LAB 5: SCANNERS

Scanners are used to dynamically change the direction of a beam of light from one point to another, changing the optical axis in real-time. This change in the optical axis is typically a change in its angular direction. Scanners may be classified into two categories: (1) refractive (using prisms), and (2) reflective (using mirrors). In this lab we will study the basic properties of reflective scanners. The scanners we will study all use a laser as their source of light, including a variety of point-of-sale (POS) scanners ("supermarket" scanners), as well as the scanner from a computer laser printer. Note that the POS scanners are designed to "read" or scan across a Universal Product Code (UPC "bar code") found on practically any product that is sold.

An important concept used in an optical scanner is that of angle doubling. When a flat mirror is rotated through some angle $\Delta\theta$, the beam is rotated in reflection through twice that angle, $2\Delta\theta$. This follows from the Law of Reflection. In the world of scanners this is called the scan magnification, the change in output scan angle divided by the change in angle of the scanning element. For a single mirror, the scan magnification is therefore 2.

The tangential velocity of the beam from a single reflecting surface (the velocity of the beam in a direction perpendicular to the optical axis) is given by:

$$V_T = 2 \cdot \omega \cdot r \quad \textbf{(5.1)}$$

where $\omega = 2\pi f$ (f is the frequency of revolution of the mirror)
and r is the distance from the mirror to the point of scan

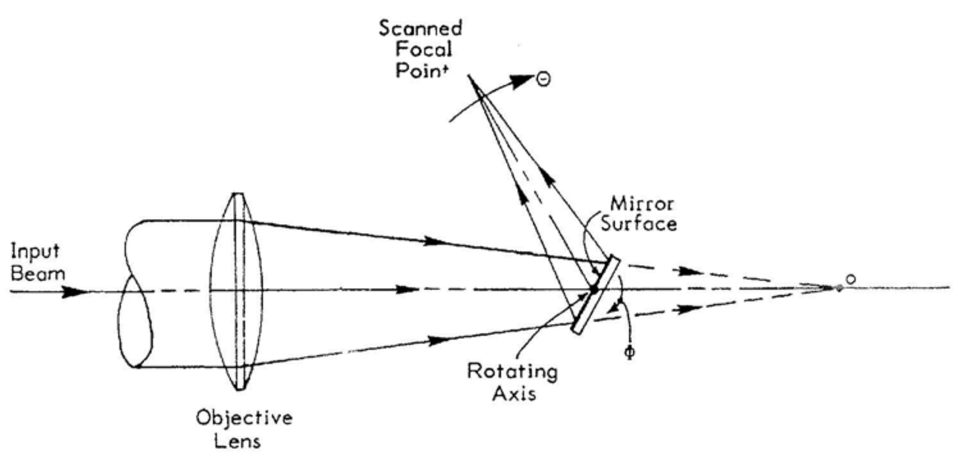

Fig. 5.1. Scan with mirror surface on rotating axis. Scan magnification is 2.

* If you desire to scan across a flat image field (such as a flat piece of paper), what is wrong with this approach?

* What simple (but not desirable) solution might you use to correct this problem?

ANGLE DOUBLING

Using a flat mirror on a rotary stage and the beam from a He-Ne laser, convince yourself that angle doubling really works. In other words, if you rotate the mirror by $\Delta\theta$, the beam (relative to the incident beam) changes in angle by $2\Delta\theta$.

* Describe a simple procedure to verify this. Carry this out.

* Take measurements to verify that angle doubling really does work.

SCAN PATTERNS

Using the scanners provided, draw (trace) their output scan patterns. Do this under "full power" of the scanner mechanisms, so that you are able to see the entire scan pattern at once.

Turn off the power to the scanner mechanism, but leave the laser powered up. Slowly spin the scanner mechanism by hand, and study the output scan pattern.

* What do you observe?

* On your traces, label the order in which the lines are scanned as a function of time.

* What is the scanning mechanism in the IBM scanner? Are there any curved mirrors in the scanning optical path?

* What is the scanning mechanism in the National scanner? Are there any curved mirrors in the scanning optical path?

LASER PRINTER

* Describe the optical path and scanner mechanism in the laser printer.

* What is the purpose of the optical fiber?

* Where is the (infrared) laser beam focused?

* What is the purpose of the two lenses?

● Calculate the frequency, f (in Hz, revolutions per second), that the mirror in this laser printer must spin at in order to scan an 8.5" x 11" page in one minute. What is the mirror scan frequency if the page rate is increased to 10 pages per minute?

Assume: --a vertical resolution of 300 dpi (dots per inch)
--the laser beam is scanned completely across and up and down the entire page
--the distance from the mirror to the drum is 12 inches
--the time it takes the page to advance between scan lines is zero seconds

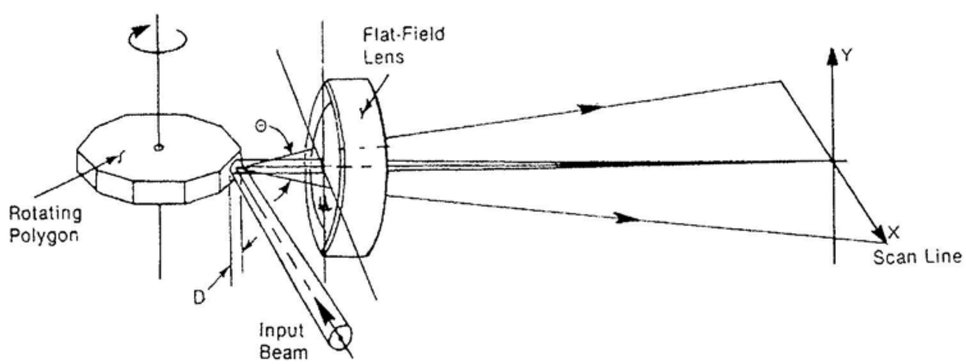

Fig. 5.2. Polygon scanner with a field-flattening lens.

LASER LIGHT SHOW

This simple two-mirror scanner uses galvanometers to move the mirrors. Have fun playing with the light patterns!!