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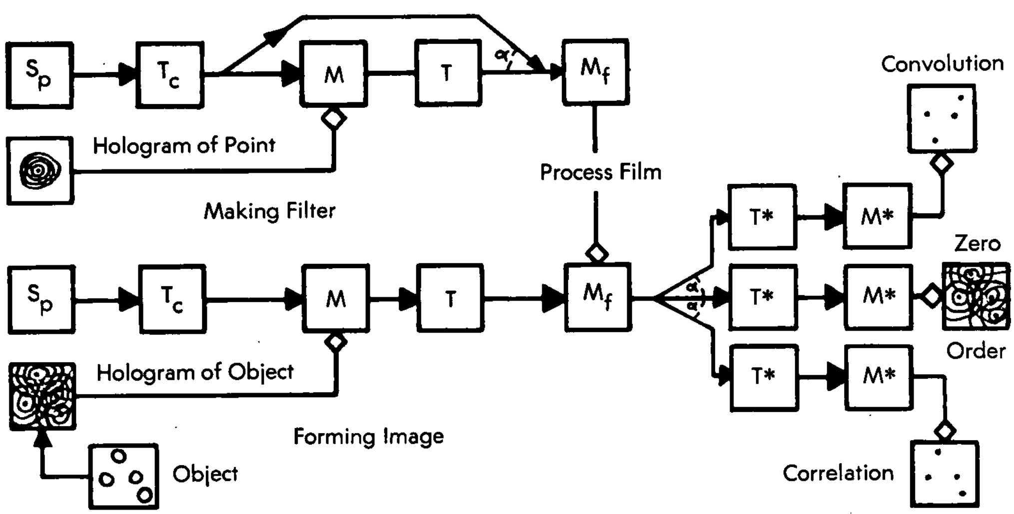
NASA TECH BRIEF

Ames Research Center

Image Formation in Microwave Holography

When laser light passes through a hologram, not all of the transmitted beam is part of the reconstructed image; there is a DC term, corresponding to a bright background, which can mask the image. In the more familiar holographic techniques, an offset reference beam causes the image to be offset from the DC term. Microwave holograms are made without an offset reference beam, but it has been found that a Vander Lugt filter can be used to produce the image offset. Also, the filter permits "decoding" of holograms in contrast with the usual practice of reconstructing visible-light analogs of the original microwave wavefronts.

Generally used in optical character recognition, the Vander Lugt filter is actually a holographic record of the Fourier transform of some particular input signal. The filter is made by using the hologram of a point object; the hologram of a complex object can be regarded as the superposition of many point holograms, so that the process results in an image. In the microwave holographic scheme, the same optical equipment is used to make filters and images merely by blocking the reference beam for image forming. The M* and T* blocks in the diagram represent a 35-mm camera with a bellows lens; only one is used, and only the correlation function is recorded.



Images have been made of metallic objects, such as foil-covered paper tubes and styrofoam spheres suspended from strings. For example, the hologram of a 12-cm ball is made at a distance of 122 cm away from the microwave horns; this is an approximation of the hologram of a point reflector and is used to make the Vander Lugt filter. The original hologram can be used as the input to the system shown in the

(continued overleaf)

diagram; preferably, a hard-clipped copy is made by tracing the hologram with india ink. Photographic film is used to make the filter, exposing it in a 35-mm camera with the lens removed; the processed filter is mounted in a liquid gate.

When the filter and hologram are put into the processor, rotational positioning is critical, so that it is important to have holograms as symmetric as possible. A remote-controlled servomotor is used to rotate the hologram to be imaged and to make the X-Y adjustment at the filter. Since the transform is invariant with respect to the X-Y position in the input plane, positioning of the filter is made easier; if all adjustments were made at the filter, it would have to be carefully centered in the rotating fixture or three nonindependent adjustments would have to be made. However, the filter must be put into the exact position it occupied during its exposure, for example, X-Y positioning accurate to 0.13 mm.

It is to be noted that the limiting aperture of the processor must not be the same for making the filter and for imaging. This prevents the appearance of a recognition spot for the aperture, which could appear in the center of all images if the aperture were not changed.

Note:

Requests for further information may be directed to:

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NASA has decided not to apply for a patent.

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