A SYSTEM FOR MAPPING THE EARTH'S SURFACE USING A LINE-BY-LINE CONVERSION DEVICE

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A system has been described for mapping the Earth's surface by means of a line-by-line light-sensing converter based on charge coupling devices (CCD); the principal problems associated with the operation of this system in the real time scale have been considered.

Recently, almost exclusive use has been made of light sensors with charge coupling devices (see [1,2]) in order to map the Earth's surface. The reason for this lies in the high resolving power associated with a large number light-sensing points in a line, the geometric accuracy with which the light-sensing film is positioned in accordance with monolithic production technology, the wide dynamic range of the sensor, the broad spectral range which reaches the infrared region, the small mass and size of the sweep device, and also the high immunity against external magnetic fields.

Light-sensing line pickups of the CCD type operate on the accumulation principle. During a specified time (the accumulation or integration period), their light sensing elements accumulate a light energy corresponding to the optically swept pattern and convert it into an equivalent electronic charge. After completion of the period t_{int} of integration, the charges from all of the light-sensing points are simultaneously transferred to analog shift registers, and a new integration period begins. The charges located in the analog shift registers are sequentially transferred to a charge detector which converts them into voltage levels for further processing.

In line-by-line light-sensing structures, the creation of a two-dimensional video signal corresponding to the planar projection of the Earth's surface onto the plane of the sweep device requires the formation of a raster sweep (Fig. 1). In order to obtain a geometrically undeformed sweep in the y direction it is necessary to ensure that the swept bands of the raster follow continuously one after the other. For a constant flight speed v_y and a constant relative altitude h of the aircraft above the mapped surface, the individual bands of the raster will be situated at a mutual distance of

$$D = v_y t_{\text{int}} \tag{1}$$

and their continuous succession requires the condition d = D. The width of the swept band for the condition requiring a square shape of the elementary video points of the line sensor L = nd, where n is the number of light-sensing points in the line; hence d = L/n. From Fig. 1 it follows that

$$\text{tg}\,(\varphi/2) = L/2h, \tag{2}$$

while from Eqs. (1), (2) we derive the desired integration time $t_{\text{int}} = ((2\ \text{tg}\ (\varphi/2))/n)\,(h/v_y)$.

It is clear that in order to satisfy the condition for continuous succession of raster bands for a recording device having a specified number of light-sensing elements, the integration period t_{int} = const only in the case of a constant h/v_y. The required line-mapping frequency s is inversely proportional to the integration time $s = t^{-1}_{int}$, therefore

$$s = (n/(2\ \text{tg}\,(\varphi/2)))\,(v_y/h).$$

The constancy of the ratio v_y/h cannot be sufficiently guaranteed. In order to prevent geometric deformations of the swept pattern which are caused by changes in flight speed and altitude of the aircraft, it is

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