

Integrated Pointing and Signal Detector for Optical Receiver

Signal power would be utilized more efficiently and alignment would be less critical.

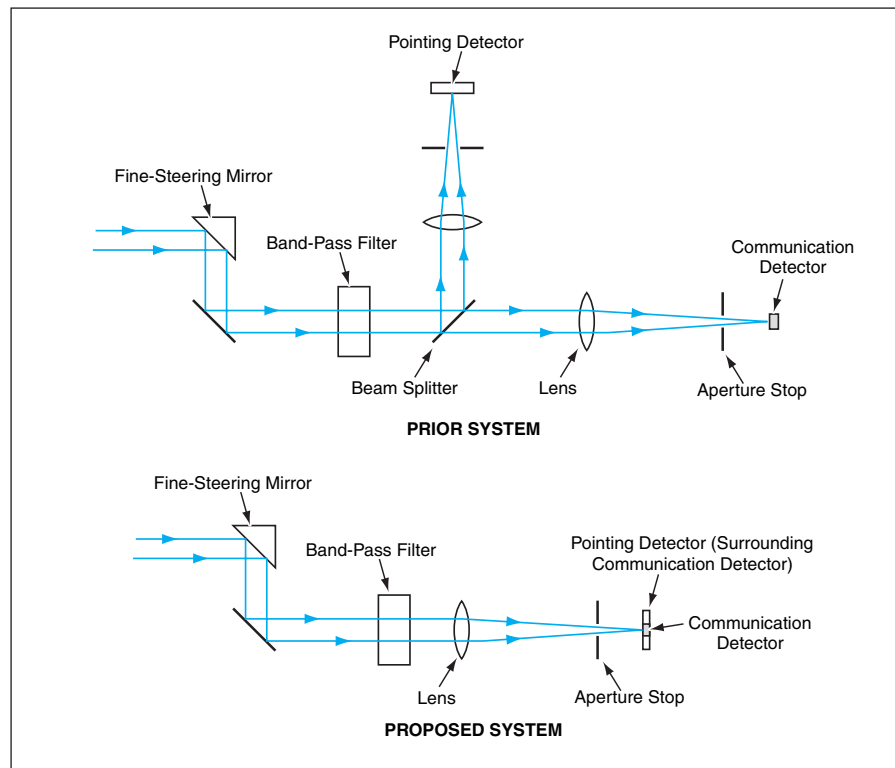
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A design concept for the receiver portion of a proposed free-space optical-communication terminal calls for integration of its communication and pointing detectors. As explained below, this would entail a departure from prior designs, in which pointing and communication detectors have been separate.

As used here, "communication detector" denotes a single high-speed photodetector used for reception of a laser beam that has been modulated to convey information, while "pointing detector" denotes an array of photodetectors (typically, a quad-cell detector or a charge-coupled device) used in sensing the pointing error (the error in the aim of a receiver telescope, relative to the laser-beam axis). The pointing detector of this or any free-space optical-communication receiver is necessary for proper acquisition and tracking of the received laser beam. The suitably processed output of the pointing detector is fed back to a fine-steering mirror to reduce any pointing error and thereby maintain optimum reception.

Heretofore, it has been common practice to pass the incoming laser beam through a beam splitter that sends about 10 percent of the beam power to a pointing detector and the rest to a separate communication detector, as illustrated in the upper part of the figure. One disadvantage of this is that because only 10 percent of the received signal power is available for use by the pointing detector, the signal-to-noise ratio (SNR) at the pointing detector is lower than it otherwise would be. The performance of the pointing detector is correspondingly limited. Another disadvantage is that the alignment between the communication and pointing detectors is critical and must be ensured by means of a calibration procedure.

According to the proposal, there would be no beam splitter. The communication and pointing detectors would be positioned coaxially in the same focal plane, as shown in the lower part of the figure: the communication detector would occupy the central part of the focal plane, while the pointing detector would occupy the surrounding area. This arrangement would inherently ensure the proper alignment of the detectors with each other.



The **Pointing and Signal Detectors** are separate units on different output paths of a beam splitter in the prior system. In the proposed system, the pointing and signal detectors would be coaxial, integrated into a single unit.

The dimensions of the signal and pointing detectors would be chosen to take advantage of the Gaussian distribution of signal power in the focal plane. The communication detector would be sized to receive 85 percent of the received signal power at zero pointing error (in other words, when the received laser beam was centered on the focal plane). The reason for choosing this size is that it would maximize the SNR in the communication detector in the presence of background light.

During zero pointing error, the remaining 15 percent of the received signal power would impinge on the pointing detector. This would be half again as much signal power as is available to the pointing detector in the beam-splitter approach. Even more advantageously, during nonzero pointing error, the proportion of signal power available to the pointing detector would increase by a large amount because the Gaussian peak would no longer be centered on the communication detector. For example, if the pointing error were such as to

place the half-power radius of the beam at the center of the focal plane, then the power incident on the pointing detector would increase to five times that of the beam-splitter approach. This increase in power would help to make it possible to correct rapidly for large pointing disturbances — for example, those caused by wind.

This work was done by Michael Britcliffe and Daniel Hoppe of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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