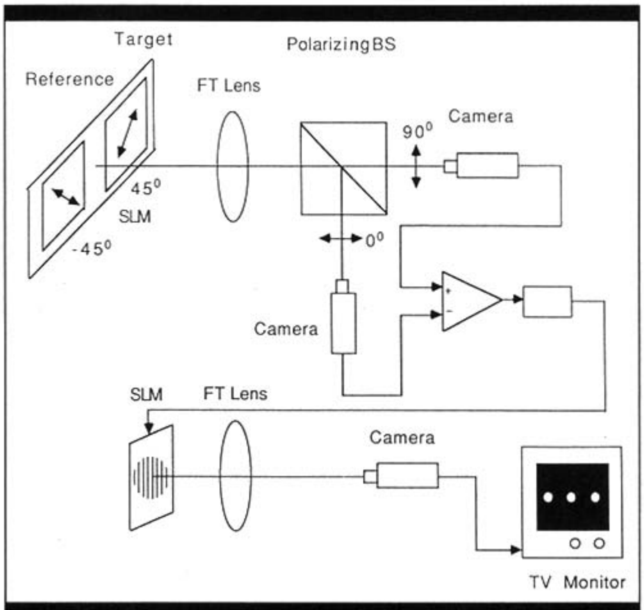
INTENSITY-INVARIANT JOINT TRANSFORM CORRELATOR

By Suganda Jutamulia, Kowa Company, and Don A. Gregory, U.S. Army Missile Command, Redstone Arsenal

The optical joint transform correlation results from the diffraction of a collimated beam from a prerecorded interference pattern, produced by the Fourier transform of a target and a reference. The joint transform can be seen as the Young interference generated by multiple pairs of point sources separated by the same distance. When the intensities of the target and reference are not identical, the generated Young fringes cannot achieve a unity visibility, and, as a consequence, the final correlation intensity (which is the light diffracted by the recorded fringe pattern) is not a maximum.[1]

We have proposed a differential method[2] that can produce a unity interference visibility (which in turn produces maximum correlation efficiency) independent of the illumination of the target and reference. In the joint transform correlator (JTC), when the intensity of the input differs from that of the reference, the recorded fringe pattern has a pedestal term that can substantially reduce the diffraction efficiency and the correlation intensity.



OPTICAL ARCHITECTURE FOR POLARIZATION-ENCODED TWO-CHANNEL DIFFERENTIAL JOINT TRANSFORM CORRELATOR.

The optical architecture of the polarization encoded two-channel JTC is shown in the figure. The target and the reference are arranged side by side on a single SLM or two separate SLMs. In contrast to an ordinary JTC, the polarizations of the reference and target beams are made orthogonal. The polarizations of the reference and the target are set at −45° and +45°, respectively. Consequently, no joint transform power spectra—interference fringes—can be observed, since the two beams have orthogonal polarizations.

However, after the beams pass through a polarizing beamsplitter as shown in the figure, a fringe pattern will appear on each side of the beamsplitter. The original polarizations (−45° and +45°) have been decomposed into horizontal (0°) and vertical (90°) components; therefore, the resulting interference of the two beams having horizontal and vertical polarization orientations are always out of phase. Subtraction of the two fringe patterns can be performed electronically, resulting in a pedestal-free fringe pattern. The result of the subtraction can be used to produce a binary phase filter. A positive amplitude filter can also be formed by adding a bias equal to the minimum amplitude.

We have described a novel polarization-encoded two-channel JTC that is capable of effectively producing a unity visibility joint transform power spectra-independent of the illumination of the reference and the target. The main advantage of the architecture is that the adaptivity of the JTC (not possessed by the Vander Lugt correlator) is maintained, while the drawback of poor performance caused by an imbalance of the reference with the target illumination (which is not a problem with the Vander Lugt correlator) can be overcome.

References

1. D.A. Gregory *et al.*, "Illumination dependence of the joint transform correlation," Appl. Opt. **28**, 1989, 3288-3290.
2. S. Jutamulia *et al.*, "Illumination-independent high-efficiency joint transform correlator," Appl. Opt., in press.