	200Hz, 100Hz, 50Hz, 1Hz
Resolution	24bit
Time Calibration	GPS (Continual, Interval)
Data Format	WIN Format
Storage Media	Compact Flash (48MB - 2GB)
Interface	Ethernet (10BASE-T), RS-232C
Power	DC12V (1.2 - 2.52W)
Temperature	-20 - +50 C
Size / Weight	155 x 187 x 56mm / 960g

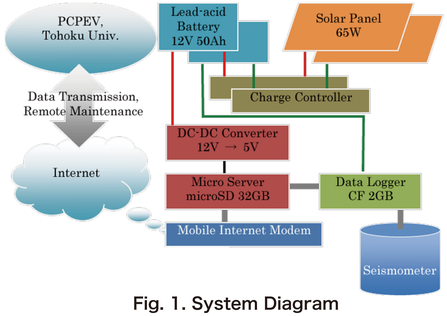

Fig. 1. System Diagram

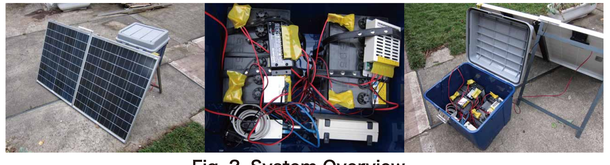

Fig. 2. System Overview

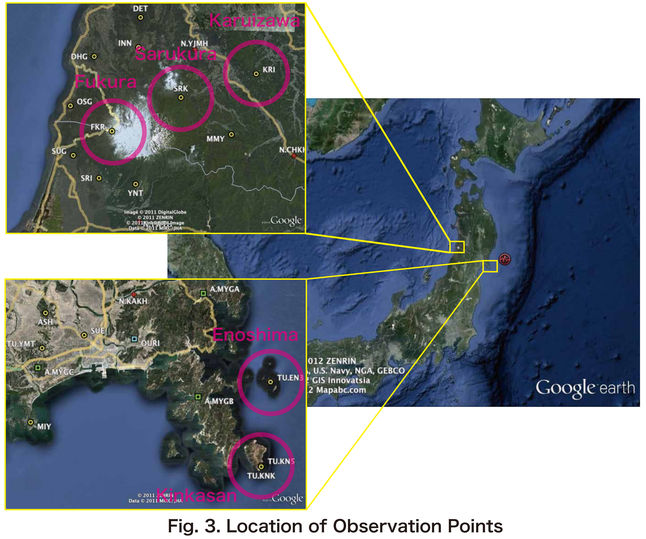

Fig. 3. Location of Observation Points

INSTALLATION

Immediately after the 2011 off the Pacific coast of Tohoku Earthquake, data transmission from Enoshima and Kinkasan islands stopped because of a power failure and a land-line failure. Our system is used to recover and backup the Internet connection. In Mt. Chokai area, Sarukura, Karuizawa and Fukura observation points are outside of the ISDN and ADSL service area. Our system is also used to expand the coverage area of Internet connection.

Table 3. System Equipments and Operationg Period

Observation Point	Mobile Internet Modem	Micro Server	Data Logger	Operating Period
Enoshima (TU.EN3)	NTT docomo L-05A(LG)	Armadillo-420	LS-7000XT	18 Apr. 2011 - In Operation
Kinkasan (TU.KN5)	NTT docomo L-05A(LG)	Armadillo-420	LS-7000XT	9 Sep. 2011 - In Operation
Sarukura (SRK)	KDDI au W05K (Kyocera)	Armadillo-420	LS-7000XT	6 Sep. 2011 - In Operation
Karuizawa (KRI)	KDDI au W05K (Kyocera)	Armadillo-420	LS-7000XT	6 Sep. 2011 - In Operation
Furkura (FKR)	NTT docomo L-05A(LG)	Armadillo-420	LS-7000XT	19 Oct. 2011 - 2 Nov. 2011

Fig. 4. Enoshima (Onagawa, Miyagi)

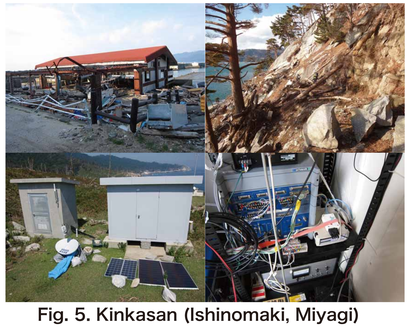

Fig. 5. Kinkasan (Ishinomaki, Miyagi)

Fig. 6. Sarukura (Yuri-Honjo, Akita)

Fig. 7. Karuizawa (Yuri-Honjo, Akita)

Fig. 8. Fukura (Yuza, Yamagata)

SUMMARY

We have developed an autonomous telemetry system using mobile networks which enables an online seismic observation and a long-term data backup at the time of emergency. We are planning to upgrade the stability of DC-DC converter and support newer mobile Internet modems.

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