Sensor's Arbitrarily Location Mapping to the Computer in High Resolution Image Reconstruction Experimental Devices

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Abstract - **The primary objective of this paper is consideration of the several methods, permitting quick and easy mapping of the sensors position during near field measurements. Measured field's data (amplitudes and phase) in high resolution image reconstruction experimental devices must be mapped in the computer Cursor Position (CUP). The main goal is construction of a high-speed device for measurement and recording to the amplitude and phase information of the reflected electromagnetic wave over a two-dimensional surface appropriate to the exact space coordinates.**

I. INTRODUCTION

There are several theoretical methodologies and approaches for solution of inverse problems – based on reflected field determination of the shape and position of metallic and/or dielectric bodies embedded within a dielectric media as well as determination of dielectric parameters of the body suppose. For more efficiency monitoring pulses which have wide frequency spectrum are used. They are working pretty well in case of computer simulation using direct and inverse problems solution, when we use precise values of reflected field [1,2].

In reality we need to use mentioned method for real-life experiments. According to the [1] the sequence of operations must be followings: the impulses of the EM field via antenna expose the earth. The part of the EM field's penetrates inside the earth and then reflected one brings information from the composition of the ground and objects inside. In order to visualize and reconstruct the image it is necessary to measure reflected field's pulse on some surface above and along the earth. The time delay and behavior of the reflected field upon the screen of the measuring surface contains information we need. Then several problems arise to build properly measurements systems: choosing the best shape of the pulse which penetrates dipper, considering spectral characteristics of the illuminated and receiver antennas together with amplifier's - Consideration of the Sensors Gain-Phase Characteristics [3], to choose the best way of the quick and high-speed measurements in order to get image in real time.

Motivation of this paper is to consider last problem, more specifically, how easy and quick measured data put to the computer into the corresponding space mapping for high speed image reconstruction device. One of the options is to build several antennas along the line, periodically illuminating and getting information from each antenna using commutator and step by step moving the line going straight on. Such device was built in the beginning. But there are current system shortcomings. Every antenna has own amplifier with different characteristics, commutator is not ideal putting extra noise to the amplifiers one which all together gives not adequate, noisy data. But worst is that to get information from one screen (1.5x2.0 m^2) takes almost 20 minutes. Such device is huge and nonmobile.

The idea of the proposed method is to use one sensor-receiver antenna with system, which could be able mapping into the computer arbitrary position of the hand-off sensor, navigated by operator through the relations to the fixed point. In case of immediate mapping every displacement could be synchronized with pulse generator getting quick respond from the earth. There are several options for solution this problem:

- Unfortunately, distance measurements accuracy of Global Positioning System (GPS) is not good for solution this problem; otherwise it would have been done.
- An ultrasonic measurement of the distance is not reliable and demands big vertical plates.
- The accuracy of laser system for distance measurements is very high but they are expensive and also, demands orthogonally related reflected pates which could be mowed.
- Position mapped system based on rope or cable can be also done. One of the ideas is to move sensor uniformly around the cylinder along the Archimedean spiral. But action period of such system cold not be high and difficult to manage.

II. DISCRIPTION OF THE PROPOSED SYSTEMS

Two systems we considered below and, suppose, are lack of the mentioned shortcomings.

1. There is a light sensitive sensor located on a movable measuring device. Examined area is illuminated by a LCD projector. Considering the projector’s resolution, let as say, it is 640x480 pixels; it displays a moving dot, which line by line scans examined area. When the light sensitive sensor’s position matches with scanning point position, by means of known coordinate transform, the position of the sensor and the measuring device could be calculated.

2. There is a light source on the movable measuring device and a camera pointed to the examined region. Camera monitors the motion of the measuring device continuously and with known coordinate transform precise coordinates may be written to the measurement matrix with the measured data. Since the surface of measured area may not be perfectly plane, the measuring device will experiment inclinations. It is very important to account for changes in orientation of receiving sensors. This problem is solved by use of auxiliary equipment. A vertical luminous strip is mounted on the measuring device. It’s movements are monitored by a camera, and inclinations are calculated with computer software. An example of such operation can be seen at Fig.1
The luminous strip on Fig.1 is made from red light-emitting diode. In order to monitor only the red strip the camera has a red filter and can be also blended. As it is shown on Fig. 1. the software is able to recognize also the angle between the strip and a vertical line, and it also can calculate the center of the strip (lower part of the image). Software itself was programmed using labview, image vision, css pcw. The hardware part is based on microchip RISC processor and is connected to PC by USB and com port.

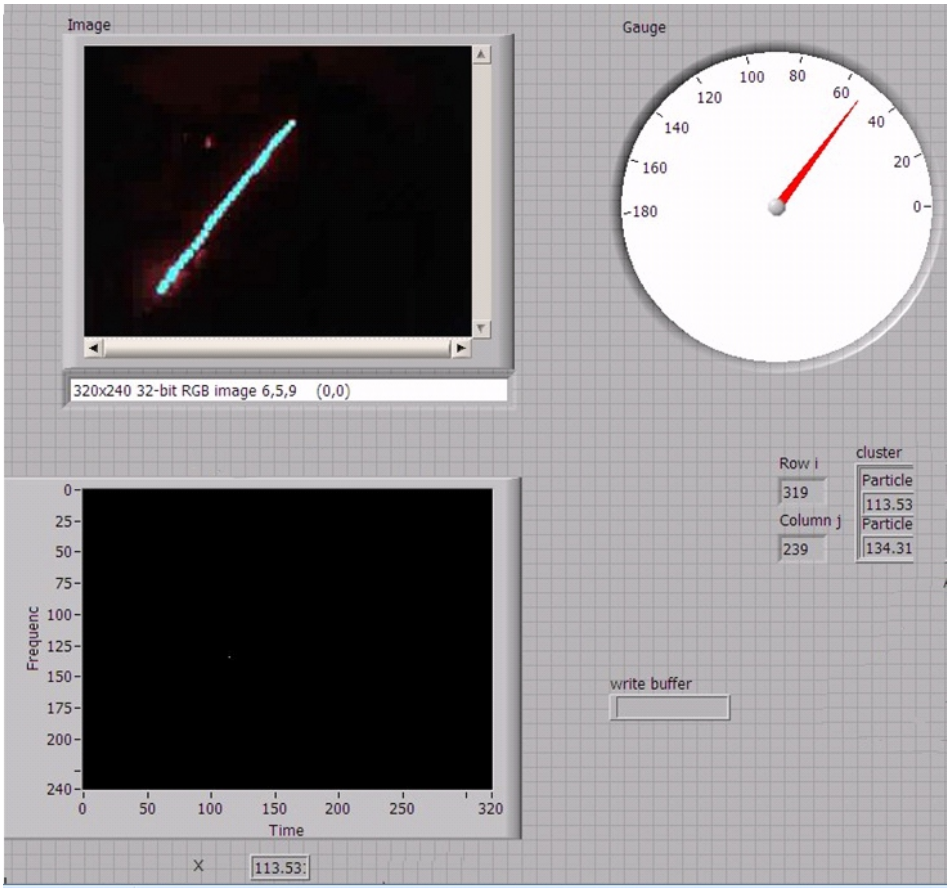

Fig 1. A luminous strip is being bent, the software analyzes video input and shows the angle of the strip and a vertical line. The dot on the lower screen represents the center of the strip

III. EXPERIMENTAL DATA

Let us consider a real life scenario. We will use a Hall's sensor to visualize a hidden toroidal magnet. In the experiment a red LED was mounted on top of the Hall's sensor and a camera with a red filter was monitoring examined area. By random movement of the sensor on the examined plane the field data represented as byte (0-255) values were recorded. The software, which analyzed the video input, mapped measure data with corresponding coordinates resulting in an image reconstruction of the magnet's surface like presented on Fig. 2.

The Hall's sensor was moved in random directions on the examined plane surface, located in the space of the magnet field source behind that surface. The measured data was recording to a matrix with coordinates calculated by our software based on video input of the camera.

As it can be seen from Fig. 2, the field measurments with coordinate mapping enabled us to visualise toroidal magnet's form by arbitrary scanning of examined area.

It should be noted that very simple and cheap web-cams were used in this experiment. A problem with dynamic range of the camera can arise, since in filed experiments difference between dark and light areas can be very big. In our experiment this problem was solved by the use of red LED's and red filter in the camera.

The image of the toroidal magnet field on the Fig. 2 is rough just because the size of the Hall's sensor was big but precession of the mapping approximately is 1mm.

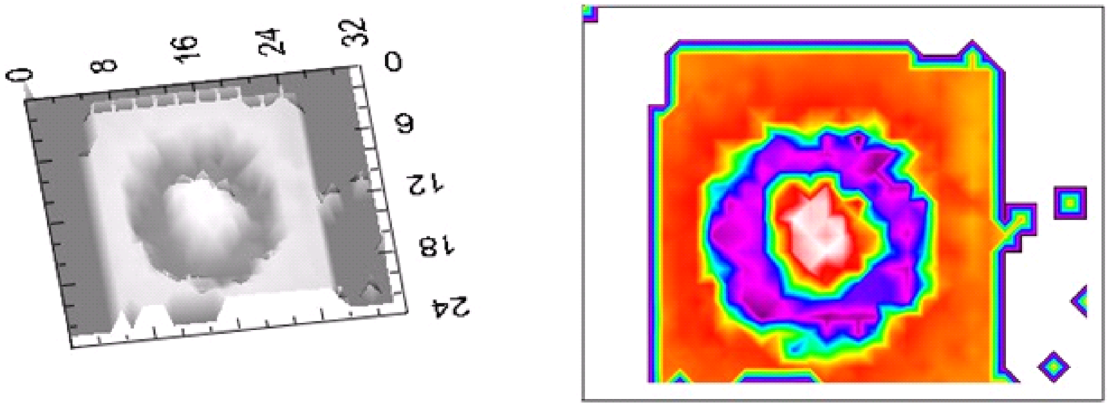

Fig. 2. Toroidal magnet visualisation by Hall's sensor. The scale on the figure is in millimeters. Halls sensors's size is around 1mm.

In addition to described above methods one more method can be considered. It is so called "substruction" method. There is a moving object (a red LED) and a monitoring camera with a narrow red filter. We can find difference between current frame and previous one by substructing one frame from the other. The resulting difference is equivalent to the movement of the examinged object during the same time interval.

CONCLUSIONS:

Several methods, permitting quick and easy mapping of the sensors position during near field measurements were discussed. Two methods of coordinate mapping were presented and realized in practice. Results of real-life experiment performed for laboratory use were shown. It is obvious, suggested methods of measurements must be realized for outdoor measurement combined with high resolution image reconstruction program package. This is we suppose to realize in future.

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