ЛИТЕРАТУРА

1. Статистика: учебник / под ред. С. А. Орехова. – М.: Эксмо, 2010. – 448 с.;
2. Ханин Г. Лукавые цифры российской статистики [Электронный ресурс] // Ведомости. – 2014. – 18 марта №46 (3550) – URL: http://www.vedomosti.ru/opinion/news/24095291/lukavayacifra-protiv-ekonomiki-rossii (дата обращения: 01.04.2014);
3. Харченко Н. М. Статистика: Учебник. – М.: Издательско-торговая корпорация «Дашков и К», 2011. – 368 с.

ELECTROMAGNETIC LEVITATION SYSTEM

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Annotation: Magnetism is a physical phenomenon produced by the motion of electric charge, resulting in attractive and repulsive forces between objects. It is widely adopted in many spheres of our routine life. By using the effect of magnetism, it has become possible to create non-frictional bearings, contact-free shock absorbers and many things, which found their appliance in industrial usage. There are many great inventions connected with magnets, such as the train on the air cushion (Maglev train). Maglev stands for magnetic levitation, a principle that allows keeping an object in midair. This technology has a great potential, however there are always things, which need to be improved, for instance reduction of disturbance and lowering of the price.

Introduction.

In order to levitate a small permanent magnet in midair the electromagnetic levitation system must be designed. With an appropriate controller in the loop, the small magnet levitates in the air indefinitely without any disturbance.

The vertical position of the levitating magnet is measured using a linear Hall effect sensor and the current in the electromagnet is actively controlled to achieve stable levitation. As a result of conducting a thorough research of a small model, it will be possible to determine how magnetism can be used in real-world applications.

System description.

The model of the electromagnetic levitation system is shown in Figure 1, where R is the resistance of the coil, L is the inductance of the coil, v is the voltage across the electromagnet, i is the current through the electromagnet, m is the mass of the levitating magnet, g is the acceleration due to gravity, d is the vertical position of the levitating magnet measured from the bottom of the coil, f is the force on the levitating magnet generated by the electromagnet and e is the voltage across the Hall effect sensor [1].

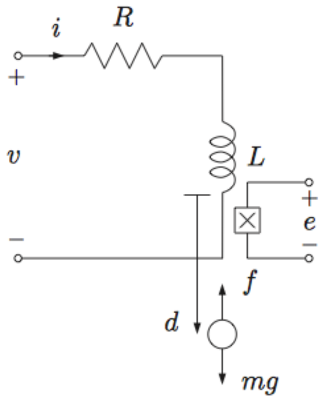

Figure 1. Electrical Circuit

The control unit regulates the magnetic field generated by an electromagnet to levitate a small magnet in midair according to the information it gets from Hall sensors. The vertical position of the levitating magnet is measured using a linear Hall effect sensor and the current in the electromagnet is controlled using a digital signal controller. If the object is about to fall, controller increases magnetic field.

Technical details.

To levitate a small object an electromagnet with an active resistance around 20 Ohm must be used otherwise it will be overheated. Power source should provide more than 1 A current and 12 V. It is necessary because of big currents in a coal (to avoid short circuit).

In fact the Arduino microcontroller may provide only 5 V of power [2]. That is why it is needed to use PWM (pulse-width modulation) to control magnetic field with the IGBT module. This module consists of transistors based on effect of semi-conductor conduction.

Assembly

It is possible to program the Arduino using special Arduino IDE. Schematic diagram of assembly is shown in Figure 2 [3].

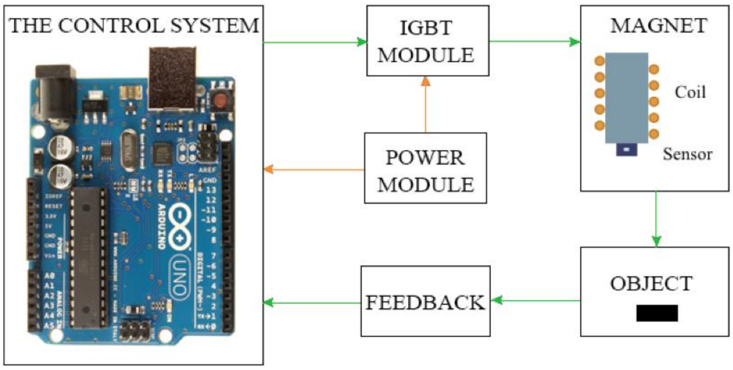

Figure 2. Schematic diagram of the system

The force applied by the electromagnet on the levitating magnet can be closely approximated as

$$f = k\frac{i}{d^4},$$

where k is a constant that depends on the geometry of the system. The voltage across the Hall effect sensor induced by the levitating magnet and the coil can be closely approximated as

$$e = \alpha + \beta\frac{1}{d^2} + \gamma i + n,$$

where α, β and γ are constants that depend on the Hall effect sensor used as well as the geometry of the system and n is the noise process that corrupts the measurement [4]. It follows from Newton's second law that

$$m\ddot{d} = mg - k\frac{i}{d^4}.$$

Moreover, it follows from the Kirchhoff's voltage law that

$$v = Ri + L\dot{i}.$$

Conclusion.

According information marked above prototype of this system was made and tested. Now this system must be improved to achieve maximum precision.

The initial objective was completed successfully. The result of the conducted research is the ability to contemplate the effect of magnetism in reality. It can be said for certain that magnetism will find its place in many appliances and that there are many ways to develop and improve the levitation system.

REFERENCES

1. A. Smaili and F. Mrad, Applied Mechatronics. MA: Oxford, 2008.
2. Blink Tutorial, http://arduino.cc/en/Tutorial/Blink.
3. D. K. Cheng, Field and Wave Electromagnetics. MA: Addison-Wesley, 1983.

TWO-PHASE FLOW IN A POROUS MEDIUM MODELING

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This research is devoted to the multiphase modeling in substances containing pores. The experimental setup is built in Comsol Multiphysics package and constitutes a soil column that deals with two substances when one of them goes from above of the column while the other one goes from below. Throughout the experiment air represents the 'upper' substance while the second one varies. The varying matter allows checking the model for its accuracy. After the check the transition to the air/oil system is done. The result of simulation is distribution of substance pressure in the laboratory column at the final time.

Multiphase Flows. In general, porous medium stands for a solid object that contains pores or voids. Studies of flows in porous media form the basis in soil mechanics, industrial filtration, groundwater hydrology, water treatment and others. In oil extraction, flow modeling is used to model processes when water or gases are entered to the oil-saturated medium in order to displace and collect oil [1].

Phase is one of the substance states which could be liquid, solid or gaseous. Multiphase flow is a simultaneous flow of a few liquid-and-gas mixture phases [2].

Experimental Setup. The whole experiment is divided into 2 parts: the first one employs water and air while the second one includes air and oil. As two substances take part in this experiment one of them is referred to as 'wetting fluid' (water or oil) while another one is referred