APPLICATIONS NOTE

NO. E6

UNIQUE PROPERTIES

OF

IMAGE DISSECTORS

12/3/63

The term "image dissector" or more concisely "dissector" is applied by ITTIL to a scanned pickup tube. In this tube an input radiant energy image is focused onto a photocathode, followed by an electron optical focusing system forming an electron image of the emitted photoelectrons in the plane of a small defining aperture. An electron multiplier follows this aperture, and a deflection system, either magnetic or electric, is included for deflecting the electron image over the defining aperture in such a way that various portions of the image are examined in sequence.

The dissector as thus defined has unique and rather unusual properties not generally recognized which should be taken into consideration when selecting an appropriate camera tube for a specific application:

1. Non-Storage

Because no storage is involved, the scan rate on a dissector can be varied at will without changing the signal current amplitude. In fact the scan can be stopped completely at any image point or points at which further detailed information is desired. Dual or multiple scan modes can also be adopted, in which an earlier large raster scan is replaced by a smaller scanned area for image analysis or image tracking. This ability to vary the scan speed and raster size is quite unique with the image dissector and is so unusual that it is often overlooked in new design considerations.

2. Panned-Camera

Directly related to nonstorage operation is the ability of the dissector to operate with a panned or nonstabilized platform. Since no information storage, over a preceding comparatively long frame time or line time is required, the camera platform need not be stabilized for that same period. Full resolving power is retained in the dissector if the platform remains stable within one resolution element only for the "dwell-time" on each resolution element, rather than for the total frame time. This is a relaxation of the platform stabilization requirements by a factor equal to the total number of resolvable picture elements. Image distortion resulting from panning can, of course, be removed during data processing.

3. High Resolution

Image dissectors achieve paraxial resolutions closely predictable on the basis of selected electron beam defining aperture size. For example, in magnetically focused tubes, contrast ratios as high as 40 percent have been observed experimentally with 0.001 inch diameter apertures at 1600 TV lines/inch resolving power (800 line pairs/inch). These high resolutions are quite compatible with the ultimate limits set by the emission energies of the photoelectrons for tubes of this type, as established by G. Papp of ITTIL (IRE Tr. on Nuclear Science, Vol NS-9, No. 2, April 1962, p 93).

Off-axis resolution approaching the paraxial performance can be achieved with a moderate degree of dynamic focusing only in magnetically-focused varieties. For electrostatically focused dissectors, off-axis loss of resolution, even with dynamic focusing is appreciable.

4. Linearity

The basic multiplier phototube operating principle used in image dissectors is linear over many orders of magnitude, at least 4 to 5 orders in normal usage. The image dissector is therefore particularly useful where a wide dynamic range of signal inputs with linear response is encountered. Even greater dynamic range can be accommodated by re-adjustment of the multiplier gain by altering the applied operating potentials.

Response linearity from one portion of an input image to another portion of the same image is limited to some extent, as it would be in any camera tube, by internal light reflections within the camera tube envelope. Dissectors with internal optical trapping can be supplied on special order.

5. Noise

Noise in an image dissector camera normally arises from three readily identified sources: dark emission from the photocathode, background lighting on the photocathode, and the signal flux itself. The multiplier gain is normally high enough so that other noise sources, such as amplifier noise etc. are negligible. With nearly all photocathodes except infrared sensitive types the dark emission noise is also negligible, so that the dissectors, in general, operate either under a background noise limited or a noise-in-signal limited condition. Photon fluctuations of the flux input, modified by the quantum efficiency of the photoemissive conversion process at the photocathode, are then observable in the dissector. For location of images on a dark background, as in star tracking, the dissector may therefore be more sensitive than expected because of the almost total absence of dark noise in the nonsignal areas.

See ITTIL Research Memo 386 for additional information on dissector noise.

6. Special Apertures

Dissectors are readily adapted to the examination of specialized portions of the input image using appropriately shaped defining apertures. Apertures can range from a long slit aperture for examining single line scans of a spectrum to such complex apertures as pin-wheels, etc., used with special scan modes to obtain additional picture information or discriminate against certain input patterns.

7. Multiple Apertures

By appropriate electron optical techniques, two or more separate electron multipliers can be placed behind appropriate dissector apertures to achieve simultaneous differential readout of picture information. This can be useful in character recognition and other specialized problem areas.

8. Simple Operating Theory

The operational theory of the dissector is simple and straightforward, making it possible to predict, a priori, what the resulting system capabilities will be. This is useful to the system designer and in the system check-out. See, for example, "Reference Data for Radio Engineers" ITT Corporation, 4th Edition, p 410.

9. Reliability

The dissector is a simple, rugged, reliable device without a thermionic cathode, which limits the lifetime and consumes operating power. Shelf life is many years and operating life is comparable, unless excessive input illumination occurs for long time periods. Momentary exposure to sunlight or even the sun's image does no harm. No delicate films or vibration sensitive parts are required.

10. Fast Turn On

The dissector is ready to operate at full efficiency as fast as the associated circuitry can be activated.

11. Scan Drive

The dissector is adaptable to both magnetic and electric deflection, although magnetic deflection has proven to be more readily adaptable to low power transistor drive circuitry. If fast fly back or fast random access is not required, a dissector with magnetic scan can supply large amounts of picture information at high output signal levels, with a minimum of total required system power.

12. Spectral Response

This extends over all regions for which suitable photocathodes are available and therefore includes the near infrared to the extreme ultraviolet region. Windowless dissectors capable of operating into the X-ray region can be constructed.

13. Raster Edge Effects

Unlike such beam scanning tubes as the image orthicon and vidicon, the dissector has no scanned raster area surrounded by an uncharged unscanned area. As a result no edge effects are encountered in the dissector resulting from potential discontinuities at the raster edge and showing up as abnormal signal amplitudes along all raster edges as observed in image orthicons and vidicons. A small raster, of for example only 5 or 6 short scan lines can be located anywhere on the dissector sensitive area, with each scan line, even at the edges, contributing proper signal amplitudes, and with no raster "burn-in".

14. Size

Dissectors can be constructed in a wide variety of sizes to meet specialized requirements. There are no restrictions on thin film size (as in the image orthicon), gun size, etc., 1 inch, 1-1/2 inch, and 4-1/2 inch O.D. sizes are presently available from ITTIL, and 1/2 inch, 3/4 inch, and 2 inch sizes, as well as larger varieties are available on special order. The 1 inch and 1-1/2 inch sizes are designed to operate with standard vidicon coil systems.

ITTIL has prepared a number of Research Memos and other publications concerning image dissectors available on request. These include Research Memos Nos. 309, 336, 353, and 386, as well as applications notes on the FW-146/FW-125 image dissectors. ITTIL has been a pioneer in the development of image dissectors since the earliest days of television, when Philo T. Farnsworth of ITTIL developed the image dissector as the earliest all-electronic television scanning pickup device.

ITTIL will be pleased to cooperate with prospective customers requesting more information regarding image dissector principles and the latest developmental advancements, or requiring special tube design to meet individual system specifications. Please contact Component Sales, ITT Industrial Laboratories, 3702 E. Pontiac Street, Fort Wayne, Indiana.