MATHEMATICS AND COMPUTER TECHNOLOGIES

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GRAPHICAL COMPUTING - THE MODERN METHOD OF COST EFFECTIVE AND SUPERFAST DATA PROCESSING

Multi-core processors are no longer the future of computing – they are the present day reality. Since 2003 multicore processors, especially the GPUs, have led the race of floating-point performance. While the performance improvement of general-purpose microprocessors has slowed significantly, the GPUs have continued to improve relentlessly. As of 2009, the ratio between multicore GPUs and multicore CPUs for peak floating-point calculation throughput is about 10 to 1. So, we have the possibility to unite the performance of CPU and GPU, which will allow performing of programming operations much faster and effectively. This possibility is very important today, because it reduces the computational cost in few times.

This work is dedicated to the question of applying of parallel computing in practice. During the development of GPU programming technologies a few program environments were created, such as Open CL (Open Computing Language) – free software, which are used for creating the programs connected with the parallel computing with the help of various GPU and CPU. But I used less universal, but more convenient software – CUDA (Compute Unified Device Architecture). But it is not simply a programming environment, but rather the whole software and hardware architecture of the parallel computing. It can be applied only for GPUs of NVIDIA Company. CUDA includes a lot of additional programs, tools and so on, it uses C programming language, that makes the transfer for the programmer to CUDA technology much easier. In my work I used Microsoft Visual Studio (further MVS) as a programming environment, which supports CUDA technology. To use GPU for mathematical calculations I wrote a program. At last, it is the necessity to check the "participation" of graphical unit in calculation process. The simple software - TechPowerUp GPU-Z solves this problem. The result of an experiment is shown in my work. So, the information about the great performance of graphical processing unit and its advantages in comparison with central processing unit is actual for resource-aided computations. The ways of applying this possibility in practice are different, one of them have been described in detail. The MVS supports CUDA technology and gives the programmer a possibility to write the programs through C programming language and to perform calculations by GPU mediation. At last, the programmer can to see the GPU load with the help of special software, for example TechPowerUp GPU-Z.

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APPLICATION OF INTEGRAL RELATIONS FOR CALCULATING THE BOUNDARY LAYER THAT DEVELOPS ALONG THE SURFACE OF THE POROUS CONICAL DIFFUSER

Taking as the initial velocity profile expression $u/u_m=\bar{y}(2-\bar{y})$, $\bar{y}=y/\delta$, Mamchuk V. received the following relation for calculating the parameters of the boundary layer (BL):

$$z_1=\frac{6k_1u_m^{k_2}}{R^2}\exp\left(-3k_1\int_{x_0}^{x}\frac{u_H}{u_m^2}u_H^{'}dx\right)\int_{x_0}^{x}\frac{R^2}{u_m^{k_2+1}}\exp\left(3k_1\int_{x_0}^{x}\frac{u_H}{u_m^2}u_H^{'}dx\right)dx, \qquad (1)$$

$$z_2=\frac{u_m^{k_2}}{R^2}\exp\left(-3k_1\int_{x_0}^{x}\frac{u_h}{u_m^2}u_H^{'}dx\right)\int_{x_0}^{x}\frac{2k_1\ \ 3+\theta_1}{u_m^{k_2+1}}R^2\exp\left(3k_1\int_{x_0}^{x}\frac{u_h}{u_m^2}u_H^{'}dx\right)dx, \qquad (2)$$

where $\theta=v_0\delta/v$; $z=\delta^2/v$; stroke is a derivative of x; z_1, z_2 are respectively the first and second approximation for the existing transverse velocity component on a streamlined surface.

If we apply the expressions (1-2) in the calculation of the pancreas in porous conical diffuser ($u_m=u_H=u_в r_0^2/x^2$, where $u_в$ is a speed in the input section; r_0 is a distance from the vertex of the cone to the input section, $R=x\sin\alpha$), we can gain the expression:

$$z_1=4{,}39\frac{r_0}{u_в}\left(\left(\frac{x}{r_0}\right)^{8{,}86}-\left(\frac{x}{r_0}\right)^{3}\right)\cdot \qquad (3)$$

If we limit ourself with the the first term in equation (3), then the second

approximation of equation (2) we obtain:

$$z_2=4{,}39\frac{r_0}{u_в}\left(\left(\frac{x}{r_0}\right)^{8{,}86}-\left(\frac{x}{r_0}\right)^{3}\right)+12{,}56\frac{r_0v_0}{u_вu_в}\sqrt{\mathrm{Re}}\left(\left(\frac{x}{r_0}\right)^{8{,}86}-\left(\frac{x}{r_0}\right)^{7{,}43}\right), \qquad (4)$$

where $\mathrm{Re}=\frac{u_в r_0}{v}; v_0=\mathrm{const}.$ Tension friction is determined by the formula:

$$\tau_w=\frac{\mu u_в}{\sqrt{v}x_1^2\sqrt{z_2}}\left(1{,}7143-0{,}4756\frac{u_в z_2}{r_0x_1^3}-0{,}4286\cdot v_0\sqrt{\frac{z_2}{v}}\right)\cdot \qquad (5)$$

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MATHEMATICAL MODELING OF ROCKET LAUNCHING FROM THE BOARD OF AIRCRAFT – CARRIER

Ukraine is the space state because there are such gigants of cosmic industry as CB "Yuzhnoe" and "Yuzhmash" which not only design these launch vehicles and spaceships, but produce them at the current plant. Just due to such enterprises Ukraine takes part in many international projects as: the project of new type of engines "Vega"; "Sea launch"; with using the Ukrainian launch vehicle "Zenit – 3SL" as the main spaceship launch vehicle. To this project we can add the reproducing of intercontinental ballistic rocket "Dnepr" for launching of small spaceships and the project "Cyclone -4" together with the cosmic Brazilian agency for launching spaceships from the Alcantara start site; and many others. The idea of launching rockets from the board of the plane is not new. In the XX century the scientists of the Soviet Union and United States developed the projects on the base of different planes. But because of the numbers of risk factors any project has got its realization.

A spaceport (launching site) or cosmodrome is a site for launching (or receiving) spacecraft, by analogy with seaport for ships or airport for aircraft. The word spaceport, and even more so cosmodrome, has traditionally been used for sites capable of launching spacecraft into orbit around Earth or on interplanetary trajectories. In this work you can find absolutely new type of such construction with new meaning, and fresh ideas. The project can be applied in close time and with minimal costs in comparision with constructing of new spaceport or reconstructing old launch sites.

The goal of this research project is to elaborate the strategy for launching the space vehicle from the board of airplane.

The main purpose was to make the mathematical model, which would be able to describe the flight of the given launch vehicle after its separation from the aircraft and climbing the altitude with the following flight into space.

In the process of work on this project the following operations were done: the wing of launch vehicle was developed. It is the oval-looking wing construction with internal frame, additional external hinged ruling components as elevons, also additional ruling engines (which is mounted on the rocket frame perpendicularly to the direction of flight) and many other small components. All these elements work on the electro-distance conducting system. The whole operations of controlling of the rocket flight are done by the board calculating system (central computer).

Due to the results of the fulfilled work it was proved that the launching of the rockets from the board of the airplane is possible, and even more conveniently in comparison with fixed launch stations.

Ukraine will be able to construct its own launching site and to launch rockets from it.

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UDC 515.126

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TOPOLOGICALLY ISOMORPHIC CHAINS OF LINEAR MAPPINGS

This is a joint work with V. Sergeichuk. We consider systems of linear mappings $A_1,\dots,A_{t-1}$ of the form

$$\mathrm{A}:\ U_1 \overset{A_1}{-} U_2 \overset{A_2}{-} U_3 \overset{A_3}{-} \dots \overset{A_{t-1}}{-} U_t$$

in which $U_1,\dots,U_t$ are unitary (or Euclidean) spaces and each line is either the arrow $\rightarrow$ or the arrow $\leftarrow$. Let A be transformed to

$$\mathrm{B}:\ V_1 \overset{B_1}{-} V_2 \overset{B_2}{-} V_3 \overset{B_3}{-} \dots \overset{B_{t-1}}{-} V_t$$

(with the same orientation of arrows) by a system $\{\varphi_i : U_i \to V_i\}_{i=1}^{t}$ of bijections, that is,

$$\begin{array}{ll} B_i\varphi_i = \varphi_{i+1}A_i, & \text{if } A_i : U_i \to U_{i+1} \\ \varphi_i A_i = B_i\varphi_{i+1}, & \text{if } A_i : U_i \leftarrow U_{i+1} \end{array}.$$

We say that A and B are linearly isomorphic if all φ_i are linear. Considering all U_i and V_i as metric spaces, we say that A and B are topologically isomorphic if all φ_i and φ_i^{-1} are continuous.

Theorem. [2]. Two chains of linear mappings on unitary (or on Euclidean) spaces are
topologically isomorphic if and only if they are linearly isomorphic.

1. Sergeichuk V.V., Computation of canonical matrices for chains and cycles of linear mappings, Linear Algebra Appl. 376 (2004) 235-263.
2. Rybalkina T.V., Sergeichuk V.V., Topological classification of chains of linear mappings, Linear Algebra Appl. 437 (2012) 860-869.

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RESEARCH OF HYBRID SYSTEMS FOR SIMULATION OF AIR TRAFFIC FLOW

Nowadays, the problem of oversaturated air traffic flow is extremely important, because every day it becomes more difficult to control it. Existing simulation tools of the national airspace have functionality that combines runway modeling and airport capacity, but it is not enough to display the full real picture.

Hybrid (complex dynamic) systems – is the hierarchical, event-driven systems with variable structure. Complex dynamic systems are extremely in demand for practice and for their modeling in the whole world are created visual modeling software systems that include graphic language design and adjustent of models, operation of computational experiments, visualization and interactive intervention in the course of the experiment. Complex dynamic systems are highly abstract, hard for human understanding and require visualization at the stage of model's design. Today, the term of hybrid systems is used to indicate the continual systems which are governed by computers and the class of models in which simultaneously are modeled both: discrete and continual behavior of the object.

Air traffic flow is an open complex continual dynamic system with mixed structure. As a result, it is expedient to use the theory of hybrid systems, which in the world of rapid development of modern technologies will not just allow us to describe the system, but also let us to get its adequate model. The difficulty of model's behavior which is connected with the presence of several modes, which change caused by the onset of external or internal events. Today it is not enough to study each mode separately. It is necessary to build a model of the whole object. For the description and research of complex objects we need new models which were based on modern technologies.

In 2004, professors from the Stanford University brought control theoretical model of the air traffic flow, based on sectors, using the theory of hybrid automation. Then it was used as a subset of this model to generate Lagrangian analytic predictions of the traffic flow (dynamic sector capacity, extend of traffic jams), which were linked to Eulerian models of the National Airspace System.

The results were used to predict the conditions under which the saturation of airspace can not be solved at the level of a single sector, and requires centralized solution. These predictions were checked by comparison with an abstraction of the real system. Finally, the flow conditions were generated under which they can be decorrelated metering from conflict resolution.

In conclusion we can note that with the help of hybrid systems' research we can get an adequate model of the flow, which gave us an opporunity to improve the control of air traffic flow, and what is the most important is that this model will increase the safety and efficiency of air traffic control.

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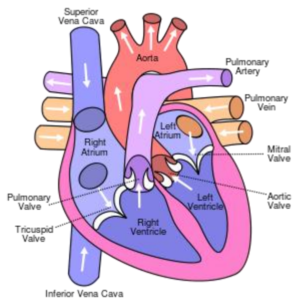
APPLICATION OF INTEGRATION IN MEDICINE

Definite integral has many applications. Applying definite integrals we find areas, length of curve, volume of solid, centre of mass, moments of inertia, force due to liquid pressure, average value, work by a variable force and so on. There are some applications of integration in economics (consumer surplus), biology and medicine (blood flow, cardiac output).

We'll consider example of evaluation of cardiac output.

Figure shows the human cardiovascular system.



Cardiac output is the volume of blood pumped by the heart per unit time, that is the rate of flow into the aorta. Cardiac output is a function of heart rate and stroke volume. The heart rate is simply the number of heart beats per minute. The stroke volume is the volume of blood, in milliliters (mL), pumped out of the heart with each beat.

According to dilution method the output of heart is equal to the amount of indicator injected divided by its average concentration in the arterial blood after a single circulation through the heart.

That is, cardiac output is

$$F = \frac{A}{\int_0^T c(t)dt},$$

where the amount of dye A is known and the integral can be approximated from the concentration readings.

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APPLICATIONS OF CORRELATION AND REGRESSION ANALYSIS

The correlalion is one of the most common and most useful statistics. A correlation is a single number that describes the degree of relationship between two variables.

Regression is a way of describing how one variable, the outcome, is numerically related to predictor variables.

Regression analysis involves identifying the relationship between a dependent variable and one or more independent variables. A model of the relationship is hypothesized, and estimates of the parameter values are used to develop an estimated regression equation.

Correlation and regression analysis is widely used in various fields of science, business and industry.

For example, there are three main uses for correlation and regression in biology. One is to test hypotheses about cause-and-effect relationships. In this case, the experimenter determines the values of the X-variable and sees whether variation in X causes variation in Y.

The second main use for correlation and regression is to see whether two variables are associated, without necessarily inferring a cause-and-effect relationship. In this case, neither variable is determined by the experimenter; both are naturally variable. If an association is found, the inference is that variation in X may cause variation in Y, or variation in Y may cause variation in X, or variation in some other factor may affect both X and Y.

The third common use of linear regression is estimating the value of one variable corresponding to a particular value of the other variable.

Correlation and regression analysis can help business to investigate the determinants of key variables such as their sales. Variations in companies sales are likely to be related to variation in product prices, consumers, incomes, tastes and preference's multiple regression analysis can be used to investigate the nature of this relationship and correlation analysis can be used to test the goodness of fit. Regression can also be used to estimate the trend in a time series to make forecast.

The stockbroker wishes to predict stock market behaviour as a function of a number of observable key indices. The sales manager of a chain of retail stores wishes to predict the monthly sales volume of each store from the number of credit customers and the amount spent of advertising. The political scientist may wish to relate success in a political campaign to the characteristics of a candidate, the opposition, and various campaign issues and promotional techniques.

Regression and correlation can be used wherever it is necessary to study the behaviour of one or more variables and how they affect the final result.

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