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Positional Coordinate Display Technique for Geostationary Satellites and Position Coordinate Display System Based on Developed Technique

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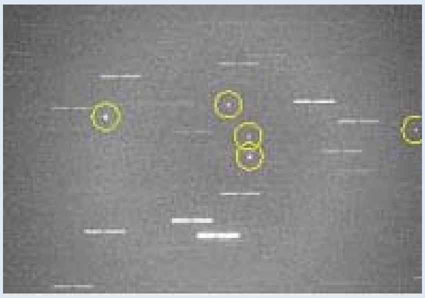

Optical image data of geostationary orbit
(The geostationary satellites are enclosed in circles.)

Overview of technology

The technique of this invention photographs satellites in geostationary orbit together with fixed stars using a telescope, rendering it easy to find the longitude and latitude of a sub-satellite point of a geostationary satellite, based on the positions of the fixed stars. The image of a geostationary satellite taken by a camera attached to a fixed telescope with the shutter opened for several seconds appears as a dot because the satellite appears stationary, as its name indicates. On the other hand, fixed stars appear as lines in the longitudinal direction due to the rotation of the earth (Fig. 1). This photograph and the data on the direction and time of the photograph are used to identify the fixed stars and to determine the apparent right ascension and declination. The right ascension and declination coordinates are then constructed on the photograph. Then, by calculating the true right ascension and declination via coordinate conversion and by calculating the central position of the geostationary satellite photographed as a point, we can find the precise position of the satellite. Here the precision of the time at which the shutter is opened and closed has a direct effect on the precision of observation. Thus, we need to ensure precise timing using a GPS or other method, and we also need to ensure precision in the shutter control system and other equipment. Although the data can only be measured at night in clear weather, we can acquire the right ascension and declination at a precision one order of magnitude higher than positional measurement with a parabolic antenna. The resultant data, observed and calculated at high precision, can be used to determine the orbit of a geostationary satellite, if taken over two or more days at intervals of several hours at night.

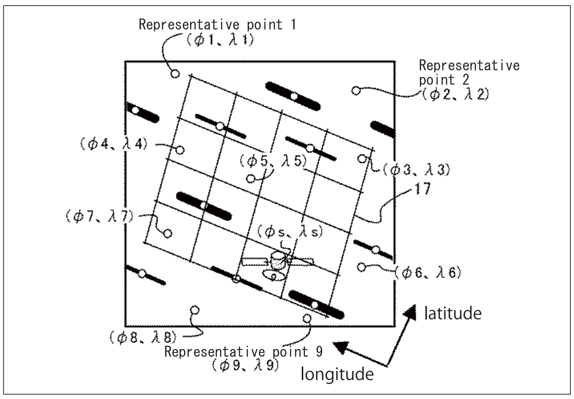

Fig.1 Image of geostationary satellites and fixed stars

Practical operation

Fig.2 Optical telescope with 35-cm diameter (The square box in the upper right of the photograph is the cooled CCD camera.)

The Kashima Space Research Center performs near-continuous observation of near-geostationary orbits based on this method using an optical telescope (Fig. 2). The Center has accumulated positional data for geostationary satellites and published a portion of the acquired data. However, this sort of observation is extremely labor-intensive if operated in a purely manual manner. To begin with, optical observation is only possible at night and in clear weather. It is not efficient to have operators wait through the night when they will have no idea as to whether and when the weather will clear. The Kashima Space Research Center performs unmanned night observation by fully automating the observation sequences, including weather survey and control of the telescope and camera, including the components described in the overview of the invention. Of course, all procedures associated with this invention are also automated, including the identification of fixed stars and geostationary satellites in the observed image and the final calculation of the right ascension and declination of the geostationary satellites.

The Kashima Space Research Center observes approximately 50 geostationary satellites, including those operated by Japan (approximately 20 satellites) and those operated by other countries. When we include satellites that no longer provide services, approximately 80 objects in near-geostationary orbits are targets of observation. When we observe near-geostationary orbits, we view many objects crossing the equator. Most of them are discarded satellites and their remains, referred to as space debris. In a geostationary orbit, objects remain in orbit even when they stop functioning, leading to a continuously increasing amount of space debris. Sometimes this debris leads to near-miss incidents with operating satellites. As these discarded satellites stop radio waves, optical observation is essentially the only method of observation. The Kashima Space Research Center has observed near-geostationary orbits (from longitude 80˚E to 160˚W and latitude of $\pm 0.5^\circ$) where observation is possible, and has also performed specific observations for events such as satellite launches into geostationary orbit. As two telescopes are now available, we plan to perform regular observations of near-geostationary orbits process the data, and publish all such data in the future.

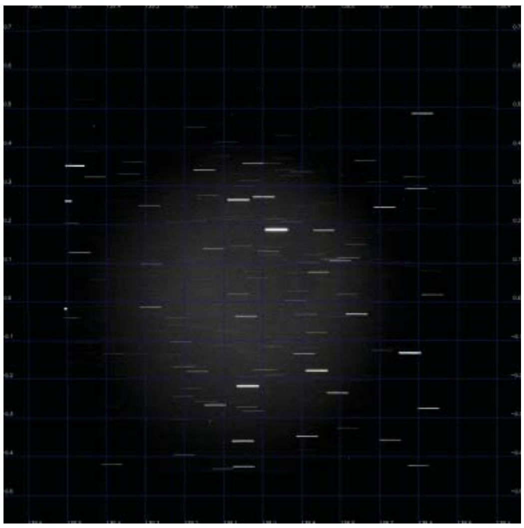

Fig.3 Geostationary satellite image data (Image data from November 30, 2006)

Data provided

We provide the images observed by the Kashima Space Research Center, from which accurate satellite positions can be read, to companies that operate and manage satellites. This service is provided on a fee basis. If you would like to receive images, please contact us as indicated below. A sample image (Fig. 3) is available at the URL below. We encourage you to view the crowded geostationary orbit.

Geostationary satellite image is provided at
http://www2.nict.go.jp/w/w122/control/geoscale/geoindex-j.html

(Article written by SAWADA Fumitake , Expert, Intellectual Property Management Group, Research Promotion Department)

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