A Figure Control Sensor For the Large Deployable Reflector

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A sensing and control system is required to maintain high optical figure quality in a segmented reflector. Upon detecting a deviation of the segmented surface from its ideal form, the system drives segment-mounted actuators to realign the individual segments and thereby return the surface to its intended figure.

When the reflector is in use, a set of figure sensors will determine positions of a number of points on the back surface of each of the reflector's segments, each sensor being assigned to a single point. By measuring the positional deviations of these points from previously established nominal values, the figure sensors provide the control system with the information required to maintain the reflector's optical figure.

The physical properties of the segment support structure and the control system itself are two of the major factors determining the performance requirements imposed on the figure sensors. Information available at this time allows us to define preliminary estimates of the sensor's resolution, overall measurement range, and update rate. On the basis of the estimates for these requirements, three technologies have been identified as the most promising for the development of the figure sensor: optical lever, multiple wavelength interferometer and electronic capacitive sensor.

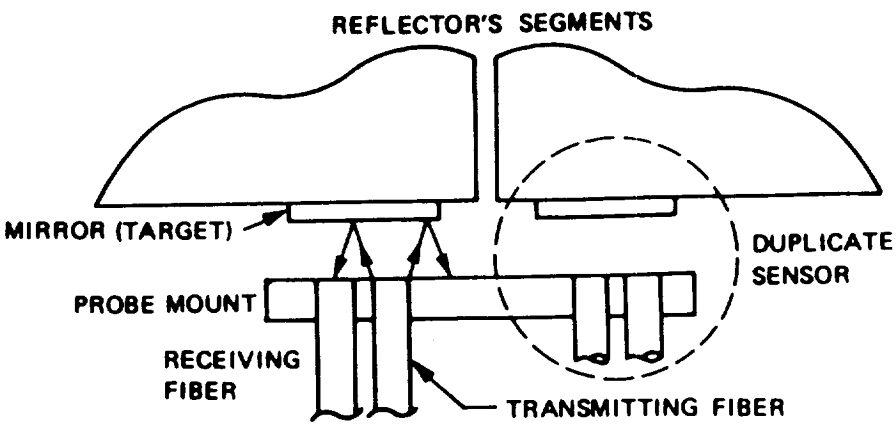

FIGURE 1. Optical Lever

The optical lever concept, which is illustrated in FIGURE 1, is an intensity-based method for determination of position. The amount of light intercepted by the collecting fiber depends on the target-probe separation and, therefore, can be used to measure position of the target relative to the probe. Optical lever sensors need to be deployed in pairs, as shown in FIGURE 1, to determine relative edge displacement of adjacent segments.

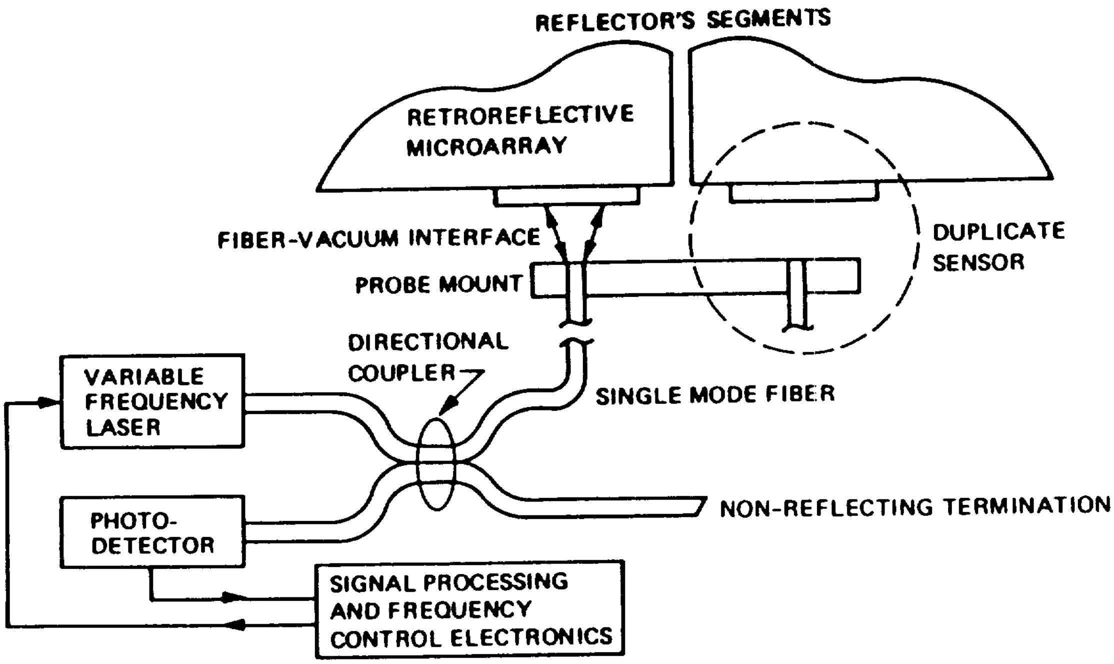

FIGURE 2. Multiple Wavelength Interferometer

An implementation of a multiple wavelength interferometer is shown in FIGURE 2. Optical radiation returned by the retro-reflector interferes with that reflected from the fiber-vacuum interface. In this approach, the target-probe separation is arranged to be the path difference between the two arms of the interferometer. Multiple wavelength operation is required to resolve the $\lambda/2$ range ambiguities. Sensors of this type also need to be deployed in pairs.

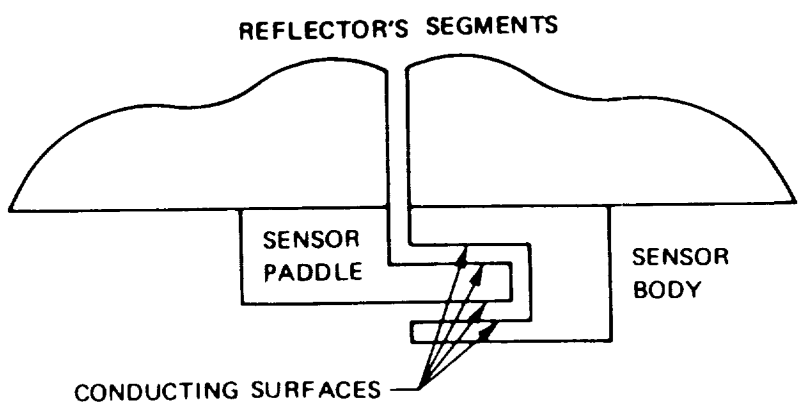

Figure 3. Electronic Capacitive Sensor

Basic operation of an electronic capacitive sensor (which is to be used on the Keck telescope) is illustrated in FIGURE 3. The electrical capacitance formed between two or more parallel conducting surfaces is measured to determine their separation.

To select a particular implementation of the figure sensors, performance requirements will be refined and relevant technologies investigated further.