

Development of Artificial Geomagnetic Disturbances Monitoring System

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Abstract

The performance of geomagnetic field measuring instruments is quite good now. However, our life styles are changing with urbanization, and sometimes this has a bad influence on the environment of observations. Vehicles which run near an observation point are especially troublesome, making it difficult to keep the progress of data quality. We aimed to build a system to monitor artificial disturbances, to be completed in 2006. Using this system, we expect to obtain more accurate analytical results.

1. Introduction

A fundamental algorithm which estimates artificial geomagnetic disturbances by several geomagnetic measurement devices has been developed last year. Meanwhile, artificial geomagnetic disturbances caused by magnetic bodies, such as automobiles or buildings, can be virtually considered as one magnetic dipole moment. So, a real-time artificial geomagnetic disturbance monitoring system can be constructed combining real-time magnetic data recording systems, such as the Automatic Observation System of Kakioka Magnetic Observatory. The monitoring system analyzes the position and magnitude of the magnetic moment, and gives useful information whether geomagnetic disturbances exist or not.

However, it is more difficult to analyze a momentarily changing magnetic moment by varying geomagnetic disturbances caused by a moving automobile. We have a plan to add an equipment which locates the automobile's passing at a fixed point in this system. It also seems important to review what is the most efficient arrangement of a restricted number of observation instruments. This system will make us look for-

ward to get more accurate analytical results. This system is going to be built in 2006. We will outline it below.

2. Estimate of Disturbance Quantity and Arrangement of Survey Points

The arrangement of survey points is important in order to get a disturbance source efficiently with a limited number of magnetometers. In the past, a lot of disturbances occurred from automobiles which run at the road in the observatory east side. For example, the estimated quantity of the influence in each survey point in such a case is shown in Fig. 1. The track where the car passes to the south from the north is shown by the black thick line on the map. In this case, it is barely possible to detect it in point F3, and is very difficult in point F4.

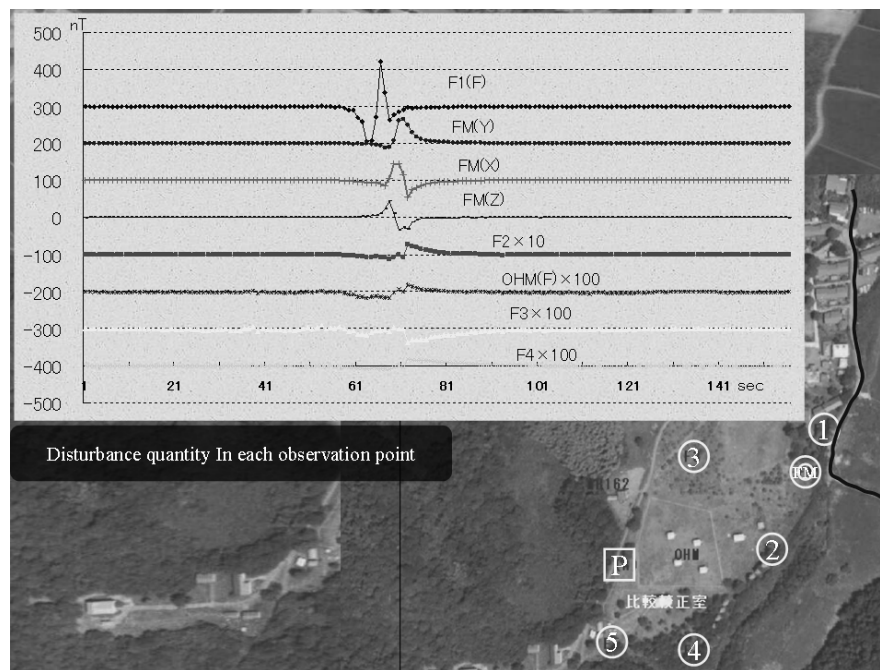


Fig. 1. Disturbance quantity in each observation point.

As a result, we considered the following factors as decisive in the arrangement:

- The disturbance quantity is larger than the measuring noise level.
- The disturbance period is expected to be longer than several seconds.
- The change is expected to appear at more than one component or point.
- The change appears clearly in each component of the fluxgate magnetometer.
- The disturbance area is not as wide as the vehicle.

This year we were mainly concerned with detection of the disturbance sources around the southeastern area of the observatory.

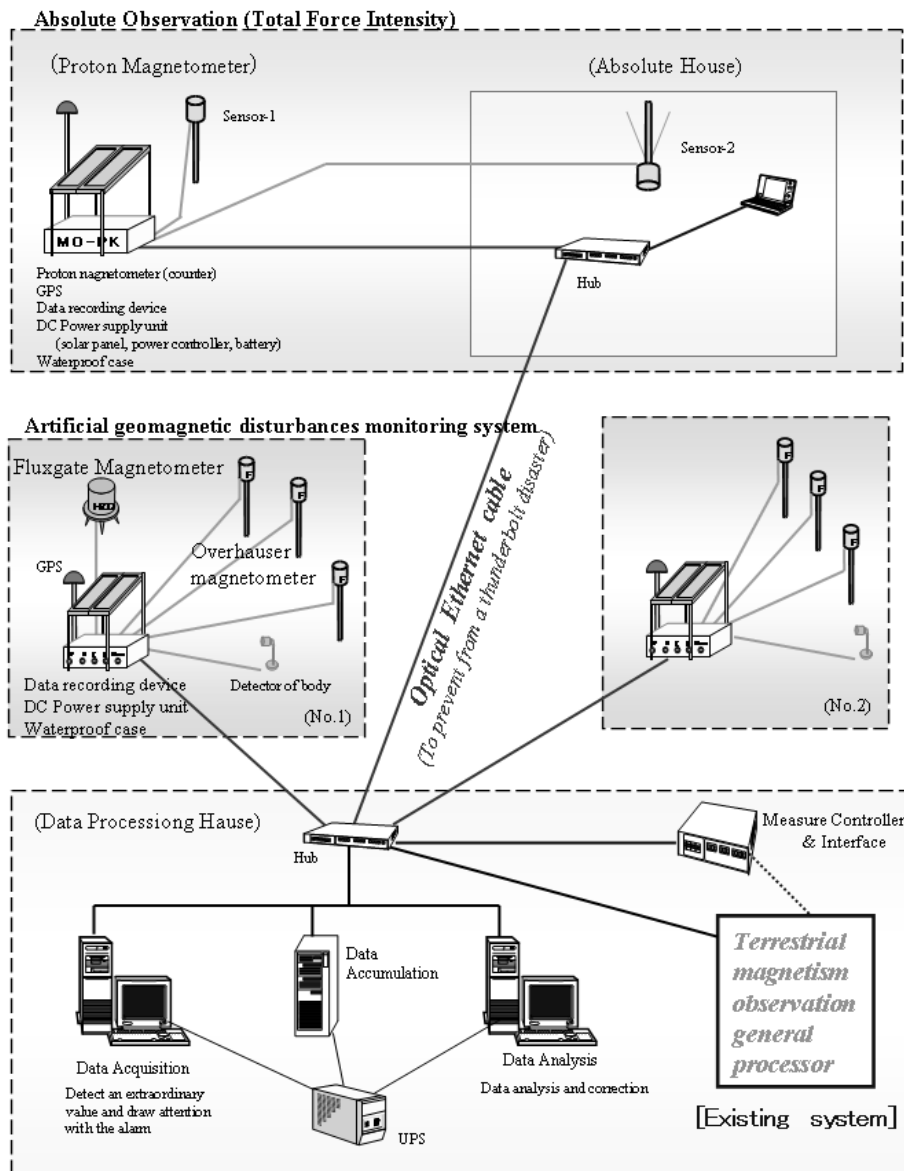
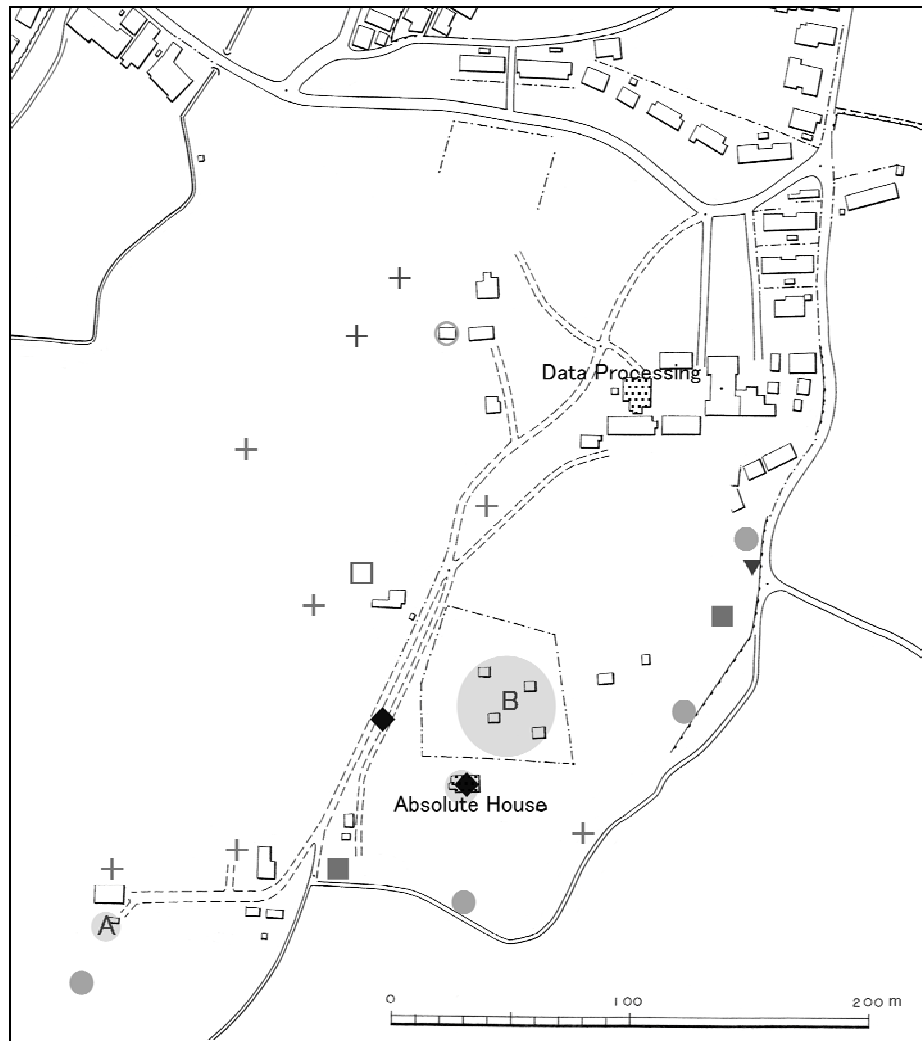


Fig. 2. The equipment composition.

3. Equipment

The system is composed of the following equipment (Fig. 2):

- Proton magnetometers: 2 sets.
- Fluxgate magnetometers (X, Y, Z): 2 sets. This includes an inclinometer of the sensor X, Y and a thermometer (sensor and amplifier circuit).
- Overhauser magnetometers (F): 4 sets (It is possible to extend it to 6 sets).



Sign	Magnetometer	Component	Resolution	Sampling
A	Fluxgate magnetometer	H Z D	0.01nT	1s
B	Overhauser magnetometer	F H Z D	0.01nT	1s
◆	Proton precession magnetometer	F	0.01nT	5s-60s
●	Overhauser magnetometer	F	0.01nT	1s
■	Fluxgate magnetometer	H Z D	0.01nT	1s
▼	Moving object detection device	On/off		1s
○	Overhauser magnetometer	F	0.01nT	1s
□	Fluxgate magnetometer	H Z D	0.01nT	1s
+	Repeat observation point	F	0.1nT	1s

Fig. 3. Arrangement of observation points.

- Moving object detection device: 1 set (It is possible to extend it to 2 sets). The detector of bodies uses supersonic wave Doppler method. Provided that the neighborhood residents' privacy is not violated, it is possible to think about changing to a CCD camcorder in the future.
- Data recording and control interface devices: 2 sets. This includes a backup storage (Compact Flash Memory card).
- Power supply (solar panel and battery, deep cycle type): 3sets.
- Optical Ethernet cable (LAN).
- GPS.

The arrangement of observation points is shown in Fig. 3. To prevent a disaster by thunderbolts, the instruments are driven by a solar battery DC power supply. Also, for similar reasons, each signal is exchanged by LAN which uses optical Ethernet cables.

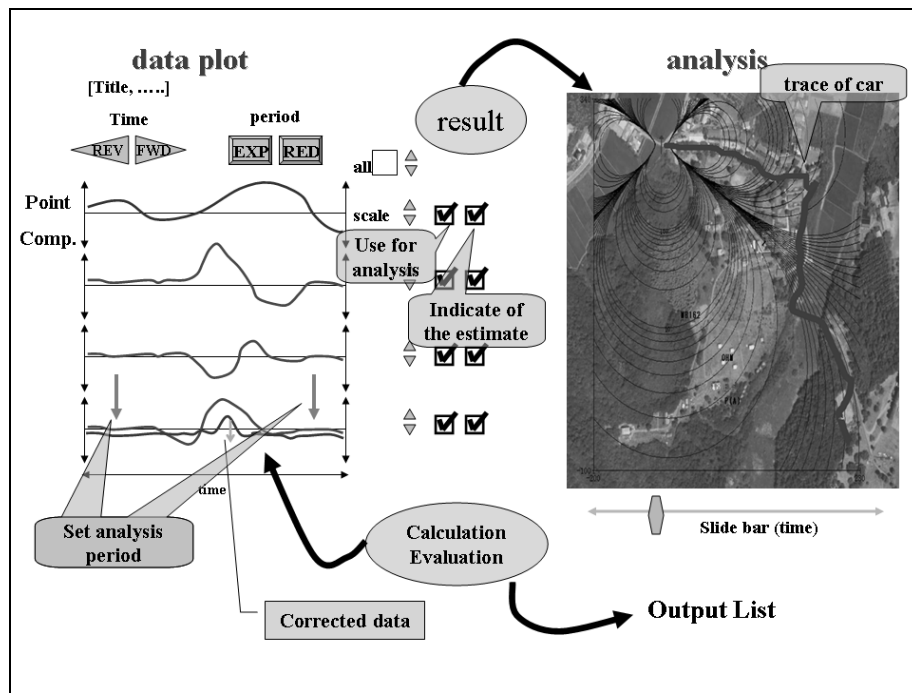


Fig. 4. Analysis process.

4. Monitoring and Analysis

The system has the following purposes:

- Watching whether the regular observation point receives an artificial disturbance or not.
- Alarm of the artificial disturbance occurrence by a real-time process.

- Analysis of size and position of the magnetic dipole moment of a source.
- Correction of the regular observed value.

The process of analysis gives a big load to the computer. Therefore, as a pre-treatment of the analysis, it is realistic to make a judgement using a comparison between survey data and some reference data. Next, the interactive process is calculated and the quality of the regular observed value is improved (Fig. 4).

Such high quality terrestrial magnetism observations may be useful in the study of volcanism, seismic activity prediction, the study of magnetosphere disturbances related to solar activity, and so on.

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