THE PREDICTION OF COMPETITIVE ENVIRONMENT IN BUSINESS

1. INTRODUCTION

The two dimensional partial differential equations of second order can be used for the simulation of competitive environment in business. The article presents the deduction of equation necessary for calculation, explains the used variables and their interpretation in the competitive environment. The first test case explains the way of the use and calculation and the second case presents the application in practice. The method can be used for the build up of a model of competitive environment in the field of markets, banks, firms, supplier-customer relations, etc.

2. THEORY

Two dimensional partial differential equations of second order will be used for simulation of competitive environment in the form

$$\frac{\partial D}{\partial t} = K_x \frac{\partial^2 D}{\partial x^2} + K_y \frac{\partial^2 D}{\partial y^2}. \tag{1}$$

It is necessary to transform the equation to a suitable form for numerical computation. The equation of the derivation of the first order has the form

$$\nabla D_i = D_{i+1} - D_i. \tag{2}$$

The equation of the derivation of the second order has the form

$$\nabla^2 D_i = \nabla D_i - \nabla D_{i-1} = D_{i+1} - D_i - (D_i - D_{i-1}) = D_{i+1} - 2D_i + D_{i-1}. \tag{3}$$

The equation of the first order for derivation of time t can be written in the form

$$\frac{\partial D}{\partial t} = \frac{D_{t+1} - D_t}{\nabla t}. \tag{4}$$

The partial derivation equation of the first order of variable x can be written in the form

$$\frac{\partial D}{\partial x} = \frac{D_{i,j+1} - D_{i,j}}{\nabla x} \tag{5}$$

and for variable y

$$\frac{\partial D}{\partial y} = \frac{D_{i+1,j} - D_{i,j}}{\nabla y}. \tag{6}$$

The equation of the partial derivation of the second order for variable x has the form

$$\frac{\partial^2 D}{\partial^2 x} = \frac{D_{i,j+1} - 2D_{i,j} + D_{i,j-1}}{(\nabla x)^2} \tag{7}$$

and for variable y

$$\frac{\partial^2 D}{\partial^2 y} = \frac{D_{i+1,j} - 2D_{i,j} + D_{i-1,j}}{(\nabla y)^2}. \tag{8}$$

We can write the equation in the following form when we use the previous equations (4), (7), (8)

$$\frac{D_{t+1,i,j}}{\nabla t} = \frac{D_{t,i,j}}{\nabla t} + K_x \left[\frac{D_{t,i,j+1} - 2D_{t,i,j} + D_{t,i,j-1}}{(\nabla x)^2} \right] + K_y \left[\frac{D_{t,i+1,j} - 2D_{t,i,j} + D_{t,i-1,j}}{(\nabla y)^2} \right]. \tag{9}$$

When we set up the condition $\nabla x = \nabla y$, we can rewrite the equation (9) in the following form

$$D_{t+1,i,j} = D_{t,i,j} + \frac{\nabla t}{(\nabla x)^2} \left[K_x \left(D_{t,i,j+1} - 2D_{t,i,j} + D_{t,i,j-1} \right) + K_y \left(D_{t,i+1,j} - 2D_{t,i,j} + D_{t,i-1,j} \right) \right]. \tag{10}$$

If we substitute

$$K = \frac{\nabla t}{(\nabla x)^2} \tag{11}$$

we can write the final equation in the form

$$D_{t+1,i,j} = D_{t,i,j} + K \left[K_x \left(D_{t,i,j-1} - 2D_{t,i,j} + D_{t,i,j+1} \right) + K_y \left(D_{t,i+1,j} - 2D_{t,i,j} + D_{t,i-1,j} \right) \right]. \tag{12}$$

This equation can be used for the build up of competitive environment model.

3. BUILD OF THE MODEL

The meaning of used variables in the problems of build up of a model of competitive environment is as follows: The values of "cells" of competitive environment $D_{t,i,j}$ with index of time t and system of coordinates i, j are presented by the range from *+100%* to *-100%*, where *+100%* means maximum negative competitive environment and *-100%* means maximum positive competitive environments. The value *0%* means neutral competitive environment. The definition of variable of competitive environment D depends on a concrete application. It can be defined for example by the count of clients of banks, firms, companies and the count of inhabitants in towns, villages etc. The various counts and their changes create the competitive environment. The variable for competitive environment D has the first derivative of competitive environment D' that presents the flow of the competitive environment and the second derivative D'' presents the acceleration of competitive environment.

The value K is a simulation constant. The constants K_x and K_y present the rate of spread of competition environment in direction of x and y. Each cell $O_{i,j}$ is coded in the following manner:

 a) any influence on competitive environment (except initial condition),
 b) solid obstacle (any influence on competitive environment),
 c) positive and constant influence on competitive environment,
 d) positive and variable influence on competitive environment,
 e) negative and constant influence on competitive environment,
 f) negative and variable influence on competitive environment.

The program was designed for the simulation of the competitive environment. The input values are constants K, K_x, K_y, matrix $D_{0,i,j}(n \ x \ m)$ (initial conditions D of competitive environment of each cell in time $T_0 = 0$), matrix $O(n \ x \ m)$ (code of each cell). The last item is the time T_{end}, the end time of calculation of competitive environment.

4. TEST CASE

The process of set up of inputs and presentation of results of calculation of the designed program is done via display. The description of the screen of a program with test data is presented in fig. 1.

The right side of the screen enables to set up the time T_{end} [Time] (the end time of calculation of competitive environment), the delay [Delay] between steps of calculation for displaying, when the stepping is allowed. The check box [Graph] determines whether the data are displayed in the form of figures (it is enabled only for the matrix up to dimension 10x10, there are displayed the codes of cells, their initial and final values of competitive environment D) or by colours (only the matrix of environment competition D is displayed in colours). The check box [Step] determines whether the results of the single step of calculation are displayed with the set up delay [Delay] or only the end state. The course of value of competitive environment D of concrete cell in time can be recorded into the file by setting its coordinates x and y [History record X-axis, Y-axis]. The displayed value [Step No.] informs about the process of calculation, which step is done. The choice of set of data can be made in file box. The start of calculation is done by button Start. The stop of calculation is done by button End.

Competitive Environment

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  .   e   e   .   .   a   .   .   .   .
  .   .   .   .   .   .   .   .   .   d        Designed by Petr Dostál 2008
  :   :   :   :   :   :   :   f   :   :    Time   280          □ Graph
  .   c   .   .   .   .   .   .   .   .
  .   b   b   .   b   .   b   b   .   .    Delay  0            □ Step
  :   :   :   :   .   .   .   .   .   .
  .   a   .   .   .   .   .   .   e   .        History    8   X-axis
                                               record     5   Y-axis

  000  100  100  000  000  100  000  000 -000 -000
 -000  000  000  000  000  000  000  000 -000 -000      Step No.:  280
  000  000  000  000  000  000  000 -000 -000 -050
 -000 -000 -000 -000  000  000  000 -000 -000 -000   ┌──────────┐
 -000 -000 -000 -000 -000  000 -000 -000  050 -000   │ CR.dat   │
 -000 -100 -000 -000 -000 -000  000 -000 -000 -000   │ EU.dat   │
 -000 -000 -000 -000 -000 -000  000  000  000  000   │          │
  000  000  000  000  000  000  000  000  000  000   └──────────┘
  000  000  000  000  000  000  000  000  000  000
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  034  100  100  033  020  029  014  003 -001 -004
 -001  028  030  012  008  012  006  001 -006 -020
  001  005  006  003  002  003  001 -003 -018 -041     ┌──────────┐
 -002 -004 -001 -000  000  001  000 -002 -011 -021     │Calculation│
 -010 -026 -009 -002 -000  000 -001 -005  007 -009     └──────────┘
 -026 -100 -026 -005 -001 -000  000 -001 -005 -001     ┌──────────┐
 -000 -029 -011 -002 -000 -000  000  000  000  000     │   End    │
  001  000  000  001  000  000  000  000  006  003     └──────────┘
  007  015  007  002  000  000  003  012  028  013
  018  030  014  004  001  001  006  030  100  036
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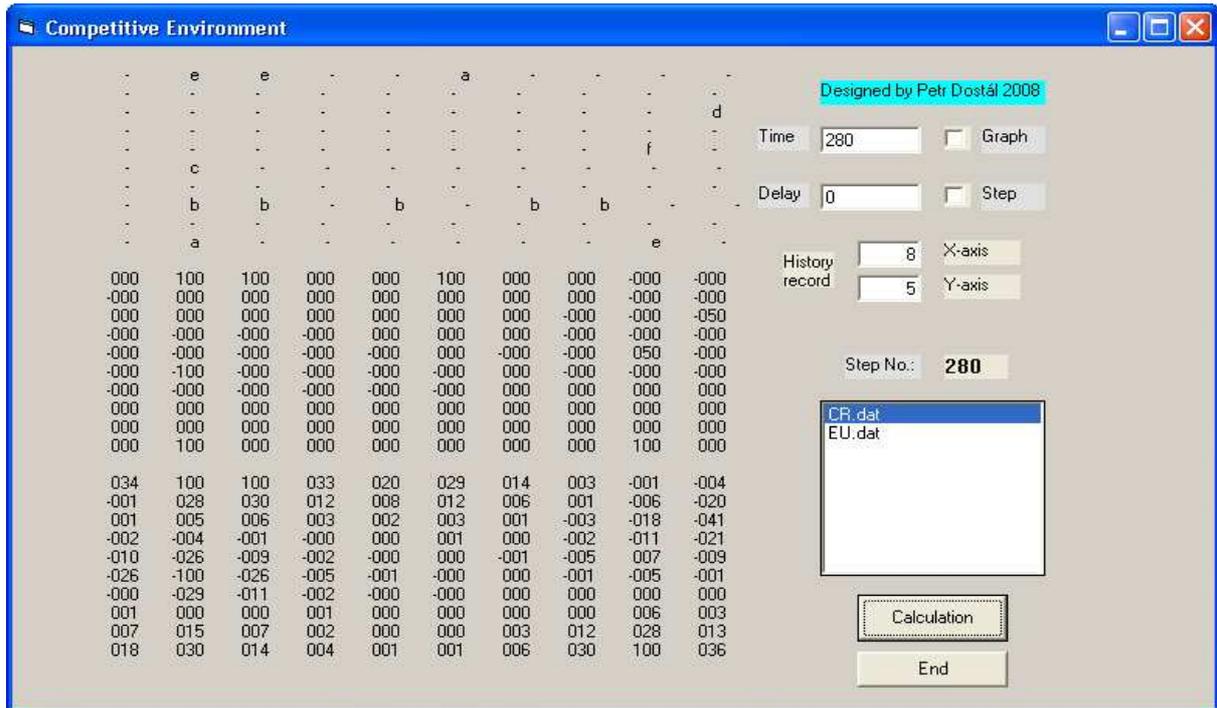
Fig.1 The screen of a program with the use of figures

The test case is presented by the matrix of 10x10 dimensions. The left upper side of the screen shows the matrix $O(10x10)$ of codes of cells, the left middle side shows the matrix $D_0(10\ x10)$ of initial values of competitive environment D in time $T_0 = 0$ and the left lower side shows the matrix of results of end values of competitive environment $D_{end}(10\ x10) = D_{280}$ in time $T_{280}=280$.

Fig.2 presents the test case where the values of the competitive environment are in colours on the left side of the screen. The spectrum of colours is used from red (*100%*), through yellow (*0%*) to green (*-100%*). The scale of colours presenting the value of competitive environment D is displayed on the right part of the screen. The cells with non zero initial condition of competitive environment D are marked by letter *a* and they were set to maximum negative competitive environment (*+100*), the solid obstacle is marked *b*, the cell of positive and constant influence on competitive environment is marked *c*, the cell of positive and variable influence on competitive environment is marked *d*, the cell of negative and constant influence on competitive environment is marked *e* and the cell of negative and variable influence on competitive environment is marked *f*. This test case presents all possible situations.
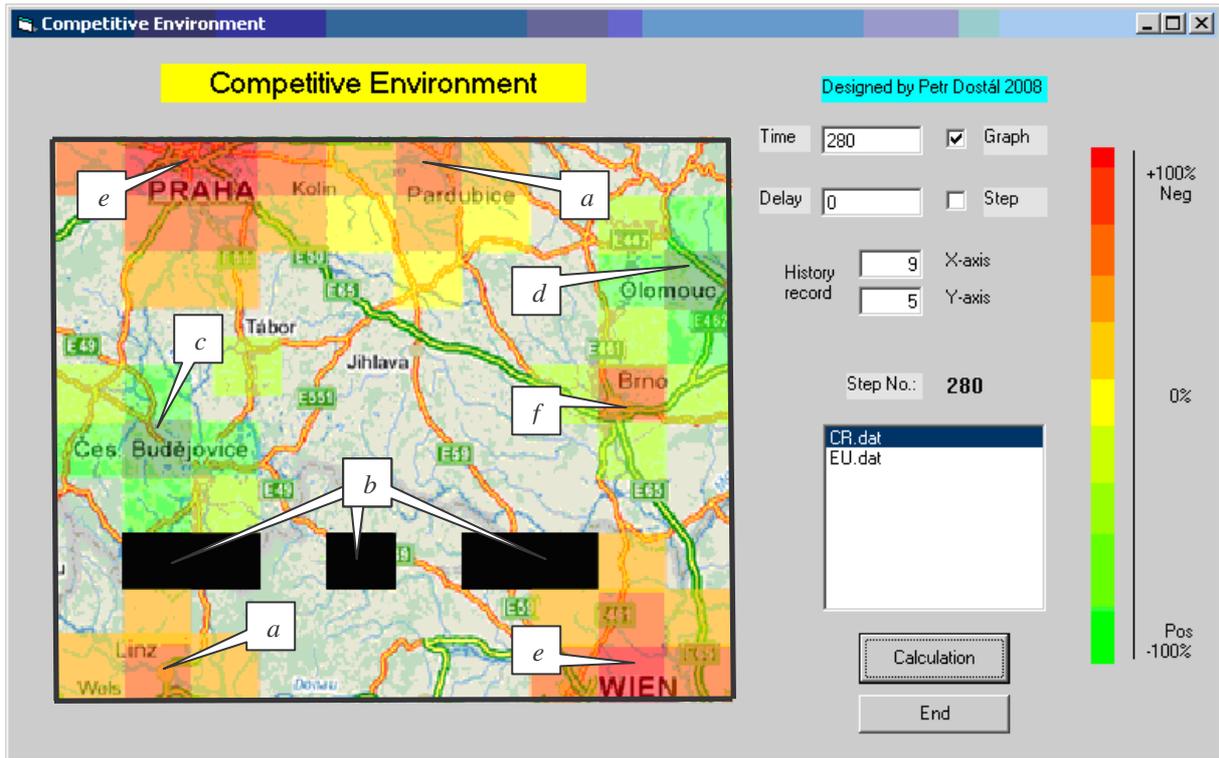
Fig.2 The screen of test case of competitive environment

Each cell has a colour, its value corresponds with the value of the competitive environment D after calculation ($T_{280} = 280$), from green, via yellow to red. The situation in end time ($T_{280} = 280$) is as follows. Some cells have negative, some positive and some neutral influences on the competitive environment D.

Fig.3. presents the course of value of the competitive environment D of the cell with coordinates $x=9$ and $y=5$ in time marked as cell f and place Brno. It is suitable to evaluate the first derivative of competitive environment D' that presents the speed of change of value of competitive environment D and the second derivative D'' that presents the acceleration of change of value of competitive environment D. It enables to make an evaluation in a greater detail.
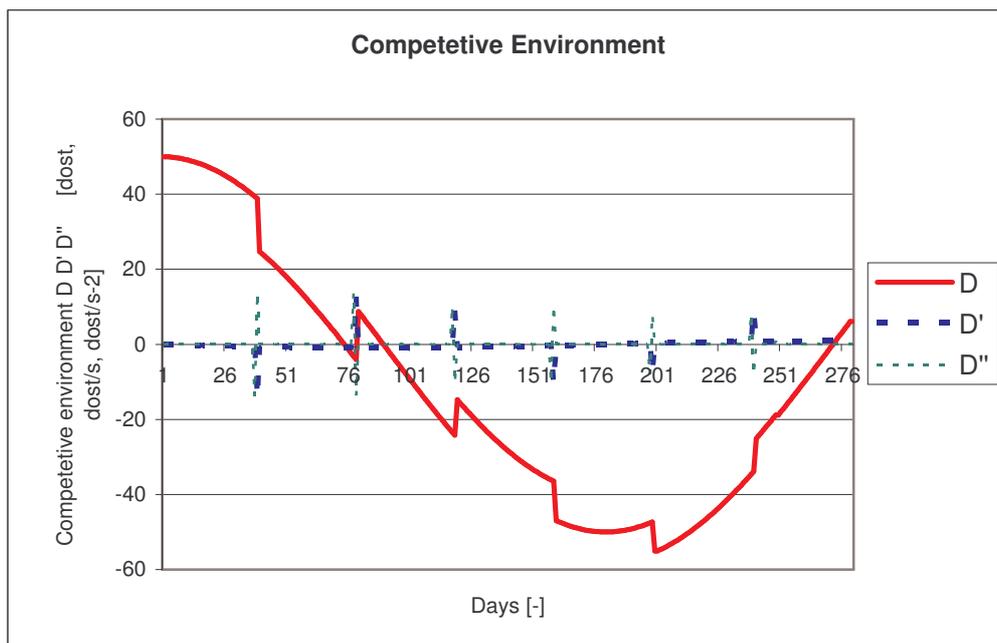

Fig.3 The behaviour of competitive environment D, D', D'' in time

The graph presents the fact that the high negative value of the competitive environment D is decreasing in time and it continues to be neutral, further it continues to be positive and it ends nearly neutral. The course of value of the competitive environment D is not smooth (there are some steps) because of build up model with chaotic and random behaviour except deterministic.

5. REAL CASE

The real case presents the situation of competitive environment presented among EU nations represented by capital cities such as Amsterdam, Berlin, Bern, Bratislava, Brussels, Budapest, London, Ljubljana, Luxemburg, Paris, Prague, Vaduz, Warszawa, Vienna and Zagreb. Some cities have positive influences such as towns of new EU states. Some cities have negative influences of competitive environment such as old EU states. The situation presents the struggle for new territories in business. Fig.4 presents such situation by means of colours after 100 days.
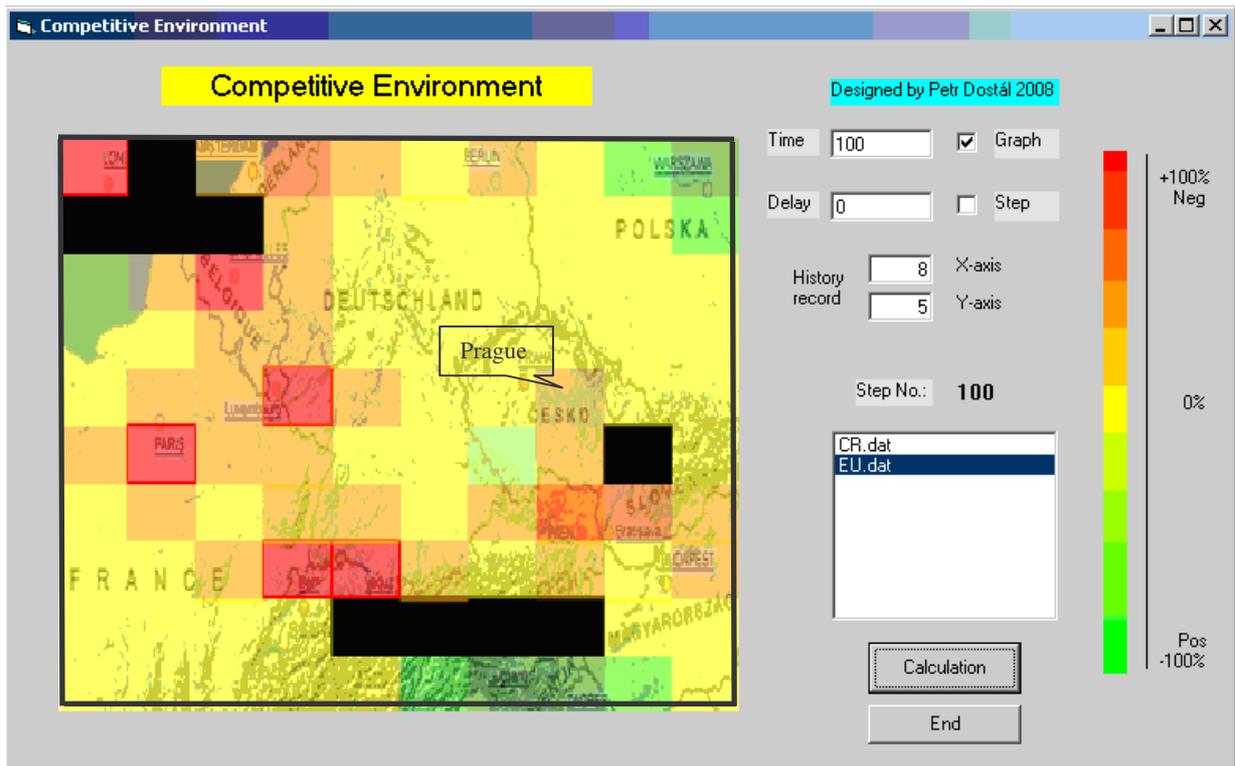

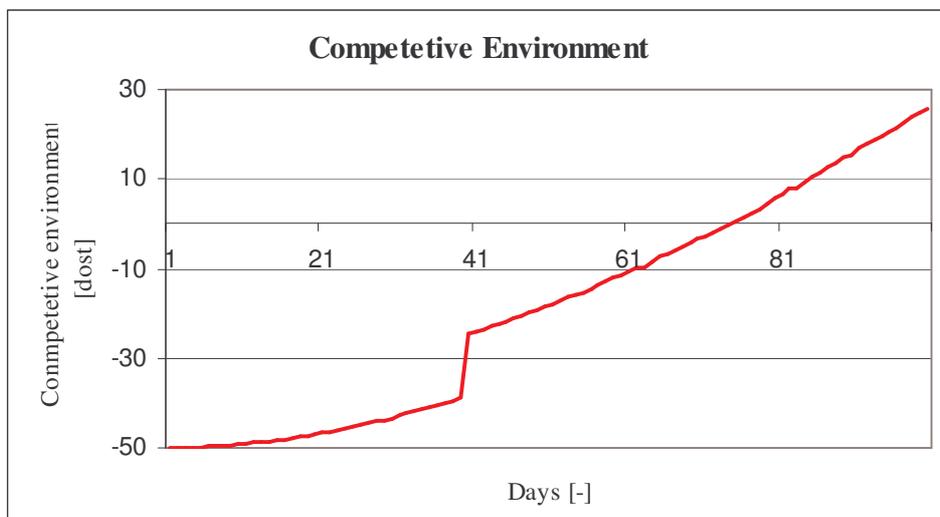Fig.4 The screen of program with the use of colours

Fig.5 The behaviour of competitive environment D in time

The process of calculation of the competitive environment is a dynamic process where the time plays an important role. Therefore it is suitable to search for the behaviour of cells from the point of values of competitive environment D in time. The course of value of competitive environment D of the cell with coordinates $x=8$ and $y=5$ in time is presented in fig.5 and is marked as a cell of Prague in Czech Republic.

The graph presents the fact that the high positive value of the competitive environment D is decreasing in time and it ends to be slightly negative competitive environment.

Some cells can have constant behaviour, others have behaviour that is dependent on time. This dependence can be generated by any function. Other dependence can be created by chaotic or pseudorandom generator. The cells influence each other. Their mutual influence is described by partial differential equation of the second order that was mentioned in the chapter dealing with theory.

6. CONCLUSION

The mentioned newly designed method in the article is focused on the field of business and economy where the competition environment plays a very important role. This method of the build up of a model and its realization by suggested program enables the search for competitive environment that could be very important and its results can be used for decision making processes. The calculation can prevent great losses. This initial research will be further developed, detailed and tested. The designed method can be used in the field of markets, banks, firms, supplier-customer relations, etc.