References

1. *Černecký, J. - Pivarčiová, E. - Dubovská, R.*: Holography and its technical applications. Radom : Poľsko, 2003, pages 283-289.
2. *Králik, M.*: Automated design of production-conditioning systems. Manufacturing Engineering. Košice: TU, 2004, pages 29-31, ISSN 1335-7972.
3. *Lipták, P. – Barborák, O.*: Automation and robotic systems in a special engineering technology, 8 a national conference with international participation "Automation / Robotics in theory and practice – ROBTEP 2006“, TU Košice, 31.5.-2.6.2006, Jasná – Nízke Tatry, ISSN 1335-2393.

* * *

Павол Божек, PhD, профессор, Словацкий технический университет, Братислава, Словакия

Ото Барборак, PhD, доцент, Университет Александра Дубчека, Тренчин, Словакия

Ю. В. Турыгин, доктор технических наук, профессор, Ижевский государственный технический университет, Россия

Численное моделирование испытаний робота

Разработана информационная система качества управления и автоматизации испытаний робототехнических средств. Численное моделирование реализовано на основе системы автоматического сбора и анализа данных промышленной эксплуатации роботизированных средств. Предлагаемая новая информационная система эксплуатационного и испытательного процессов позволяет осуществлять контроль в соответствии с заданными условиями. Критерии оценки подтверждены в лабораторных условиях. Применение численного моделирования позволяет автоматизировать процесс оценки функционирования системы с учетом установленных критериев и повысить качество ее функционирования.

Ключевые слова: робот, информационная система, численное моделирование, автоматизация

Получено 12.04.10

УДК 681.586

Jozef Šuriansky, PhD, Prof., Faculty of Environmental and Manufacturing Technology,
Department of Informatics and Automation Technology;
Mária Hrčková, PhD, Faculty of Environmental and Manufacturing Technology,
Department of Informatics and Automation Technology
Technical University in Zvolen, Slovakia

IDENTIFICATION OF THE VEHICLE ACCORDING TO MAGNETIC TRACK

Identification, control and evaluating system for analysis of the object magnetic signatures is presented. A measuring unit with HMR sensor and control and evaluation system are described. The results achieved during measurements with their interpretation are given.

Keywords: magnetic sensor, object identification, magnetic field, measurement system, automated system

1. Introduction

The object´s magnetic signature is combination of disturbances caused by the presence or by the movement of the object in magnetic field. These signatures we can measure, record an this record can be analysed.

Every object, which is in the magnetic field causes its disturbance. This disturbance is called as a object magnetic signature. Depending on material permeability and geometric sizes of the object, batch off the largeness of the magnetic field disturbance.

Objects, such as vehicles, also contain a feromagnetic materials, which deform surrounding magnetic field. But the desintegration of feromangetic materials in vehicles is differ from the type of the vehicle, also the disturbance of mangetic field caused by the presence of the vehicle is different.

One of the main peripheral influence on magnetic signature of the vehicle is Earth magnetic field. The interaction between Earth magnetic field and own magnetic field of the vehicle producing magnetic signature of the vehicle. The result field is given by the sum of intesities of geomagnetical and own field of the vehicle. Horizontal an vertical part of the field is a function of vehicle geographic position and orientation of magnetic moment with respect to geomagnetical field [6]. By measuring of the object´s magnetic signature we can get information about properties of the object, or we can sort or identify the objects.

The measurement of the object´s magnetic signature can be done by two ways. First way is a case, when the object is moving and the sensor is in a fixed position. In second case, the sensor is moving and the object is fixed.

2. Theory

2.1. Magnetization vector

By [1], the macroscopic volume of the continual magnetic consists of the elementar magnetic “dipoles” sufficiently small, so the arbitrarily small volume $d\tau$ contains sufficiently big number of the “dipoles” with the moment $\vec{m}$ and the subject has no magnetic “graining”.

Magnetic dipol is characterized by the vector quantity – magnetic dipole moment $\vec{m}$. In case of current loop we can evaluate it by formula

$$\vec{m} = I\vec{S} \ \ [\mathrm{A.m^2}] \qquad (1)$$

where I is current through the loop and $\vec{S}$ is oriented area limited by the dipole loop. Vector $\vec{S}$ is oriented face to plane of the loop and from the equation (1) we can see, that the same direction has also the vector of dipole moment. If the direction of the current in loop is changed, the direction of the vector $\vec{m}$ will be changed too.

Assuming that, the material has no magnetic history and is not in external magnetic field, it will not has any external magnetic properties, because we can assume, that moments in subject are distributed statisticaly uniformly to all directions and their effects are in space and time self compensated due to the thermal motion.

According to the macroscopic theory the decrease of magnetic field in diamagnetic we can express by the presence of magnetic moments directed against the vector of magnetic induction. If we put the subject into the magnetic field with the induction $\vec{B}$, the subject dipoles under the influence of the rotary moment $\vec{m}x\vec{B}$, will tend to rotate to the direction of the vector $\vec{B}$.

The activity ratio of arragement of the moments to the direction of field will depend on the intensity of the field $\vec{B}$ in subject. In the upshot, in the subject the “polarization” of the moments will be created, which will be proportionate to the quantity and latgeness of the each moments and volume.

The vector sum of the magnetic moments in volume element defines the vector value

$$\vec{M} = \lim_{\Delta\tau \to 0} \frac{\sum_i \vec{m}_i}{\Delta\tau} \text{ [A.m}^{-1}\text{]} \quad (2)$$

which is called magnetization or vector of magnetization $\vec{M}$. We can see, that formula (2) expresses the vector volume density of the magnetic moments. In unmagnetizated area are idividual moments statisticaly adjusted to all possible ways, and in case $\vec{M} = 0$. In case of identical moments $\vec{m}$ in choosen direction with volume concentration n the magnetization can be expressed as

$$\vec{M} = n.\vec{m} \text{ [A.m}^{-1}\text{]} \quad (3)$$

and in case of continual configuration of the moments can be expressed as

$$\vec{M} = \frac{d\vec{m}}{d\tau} \text{ [A.m}^{-1}\text{]} \quad (4)$$

2.2. The mesauring system with sensor HMR2300

The measurement system being described is composed from the rotary system and sensor. In rotary system the sensor HMR2300 is placed. This system is driven by step motor, which is controlled by processor. Processor provides the control of the motor, adjusts the sensor to his default position and stops the measurement when sensor reached his final position.

The start of the measurement and processing of the measured data is realized by the PC.

Sensor HMR2300 (fig. 1) is anisotropic magnetoresistive sensor by Honeywell.

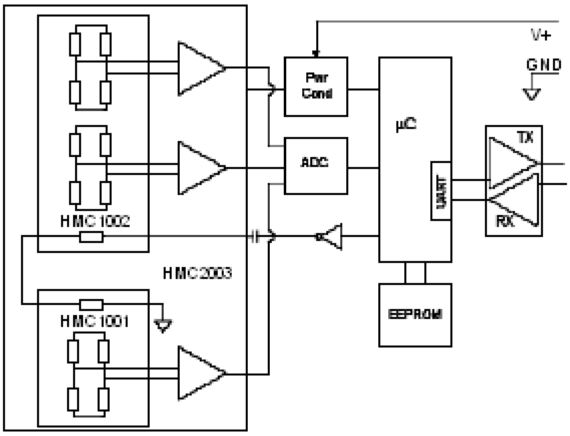

Fig. 1. Block diagram of sensor HMR2300

By [2], it is a three axis digital magnetometer, which measures the intensity and direction of the magnetic field.

Sensor consists of three one another normal magnetoresistive sensors, that permits to measure each part of magnetic field in direction of axis X, Y and Z. The output voltage of the sensor corresponds to the induction of the magnetic field and can be described by the following formula:

$$\Delta V_{OUT} = \left(\frac{\Delta R}{R}\right) V_b \text{ [V]} \tag{5}$$

where:

ΔV_{OUT} – output voltage from the sensor [mV]

ΔR – is a change of the resistance of the resistive elements in bridge [Ω]

R – is resistance of magnetoresistors in bridge [Ω]

V_b – is supply voltage of the [mV]

The output signal from the sensor is process in 16-bit analog-to-digital convertor. The adjustements of the working parameters of the sensor are placed in the memory of the sensor.

Data communication is fully duplex and is realized by RS 232 interface.

Properties of the sensor HMR2300:

- range ± 2 gauss,
- resolution < 70 μgauss,
- digital output of all three measuring axis with resolution 16-bits,
- communication through RS 232.

The sensor HMR2300 transmits three 16-bit information about the intensity of measuring field. Output data format can be in ASCII code, or it is accessible as binary value in hexadecimal code. By the type of choosen data format, the baudrate and the number of measurements per second is choosed. This number can be from 10 to 154 measurements per second.

The sensor contains a feature of external field suppression. By [2], the sensor measures the actual value of magnetic field and this value is evaluated from other measured values. By this way, the output data from the sensor correspond only to disturbance of magnetic field caused by object presence.

Most low field magnetic sensors will be affected by large magnetic disturbing fields (> 4 – 20 gauss) that may lead to output signal degradation. For reduction of this effect and for increasing the output signal, the magnetic "switching" mode applied on bridge is used. This mode eliminates effect caused by affect magnetic field from the past.

The purpose of set/reset strap is to set the sensor to his most sensitive state for measuring of magnetic field. This is done by conducting of current through set/reset strap. This strap differs from offset straps, because it is magnetically connected with magnetoresistive sensor in normal axis – insensitive axis. If the sensor is in state set (or reset), it measures with low noise and higher sensitivity. To provide the higher sensitivity we have optimized the control signal for magnetoresistive sensor, [7].

2.3. Control program

To set the wanted parameters of the sensor and to start the measurement serves the original program (fig. 2), which generates the competent commands. Beside these commands, it take care on communication with position system. It generates starting commands for position system and also provides the data collecting.

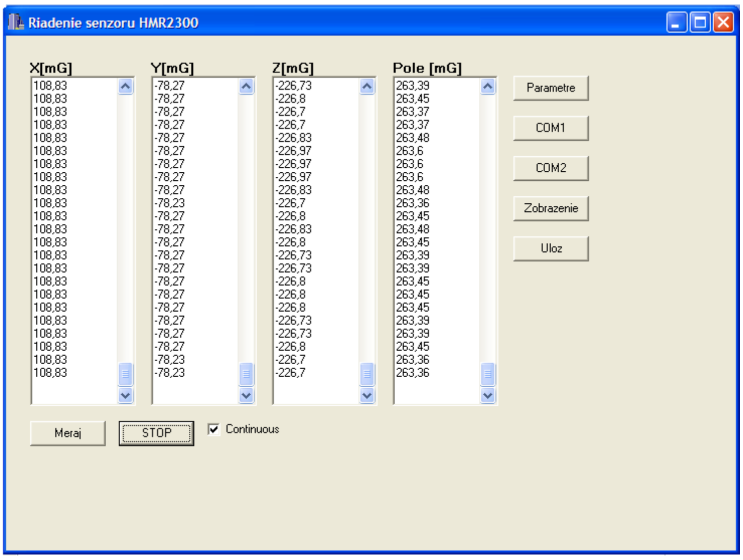

Fig. 2. Window of control program

Beside the generating commands for the sensor and position system, program can visualisate the measured data, like in numerical representation and also in graphical representation in all three axis and calculation and visualisation of absolute magnetic field.

2.4. Evaluation program

Evaluation program serves for correction and analysis of the merasured data, (fig. 3).

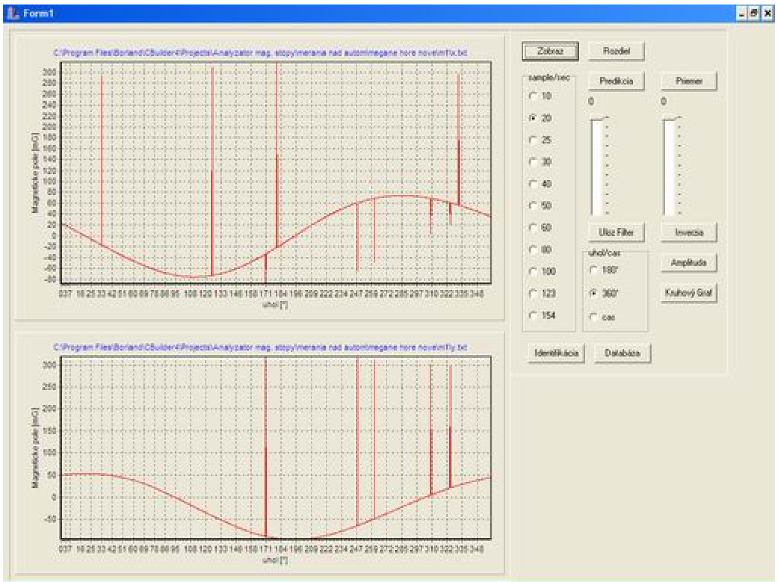

Fig. 3. Window of the Analysator of magnetic signature

By measuring of the magnetic field induction rising the flashes, which have an influence on measurement. Mostly it was slim impulses, which were caused by surrounding electric cables. To suppress these disturbing signals, the predictor 3-th order was realized. To suppress the noise by measured data processing, program uses the averaging filter. Beside the data corrections, program containes also database of magnetic signatures and identification module of processing magnetic signature. The visualization can be realized eighter in time area, or in depending on position of the sensor against the object.

3. Experiment

With designed system, the measurements of vehicle magnetic signatures were realized.

During measurement the sensor was placed in rotary system, which moves with him in range 0 – 360°.

Because sensor was moving, we can´t use the function for suppression of external magnetic field, which is built in sensor. Therefore, the measurement was realized twice. First time the magnetic field with the object was measured and second time, the magnetic field without object was measured.

The measured data were first processed by the predictor, whereby the influence of surrounding disturbing sources was suppressed and then the data were mathematically processed to suppress the external magnetic field and the object magnetic signature was visualisated.

During the calculation of absolute magnetic signature of the object were the data from axis Z ignored, because this value was changed just a little. As an example we introduced the four different vehicle magnetic signatures – Renault Megane Grandtour, Škoda Felicia, Daewo Espero a Fiat Brava, which was measured by this system, (fig. 4). The sensor was placed 20 cm away over the objects.

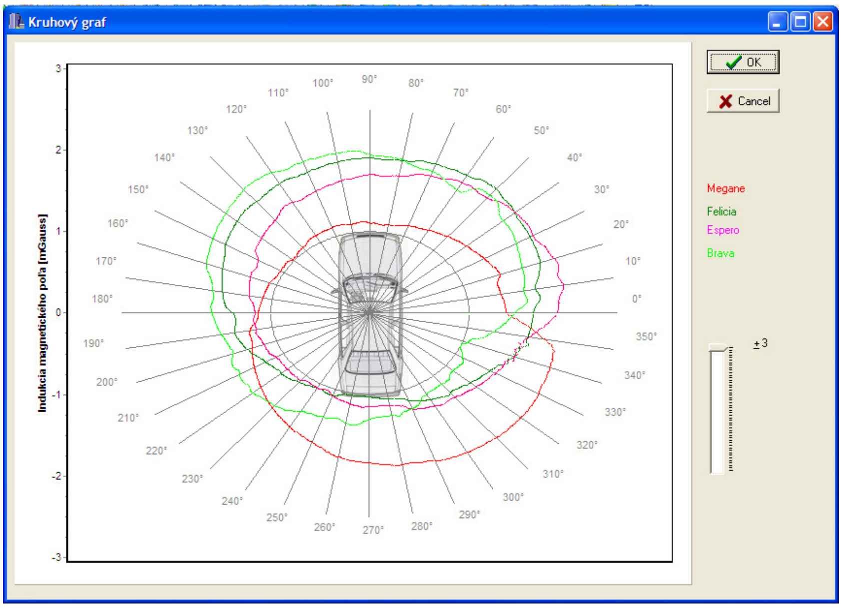

Fig. 4. Magnetic signatures of the vehicles after the suppression of external magnetic field

4. Conclusion

The signatures of the object were different in behavior. To comparation of these signatures, were their amplitudes corrected to the same range. From the results followes, that the object can be identifie by the behavior of his magnetic signature.

Magnetic signature of the object is the unique identification sign, which can be used for object identification. A described measuremnt system allows to measure the magnetic signature of the objects placed in the magnetic field. After data processing by the system and their describing by the characteristic vector will be possible use this system for identification of the objects placed in the magnetic field.

Literature

1. *Tirpák, A.*: *Electromagnetism.* Univerzita Komenského, Bratislava, Bratislava 2004, ISBN 80-88780-26-8.

2. Smart Digital Magnetometer, Solid 12001 State Highway 55, Plymounth State Electronics Center,

3. 1 – and 2 – Axis Magnetic Sensors, Solid State Electronics Center, 12001 State Highway 55, Plymounth, MN 55441.

4. *Virius, M.*: C++ Builder 5.0 – podrobný průvodce, Grada, 2005.

5. *Porubský, M., Šuriansky, J., Adamec, A.*: Options magnetic-resistive uses sensors to measure the stationary magnetic field, III. Scientific Conference with international participation, Zvolen.

6. *Božek, P.*: Automated system project for testing of vehicles performance subgroups. In: Materials Science and Technology [online]. - ISSN 1335-9053. - Roč. 5, č. 1 [cit. 2005-03-29] (2005).

7. *Porubský, M., Šuriansky, J., Adamec, A.*: Possibilities of Magnetoresistive Sensors Sensitivity Increase, Internacional workshop control and information technology, Ostrava, Sept. 2007, ISBN 978-80-248-1567-1, P. 221.

* * *

Йозеф Шуриански, PhD, профессор, Технический университет, Зволен, Словакия
Мария Хрчкова, PhD, Технический университет, Зволен, Словакия

Позиционирование транспортного средства по магнитной дорожке

Дано описание системы ориентации, управления и оценки для анализа магнитных знаков объекта. Описаны измерительное устройство с магниторезистивными датчиками фирмы Honeywell (HMR) и система управления и оценки. Приведены результаты измерений и их интерпретация.

Ключевые слова: магнитный датчик, опознавание объекта, магнитное поле, измерительная система, автоматизированная система

Получено 05.02.10