

NEW TACTILE SENSOR FOR SCANNING OF FORCE AND SLIP

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Abstract: This paper describes new construction of tactile sensor, which is enabled scanning normal force, tangential force and slip, too. Both functions are integrated in one sensor. The properties, design and electronic circles are described.

Keywords: Tactile, sensor, transducer, conductive elastomer, force, slipping.

1. INTRODUCTION

The idea of the using of the tactile information for the technical or biomedical purposes is found out the second part of the 20th century. The medicine development can give us better information of scanning, transmission and processing of tactile information.

2. THE DEVELOPMENT OF TACTILE SENSOR

The tactile information consists of some segments – the detection of mechanical suggestions, detection of pain and detection of the relative position of parts of the human body. We tried to detection of the strength and slipping. The scheme shows Fig.1.



Fig. 1: Scheme of the sensor

We thought of nine sensors for the detecting of the forces for the Cartesian coordinate system $[0,x,y,z]$ – eight sensors in the plane xy (the angle $8 \times 45^\circ$) and the ninth sensor for the detecting of the force of the direction of z -axis. We reduced the number of the sensors in the plane xy - we use only four sensors (direction $+x, +y, -x, -y$) for the direction of the force. The system of the force sensors consists of two electrodes and a slice of conductive rubber between them. The conductive rubber changes its resistivity against the loading force. The output value of this type of sensor is analogue value of the voltage U_{2i} for each sensor. This analogue voltage is turned into the digital value by the analogue-digital converter, so we can obtain digital data.

Scanning part of sensor is evident on the Fig. 2 and 3. The moving octagon matches the tactile force transducer, which is placed inside of full transducer case.

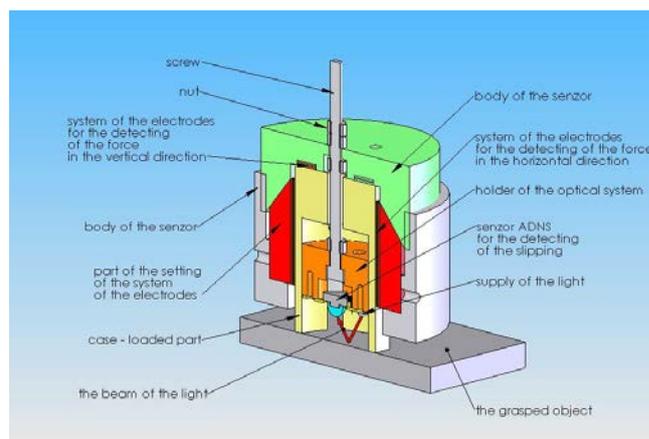


Fig. 2: Principle and construction of the sensor

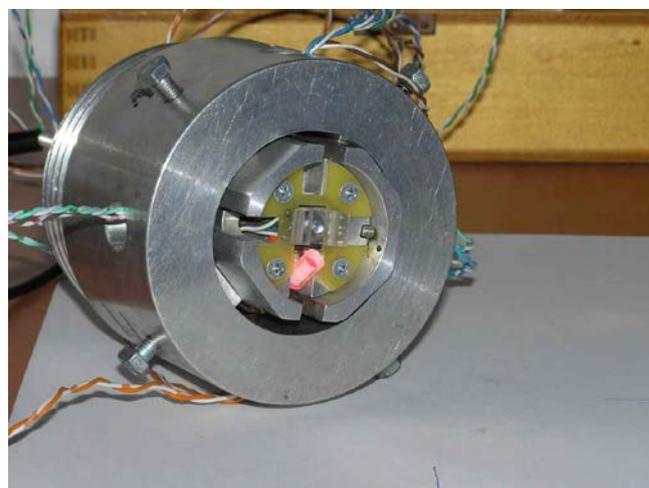


Fig. 3: Bottom view – measure part of the sensor

Slipping sensor (Fig. 4) – there is used an optical principle of the detection of the slipping. The advantage of this system is no contact between the sensor and the grasped object. The slipping can be detected unambiguously instead of mechanical detection. The LED diode (red light - wavelength $\lambda = 639-835$ nm) is used as a light supply. The sensor ADNS-2610 was used as a receiver of the red light.



Fig. 4: Optical slipping part of sensor

This sensor can catch the beam of the reflected light from the surface of the touched part. This reflected light can turn into the picture. The reflected light is captured in the periods of the time. The sensor can compare the (k) and (k+1) picture and calculate the slipping. The sensor sends data of the motion of the direction x and direction y. The output value of this type sensor is data of the motion for the direction x and direction y.

All sent data is captured by microprocessor AT89C2051. This microprocessor can send the data in PC.

3. TESTING OF THE ASSEMBLED SENSOR

The functionality of an assembled sensor was tested after assembling of the sensor. Printed circuit board was completed. The test of the sensor was divided into four parts – test communication between microprocessor and PC, test of the sensors of forces, test of the conversion analogue voltage U_{2i} into digital value.

Test of communication – the program for AT89C2051 was very simple. Each register of microprocessor (register R0-R7) consisted of 8-bit value and this value was sent into PC. The master of this communication was set PC, the slave was a microprocessor. The principle of the communication was set a half-duplex communication.

Test of the force sensors – each sensor was loaded by weight. The range of the weight was $<0;900>$ g and voltmeter shown the range of analogue voltage $<0;1>$ V.

Test of A/D converter – The analogue value of the voltage was set and the data of A/D converter was sent to PC and the value was read. The analogue value was calculated too and the result was compared to PC value.

Test of the slipping – the Cartesian coordinate system $[0,x,y]$ was drawn on the pad. The assembled sensor was moved in direction +x, +y, -x and -y and the data from the

sensor of slipping was read. All measured data was in accordance of the datasheet [2]. All tests were successful.

The assembled sensor was calibrated after the tests, see Fig. 5. All adjustable parts were fixed and marked as “fixed setting”. All sensors of force for each direction of the loaded force were individual loaded in accordance of the principle of superposition. The sensor was loaded by range of the weight $<0;900>$ g and the analogue value U_{2i} was read. It is necessary to indicate the range of loaded force due to correct setting of the upper reference analogue value for the A/D converter, it is better to measure the analogue value U_{2i} . So this analogue value U_{2i} was set as output of the i-force sensor. Each force sensor was measured tenth for each value of the weight and the uncertainties for each force sensor were calculated

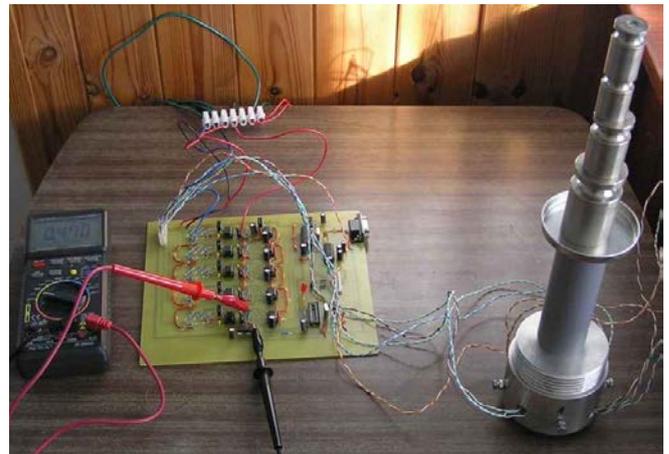


Fig. 5: Calibration of sensor

The sensor of the slipping was calibrated too, but only the direction. The measured values were the same like the values from datasheet [2]. We don't need calibrate the speed and the distance.

4. CONCLUSION

We assembled the prototype of functional model of the sensor for the tactile information. This sensor can detect tactile information – force information and information of the slipping. We resigned some parameters of the sensor due to capital intensity. This prototype of the tactile sensor consists of a lot of adjusting elements. These adjusting elements increased its volume (diameter $D = 85$ mm and the height $H =$ cca 75 mm). If we use a nanotechnology, the dimensions of the sensor can be reduced into acceptable dimensions. Signal output can be determined for the human body in future. The output value of the forces sensors shows Fig. 6. The upper reference value can be set suitable on the basis of the range of values of U_{2i} . If the upper reference value is set unsuitable, the sensor will be not more sensible due to error of the discretization

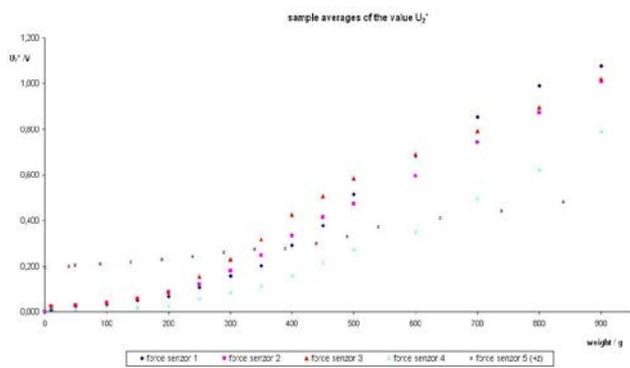


Fig. 6: Sample averages of the values of the force sensors

The Fig. 7 shows design of full sensor, whose parameters and properties was described in this paper. In next development we suppose dimension miniaturization.



Fig. 7: The design of full sensor (top view)

5. ACKNOWLEDGEMENTS

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