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NASA TECH BRIEF

Ames Research Center

Planet Geometric Center Tracker

A new tracker, designed to locate the geometric center of planets, has an angular accuracy on the order of 1 arc-second. By suitable optics, the image of the planet is projected onto an image dissector tube. The output signal is processed by electronic circuits. The tracker uses a spiral scan in the "search mode" to find the planet, then switches to the "track mode" which utilizes a roulette-type pattern having (n-1) or 11 small loops and constrained to be circular. In the track mode, an f_o/p slither modulation is used to allow tracking on the true center of the planet rather than on the center of the illuminated area.

The planet tracker operational mode was optimized by a computer analysis which involved the output amplitude of the f_o and $(n-1)f_o$ harmonics as a function of decentration in the x and y axes. When a planet with $a/b = 0.6$ on the f_o harmonic is plotted to include phase transformation and the outputs of 0° and 90° phase detectors, the familiar S-shaped response results. A null occurs at y 0, x -1.5 du (decentration unit; 1 du = 0.1 planet radius) for $a/b = 0$. The worst case would be for a/b 0, where $y = 0$, $x = -2.5$ du.

Therefore, to achieve higher accuracy, an f_o/p slither modulation is added to the scan. This results in the modulation of the $(n-1)f_o$ harmonic amplitude. The peak of the $(n-1)f_o$ amplitude vs decentration curve can be found electronically by using an amplitude detector followed by f_o/p phase detectors at 0° and 90° for x and y. This circuit will allow tracking on a null or secondary peak, as well as on the primary peak. Therefore, a further condition imposed on the track mode is that the $(n-1)f_o$ amplitude be greater than 0.13 amplitude unit.

The planet tracker will settle on the point of the peak where ±0.5 du produces equal excursions of $(n-1)f_o$ amplitude. Using this criterion, the worst case is $a/b = 0.8$, where $y = 0$, $x = -0.8$ du.

Notes:

1. The tracker locates the geometric center of planets even when they appear gibbous or crescent.
2. The tracking of the geometric center rather than the illumination center is particularly significant since the geometric center of a planet is a more precisely known astronomical reference than the illumination center.
3. Completely automatic operation of a planet tracker without the requirement for planet-size input can be achieved by incorporating a planet-radius seeking circuit.
4. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $6.00
   (or microfiche $.95)

   References:
   NASA CR-73162 (N68-13021), Planet Geometric Center Tracker, Vol. I.

   NASA CR-73163 (N68-13022), Planet Geometric Center Tracker, Vol. II.
5. Requests for further information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B71-10445

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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