Experiments assigned to determine the acceleration of 8000kN shear laboratory model elements

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Abstract. In this paper presents an experimental kinetics study by measuring accelerations using a bi-axial accelerometer constructed in the basis of a miniature integrated circuit, included in the class of micro-electrical and mechanical systems - MMA6261Q on the experimental installation reduced to the 1:5 dividing rule by comparison with the shear existent in exploitation, conceived and projected at the Faculty of Engineering in Hunedoara.

1. Description of the laboratory model of scissors 8000 kN
The laboratory model of scissors dimensional 8000kN is reduced to 1:5 scale, to real scissors. The model is powered by an AC motor with 0.8 kW drive power and a speed of 985 rev / min (Figure 1).

2. The experimental installation for measuring acceleration
To perform the experiments was used the following equipment:
- Biaxial accelerometer constructed in the basis of MMA6261Q circuit;
- Type data acquisition board NI PCI-6024;
- Computing system IBM-compatible PC.

2.1. Biaxial accelerometer built on circuit MMA6261Q
In order to build the accelerometer, it has developed a printed circuit on which components were installed, MMA6261Q chip resistors for adjusting the frequency and duty cycle filtering capacitors as shown in Figure 2.

For this type of accelerometer was provided out for analog, power accelerometer was conducted from a source DC 3.6V.

For fixing quick and easy, on the opposite side of the integrated circuit was placed a magnet. Before the establishment of this type of fixing were made experiments to reveal any influences which may be caused by the behavior of the magnetic field in the operation of the accelerometer. Did not were highlighted such interference, therefore it was considered that this type of fixing is the most suitable in this case[1], [2].

In order to do not achieve measurement errors, it was ensured couple against rotation around its axis during operation.
2.2. Plate of data acquisitions of type NI PCI-6024E
For collecting and transmitting the quantities recorded accelerometer to the computer, using a data acquisition plate specializes in digital computer interfacing with external circuits.

Acquisition plate NI PCI-6024 are installed in an IBM-PC compatible computer and the acquisition system is shown in Figure 3 [3].

Acquisition plate was made an "array" of contacts for the connections where the 8 channels of purchase.
Figure 3. The data acquisition system

Accelerometer allows simultaneous measurement of components after the two-axis acceleration of the reference system, data acquisition was done in analog format.

Figure 4. Accelerometer calibration mode
Calibration of the accelerometer was made by placing it in four positions so that the acceleration of gravity to be the x and y axes in either direction (Figure 4), after which the resulting voltage measured using acquisition program. Linear transformations that convert voltages in acceleration values are obtained simply having two reference points: the measured voltages to -g and g.

A general formula for deducting a linear transformation a(u) having two values $A_1$ and $A_2$ corresponding to $u_1$ respectively $u_2$ is:

$$a(u) = A_1 + (A_2 - A_1) \frac{u - u_1}{u_2 - u_1}$$  \hspace{1cm} (1)

In this case: $a_2 = g$ şi $a_1 = -g$, therefore:

$$a(u) = -g + 2g \frac{u - u_1}{u_2 - u_1} = 2g \left( \frac{u - u_1}{u_2 - u_1} - \frac{1}{2} \right)$$  \hspace{1cm} (2)

When has been experimentation, for purposes of convenience has taken positive x direction opposite to the calibration, so it is necessary to change the sign once more in the program. C syntax conversion functions are:

- Ox-axis function has the expression:
  ```
  double scx(double x) {
    return -2 * 9.81 * ((x - 1.112362) / (2.530534 - 1.112362) - 0.5);
  }
  ```

- Oy-axis function has the expression:
  ```
  double scy(double y) {
    return 2 * 9.81 * ((y - 0.78675) / (2.296962 - 0.78675) - 0.5);
  }
  ```

To acquisition of data provided by the accelerometer has been designed and wrote a program in C ++.

3. **Measurements and results obtained using accelerometer-based on integrated circuit MMA6261Q**

Experiments were performed on experimental stand on the scale of 1: 5 to 8000kN scissors, Figure 1. For each kinematic coupling were measured components of accelerations after the two axes of the reference system. The measurements were performed for several cycles kinematics, and in Figures 5-8. are shown these graphics dependencies for one cycle cinematic.

Coupling E has a translational movement on OY.

4. **Conclusion**

From the many methods of measuring the acceleration, the use of an accelerometer-based integrated circuit technology built using micromachining of silicon (silicon micromachining) is an effective and relatively simple to achieve. This type of sensor is used in robotics, the technique for monitoring vibration of any kind, inertial navigation systems etc; accelerometer built on integrated circuit MMA6261Q accelerometer is a biaxial low-g (for small accelerations) can measure both dynamic acceleration and static (eg gravitational acceleration).

From the data obtained by measuring the stand is established that there is interference (vibration, variations in acceleration due to sudden shocks by turning off certain components and others start twisting torque, etc.) but analyzing the results obtained by analytical calculation and simulation it can be concluded that the use of the accelerometer that is appropriate experimental means[4].
Figure 5. The variation of acceleration components of the measurement approach for the coupling C

Figure 6. The variation of acceleration components of the measurement approach for the coupling D
Figure 7. The variation of the acceleration component on OY obtained by measuring for the coupling E

Figure 8. The variation of acceleration components of the measurement approach in point F
References
[1] Viksten F 2001 On the use of an accelerometer for identification of a flexible manipulator, Linkoping University, Sweden, Master thesis project in Automatic Control at the Department of Electrical Engineering Reg. Nr: LiTH-ISY-EX-3028
[2] ***±1,5g Dual Axis Micromachined Accelerometer, www.freescale.com
[3] ***www.ni.com http://sine.ni.com/nips/cds/view/p/lang/en/nid/10968
[4] Budiul Berghian A, Vasiu T, Abrudean C and Stoica D 2013 Mathematical model to determine the acceleration to the elements of the laboratory model to the 8000kN shears, AIP Conf. Proc. 1558 1639-1642