FIBER OPTIC SPECKLE BASED INTERFEROMETRY FOR IR RADIATION SENSING AND INTRUSION MONITORING SYSTEMS

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Speckle-based methods are widely used for registration of physical parameters. These methods have been extensively used for industrial applications in measurement of deformation and displacement, object shape, vibrations, etc. Electronic speckle interferometry combined with PC processing technique offer powerful tools for registration of physical quantities and industrial control. In the previous paper we have reported a fiber optic method for registration of low intensity infrared radiation based on the effect of interference of propagation modes in the far field of a multimode fiber. In this paper we present new results on the method.

We describe here a speckle based fiber-optic technique that can be used for IR radiation sensing as well as for intrusion-monitoring systems. The method is based on the effect of variation of the speckle pattern in the far-field of a multimode fiber under external perturbation of IR radiation. Computer processing of the speckle image provides information on the amplitude of the IR radiation that hits the lateral surface of the fiber. An algorithm has been developed for processing of the speckle image and determining the amplitude of the output signal. The algorithm is based on comparison of speckle image taken at $t = 0$ and each one of the subsequent current speckle images taken at equal time intervals. The first speckle image I_0 is captured by CCD camera at initial time $t = 0$ when launching the procedure. Then at each subsequent time moment t_k ($k = 1,2,3\ldots..k_{max}$) the CCD cuptures the current image I_k. The difference of two speckle images is calculated by subtracting pixel-by-pixel of two images and the value of the sum S_k is calculated with subsequent plotting on PC monitor (Fig. 1).

The program for computer simulation of the modal interference in the far-field of the fiber has been developed on the basis of *C++* language and run on the *Linux* platform. According to the Huygens' principle each of the point on the fiber end face $s(x_f, y_f)$ can be considered as a point source of spherical waves. These waves interfere constructively or destructively in the image plane of CCD. The simulation procedure has been carried out for two cases: for the ideal case without noise and for the case when the speckle pattern is composed of "*true*" signal speckle pattern, accompanied by a speckle noise. The results of computer simulation correlate sufficiently well with experimental ones.

Fiber optic speckle technique can be used for application in intrusion-monitoring systems. Such a system is capable of detecting intruders from the pressure of their weight on the earth's surface. A multimod optical fiber was used as a sensing element of the model of intrusion-monitoring system. The presence of an intruder in proximity to the buried optical fiber induces a phase shift in light propagating along the fiber which allows for the detection of intrusions. Disturbances can be monitored and registered at the output end of the fiber (Fig. 2).

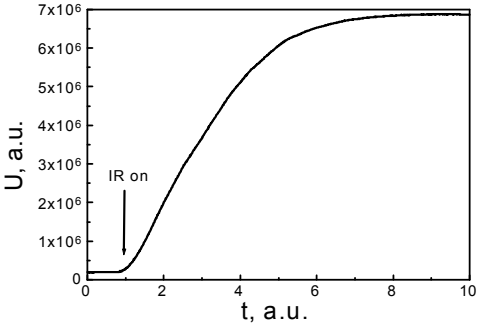

Fig. 1. Output signal characteristic after switching on the IR radiation P_{IR} = 27 μW. The probing light source is a HeNe laser at 633 nm.

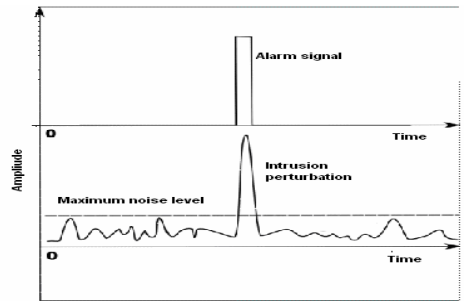

Fig. 2. Illustration of the principle of fiber optic intrusion-monitoring system