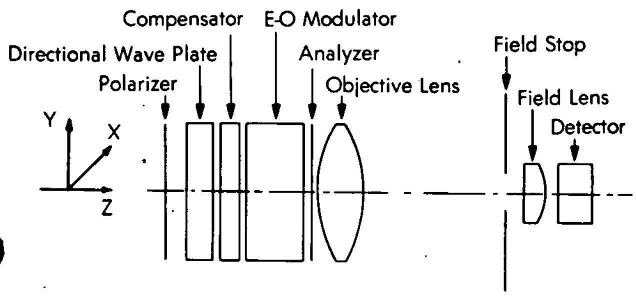
NASA TECH BRIEF

NASA Pasadena Office

Light-Direction Sensor Based on Birefringency

The problem:

To replace expensive, complicated light-direction image dissectors with a cheaper, simpler device.



The solution:

Use the familiar optical system consisting of polarizer—analyzer—quarterwave retarder to convert the incident light beam to one which has an intensity related to the extent the incident beam is off axis.

How it's done:

The direction-sensitive modulator is comprised of a sandwich of five anisotropic elements in plane-parallel relationship as shown in the diagram. The polarizer is of sheet form and is set with its transmitting axis at 45 degrees to X and Y; it polarizes the incident light, that is, it lets through light which is vibrating in one particular direction. Thus, the light incident on the directional wave plate is composed of equal X and Y components in phase with each other.

The directional wave plate is cut from a uniaxial crystal (quartz, potassium dihydrogen phosphate, etc.) so that its optical axis is at an angle with the direction normal to the slice (the optical axis of the sensor system); with this configuration of optical axes, the incident Y-direction polarized component entering the wave plate is transmitted as an extraordinary ray for which the index of refraction depends on the angle between the wave normal and the angle which the crystal axis of the slice makes with it, while the X component is transmitted as an ordinary ray with an index independent of direction. Since the index of refraction for the extraordinary ray depends on the angle between the wave normal and the crystal axis, the phase of the extraordinary ray relative to that of the ordinary ray also depends on the angle; the retardation of the directional wave plate changes linearly with the deviation of the incident beam from optical axis of the polarimeter.

A compensator is used to remove the large constant part of the retardation; the compensator is also cut from a uniaxial crystal but with its axis on the plane of the slice and oriented in the X-direction; as a result, its retardation is not strongly direction dependent.

The electro-optic modulator used in the direction sensor is of conventional configuration, e.g., a potassium dihydrogen phosphate wafer having both its optical axis and the applied field oriented normal to the wafer. The modulator is driven sinusoidally so that it adds retardation; as a result, the total retardation is a time variant function which appears as a photosignal of a given frequency at the output of the detector. The objective lens, field stop, and field lens perform the usual function of gathering light and bringing it to a focus on the detector, which may be a photomultiplier or a solid-state diode.

Patent status:

This invention has been patented by NASA (U.S.

(continued overleaf)

Patent No. 3,670,168). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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