A DIFFERENCE SCHEME FOR SOLVING RADIATIVE HEAT TRANSFER ON ADAPTIVE MESHES WITH USE OF MARCHING FOR SLAE

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The implicit finite-difference approximation of the heat transfer equation on an unstructured mesh gives a system of linear algebraic equations (SLAE) which are usually solved with an iterative method. Since the iterative methods are rather expensive and time demanding, the search for more economic ones is under way.

For solving the radiative heat transfer equation on adaptive meshes we constructed an economic difference scheme where the difference equations are solved by marching.

The 2D radiative heat transfer equation is approximated in accord with ROMB ideology. The resulted difference scheme approximates the initial equations within one cell of an adaptive mesh. The 2D difference equations are solved by splitting the 2D problem into a set of simple 1D ones on an unstructured mesh. Figure 1 shows an example of the mesh structure for which the systems of 1D difference equations are to be solved.

For solving the resulted SLAE on adaptive meshes, we developed a method based on stream marching [3].

Comparative results for model problems solved on adaptive fractional meshes are provided. One of these problems is the plane problem of material heating by a heat flow through the left boundary. The initial and boundary conditions are

$$\frac{\partial T}{\partial t} = \frac{\partial}{\partial x}\left[k_0 \cdot T^{\alpha}\frac{\partial T}{\partial x}\right];\ T(0,t) = \left(\alpha D^2 \frac{t}{k_0}\right)^{1/\alpha};\ T(x,0) = 0.$$

The problem has an analytical solution in the form of the traveling heat wave [4]

$$T(x,t) = \begin{cases} \left(\alpha D \dfrac{Dt - x}{k_0}\right)^{1/\alpha}, & 0 \le x \le Dt; \\ 0, & x > Dt, \end{cases}$$

where D is its velocity. Calculation parameters were $\alpha = 3$; $k_0 = 6$; $D = 5$. The calculation region was $[0;10]\times[0;10]$. Calculations were done to $t = 1$ at a step $\tau = 10^{-3}$. The calculation mesh was intentionally taken to be unstructured (Fig. 2) to test the method for "sensitivity" to its irregularity.

Figure 2 shows the spatial distribution of temperatures in the system at times $t = 0.6$ and 1. It is seen from the position of the heat front at these times that the velocity of heat propagations remains the same, $D = 5$. One can also see that the unstructured mesh insignificantly influences the temperature fields in the direction normal to the wave motion.

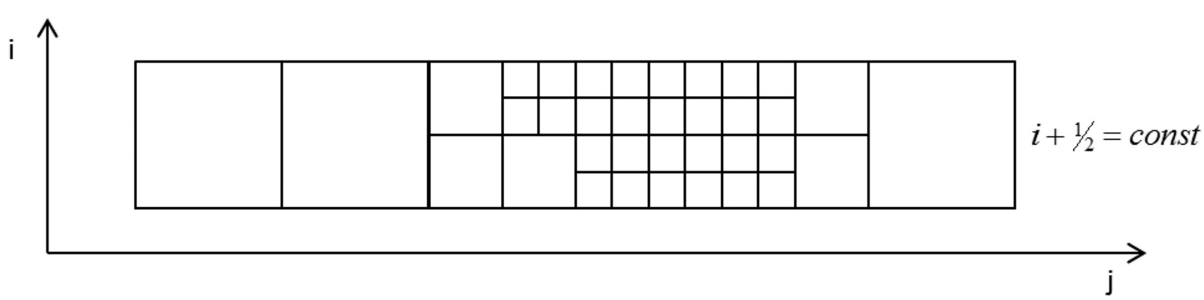
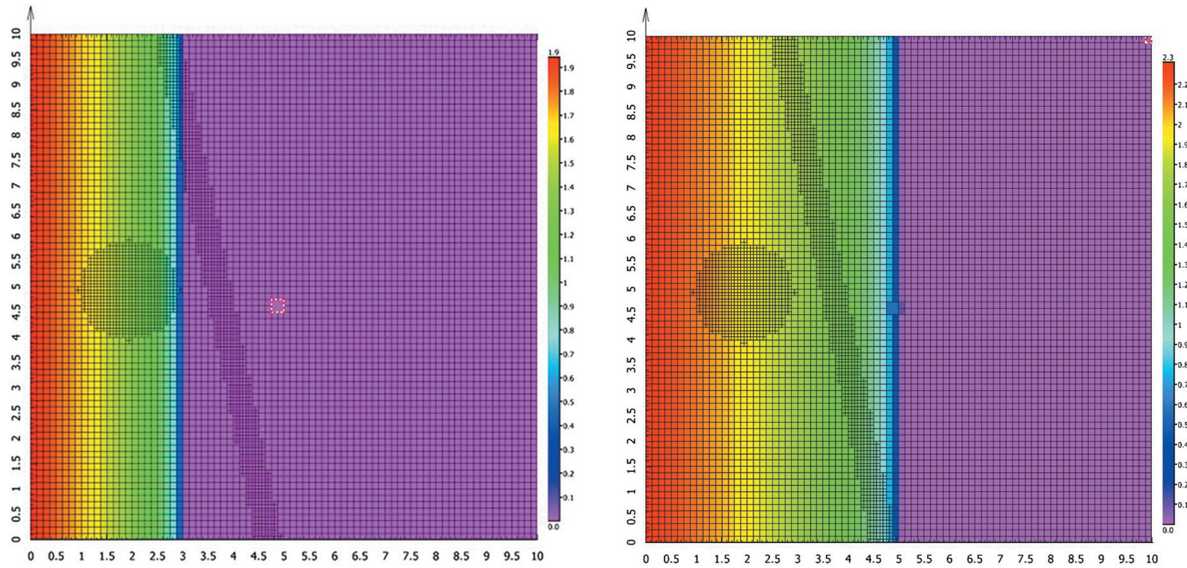


Fig. 1. An example of the unstructured mesh



a *b*

Fig. 2. Temperature fields at $t = 0.6$ (*a*) and $t = 1$ (*b*)

References

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