NASA TECH BRIEF

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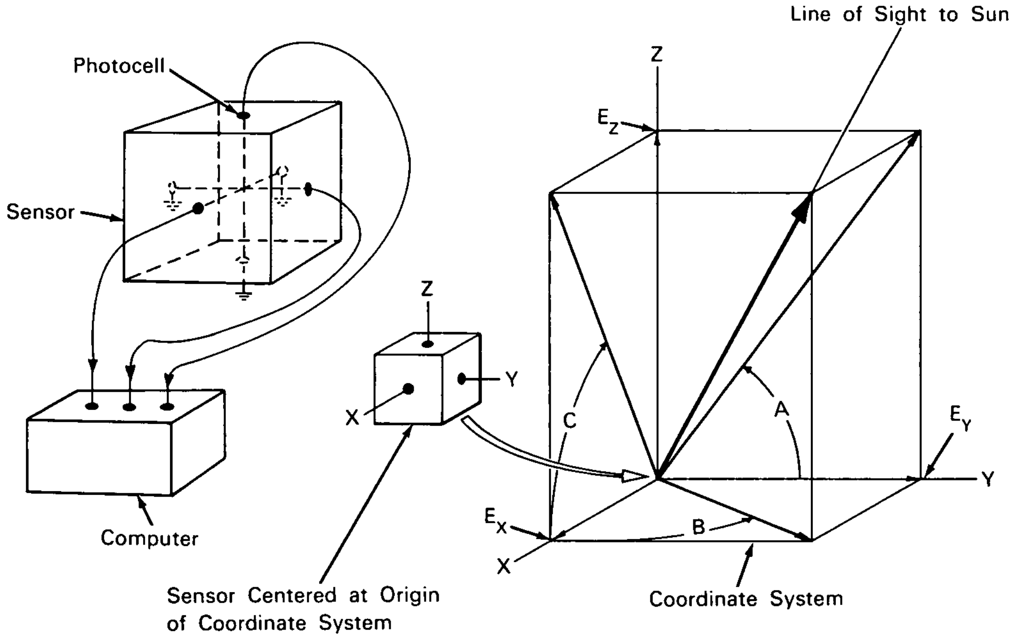
Solar-Angle Sensor Has No Moving Parts



The problem: To design a simple device that will measure the direction of the sun over a spherical field of view.

The solution: A device, without moving parts, composed of a cube with a photocell on each of its six faces. The outputs of the photocells viewing the sun are fed into a computer which determines the position of the sun relative to an orthogonal coordinate system.

How it's done: A photocell is located in the center of each of the six faces of a cube. The photocells on opposite faces of the cube are wired in series to have opposing outputs. The output from each pair of photocells is connected to a computer. If a positive output is obtained from one of the lines when the sun shines on a certain photocell, a negative output is obtained when the sun shines on the photocell located on the opposite face of the cube. The voltage output from each of the three photocells facing the sun is represented respectively by E_x, E_y, E_z. The subscripts correspond to the X, Y, Z axes of an orthogonal coordinate system. The cubic array of the photocells is assumed to be centered at the origin of the coordinate system.

The direction of a line of sight from the sun to the origin of the coordinate system, where the sensor device is located, can be conveniently measured in terms of the angles A, B, and C, which are formed by the

(continued overleaf)

projections of the line of sight on the Y-Z plane, X-Y plane, and the X-Z plane, respectively. If the electrical output of each photocell is proportional to the incident light intensity, and if all photocells have the same characteristics, then the direction of the sun is determined by:

$$A = \arctan \frac{E_z}{E_y}; \; B = \arctan \frac{E_y}{E_x}; \; C = \arctan \frac{E_z}{E_x}.$$

The computer automatically determines the value of each of these functions and provides voltage outputs which correspond to the three direction angles referred to the orthogonal coordinate system.

Notes:

1. Each face of the sun sensor requires a hemispherical field of view. If the device were mounted on a spacecraft, projecting surfaces on the craft might block part of the view and introduce serious errors in the angle measurement. To eliminate this source of error, a mirror arrangement is used with the photocells that may fall into the shadow of surface structures on the spacecraft.
2. When a spacecraft is near the earth, reflected sunlight from the earth may cause errors in measuring the sun's direction. Since the earth is a relatively poor reflector of wavelengths longer than 0.6 micron, slightly improved earth discrimination can be obtained by limiting photocell response to wavelengths longer than 0.6 micron, which are present in direct sunlight.

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated.

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