STUDY ON THE GRID REFERENCE SYSTEM FOR KOMPSAT- 3 IMAGERY

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ABSTRACT: The Grid Reference System, which was firstly used in SPOT series, has been successfully adapted in KOMPSAT-1 and KOMPSAT-2 program, which identifies the geographical location to make image collection plans and manage the database of satellite images. Each Grid Reference System for KOMPSAT-1 and KOMPSAT-2 was designed based on system parameters related to each KOMPSAT-1 and KOMPSAT-2 and this fact leads to the need for the design of the Grid Reference System for KOMPSAT-3 (KGRS-3, hereafter), which reflects system parameters for KOMPSAT-3. The (K, J) coordinate system has been defined as the Grid Reference System for KOMPSAT-3 using heritages from KOMPSAT-1 and KOMPSAT-2 programs. The numbering of K begins with the prime meridian of K = 1 with running eastward on earth increasingly, and the numbering of J uses a value of J = 1000 at all points on the equator and begin with running northward increasingly. The Grid Reference System for KOMPSAT-3 is to be implemented in Ground Segment of KOMPSAT-3 system.

KEY WORDS: Grid Reference System, KOMPSAT-3

1. INTRODUCTION

The Grid Reference System (GRS hereafter), is mainly used for telemetry stream segmentation into scenes, organization and the indexing of scenes stored in catalogues, accessing catalogues and the ordering of satellite images, image collection planning, managing database of satellite images (Kim & Benton, 1998). The grid is made up of nodes located at the intersection of columns K and rows J. After image strips are transferred from a satellite to image receiving & processing system, they are split into scenes, which are linked with (K, J) designators representing a node on the GRS. So, each scene can be identified by a column number K and a row number J of GRS. But in the case of oblique viewing, the center of a scene does not normally coincide with the GRS nodes. Scenes that are acquired in oblique viewing mode are identified by the (K, J) designator of the node closest to the center of a scene.

In cases of KOMPSAT-1 and KOMPSAT-2 programs, each GRS was generated based on each system parameters such as mission orbit, imagery parameters and earth model. This fact leads to the need for the GRS for KOMPSAT-3. So, the GRS for KOMPSAT-3 has been designed to meet its goal. The derivations in the following sections are based on several parameters with few assumptions. In this paper, mid-latitude area, where Korean Peninsular is located, is considered as the reference for generating optimized GRS for KOMPSAT-3.

2. DESIGN OF GRS FOR KOMPSAT-3 IMAGERY

The GRS for KOMPSAT-3 imagery has been designed with KOMPSAT-3 parameters, earth model and GRS design parameters. KOMPSAT-3 parameters mainly consist of KOMPSAT-3 mission orbit parameters and imagery parameters. The mission orbit of KOMPSAT-3 is assumed to be the same as that of KOMPSAT-2. But the standard scene for KOMPSAT-3 imagery, which is the imagery parameter, is assumed to have the size of 15km×15km, which mainly leads to the new feature of the GRS for KOMPSAT-3 compared to that for KOMPSAT-2. This kind of information has an effect on horizontal and vertical spacing between nodes of the GRS.

2.1 Design Parametes

Table 1. Design Parameters for the GRS for KOMPSAT-3 Imagery

Parameters		Value
Mission Orbit Parameter	Inclination	98.127°
	Eccentricity	0.0
	Repeat cycle	409
	Mean Motion	14.624924
Scene Parameter	Standard Scene Size	15km×15km
Earth Model	WGS84	
GRS design Parameter	Longitude for K=1	0°
	J in the equator	1000
	J increase	Running Northward
	Effective Latitude	-80°~80°
	Reference Latitude	38°N

Table 1 shows overall parameters used in the design of the GRS for KOMPSAT-3. Actually, the design of the GRS for KOMPSAT-3 is to divide the earth into sections which are defined as [K, J] and have appropriate size considering the standard scene size of KOMPSAT-3 imagery. To define [K, J] coordinates on earth, it is necessary to determine the spacing between adjacent GRS nodes in both K and J direction. This kind of information is to be derived using mission orbit parameters, scene parameters and earth model.

2.2 Determination of the spacing between adjacent Js

The spacing between adjacent Js is defined as the spacing between adjacent Js in along track direction of KOMPSAT-3 trajectory. Since the scene parameter defines the standard scene size for KOMPSAT-3 imagery, the spacing between adjacent Js is designed not to exceed the height of the standard scene to be acquired. The spacing between J tracks is determined from the equation 1.

$$Spacing(J) = \frac{180^\circ \cdot \text{Image Height}}{R_{eq} \cdot \pi} \quad (1)$$

As a result, the spacing between adjacent Js is determined to have the value of 0.134747°.

2.3 Determination of the spacing between adjacent Ks

The spacing between adjacent Ks is defined as the spacing between adjacent Ks on the reference latitude along the direction parallel to the equatorial plane. For this, the spacing between adjacent Ks in equatorial plane is to be determined from the equation 2.

$$Spacing(K) = \frac{2\pi}{\text{Re}\,peat\ Cycle \cdot \left[\frac{1}{R_{eq}^2} + \frac{1}{R_{pol}^2} * \sin(\varphi_{geocentric})\right]^{1/2}} \quad (2)$$

Where $\phi_{geocentric}$ is the latitude in geocentric coordinates and can be calculated using the equation 3.

$$\phi_{geocentric} = \tan^{-1}\left(\frac{\tan(\phi_{geodetic})}{\left(R_{eq}^2 / R_{pol}^2\right)}\right) \quad (3)$$

The spacing determined from the equation 2 & 3 is about 77km on earth. This fact leads to the need for defining sub-tracks in adjacent Ks considering the size of the standard scene of KOMPSAT-3. The number of sub-tracks in adjacent Ks is to be determined from the equation 4.

$$No.\ of\ sub\text{-}tracks = \text{CEIL}(Spacing/\ scene\ width) \quad (4)$$

Finally the spacing between adjacent Ks, including sub-tracks inside the adjacent Ks, is to be determined from the equation 5.

$$Spacing = 2\pi / (repeat\ cycle \cdot No.\ of\ sub\text{-}tracks) \quad (5)$$

In this paper, the spacing between adjacent Ks is determined to have the value of 0.14669927° at Reference Latitude.

3. EXPRESSING GEOGRAPHIC COORDINATES IN TERMS OF GRS DESIGNATORS

3.1 Latitude of node [K, J]

The geodetic latitude is to be calculated using J index of the GRS for KOMPSAT-3 from equation 6 & 7.

$$\Phi = \tan^{-1}\left(\left(R_{eq}^2 / R_{pol}^2\right) \cdot \tan\Psi\right) \quad (6)$$

Where

$$\Psi = \varepsilon \cdot \sin^{-1}(\sin(inclination) \cdot \sin(Spacing(J) \cdot r))$$
$$r = |J - 1000|,\ \varepsilon = \frac{J-1000}{r} \quad (7)$$

Where ε=1 if J =1000.

3.2 Longitude of node [K, J]

The geodetic longitude is to be calculated using K index of the GRS for KOMPSAT-3. Considering that there is a nodal elongation according to the earth's rotation, the calculation process is divided into 2 steps. The first step is to calculate the longitude in the equator using K index. The second step is to calculate the amount of nodal elongation according to the latitude and compensate it to derive actual longitude.

Firstly, the longitude in equator is to be calculated from equation 8.

$$\Lambda = \Lambda_1 + Spacing(K) \cdot (K-1) \quad (8)$$

Where Λ_1 is the longitude for K=1.

The longitudinal offset arisen from the nodal elongation can be is to be calculated from equation 9.

$$\Delta\Lambda = \sin^{-1}\left(\frac{\cdot \tan\Psi}{\tan(inclination)}\right) - \frac{\omega}{meanmotion} \quad (9)$$

Where ω, the nodal elongation, is defined as equation 10 and is to be measured from the equator assuming that KOMPSAT-3 payload is imaging targeting in the nadir direction.

$$\omega = \tan^{-1}\left(\frac{\sin\Psi}{\sin(inclination)}\right) \quad (10)$$

Finally the longitude is to be calculated from equation 11.

$$\Lambda_T = \Lambda + \Delta\Lambda \quad (11)$$

4. EXPRESSING GRS DESIGNATORS IN TERMS OF GEOGRAPHIC COORDINATES

4.1 K of [Lat, Lon]

The K index is to be calculated from equation 12.

$$K = ROUND\left(1 + \frac{\Lambda_T}{Spacing(K)}\right) \quad (12)$$

4.2 J of [Lat, Lon]

The J index is to be calculated from equation 13.

$$J = 1000 + ROUND\left(\frac{\omega}{Spacing(J)}\right) \quad (13)$$

Where ω is the nodal elongation to the target position.

5. RESULT

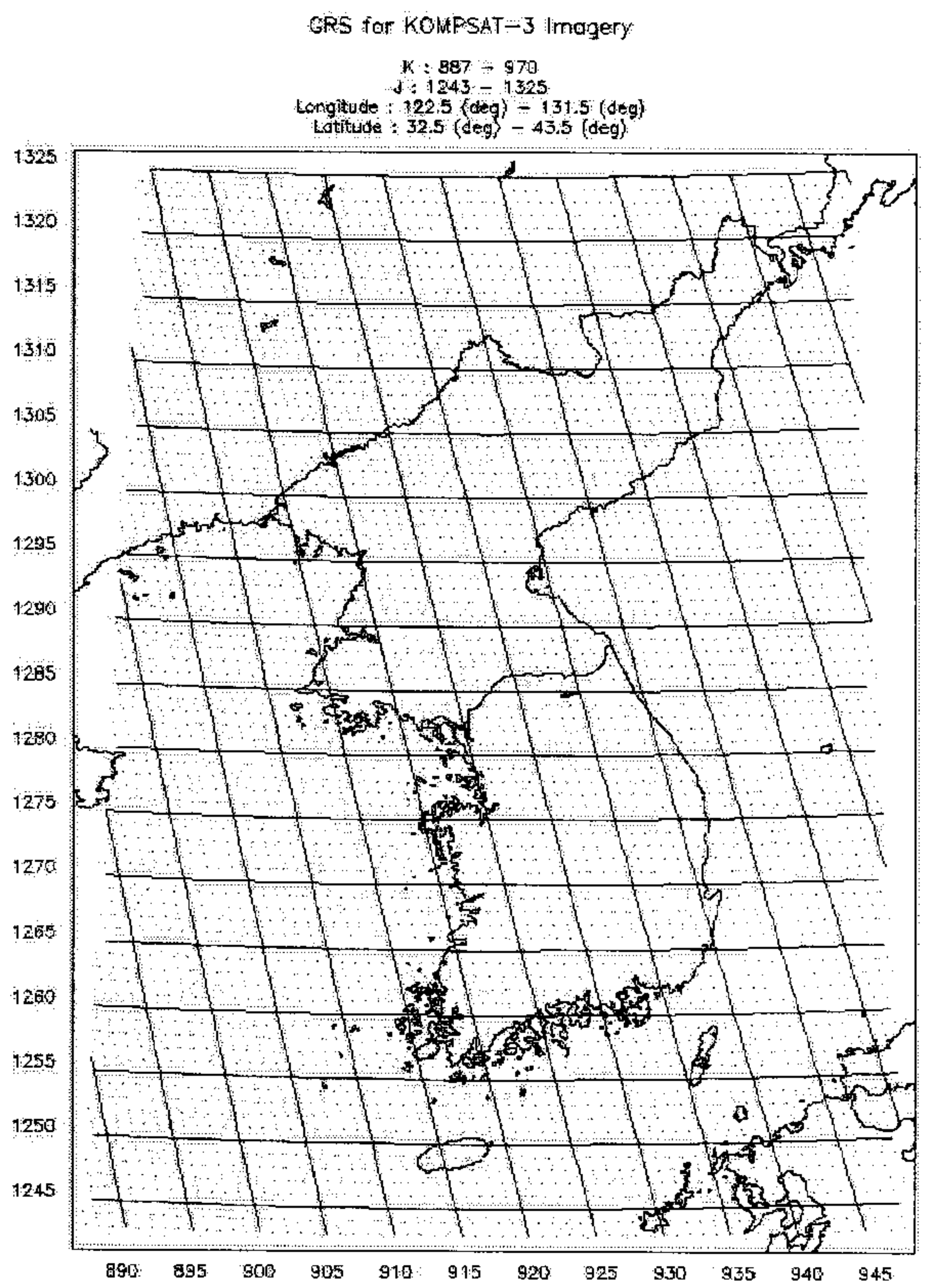

Fig. 1. GRS for KOMPSAT-3 Imagery

Figure 1 shows GRS for KOMPSAT-3 imagery near the Korean Peninsula. It is found that the Korean Peninsula is positioned on the GRS for KOMPSAT-3 in the following GRS range.

$$905 \leq K \leq 965$$
$$1243 \leq J \leq 1325$$

Meanwhile, range of [K, J] over the world is as follows.

$$1 \leq K \leq 2454$$
$$407 \leq J \leq 1593$$

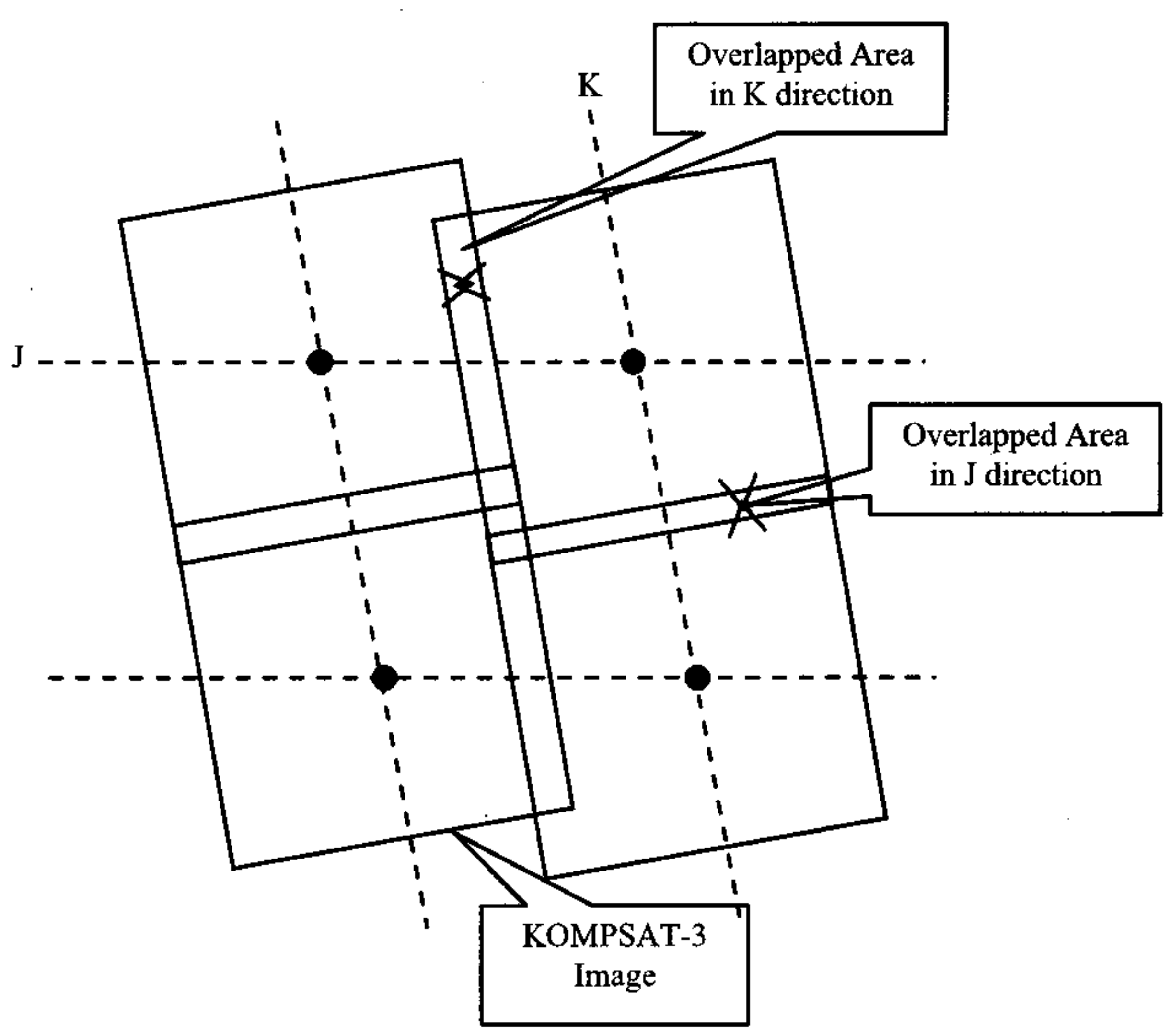

Fig. 2. Overlapped Area between adjacent GRS nodes

Figure 2 shows the overlapped scene between adjacent GRS nodes. The distance between adjacent GRS nodes near the Korean Peninsula is to be calculated using results from 2.2 and 2.3 as follows.

Distance between adjacent J's ≅ 14.98 km
Distance between adjacent K's ≅ 12.89 km

6. CONCLUSION

In this paper, GRS for KOMPSAT-3 imagery has been designed. The GRS for KOMPSAT-3 is to be used in identifying the geographical location to make KOMPSAT-3 image data collection plans and/or manage database of KOMPSAT-3 satellite images. The GRS for KOMPSAT-3 is to be implemented in the Image Receiving and Processing System for KOMPSAT-3 system.

REFERENCES

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