MAGNETIC FIELD SCANNER

Mikhail Turubanov, Svetlana Zhitkova

Saint-Petersburg State University of Aerospace Instrumentation,
Saint-Petersburg, Russia

noatime@rambler.ru, zhitkova@inbox.ru

Abstract

This paper is devoted to the development of a magnetic field visualization device the so called "magnetic field scanner".

I. INTRODUCTION

At present time the major attention is being paid to the development of the brushless permanent magnet DC machines. During the designing and assembling processes, it is necessary to control the magnetic field distribution in the air gap of such machines. The conventional measuring equipment is very expensive and has a limited functionality, not to mention its low availability on the market. The developed magnetic field scanner allows visualizing a magnetic field distribution on the surface of any magnetic material or a device (permanent magnets, coils, etc).

II. HARDWARE DESCRIPTION

The main aim was to develop a device which can measure a magnetic field in different points on a surface with the sequential representation as a 3D plot (x,y – coordinates on a surface, z – magnetic inductance). The block-diagram of the magnetic field scanner is represented on fig. 1 [1].

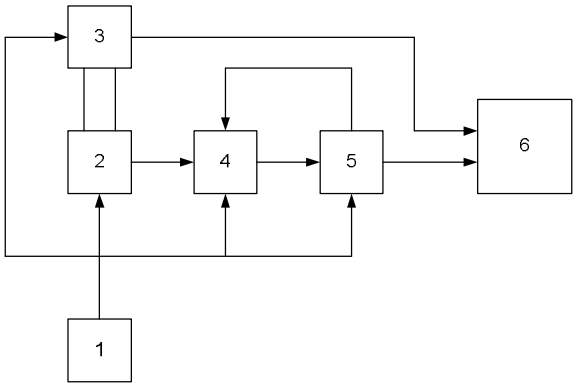

Fig. 1. The magnetic field scanner
1 – power source; 2 – magnetic field sensor; 3 – coordinates tracking sensor; 4 – amplifier; 5 – microcontroller; 6 – PC.

The main component of the device is a magnetic field measuring element based on a Hall Effect sensor. The low voltage output signal of the Hall sensor goes to the amplifier. The amplifier is an instrumentation amplifier comprising three individual amplifiers. Such a configuration allows using cheap, general purpose components with no accuracy compromising [2]. Amplified signal goes to the microcontroller transforms it to a digital code. Almost any type of microcontroller fitted with an analog-to-digital conversion (ADC) module is suitable for this purpose, but the best choice is Microchip's PIC 12F675 comprising four 10-bit ADC channels [3]. The main advantages of this controllers are low price, high reliability and low power consumption. The transformed digital data then goes to a PC.

The Hall sensor is mechanically connected to a coordinate sensor based on the sensor of a conventional optical "mouse" manipulator. All measuring elements are assembled within a computer mouse body, the rest elements of the device (the amplifier, the controller, the power source) are assembled as a separate block (fig. 2).

Fig. 2. The assembled device

III. DATA ACQUSITION AND TRANSFORM

The magnetic field scanner is connected with a PC by the standard RS232 protocol. The received data is stored as a 2D picture (fig. 3, 4) and then can be transformed into 3D plot (fig. 5, 6). Due

to a possibility of ADC noise it is needed to apply special software or hardware filters before data conversion into a 3D plot. The median filter providing the lowest data loss has been chosen empirically.

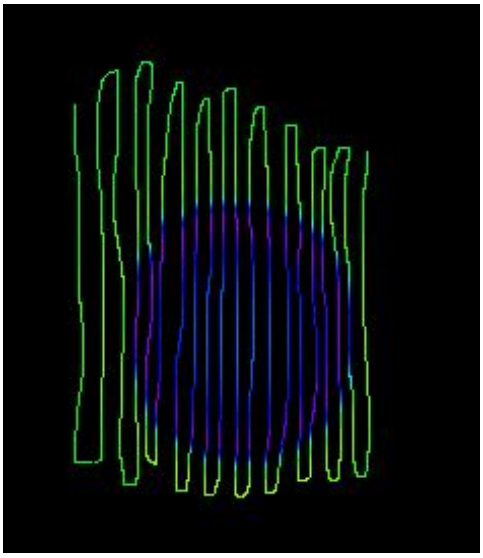

Fig. 3. 2D picture of the magnetic field of the round magnet

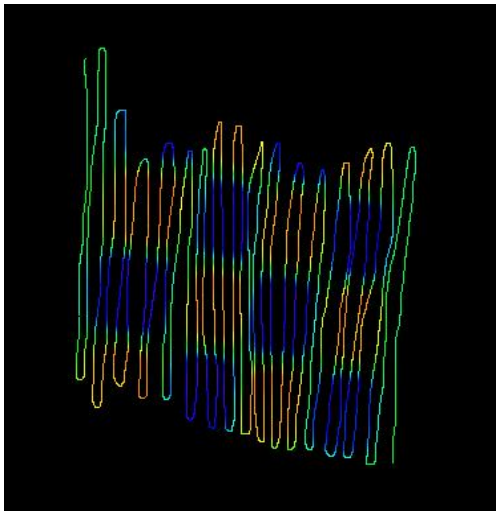

Fig. 4. 2D picture of the magnetic field of the 4x4 square magnets

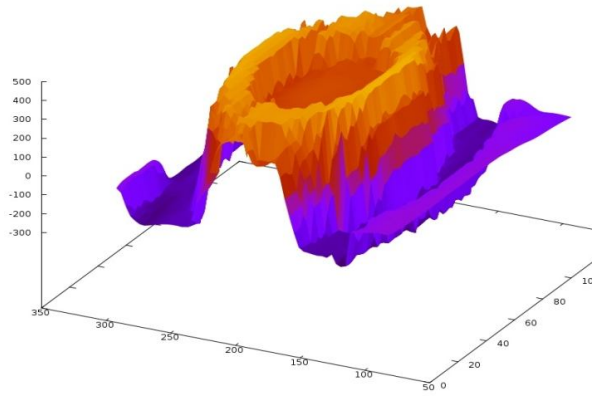

Fig. 5. 3D plot of the magnetic field distribution of the round magnet

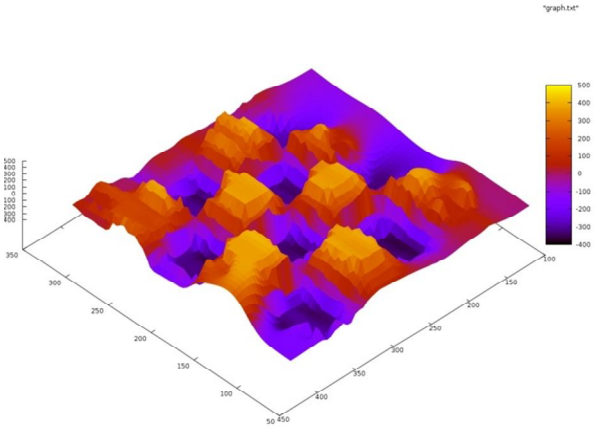

Fig. 6. 3D plot of the magnetic field distribution of the 4x4 square magnets.

IV. CONCLUSION

The designed device is compact, has a simple design, cheap and easy to use. Despite its simplicity it allows to measure low magnetic fields, thus it can be used for the magnetic nondestructive testing. The work was carried out with the financial support of The Ministry of Education and Science of the Russian Federation State Contract №20.740.11.0070

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