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OPTICAL PROCESSORS

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It is well known that in many fields of science the main task is the processing of video information. One of these areas is exploration of natural resources of the Earth from space. To illustrate the volume of this information and the speed of its receipt, it is enough to show that only one image obtained with the multi-zone camera and covering an area of 100 * 100 km with a resolution of 10m, contains approximately 1000 Mbit of information. Daily hundreds of such pictures are sent to Earth. To transmit this information, they serve digital radio lines operating at a speed of 10-100 Mbit / s and more.

This necessitated the development and creation of optoelectronic systems. registration, storage and processing of space video information. Optical methods make it possible to produce both analog and digital information processing. A characteristic feature of optical analog computing machines is that all elements of information on inputs are converted to the resulting output signal at the same time.

Thanks to this, huge productivity is achieved - more than 1.0e13 op / s. However, such computers, as well as electronic analog machines have limited computational accuracy - of the order of 1%.

Interest in digital optical information processing at the initial stage was caused by the need to overcome the problems faced by analog optical computing: low accuracy of calculations and lack of flexibility inherent in electronic technology.

The need to create such computing systems is dictated by the possibility of overcoming a number of fundamental shortcomings inherent in von Neumann computers, which limit the further increase in their efficiency and productivity. Therefore, the development of such systems should be considered as one of the alternative ways of creating super-efficient computing systems along with the multiprocessor supercomputers of parallel operation being developed at present.

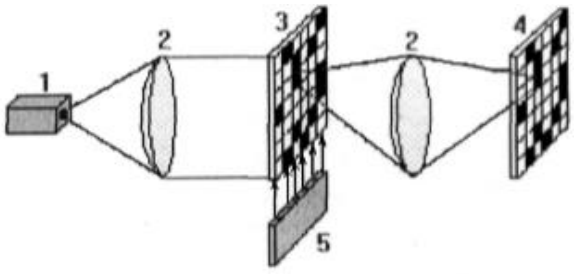
Systems for entering information into an optical processor

There are two main ways of forming images and entering them into the optical processing channel, which provide a sufficiently high input speed.

The first method is designed to input information coming in the form of a sequence of electrical or optical signals through several input channels at once. It is carried out by means of a controlled matrix transparency (SPMS - space-time light modulator), which forms an image line by line and stores information until it is read. A distinction is made between electrically and optically controlled transparencies.

The second method is designed to enter algorithms for solving problems, instructions, constants. This data is stored in permanent optical memory. Information in optical memory is stored in separate cells of a flat matrix in the form of holograms. For reading, a laser radiation addressing device is used, directing the beam to a cell with a given number. The addressing device is a multi-position laser beam deflector with arbitrary addressing. A two-dimensional image read from a hologram is fed to a transparency with an optical input and modulates its transmission or reflection function. The entrance to the banner is carried out simultaneously through all optical channels.

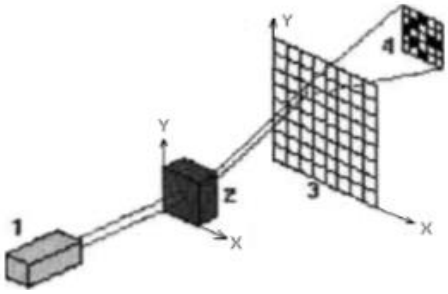
Entering information into an optical information processing device with using an electrically controlled transparency



1-laser; 2-lenses; 3-electrically controlled transparency; 4-input of the next element; 5-banner control device

Fig. 1. – Entering information into an optical information processing device using an electrically controlled transparency

Entering information into an optical information processing device using topographic storage



1-laser; 2-position baffle; 3-mattress holograms; 4-input of the information processing device

Fig. 2. – Entering information into the optical processing device information

Controlled transparencies serve for spatial modulation light beam in amplitude, phase or polarization and are used in data input-output systems.

According to the method of controlling the modulation of the light beam, electrically and optically controlled transparencies are distinguished. Both types can perform discrete or analog modulation of the light beam. In the first case, the transparency must have a nonlinear characteristic, in the second, on the contrary, it must have a linear dependence of the optical properties of the element on the control signal.

The operation of controlled transparencies can be based on various physical phenomena: electro-optical, acousto-optical, magneto-optical. Managed banners can be roughly divided into the following types:

1) Electrically operated transparencies:

a) with electron beam addressing;

b) with voltage addressing:

– liquid crystal;
– based on electro-optical ceramics;
– on ferromagnetic materials;
– on monocrystalline ferroelectrics;
– acousto-optic devices.

2) Optically controlled transparencies.

The most widely used among various types of optical processors are optical correlators. There are many different options for constructing correlators, among which there are two most commonly used:

– correlator with the frequency plane;
– correlator with simultaneous transformation.

A simulcast correlator has several advantages over a frequency plane correlator:

– less tight tolerances for the accuracy of the installation of elements, since the filter obtained as a result of recording is illuminated by a flat wave;

– contrasting interference pattern and, as a consequence, good modulation of all components in the spectrum of spatial frequencies.

The correlator with simultaneous transformation is preferably used in cases where the input functions are received in real time. It should be noted that an increase in the recognition reliability can be achieved due to preliminary processing of the original image, for example, contouring, since the contour lines for most images have the greatest information content. [1]

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