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3D STRENGTH SENSOR

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Key words: robotics, sensors, mechanical tensions, force, moment.

Abstract: In this study there are presented the structure of a loading cell, for moment and force determination from the robotic arm. It is presented a support structure that converts the mechanical stress in to a measurable elongation by using resistive sensors for force. From the cells elements, the tensions and deformations are determinate by using Finite Element Method, aiming electromagnetic resistive transducers application on the elastic structure. The paper presents the conceiving and the design of a new 3D strength sensor.

1. INTRODUCTION

Auto adaptive control of a complex mechanical structure, such as the robot, necessitate physical force measurement, force produced during the gripper movement and/or object manipulation. The kinematics forces, such as the one that are exercised in robots “hand” joint, are generated by mass object acceleration during manipulation, and the static forces are generated by gripper action on object surfaces during manipulation process.

It is necessary to study the sensor connected with whole measurement chain. There is a tight connection between mechanical components and the electrical components from the sensors structure. This connection must be considerate during projection phase to obtain a preferment sensor from all points of view.

The physical deformation transmitted to sensorial system it is realized by using a support material. The selection and shape of the support material affect the force sensor performances, especially from dynamic measurement domain

Au example of loading cell, used with thensometrical resistive (TER) for mechanical tension measurement which drives on the joint of the robot hand is presented in fig. 1, [2].

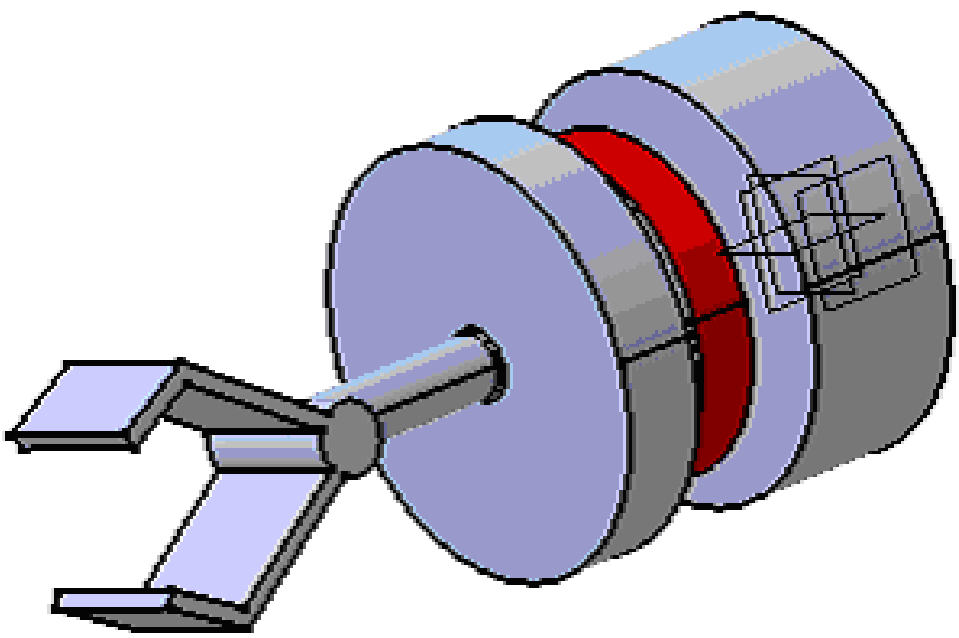

Fig.1 The sensors 3D applications example

2. CONSTRUCTION OF THE SLIPPING SENSOR

In the figure number two there are presented the constructive form of the sensitive system 3D that is used for determined the forces and moments. The system contains 3 elements (fig 2) that are assertive at 120^0 and fixed between two flanges, [3], [4]..

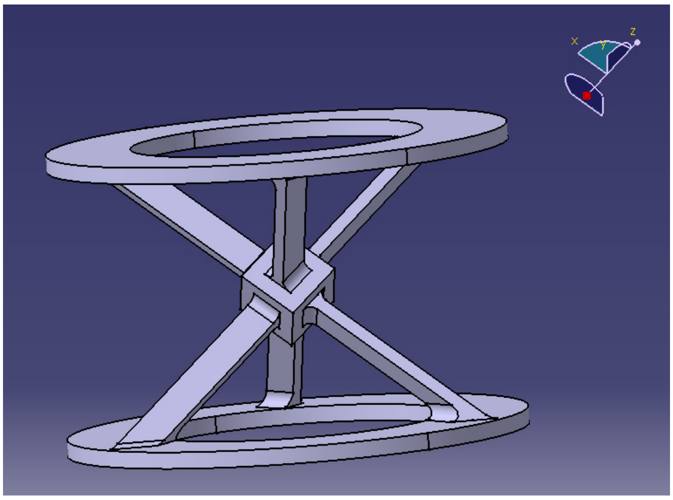

Fig. 2 The sensors 3D configures

In the figure number there is presented the constructive form of a now the sensitive system 3D that is used for determined the forces and moments. The system contains 3 elastic elements that are assertive at 90^0 and fixed between two flanges. For example the loading cell, used with thensometrical resistive (TER) for mechanical tension measurement which drives on the joint of the robot hand.
The 3D sensorial system proposed in the presented configuration and the TER application mode allows the forces and moments determination on three axes.

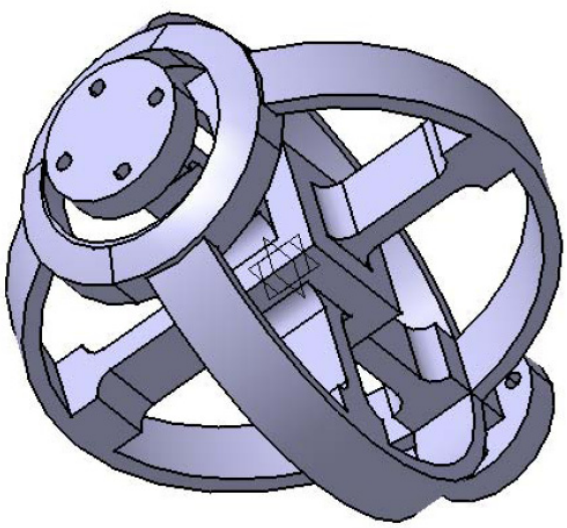

Fig.3 The sensors 3D configures

In the figure 4 are presented the constructive form of the elastic support that is used for determined the two or three components of the interaction force of the robot gripper with the environment [1].

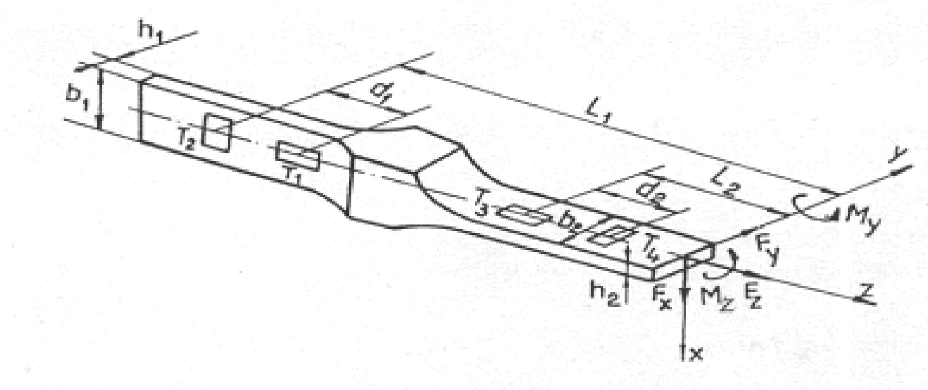

Fig.4 Sensitive element for the displacement determination on two direction

The stress sensor has an elastic element - an elastic segment - on what four elect resistive transducers TER_1 …TER_4 are soldered the four transducers achieve the Wheatstone. The determining of the connection matrix is relatively simple, the elastic structure being presented as a determined static structure fixed at one end the1formal tensions determined by -TER are:

$$\varepsilon_1 = \frac{F_y l_1}{W_z} \cdot 1 = \frac{6 l_1 F_y}{b_1 h_1^2}, \quad \varepsilon_2 = \frac{F_x l_2}{W_z} \cdot 2 = \frac{6 l_2 F_x}{b_2 h_2^2}. \tag{1}$$

The relation between the relative elongation of the elastic elements given by TER and the interaction stress, it is achieved by means of the connection matrix:

$$\begin{bmatrix} \varepsilon_1 \\ \varepsilon \end{bmatrix} = \frac{6}{E} \begin{bmatrix} 0 & \frac{l_1}{b_1 h_1^2} \\ \frac{l_2}{b_2 h_2^2} & 0 \end{bmatrix} \begin{bmatrix} F_x \\ F_y \end{bmatrix}. \tag{2}$$

This sensor is also stressed by moment after the X and Y-axis. The answers of the sensor are correct if these moments are not interfere; but in a contrary case, there can be distinguished the effects of the force F_y comparatively with those of the M_x and the effects of the F_y comparatively with those of M_x. The relative elongations of TER, determined by the components M_y or M_x, are mainly equal regardless of the distance from the application point of the force; the elongation due to the components F_x or F_y are different. If we extract the values of ε_1 and ε_3 from the relations of relative elongations of the tensometers, it can be written:

$$\varepsilon_1 - \varepsilon_3 = \frac{l}{E} \frac{6 d_1}{b_1 h_1^2} F_y , \tag{3}$$

respectively, the problem at the level of electrical signals becomes:

$$V_1 - V_3 \approx \frac{l}{E}\frac{6d_1}{b_1h_1^2}F_y, \quad V_1 - V_3 \approx \frac{l}{E}\frac{6d_1}{b_1h_1^2}F_y, \quad \frac{V_1}{m_x} \approx V_1 - \frac{V_3}{F_y}. \qquad (4)$$

To mark out the tension and deformation state of the elastic elements that are contain in the sensitive system there are apply forces amid moments an the three direction on the flange, the other flange being constraint.

By apply the finite element method we can determined the layout place of the maxim tensions for the direction and force / moment used.

By pointed the positions and the elements that indicated the maxim deformations or the maxim tensions we can use the electro – tension resistant transducer (TER) on the support structure.

In the four figure 5 are presented the sensorial system that is solicited to the forces and moments on the y axis (F_y, M_y), [4].

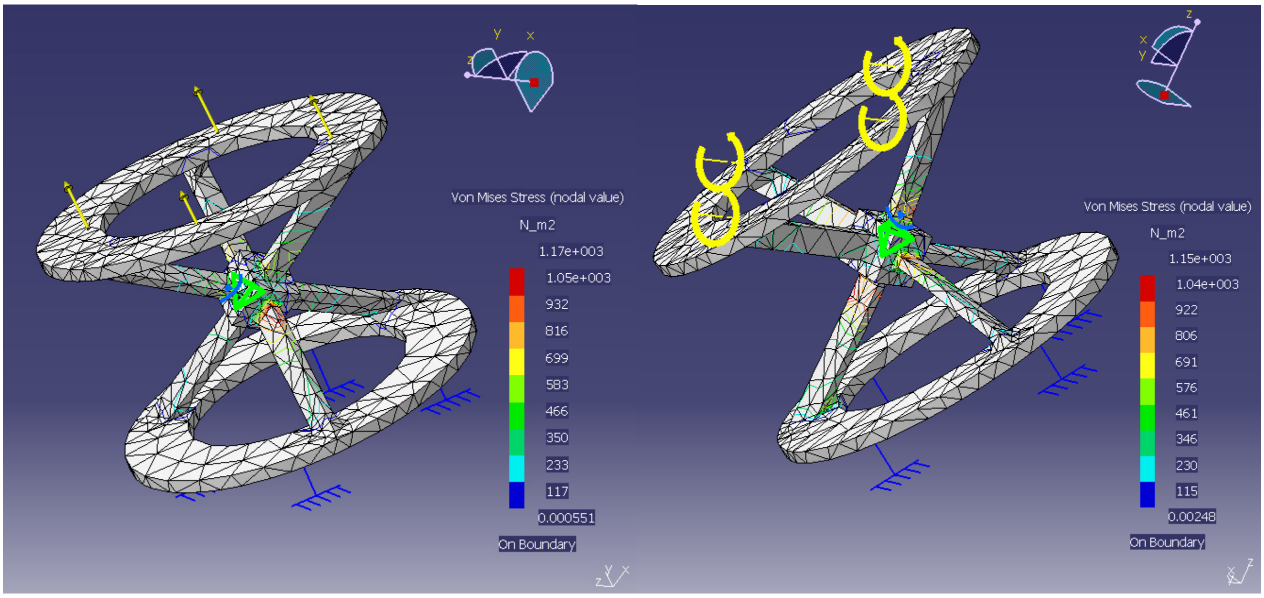

Fig. 5 The tensions and deformation of the Y axis (F_y, M_y)

After the analysis by finite element of the proposed sensorial system, we can determine the TER application zone on elastic elements of the sensor, for moment coefficient and forces determination.

3. CONCLUSION

The 3D sensorial system proposed, by the presented configuration and the TER application mode allows the forces and moment coefficients determination on three axes. After the analysis by finite element of the proposed sensorial system, we can determine the TER application zone on elastic elements of the sensor, for moment coefficient and forces determination.

4. REFERENCES

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