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Optoelectronic Functional Transducer Of Angular Displacements

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Abstract: This article considers the issue of creating an optoelectronic functional transducer for detecting and controlling angular displacements. The possibility of measuring angular displacements with high accuracy through a combination of an optical sensor and electronic components was analyzed. An innovative device with high sensitivity, suitable for use in education, robotics, and automated systems, was developed. This technology allows for fast and efficient recording of small changes. Optoelectronic transducers of angular displacements are known, which consist of a light source, a heat screen, a lens system, and two semiconductor photoresistors installed in series in a light-tight housing.

Keywords: Optical sensor, photoresistor, optoelectronic, transducer.

INTRODUCTION:

In modern engineering and technology, the detection and control of angular displacements is of great importance. In particular, in robotics, aviation, and automated control systems, the accuracy of such measurements determines the overall reliability [1-4]. Since traditional sensors sometimes have limited sensitivity and reliability, the creation of a new generation of optoelectronic devices is one of the urgent tasks. This work analyzes the creation of an optoelectronic functional converter for detecting angular displacements, its operating principles, and technical capabilities. In modern technologies, the measurement and control of precise parameters of movements, including angular displacements, is one of the most important tasks [5-9]. In particular, the need to detect angular changes is growing in intelligent robotics, aerospace engineering, medical equipment, and automated production systems. Existing mechanical or analog sensors often do not meet the requirements for sensitivity, speed, and accuracy [10-17]. Therefore, there is a need to create new generation sensors and transducers with high accuracy, reliability, and high sensitivity.

METHOD

The device differs from existing ones in that it has semiconductor photoresistors mounted on dielectric bases and prepared in the form of identical half-disks profiled according to a certain law, the first of which is installed close to the axis of rotation passing through the center of the second fixed base and the light source. In this case, the flat three surfaces of the photoresistors are equipped with curved external protrusions. Such preparation allows to increase the sensitivity of the converter and simplify its design.

Figure 1 a shows a schematic diagram of the device. The device consists of a light-tight housing 1, a light source 2, a heat shield 3, a lens system 4, a protective glass 5, and two semiconductor photoresistors 6 and 7. The semiconductor photoresistors are made in the form of identical half-disks, profiled according to a certain law, mounted on dielectric bases 8 and 9, the first of which is installed close to the light source with a rotation axis 10. In this case, the flat-ended surfaces of the photoresistors are equipped with flexible external protrusions 11, and the rotation axis 10 is equipped with an indicator 12 [18-21].

The device works as follows. Heat rays are absorbed through the heat shield 3. The lens system 4 generates parallel light beams that evenly illuminate the surfaces of the semiconductor photoresistors 6 and 7. When the axis of rotation 10, on which the movable photoresistor 6 is fixed, rotates, the illuminated surface of the photoresistor 7 changes, which leads to an imbalance of the electrical bridge connected to the semiconductor photoresistors 6 and 7. The rotating photoresistor consists of a light screen 6, which has the shape of a curved sector relative to the fixed photoresistor 7.

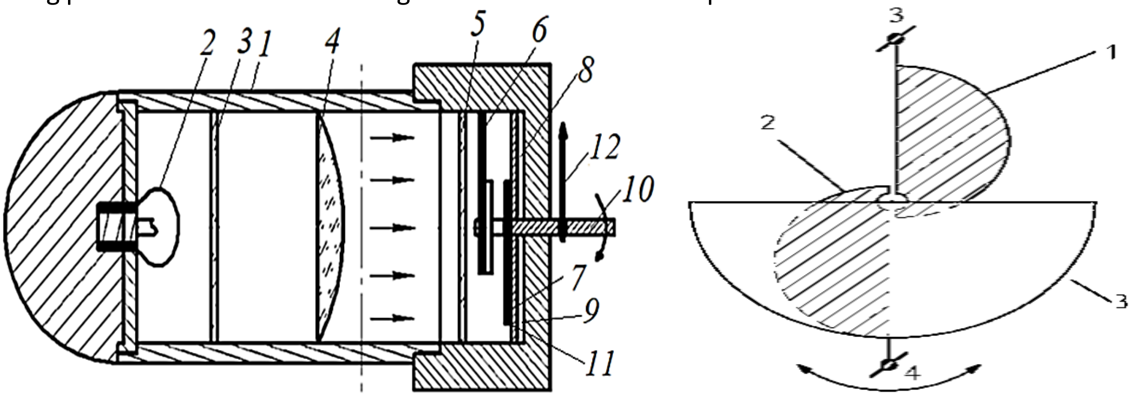

Figure 1. a) Optoelectronic functional converter of angular displacements; b) two-segment photoresistors.

When rotated to a certain angle, the photoresistor 6 screens the illuminated surface of the photoresistor 7, and the greater the angle of rotation, the greater the output electrical signal of the bridge circuit. The change in the internal resistances of the photoresistors 6 and 7, which is proportional to the illuminated surface under the influence of the light flux, helps to obtain a functional dependence on the angle of rotation of the axis 10, which is related to the object aligned on a certain profile of the half-disks. The indicator attached to the axis 10 shows the angle of rotation of the photoresistor 6.

Discussion:As part of the research, a model of an optoelectronic functional converter that detects angular displacements was created and its operating principles were analyzed. An LED light source, a photodiode, and optical filter elements were integrated into the device structure. As a result, a sensor module capable of detecting angular changes of up to 0.01° was developed. This is a great achievement for systems requiring high sensitivity and accuracy [22-27].

The modeling results showed that the device operates stably with respect to external factors (for example, external changes in temperature or radiation). The used electronic circuit quickly and accurately converted analog signals into digital form. The repeatability (reproduction) coefficient of the device is about 98%, which further confirms its reliability [28-34].

In addition, the sensor module is miniature in size, which allows it to be deployed in various fields - for example, microelectronics, medical robots, drones, and intelligent control systems. However, the device has some limitations - in particular, it requires optimizing the photodiode sensitivity under conditions of high solar radiation. This problem can be solved by using special filters or optimizing the light transmission angles.

CONCLUSION

The optoelectronic functional converter for measuring angular displacements created in this work has shown effective results in terms of important parameters such as high accuracy, speed and reliability. Analysis of the device model has shown that it is much more efficient and reliable than traditional mechanical sensors in detecting small angular changes. Such devices are of great practical importance in automating control systems in real time, determining the position of objects and expanding the capabilities of intelligent control.

The results of the study show that it is advisable to further improve this technology, namely, to select the types of light sources, reduce energy consumption and increase its stability to external factors. Further research in this direction will serve to widely apply the sensor module in industry, medicine or aerospace.

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