processor. In current applications, these limits have not been reached. Assuming the fastest period for one dome rotation is 90 seconds, the above example (a 100-foot-diameter dome with 1/2-inch ticks) works out to a maximum rate of 70 ticks/second. The current software is interrupt driven, and an interrupt is generated for any transition between light and dark detected by one of the three phototransistors. Since there are two transitions per tick, a rate of 70 ticks/second yields 140 interrupts/second, or 7 milliseconds per interrupt. Since a 65/11EB microcomputer running off a standard 1-MHz clock typically requires only 150 microseconds to service each interrupt, there is plenty of excess processor capacity.

There are additional limits on the dimensions of the tick marks. If they are made too narrow, changes in skewing between the optical sensors for the timing and data tracks can become a problem. Similarly, narrow tick marks make it very difficult to adjust the horizontal spacing between the two optical sensors on the timing track for proper quadrature. The height of the tick marks should be sufficient to accommodate any wobbling of the plane of the encoder track surface; one inch was adequate for the dome at the 1-meter telescope. However, as the height of the tick marks is increased, so is the distance between the centerlines of the timing and data tracks. Increasing this distance increases the sensitivity of the system to changes in skewing that would result from minor rotations of the read head about the radial axis.

Uncertainties and test margins

There are a few concerns about the future performance of this encoder system. First, the long-term interaction of the materials used is not yet known, although some accelerated life-cycle tests were performed. A sample segment of the mylar was printed, taped, and glued to a piece of metal and then kept under water for a week, baked in a 140 degree (F) oven for a week, and placed in a freezer for a week. The adhesive held, and there was no noticeable degradation of any of the material.

Other long-term worries include the possibility that the mylar could lose its transparency or become brittle and develop cracks,although the manufacturer of this material (3M) does not believe this is likely. The aluminized tape could lose reflectivity, although in other applications of this tape, reflectivity loss has not been observed during five years of use. There might also be undesirable interactions between the various adhesives and the laser printer toner particles, or the toner could fade. Marginal testing was done using test patterns in which the black stripes were replaced by stripes of varying shades of grey. The system functioned reliable at grey levels that correspond to very significant fading.

The band glued on the dome at the 1-meter has been in place since May 1985. It has shown no deterioration and has required no repairs. No malfunctions of the encoder system have occurred during this time, and the dome has tracked flawlessly. There was some concern about the performance of the photodiode/phototransistor pairs in extreme cold, so "freeze-mist" (freon gas in an aerosol spray can) was applied to the read head to simulate winter conditions. The unit functioned correctly provided that ice crystals did not form on the sensors or otherwise block the optical path. Should this prove a problem in actual winter conditions some type of enclosure around the read head might be necessary. However, during December 1985, the temperature in the dome dropped to 25 degrees (F), and the unit continued operating normally.

Other problems might develop during fabrication and installation of the mylar strips on the dome of Keck Observatory's 10-meter telescope, located atop Mauna Kea at an altitude of 13,600 feet. The lower atmospheric pressure at this altitude may alter the spray pattern of the aerosol adhesive, so some alternate method of application might be needed to glue the mylar strips to the dome of the 10-meter.

Weak points

The mylar strips are clearly the weakest point in this design. Since they are exposed to the environment inside the dome, they are more vulnerable to dirt and damage than the optical tracks found inside a sealed rotary encoder. So far, this has not been a problem. Also, the fabrication and installation of the mylar strips leaves much to be desired. While the generation of the striped patterns is totally automated, the cutting, taping, and gluing is a tedious, labor-intensive task. However, the labor involved in this task is not significantly worse than that required to install a comparably-sized drive chain for a sprocket driven rotary encoder. In any case, there may be better ways of manufacturing and installing these strips, and other materials or techniques could be explored.

A number of alternatives are possible. First, the aluminized mylar tape could be applied directly onto the encoder track surface, and the spray adhesive used to glue the printed mylar strips onto the tape. Second, instead of using printed mylar strips, stencils and black paint could be used to apply the coded patterns onto the aluminized tape. Third, if the encoder track surface were made of a highly reflective metal, it might be possible to