ALGORITHMS OF INTERPOLATION AND VISUALIZATION OF LOW FREQUENCY MAGNETIC FIELD BY USING EXPERIMENTAL DATA

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Abstract

For a special magnetotherapy device (magneto bed) the magnetic field is measured in special points and obtained as a set of scalars. The measurement points are: the centers of coils and the middle of the interval between centers. At any moment only one pair of coils is active. The order of the choice of pairs of coils is defined by a data table. We present the algorithms of the interpolation of magnetic induction value in a given point of an interval and visualization of results.

1. INTRODUCTION

For a magneto bed it is possible to measure the induction value in the coils centers and in the middle of the connecting them line. The results are scalar.In [1] we proposed a mathematical model for the interpolation on the obtained data. In this work we describe the algorithms of interpolation and visualization of results.

2. THE STATE OF THE PROBLEM
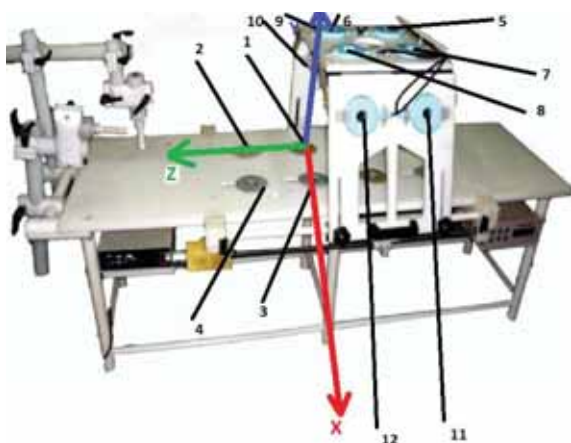
We consider the following magnetotherapy device.

Fig. 1. Magnetotherapy device

The number of every coil and the coordinate system XYZ are shown on the Fig.1. Measurement has been done for every pair of coils. The first coil of pair is denoted by "A" in the table and the second coil in the pair by "B". In the table there are coordinates of every point of measurement. For every pair of coils the measurements have been done at 3 points. The first and the second points are in the centers of the two coils and the third point of measurement is on the middle of the line between the centers of two coils of the pair. In every moment only one pair of coils is active. In the process of the system functioning every pair of coils is active by turns, and a movement of magnetic field occurs. The order of the choice of pairs of coils is defined by a data table. It is necessary to provide interpolation on the line of every pair of coils on the base of result of measurement in three points and visualize results.

3. MATHEMATICAL MODEL

As it was shown in [1] the most appropriate model in this case is L'Agrange one-dimensional square interpolation. The formulas for calculation are given below.

Here f_i are experimentally obtained values in interpolation nodes: f and f_2 are values in centers, f – in the middle of the segment.

For a point (x,y,z) consider the polynomial

$$(x,y,z) = \prod_{=,\,\neq i}^{2} \frac{\sqrt{(x-x_i)^2+(y-y_i)^2+(z-z_i)^2}}{\sqrt{(x\ -x_i)^2+(y\ -y_i)^2+(z\ -z_i)^2}}$$

such that

$$(x_i, y_i, z_i) = \ , i \neq$$

$$_i(x_i, y_i, z_i) = \quad ,$$

where l_i – the basic polynomial for the node (x_i, y_i, z_i).

Interpolation polynomial has the form:

$$L(x, y, z) = \sum_{=}^{2} f \cdot \quad (x, y, z)$$

where f_n – the value obtained by the measurement in the point (x_n, y_n, z_n).

Hence to obtain the interpolation value in a point we should calculate the interpolation polynomial in this point.

4. VISUALIZATION CHOICE

As the electromagnetic induction value continuously depends on the point position, for any given pair of coils we at first calculate the induction value in all the points of the segment by step 1 mm. Then we show the obtained distribution of the induction values in a special area in the interface in accordance with the following scheme (B denotes the induction value).

$B \in [\quad , \quad]$ –> blue
$B \in [\quad , \quad]$ –> lightblue
$B \in [\quad , \quad]$ –>yellow
$B \in [\quad , d]$ –> orange
$B > d \quad$ --> red

The user can choose the values of parameters a,b,c,d defining the color distribution. In this implementation the segment [0, d] is partitioned on 5 equal parts, where d is the maximal value of induction in the points calculated. Thus the diagram of color distribution is in agreement with the position of the point the user choose to interpolate.

5. ALGORITHMS

5.1. Interpolation algorithm

1. Choose the row from data file (the pair of active coils)
2. Write chosen data into the array for interpolation
3. Select a point for interpolation
4. Interpolation
5. Is a new pair was chosen?
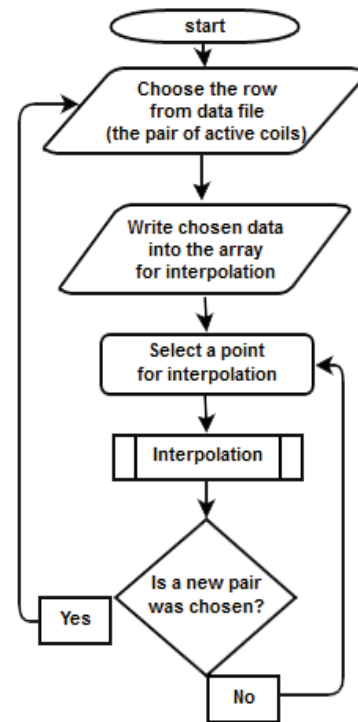   Yes – go to 1
   No – go to 4

Fig. 2. Interpolation algorithm

5.2. Visualization algorithm

1. Choose the row from data file (the pair of active coils)
2. Write chosen data into the array for interpolation
3. In cycle interpolation in the points of the segment connecting the centers of coils by step 1 mm
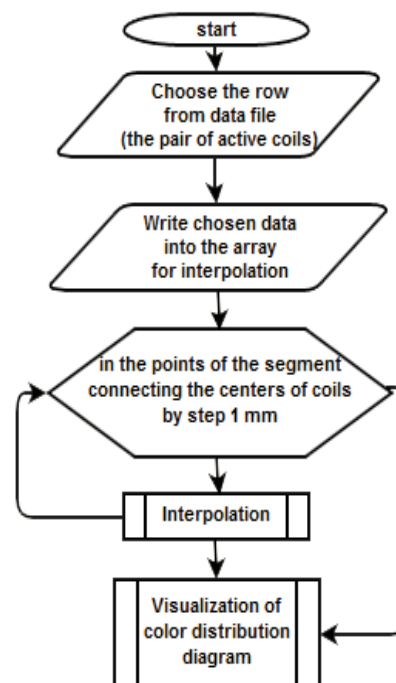4. Visualization of color distribution diagram

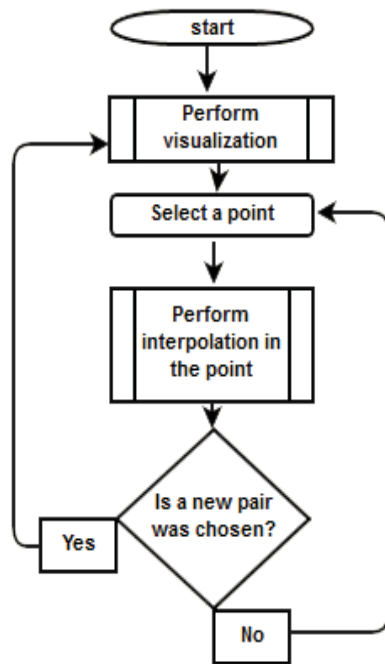Fig. 3. Visualisation algorithm

5.3. The combined algorithm

Fig. 4. Combined algorithm

1. Perform visualization
2. Select a point
3. Perform interpolation in the point
4. Is a new pair was chosen?
   Yes — go to 1
   No — go to 2

6. USER INTERFACE

The interface is shown below, digits note main fields.

Fig. 5. User interface

The user poinst the path to the input file with data obtained in results of experiments (element Input file has .txt format, columns are separated by tab symbol. In the field 2 one can chose a pair of coils (row number in the data table). Elements 3 and 4 are for input of the interpolation point. In 3 we select a point by slider, by using 4 we should point a distance the interpolation point from the left end of the segment. When changing data in 3 or 4 the result of interpolation is shown in 5 in real time. Note that color distribution diagram is drawn in element 6 immediately after the choice of coils, in doing so the position of slider corresponds the diagram.

All the described areas of the interface are shown on Fig. 5.

CONCLUSION

The algorithm of interpolation and visualization of value electromagnetic induction by using experimental data has been designed and implemented. Interpolation in a given point is performed in real time.

Acknowledgements

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