AUGMENTED REALITY FOR PHYSICAL FIELD VISUALIZATION MEASUREMENTS

Valentin Mateev
Technical University of Sofia, Sofia 1756, 8 Kliment Ohridski blvd., *e-mail: vmateev@tu-sofia.bg*

Abstract: In this work is presented a computer aided system for augmented reality generation. The system is applicable for advanced field data visualization activities such as non-destructive testing and examination; industrial testing and inspection; biomagnetics; education, etc. This system makes possible combination of different data sources in one virtual reality world that can be used for simultaneous dynamic visualization. This type of integrated visualization systems allows engineering problems to be visualized and analyzed more effectively and to acquire closer interaction in the process with the observer.

Key-Words: augmented reality, visualization, field measurements

1. Introduction

Augmented Reality is a fast emerging visualization technology which could take place in all kinds of human activity. It could be defined as a real-time view of a physical world environment that has been enhanced or augmented by adding virtual computer-generated information over it [1]. Augmented Reality as technology has the potential to influence significantly not only the communication and entertainment applications, but also practically all data visualization means in industry and science [1-5].

In this paper we are presenting a computer aided system for Augmented Reality generation. The system is applicable for advanced observations in field data visualization activities such as non-destructive testing and examination; industrial testing and inspection; electromagnetics and biomagnetics; education, etc. This system makes possible combination of different data sources in one virtual reality world that can be used for simultaneous dynamic visualization.

Many physical fields such as thermal, electromagnetic, mechanical can be measured and visualized over a video stream, generated by virtual reality engine.

2. Augmented Reality Visualization System Architecture

The main task of the proposed system is to perform an effective visualization, combining multi-physical field data with 3D quality video stream in close to real-time mode. The augmented effect is related with the ability to observe the components of physical field (e.g. field intensities, flux densities, field gradients, temperatures, etc.) over the inspected object or even inside its volume. Primary fields included are electric, magnetic and thermal fields due to presence of fast and reliable solver engines for them. The parallel reality system architecture is shown in Fig.1. System contains: Input devices that acquire data from the real world, virtual reality processing kernel and output visualization devises.

Input devices are: measuring physical field data from the real world; perform video stream capture; position/orientation data for quality visualization overlapping. Most often those are video camera device or pair of cameras, automatic field measurement devices or even sensor networks that can collect necessary data to parallel reality system processor and position/orientation sensors.

Dynamically collected data is segmented and translated to virtual reality 3D kernel. System kernel is VRML based [4, 5]. System kernel can use also data from field analysis block- data solver, which provides reconstructed or calculated field visualization pictures.

Output devises must allow coordination of the human operator behaviour with virtual reality engine and most important close and realistic visualization for the system user. [1-3]

3. Magnetic Field Imaging Arrays

Sensor array design depends largely upon the specific application. Arrays can include two- and three-axis magnetic sensors to measure vector fields. They can be configured as extended one-dimensional arrays to survey a wide area in a single pass. Two-dimensional arrays of sensors can be left in place to survey an area without moving the array.

The design of a two-dimensional array with 9 sensors is shown in Fig. 2. Each sensor is a single integral Hall's effect or magneto-resistive sensor (MR). They are connected in parallel with a common supply and ground. An example of a two-dimensional array of seven sensors is shown in Fig. 4.

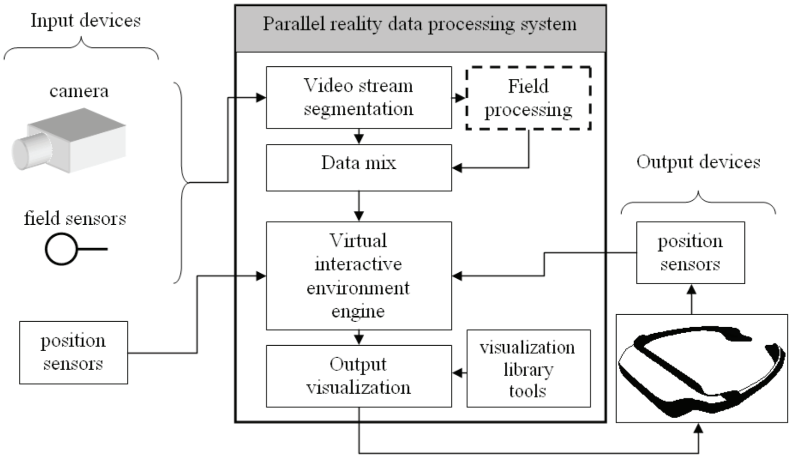

Fig.1. Augmented reality system block scheme.

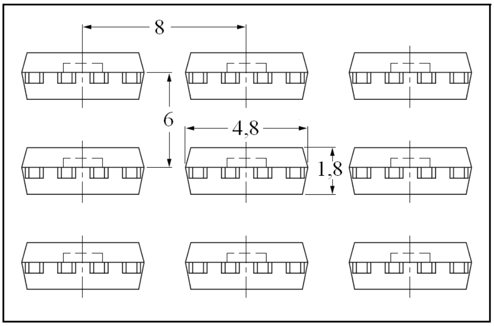

Fig.2. 3x3-element square array.

This array can assure direct magnetic field image as well as field gradient in XZ plane. [8]

The total width of both arrays is 16 mm and the length is 22 mm. They are detecting the vertical component (y) of the magnetic field.

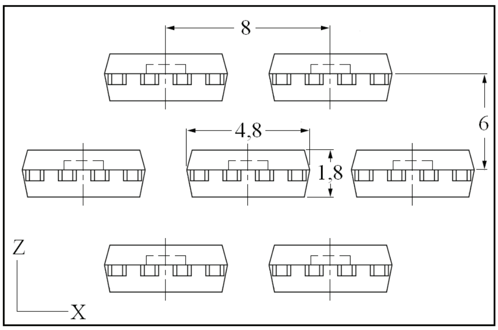

Fig.3. 7-element hexagonal array.

4. Magnetic Field Solver and Visualization

Measured magnetic field data could be used for field source reconstruction calculations, before visualizing it into the video stream. [6-8]

Magnetic flux density caused by 3D source could be calculated by the Biot-Savart law (1).

$$B_y(x,y,z) = \frac{\mu_0}{4\pi}\int_\Omega \frac{J}{r^2} d\Omega \quad (1)$$

Where $B_y(x,y,z)$ is the magnetic flux density *y*-component in (*x, y, z*) position around the field source;

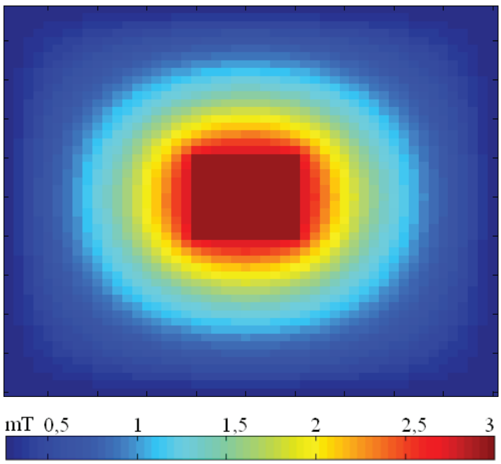

Fig.4. Calculated B_y distribution.

r - distance vector between measurement sensor position and the source;

J - source current density;

Ω - area of interest.

Biot-Savart solver is simple and relatively fast method as program realization and implementation. Example of combined magnetic field flux lines and coil image is shown in Fig.5.

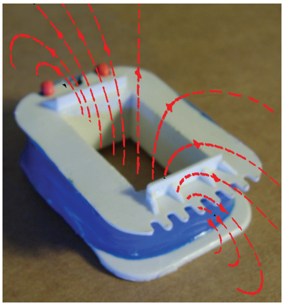

Fig.5. Parallel reality – coil with its magnetic field flux lines in one visualization set.

5. Conclusions

The proposed system allows the integration of various data collection methods types, Fig. 2. It supports also the integration of an additional analytic component, field calculator, into this complex virtual environment. This type of integrated visualization tools allows engineering systems to be visualized and analyzed more effectively in brand new observation level.

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Information about the Author:

Valentin Mateev Mateev, M.Sc. in Electrical Engineering (2004), TU-Sofia, PhD (2015). Assistant professor at the Department of Electrical Apparatus, Faculty of Electrical Engeniaring, TU-Sofia. Field of interest: computational electromagnetism; magnetic field measurements and sensors; visualization.

РАСШИРЕННАЯ РЕАЛЬНОСТЬ ДЛЯ ВИЗУАЛИЗАЦИИ ИЗМЕРЕНИЯ ФИЗИЧЕСКИХ ПОЛЕЙ

Валентин Матеев
ТУ -София, гр. София 1756, бул. "Климент Охридски" 8, *e-mail: vmateev@tu-sofia.bg*

Резюме: В докладе представлена компьютерная система для создания расширенной реальности. Система применима для визуализации наборов данных при: неразрушающем контроле; производственном контроле и испытаниях; био-магнитных применениях; образовательных целях и др. Эта система осуществляет сочетание различных источников данных в одной общей виртуальной среде, которую возможно использовать для динамической визуализации в реальном времени. Этот тип интегрированных систем позволяет проводить более эффективный анализ и визуализацию при решении широкого круга инженерных задач в тесном взаимодействии с пользователем.

Ключевые слова: расширенная реальность, визуализации, измерения полей

РАЗШИРЕНА РЕАЛНОСТ ЗА ВИЗУАЛИЗАЦИЯ ПРИ ИЗМЕРВАНЕ НА ФИЗИЧНИ ПОЛЕТА

Валентин Матеев
ТУ-София, София, бул. "Климент Охридски" 8, *e-mail: vmateev@tu-sofia.bg*

Резюме: Тук е представена компютърна система за създаване на разширена реалност. Системата е приложима за визуализация на масиви от данни при: безразрушителен контрол; индустриални инспекции и изпитания; био-магнитни приложения; образователни цели и др. Тази система осъществява комбинирането на различни източници на данни в една обща виртуална среда, която е възможно да се използва за динамична визуализация в реално време. Този тип интегрирани системи позволяват по-ефективни анализ и визуализация при решаване на широк кръг инженерни задачи, при тясно взаимодействие с потребителя.

Ключови думи: разширената реалност, визуализация, полеви измервания