An optical bend sensor design

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Abstract. An optical bend sensor is designed. It relates to optical sensors that detect and measure the solids deformation, amplitude and direction of motion. It can be used in medical, metrology, security and other branches.

1. Introduction

An optical bend sensor is suggested as a device designed to detect and measure solids deformations, amplitudes and directions of motion. It can be used in medical, metrological, security and other branches [1-3].

The optical bend sensor based on the waveguide properties of some materials. The main point of its design is to make bend sensor of easily accessible materials and components with maximum linearity of its parameters.

2. Optical bend sensor design

The sensor circuit is shown in Figure 1.

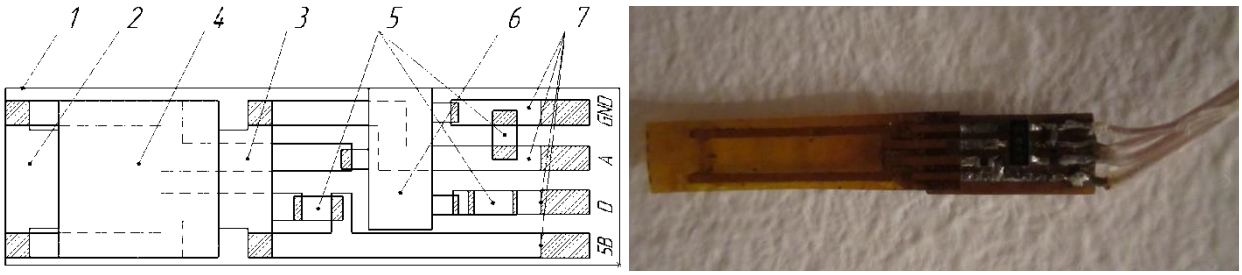

Figure 1. The optical bend sensor.

The optical bend sensor consists of a pulsed or static light source with a narrow spectrum (e.g. LED) (3), a multimode planar light guide (4), an optical detector (e.g. phototransistor) (2), a foil substrate that performs structural and circuitry functions (1, 7), electronic strapping (5, 6). Data from the detector, amplified by a transistor (6), is fed to an external ADC, which converts the intensity of the radiation passing through the fibre into an electric potential. The multimode planar light guide is made of widespread sheet silicone; if necessary it can be surrounded by an elastic protective cover. The technical result is the design of a compact, simple and cheap bend sensor, which has satisfied linear characteristics.

3. Principles of sensor operation

There are the principles of the sensor operation. The optical sensor is fixed on the object under study so that the multimode light guide is located in the deformation zone (or zone of movement amplitude estimation). The light source generates a light signal propagating through a multimode fibre. The sensor is based on optical wave reflection and refraction on the interface between two media with different optical properties in a multimode fibre according to Snell's law. When a beam falls on the interface between two media, refracted and reflected waves appear in the general case.

During deformation, the intensity of the radiation passing through the fibre drops (or increases), so the phototransistor starts to close (open). The current flowing through it is changed, and as a result, the voltage falling on the load resistor is changed too. The voltage value goes to the ADC, so the light intensity is converted into a certain numerical value, and then used to estimate the deformation amplitude changes. Due to the elasticity of the fibre material, it responds to fairly small amplitudes of motion, which allows the sensor to be used as a vibration sensor.

4. Bend sensor applications

An example of the optical bend sensor application is a project called a "cybernetic glove". The essence of the glove is the ability to control computer or other technical equipment operation based on the fingers movement. The sensor, which is mounted above a finger joint, determines the angle of finger flexion and a predefined (system) parameter is controlled by the sensor signal. Thus, replacing a computer mouse to the cybernetic glove was suggested and the idea was successfully put into practice during slides presentation. Both analogue control mode and digital mode (with two or several states) are supported with the bend sensor.

This kind of development is extremely in demand in the field of entertainment especially in the field of computer games in the virtual space.

5. Conclusions

Although different types of bend sensors are widely used in many branches of industry the idea of its design on the base of cheap components are still actual. Nowadays because of the rapid development of virtual reality technology small and cheap bend sensors are needed for being implemented in gloves and other objects to control interaction between a person and the picture he sees.

The next probably step of the bend sensor design will be use of bare phototransistor and LED. It gives an advantage, which consists in reducing the number of nonlinear effects and losses due to the lack of two optical interfaces “phototransistor (or LED) package- light guide”.

References

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