HALL SENSOR FOR THE STEPPING CONTACT FORCE

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Abstract

Walking robots are meant for application on rough, unstructured surfaces. Their adaptation to different terrains is achievable through securing a high adhesion capacity. This paper shows the process of designing a sensor capable of integration into the robot's leg. In this paper, we consider.

1. INTRODUCTION

A walking robot's control entails a continuous flow of tangible information about the complete system's status. Basic sources are the joint's angles, the contact with surfaces reached through adhesion forces and moments and the body's orientation [1], [2]. Sensor signals from audio and video sensors [4] and also each leg's pressure on the floor have different scopes and require independent interpretation [5]. The need comes from the different possible supporting-phase-combinations in the case of six, four, three etc. legs [3]. Depending on the given support phase the body's mass is cast upon the legs with different adhesion force values.

The accessible sensor types, which have been studied and analyzed do not meet the specific requirements for the basic gear of a six-legged walking robot (Aschenbeck et al, 2006) and (Weidemann et al, 2004) driven by artificial pneumatic muscles (Kepplin et al, 1999) [6]. Hence, the paper suggests a force sensor based on magnetic-sensitive reducer.

2. PRINCIPLE OF THE SENSOR

The sensor embedded within the leg's construction is shown in Fig. 1. The principal element is the flat spring, which allows displacement between magnet 2 with respect to the Hall's sensor 3. Depending on the friction force the distance between the magnet and the Hall's sensor is not constant.

The pressure varies from 4 to 10 kg depending on the number of the supporting legs. The design parameters are chosen in such way that, for example, 10 kg pressure corresponds to 0.5 mm, while 4 kg pressure corresponds to 1,6 mm.

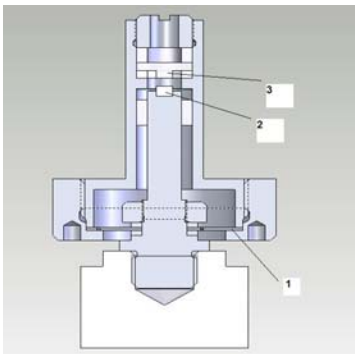

Fig. 1 Construction of the foot force sensor.

3. EXPERIMENTAL WORK

To determine the optimal parameters of the sensor, the transfer characteristic was investigated for a 5, 7 and a 9V supply, and a step of 0.1mm. The measured values of the sensor output voltage are shown in Fig. 2. It is evident that in the interval from 0.5mm to 1.6mm, the sensitivity corresponding to 5V and obtained by (1) can be considered as being satisfactory linear. The measured average square value of the noise voltage equals σ_u e 2 mV. This interval excludes nonlinearities of the characteristics, which is also valid for the two terminal positions of spring where nonlinear changes are also to be expected:

$$\delta = \frac{\Delta Dist}{\Delta Uout} \qquad (1)$$

The higher sensitivity (Fig. 3) obtained for smaller loads is an advantage, which can be used for different gaits and curvilinear motion of the robot.

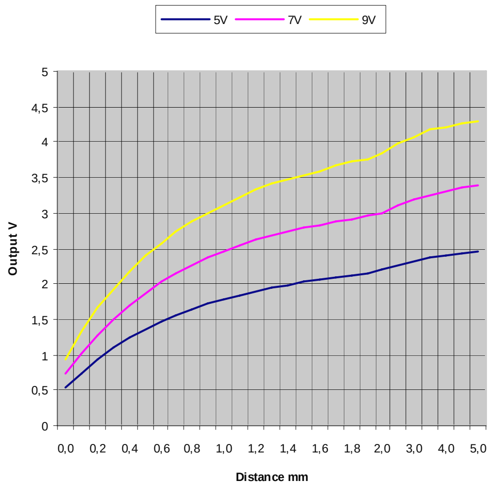

Fig. 2. Measured value of the sensor output voltage

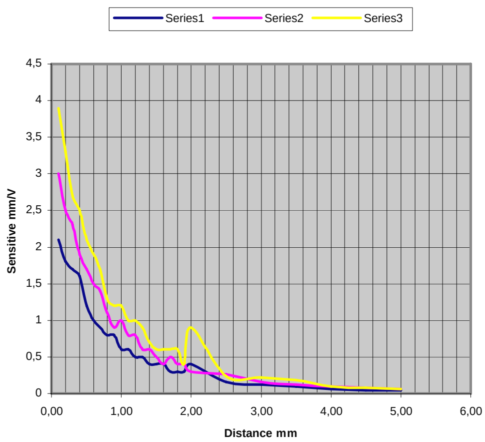

Fig. 3. The sensor sensitivity

4. RESULTS OF THE MODELLING AND DISCUSSION

The suggested sensor variant for integrating the leg into the robot is shown in Fig. 1. It has been developed under implementation of SolidWorks. The whole setting is aimed at simulating the loads, which are to be expected in the final construction variant. The entire unit has been computed using the software program „CosmosWorks". A basic element of the sensor, i. e. initial transducer, is the spring (Fig. 4). The material used to simulate the spring is steel 60C2 with diverse physical features presented in Table 1.The load and displacement simulation was made first for the spring alone and upon that – for the whole unit. The spring was wedged and loaded with a force varying from 5 N to 100 N along the Y- axis (Fig. 3). The spring's stroke was measured (along the Y-axis). The dependence characteristic is linear.

Property	Description	Value	Units	Temp Dependency
EX	Elastic modulus	2.100000005e+011	N/m^2	Constant
NUXY	Poisson's ratio	0.28	NA	Constant
GXY	Shear modulus	7.899999806e+010	N/m^2	Constant
DENS	Mass density	7700.000118	kg/m^3	Constant
SIGXT	Tensile strength	1400000000	N/m^2	Constant
SIGXC	Compressive strength		N/m^2	Constant
SIGYLD	Yield strength	1200000000	N/m^2	Constant
ALPX	Thermal expansion co	1.3e-005	/Kelvin	Constant
KX	Thermal conductivity	50	W/(m.K)	Constant
C	Specific heat	460	J/(kg.K)	Constant

Table 1. Characteristics of the applied steel

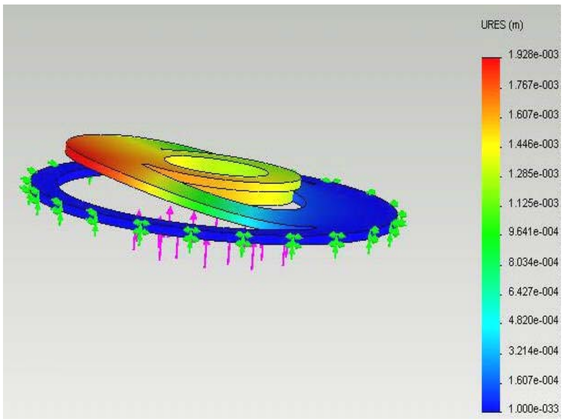

Fig. 4. Simulation displacement graphics

Fig. 5 visualizes the displacement result for the unit as a whole. In this case the system carries once again the maximum load of 100N. The obtained displacement values along the Y axis are shown on diagram Fig.6. As a function of the load the displacement is strictly linear for the entire given scope.

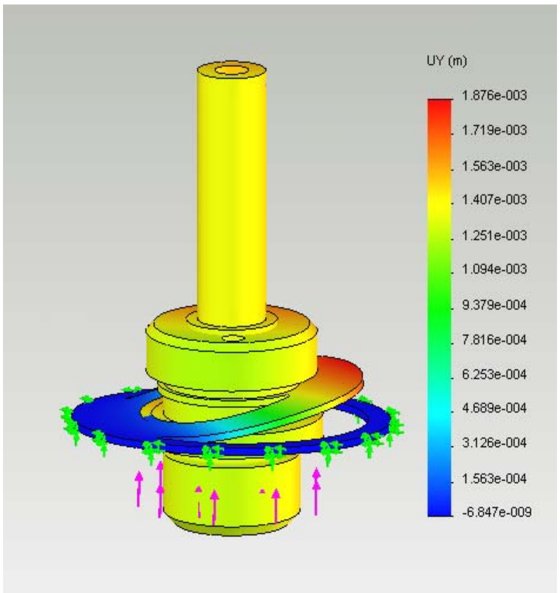

Fig. 5. Simulation displacement graphics

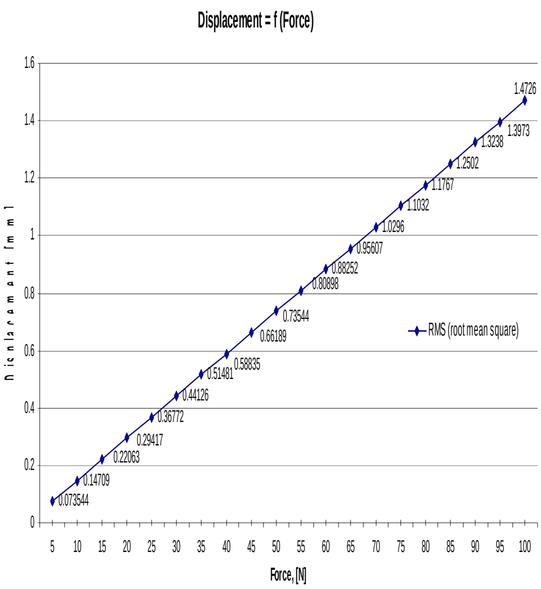

Fig. 6. Displacement of the spring as a function of the load

5. CONCLUSION

The resulting linear characteristics for both the spring and the Hall's element are premises for realization of a linear feature for the sensor as a whole.

Because of the bigger scope of the Hall's element the linearity of displacements in the range 0,5мм - 4,5мм the combining of springs with various scopes gets possible.

Following the obtained parameters the dynamic behavior of the whole sensor could be practically achieved as well as experimentally tested.

The suggested sensor type sets an alternative to the often applied for similar cases potential metric and tens metric ones.

ACKNOWLEDGEMENT

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