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SOFTWARE APPLICATION FOR THE OPTIMUM INTEGRATED HEAT EMITTING CIRCUITS

There are technical systems which contain heat sources. The examples of these systems are the systems on a chip, radiant furnaces etc. These systems work, mostly, depending on the accommodation of the heat sources they contain. As it has been described in scientific papers, the modern technologies of electronic devices operate using millions of transistors. These transistors work at GHz frequencies. One more factor to mention is the allocation of substantial amount of energy and as a result we have the temperature increase. These thermal effects make a bad influence on the functioning of the systems on a chip. For example, the high temperature causes operation errors and even destroys the microchip. At the design stage of the systems on a chip the developers are trying to solve the problem of placing the elements while allocating heat in order to minimize the bad influence of temperature extremes. The design performed by means of CAD/CAE system is helpful for the mentioned improvements.

Let's consider another example. We have to process the part of machine in the radioactive oven. Firs, there is a need to get the uniform temperature distribution. There are the elements that allocate heat on the walls of the oven. Technically they are placed in a form of matrix. They cause temperature extremes, so, as a result we obtain the needed temperature field. In terms of optimization we have to place the source of the given intensity into one of these matrix cells. CAD/CAE systems help us to find the best solution of placing the sources of given energy.

The perspective method of solving problems of this class is the minimax method of mathematical programming. We have to research the dependence of the solution of boundary value problem on the parameters of sources pacing. Boundary value problems can mostly be solved by the numerical methods in particular by the finite element method. In this paper we consider minimax problem of optimum placement of sources, when the temperature distribution is described by mixed boundary value problem for elliptical level.

This is the mathematical formulation. Let $A(x,y)$ finite function in R^2, which is the carrier of the arbitrary φ-object. So this φ-object will be called the carriers D of physical field carrier and is denoted as $supp\,D$. The function $A(x,y)$ in this case in called the intensity of source D. Let us consider the area Ω in the two-dimensional Euclidean space, which contains the carriers of physical field sources $supp\,D_i$, $i=1,\ldots,m$. Each source carrier is assigned to its own local coordinate system $O_i x_i y_i$, $i=1,\ldots,m$ and each area Ω is assigned to the global coordinate system Oxy. The rotation of the local coordinate system in relation to the global coordinate system is impossible. As a result, the placement of each carrier in global coordinate system is defined by the placement of the starting point O_i of its own coordinate system. In global coordinate system we assign O_i as $z_i=(\xi_i,\eta_i)$, $i=1,\ldots,m$

. So, the placement of all the carriers in global coordinate system is assigned as $Z = (z_1, z_2, \dots, z_m)$ -vector.

The physical field that is induced by the sources and environment is described by the following problem for equations of elliptic type:

$$\frac{\partial}{\partial x}\left(k\frac{\partial u}{\partial x}\right) + \frac{\partial}{\partial y}\left(k\frac{\partial u}{\partial y}\right) = -f(x, y, Z) \quad (1)$$

$$u\big|_{\partial\Omega 1} = \varphi,\ k\frac{\partial u}{\partial n}\bigg|_{\partial\Omega 2} = -q \quad (2)$$

$$f(x, y, Z) = \begin{cases} A_i(x, y, z_i),\ if\ (x, y) \in suppD_i \\ 0, \quad if\ (x, y) \notin \bigcup_{i=1}^{m} suppD_i \end{cases} \quad (3)$$

where $\partial\Omega 1, \partial\Omega 2$ is the sector of boundary of the area Ω, n is the normal to $\partial\Omega 2$, φ, q the functions assigned on $\partial\Omega 1$ and $\partial\Omega 2$, k is the function assigned in Ω.

The function, which depends on the carriers of physical field source is:

$$F(Z) = \max_j u(x_j, y_j, Z),\ j \in \{1, 2, \dots, p\}. \quad (4)$$

where $P_j(x_j, y_j),\ j = 1, 2, \dots, p$ are the fixed points of area Ω.

The problem statement: we need to place the carriers, of physical field so that the assigned function of maximum could get its minimum value on the condition under the carriers of sources are not crossing and remain within the limits of the area.

$supp\ D_i \cap supp\ D_j = \varnothing, i < j = 1, 2, \dots, m$ is the condition, (5)
in which the carriers are not crossing,

$\bigcup_{i=1}^{m} supp\ D_i \subset \Omega$ is the condition, in which the carriers (6)
remain within the limits of the area.

The conditions (5) – (6) define the admissible plural G of Z values. Let us e rewrite the optimization problem:

$$F(Z) \to \min, Z \in G. \quad (9)$$

This optimization problem is classified as a permanent minimax problem. To use the appropriate methods to find the stationary points of function $F(Z)$ on G it is recommended to calculate the partial derivatives of function $u(x, y, Z)$ according to the parameters of placement of the sources.

To solve this problem we have to select a lot of starting points and calculate them. Then we have to choose the best solution.

The algorithm development for solving one type of specific tasks for the discrete sources of physical field optimal placement is a scientific novelty of this research.