enterprise resource planning, current ratio, quick ratio, return of assets,
return of sales, receivables turnover, liabilities turnover.

Sławomir KŁOS[*]

THE IMPACT OF ERP SYSTEM ON ECONOMIC SITUATION OF ENTERPRISE: CASE STUDY

Abstract:

The implementation of ERP system is performed to integrate business processes, efficient charge of company resources and give important data for decision support. Implementing of ERP system is expensive and time consuming. Therefore a great number of research activities are focused on key success factors of ERP implementations but only few deals with long term impact of ERP system on enterprise performance. In the article the relationship between implementation of ERP and values of important economic ratios of enterprises is analyzed. The analysis is a base for presented evaluation methodology of ERP system from economic point of view. As an example, an enterprise is taken into account that implemented ERP system in 2001. The illustrative examples are given.

1. INTRODUCTION

The selection and implementation of ERP system is a strategic decision for each enterprise [6],[8],[10],[11]. It demands engagement of top management and a lot of work to adapt the ERP application for the enterprise requirements. The implementation process is expensive and time-consuming and has to be supported by top management of the enterprise [13],[14]. For the ERP project the company should delegate the best people who take part in implementation process and can not fully realize operation work. It means a lot of disturbances in operation activity that result with ERP system implementation. Besides of the disadvantages, the manufacturing companies decide to implement ERP because it brings the a lot of benefits such as [1],[2],[3],[7]:

- Increase and improve the capabilities and power to compete with other competitors.
- Enhance information flow to and from customers, suppliers, and other business partners outside the enterprise in a tightly coupled mode, and flexibility to operate in worldwide market.
- Improve the flow of information through centralized system, better system integration and communication among internal business processes.

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- Improve business processes and practices, and business performance.
- Cost cut in activities related to business administration and processing, and system maintenance, and ensure ongoing system support from the vendor.

The implementation of ERP system should be considered not only as a time limited project but rather as process that could continuously improve business processes. It is very difficult to evaluate all the advantages of ERP system implementation for a company [6],[12]. There some methods used for evaluation of the systems such as return of investment ratio, net present value, total cost of ownership, total benefits of ownership, return of management, earned value added, return of opportunity, etc. But the evaluation of ERP can be fulfilled by analysis of data changes of profit and loss account in several periods. The typical advantages of ERP are inventory reduction, material costs reduction, establishment charges reduction, sales increasing, etc [4],[5],[9]. In research area of ERP systems case study methods are very useful because the process of implementation is unique even in the enterprises from the same branch. Each case has to be analyzed individually to propose general relationship, models or evaluation methods rather than using large samples and following a rigid protocol to examine a limited number of variables, case study methods involve an in-depth, longitudinal examination of a single instance or event: a case. They provide a systematic way of looking at events, collecting data, analyzing information, and reporting the results. As a result the researcher may gain a sharpened understanding of why the instance happened as it did, and what might become important to look at more extensively in future research. In the next chapter the methodology of enterprise investigation to evaluate ERP system implementation is presented.

2. THE METODOLOGY OF ENTERPRISE INVESTIGATION

The methodology of investigation an economic enterprise situation in view of ERP system implementation require fulfillment of following conditions:

- The period of ERP implementation should be known.
- The data of productive start of the ERP system should be known.
- The period of time should include at least three years.

The methodology of the examination of ERP impact for economic situation of a company is presented on the Fig. 2.1

Let us consider an example of enterprise Alpha. The firm Alfa is a polish company that manufactures machines and production lines for food manufacturers. The firm completes the single, engineer-to-order production. The enterprise selected and started with implementation of ERP in 2002 and the productive start of the system is executed in 2003. It was determined two main goals of implementation of the system in company: sales support and inventory reduction. The economic ratios of the company are presented in the table 2.1.

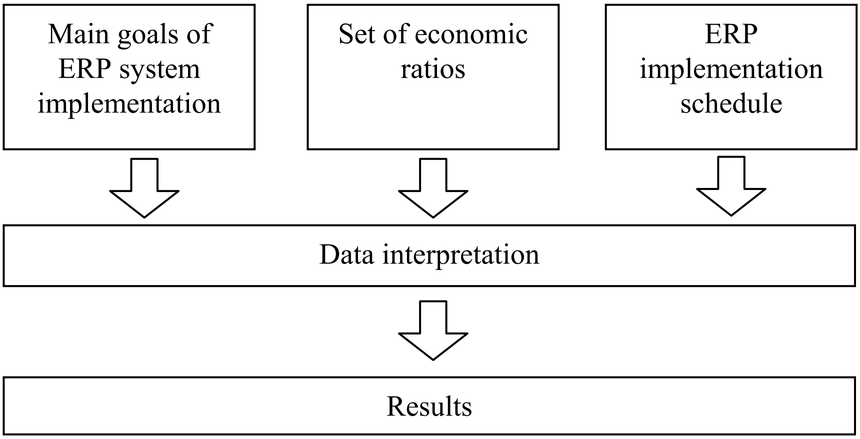

Fig. 2.1 The methodology of enterprise investigation

Table 2.1

Index name	**2002**	**2003**	**2004**	**2005**	**2006**
Net income	16 122 247	20 146 185	24 722 777	26 620 102	37 595 665
Costs	8 927 782	12 825 880	14 153 834	14 861 173	18 998 440
Profit	775 544	781 398	2 581 251	2 827 501	8 327 078
Inventories	4 984 301	4 850 111	5 595 899	7 164 281	8 899 214
Current Ratio (CR)	2,68	2,51	6,08	3,75	4,72
Average CR	1,10	1,14	1,46	1,44	1,4
Quick Ratio (QR)	1,24	0,93	3,95	1,78	2,37
Average QR	0,68	0,75	0,93	0,94	0,89
Return on Sales (ROS)	0,06	0,03	0,31	0,11	0,18
Average (ROS)	0,03	0,05	0,05	0,05	0,06
Return on Assets (ROA)	0,06	0,03	0,33	0,13	0,26
Average (ROA)	0,04	0,06	0,08	0,06	0,04
Return on Equity (ROE)	0,08	0,05	0,38	0,15	0,3
Average ROE	0,09	0,13	0,14	0,11	0,07
Enterprise productivity	1,81	1,57	1,75	1,79	1,98
Inventories productivity	1,79	2,64	2,53	2,07	2,13

The implementation of ERP system in the considered company was started in 2002 and the productive start of the system was taken the place in 2003. First the ERP system was implemented in the functional areas of construction and technology, purchasing and material management. The implementation of ERP in area of production was started in 2004 and the functions of production planning and control were used from 2005. The ERP system was implemented in the following functional areas of the Alpha company and support the following functions:

- Product design - preparing bill of materials, calculation of material cost.
- Technology - specification of technology operations, calculation of labor costs.
- Purchasing - material requirement planning, material order
- Sales - sales offers and orders registration, preparing of sales calculations
- Production – planning and control, registration of manufacturing operations.
- Financial Accounting, Human Resources, Assets management – support of administrative work.

The company did not implement the maintenance modules of ERP and the invoices are not registered in the system. The discussion and interpretation of economic efficiency of the Alpha company will be done on the base the data from table 2.1 presented on charts.

3. THE DATA INTERPRETATION

The first chart (show the Fig. 3.1) presents the main economic ratios of the Alpha. The economic situation of the company is very well.

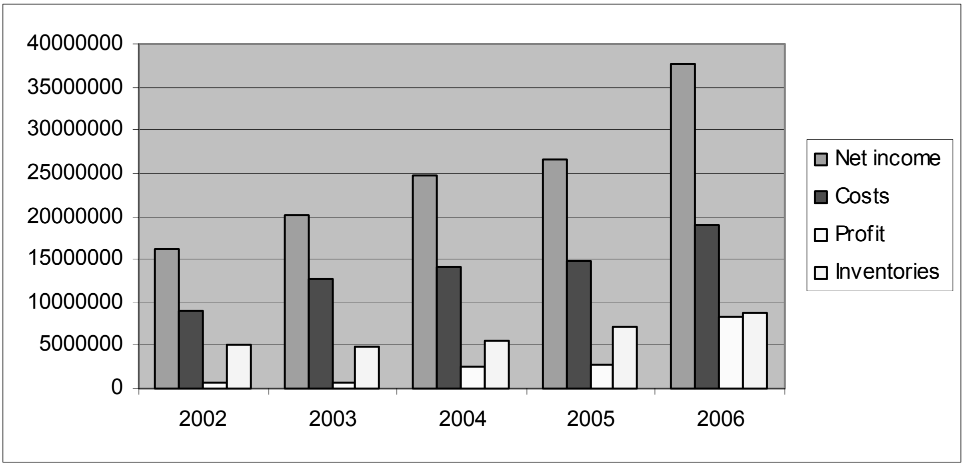

Fig. 3.1 The dependence between processes

The profit of the company increase proportional to the income and the costs of the company increase slowly then income. On the Fig 3.2 the productivity rates of the company Alpha are presented. The total productivity (Net income / Costs) of the alpha company increases from 2003. The decreasing of the ratio in 2003 was partially a result of ERP system implementation (the implementation process of ERP charges all functional areas of the company extremely). It means that the ERP implementation was generally successful and positively for the Alpha company. But the detailed analysis of inventories productivity (Net income / Inventories) show that in area of inventory and material management a lot of improvement could be done. The value of inventories productivity is very quickly increased in 2003 (before productive start of ERP the detailed stock-tacking is done). But next two years (2004 and 2005) the inventories productivity drop down (in 2006 the ratio increase again). The analyze of inventories productivity should be a base for detailed analyze and improvement of business processes in material management and inventory management functional areas of the Alpha company.

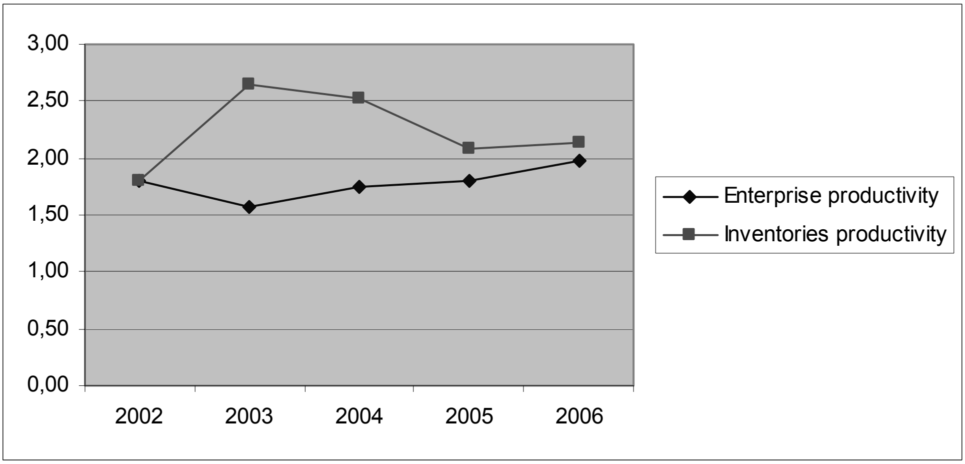

Fig. 3.2 The total enterprise productivity and inventories productivity

The first economic ratio that is examined is current ratio. The current ratio is a financial ratio that measures whether or not a company has enough resources to pay its debts over the next 12 months. It compares a firm's current assets to its current liabilities.

Acceptable current ratios vary from industry to industry. If a company's current assets are in this range, then it is generally considered to have good short-term financial strength. If current liabilities exceed current assets (the current ratio is below 1), then the company may have problems meeting its short-term obligations. If the current ratio is too high, then the company may not be efficiently utilizing its current assets. The values of CR for the Alpha company are presented on the Fig. 3.3, and show that the company could without of problem cover the liabilities (the CR is every year greater then the average CR in the industrial branch). The implementation of ERP has positively impact on the Alpha company what show the CR in the 2004 (increasing of CR value).

The next interesting finance ratio is quic ratio (QR). In finance the Acid-test or quick ratio or liquid ratio measures the ability of a company to use its near cash or quick assets to immediately extinguish its current liabilities. Quick assets include those current assets that presumably can be quickly converted to cash at close to their book values. Such items are cash, marketable securities, and some accounts receivable. This ratio indicates a firm's capacity to maintain operations as usual with current cash or near cash reserves in bad periods. As such, this ratio implies a liquidation approach and does not recognize the revolving nature of current assets and liabilities. The ratio compares a company's cash and short-term investments to the financial liabilities the company is expected to incur within a year's time. The Fig. 3.4 presents the values of QR (the required interval for the ratio are values greater the n 100%).

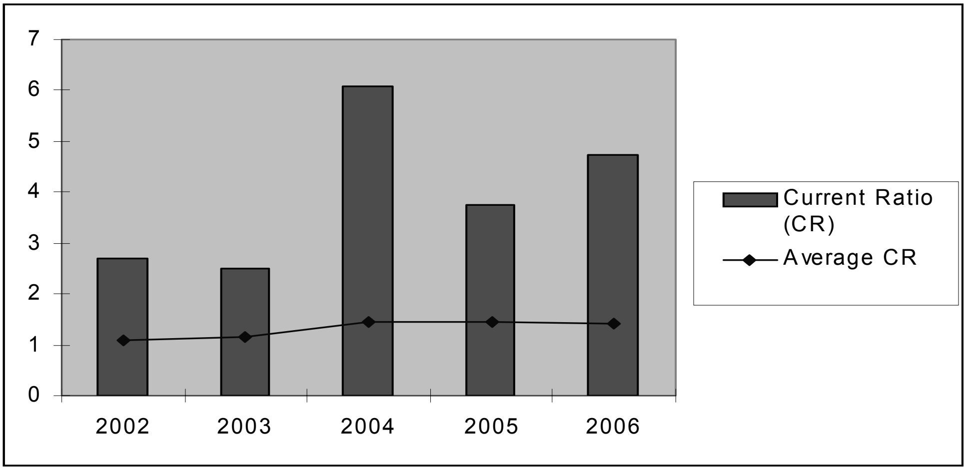

Fig. 3.3 Current Ratio

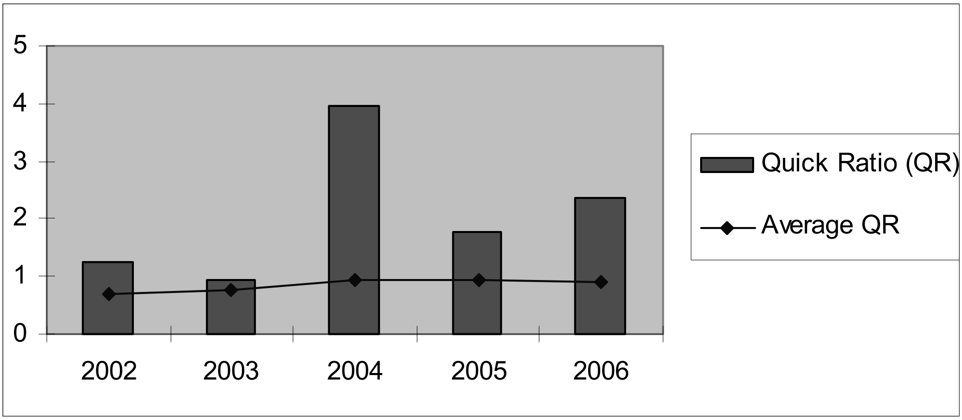

Fig. 3.4 Quick Ratio

Similarly as in the case of current ratio, the quick ratio reachs greater values as average branch ratios and required 100%. The QR next year after implementation is reached the greatest values in the whole investigated period of time.

Return on sales (ROS) is a widely used accounting ratio that detects operational efficiency. ROS is calculated as values of operating income divided by sales revenue. The return on sales ratio is presented on the Fig. 3.5 and show us that the implementation of the ERP was very profitable for the Alpha, but the year 2003 (implementation of ERP) was very difficult and the implementation has negative impact in the year on the whole company.

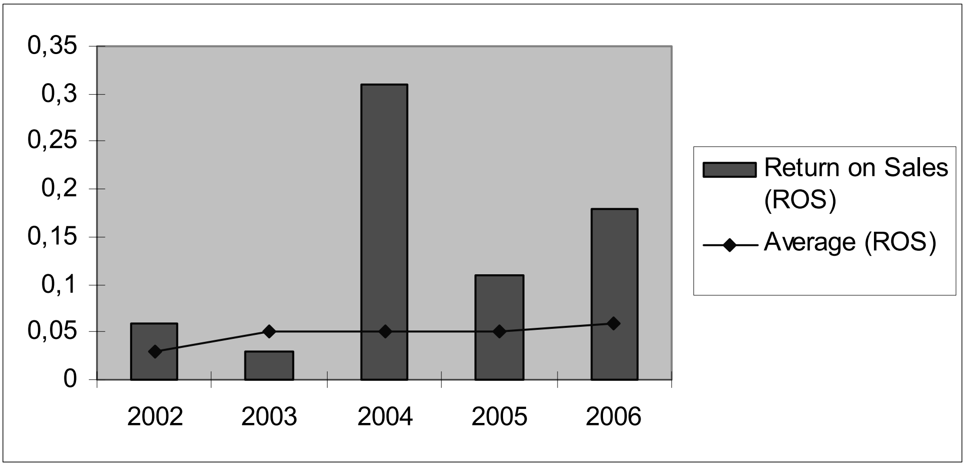

Fig. 3.5 Return on sales

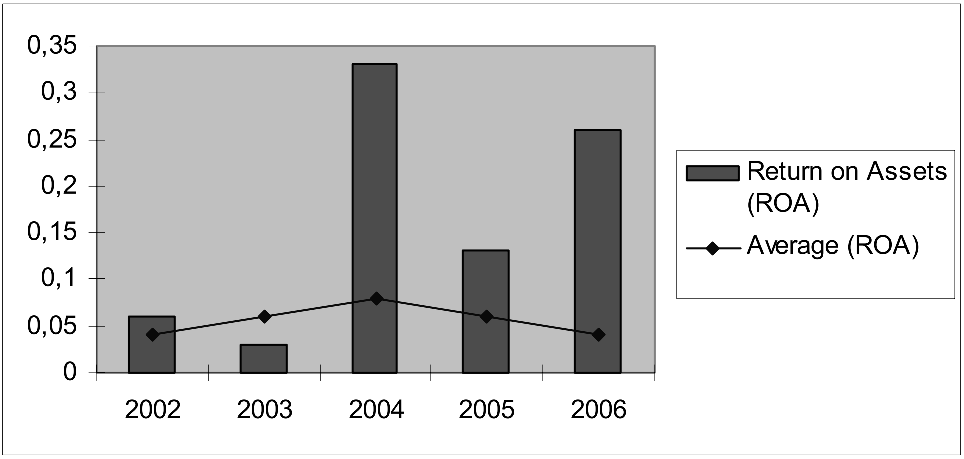

Fig. 3.6 Return on assets

The Return on Assets (ROA) percentage shows how profitable a company's assets are in generating revenue. ROA can be computed as ROA = Net income / Total Assets. This number tells you "what the company can do with what it's got", i.e. how many dollars of earnings they derive from each dollar of assets they control. It's a useful number for comparing competing companies in the same industry. The number will vary widely across different industries.

Return on assets gives an indication of the capital intensity of the company, which will depend on the industry; companies that require large initial investments will generally have lower return on assets. The company Alpha much better use capital for income generating then compatitive enterprises from the branch (especially after ERP implementation).

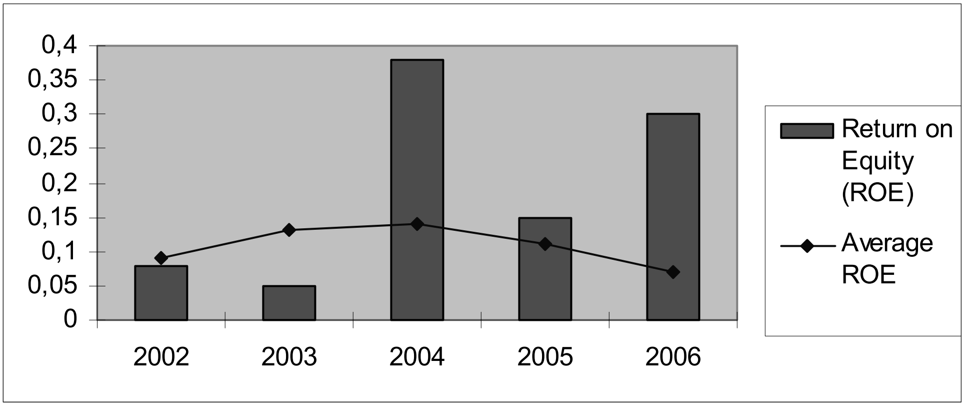

Fig. 3.7 Return on equity

Return on Equity (ROE, Return on average common equity, return on net worth) measures the rate of return on the ownership interest (shareholders' equity) of the common stock owners. ROE is viewed as one of the most important financial ratios. It measures a firm's efficiency at generating profits from every dollar of net assets (assets minus liabilities), and shows how well a company uses investment dollars to generate earnings growth. ROE is equal to a fiscal year's net income (after preferred stock dividends but before common stock dividends) divided by total equity (excluding preferred shares), expressed as a percentage. From the Fig. 3.7 results that for the Alpha company, the implementation of ERP was very profitable and especially for efficiency of capital of the company.

4. SUMMMARY

The article present a methodology of evaluation of ERP system implementation based on financial ratios analyzes. The base of the methodology is determination a main goals of the ERP system implementation and a set of financial ratios which indicate the efficiency of ERP implementation. In the article, a case study was presented based on industrial enterprise that in 2003 year implemented an ERP system. The presented values of different financial ratios give us the following conclusion:

- The ERP implementation has improved the important indexes of the Alpha company.
- All the financial ratios of the Alpha company are better then the ratios of another enterprises from the branch of industry.
- The enterprise should revise all the business processes in the area of purchasing, material and inventory management to improve the inventories productivity.

A similar analysis of all functional areas of detailed productivity indexes of the Alpha company can be done to examine the profitability of ERP implementation in all functional areas of the enterprises.

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Robotics, virtual reality, visualization, simulation, walking robot

Tomáš MICHULEK[*]

USING VIRTUAL REALITY TO DEVELOP SIX LEGGED WALKING ROBOT CONTROL SYSTEM

Abstract

This contribution presents the first results of our work related to design and development of a six legged walking robot. Real prototype was created along with its virtual counterpart that is simulated in virtual environment. A control system was created and tested on virtual model. This control system was then directly used to control real robotic construction.

INTRODUCTION

Autonomous mobile robots are becoming more and more important during last years. They are able to solve problems too dangerous for human beings. A special form of mobile robots are walking robots. This includes robots that locomote without wheels, or use walking wheels [9]. Their ability to move through uneven terrains makes them best choice for many applications were standard wheeled vehicles are useless. Many different constructions were created. Most popular are biped [12], quadruped [2] and six legged constructions. Robots are often inspired by various life forms [11].

Two main approaches can be used to control waking robot. First one is based on precise joint angle control. This approach is based on direct control of every DOF of the robot. The second is based on passive dynamics of the robot construction. In this case, part of the walk control problem is solved by robot construction. A precise joint control approach was used to control our robot.

Many software solutions were created to simulate walking robots. Examples can by found in [3] [6] [8] [10]. Simulation is being used to speed up the development of robot construction and to optimize its control system. The evolution of computing hardware has enabled more precise simulation of complicated robotic construction during last few years.

In this paper, we present the results of our development of a six legged walking robot, along with its virtual counterpart. A control system developed to control these robots is also described.

2. SIMULATION SOFTWARE

Since we had problems to find software package capable of meeting all our current and future requirements, our own software environment was created. It was written in C++ GLSL

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and Lua programming languages. It is based on OpenGL, SDL and Boost libraries. It iscompatible with Linux and Windows operating systems. Application consists of multiple different interface modules. Their responsibility is to interact with the user.

- **Viewport manager** - manages other modules and user interaction with the software
- **Model editor** – gives user the ability to create, modify and test virtual robots.
- **Control system editor** – gives user the ability to create and modify control systems.
- **Scene manager** – is responsible for simulation of robots in virtual environment.

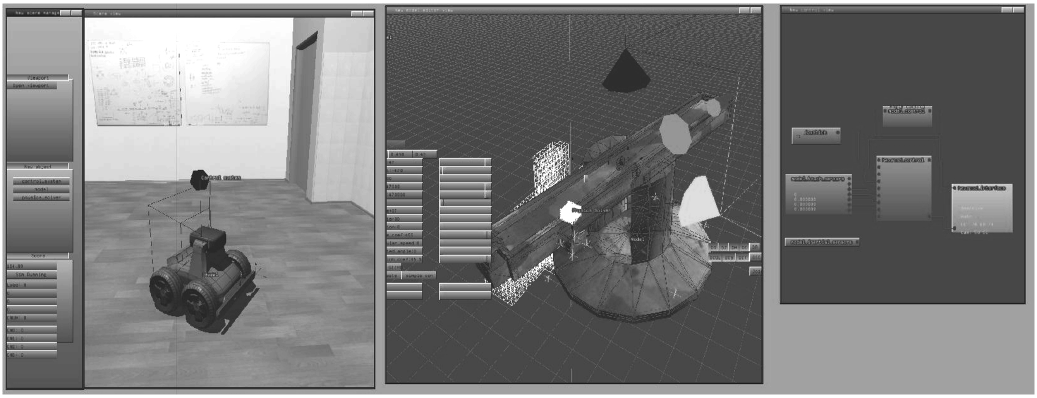

Fig. 1. Application front end: scene manager, model editor and control system editor

Each of these modules is independent dynamically loaded library. The simulation system itself is divided into these parts:

- **Robot body simulation**
- **Collision system**
- **Virtual sensors**
- **Communication interface**

2.1 Robot body simulation

Simulation of a robot body is based on rigid body dynamics. The model consists of rigid segments connected together with flexible joints. Segments are defined by their geometric shape, mass and inertia matrix. Every rigid part is affected by various forces. These forces are generated in joints in order to preserve the model geometric configuration. Another group of forces is generated as a result of a robot versus environment interaction. All these forces are then applied to a corresponding segment.

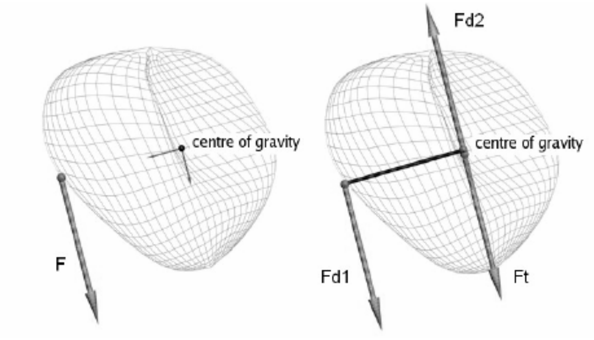

Fig. 2. Force transformation

After transformation displayed in Fig. 2. every force $\vec{F}_i$ is transformed to $\vec{F}t_i$, $\vec{F}d1_i$ and $\vec{F}d2_i$ parts. $\vec{F}t_i$ affects movement of the segment.
Resulting force is given by an expression:

$$\vec{F}_t = \sum_{i=0}^{n} \vec{F}_{ti} \tag{1}$$

Acceleration $\vec{a}$, speed $\vec{v}$ and position $\vec{c}$ of segments centre of gravity are then given by:

$$\vec{a} = \frac{\vec{F}}{m} \qquad \vec{v} = \vec{v}_0 + \int_0^T \vec{a}dt \qquad \vec{c} = \vec{c}_0 + \int_0^T \vec{v}dt \tag{2}$$

where T is actual time of simulation, $\vec{c}_0$ is position and $\vec{v}_0$ speed of the segment at the moment of a simulation start.
$\vec{F}d1_i$ with $\vec{F}d2_i$ forces affect rotation of the segment (Fig. 3.).
The resulting torque $\vec{M}_i$ is given by an expression:

$$\vec{M}_i = \vec{F}d1_i \times (\vec{p}_1 - \vec{p}_2) \tag{3}$$

The torque $\vec{M}$ affecting the segment is then computed by:

$$\vec{M}_t = \sum_{i=0}^{n} \vec{M}_i \tag{4}$$

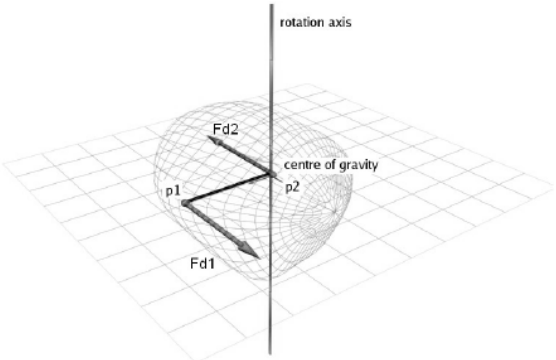

Fig. 3. Segment rotation

Angular speed of the segment can be simply computed from the torque $\vec{M}$. Control system commands are not directly affecting forces generated in joints. Various preprocessing algorithms are used to simulate real world motors. The model of six legged robot contains virtual servo motors. Only an expected angle of the joint supplied to this servos and simple regulator generates appropriate forces. This way the behavior of the simulated model can be externally affected. Simulation is being used for development and testing of control systems. Therefore, flawless behavior from the physics point of view is not required. Only a decent degree of similarity between reactions of real and virtual model is necessary.

2.2 Collision system

Every interaction between the robot and the environment results in a set of collision forces. Main task of the collision system is to compute these forces. To simplify this task, a special representation of objects in 3d space is used. Each object in the simulation is represented by a set of collision points(cpoints) and a set of collision triangles(ctriangles) (fig.4 left). Solving a ctriangle vs. cpoint collision is relatively simple. When two objects interact, the resulting force is computed as a sum of forces generated by individual ctriangle vs. cpoint collisions.

There are two separate forces resulting from the interaction between cpoint and ctriangle. First one is in the direction of triangle normal ($\vec{F}_N$). Second is parallel to the triangle ($\vec{F}_F$). $\vec{F}_N$ is given by:

$$\vec{F}_N = \vec{N}.(C_p.d) - \vec{v}_y.C_d \tag{5}$$

Where $\vec{N}$ is triangle normal, C_p is press constant, d represents depth of collision, $\vec{v}$ is csphere speed relative to collision triangle and C_d id damping constant.

The friction force computing is more complicated, because static and dynamic friction must be taken into account.

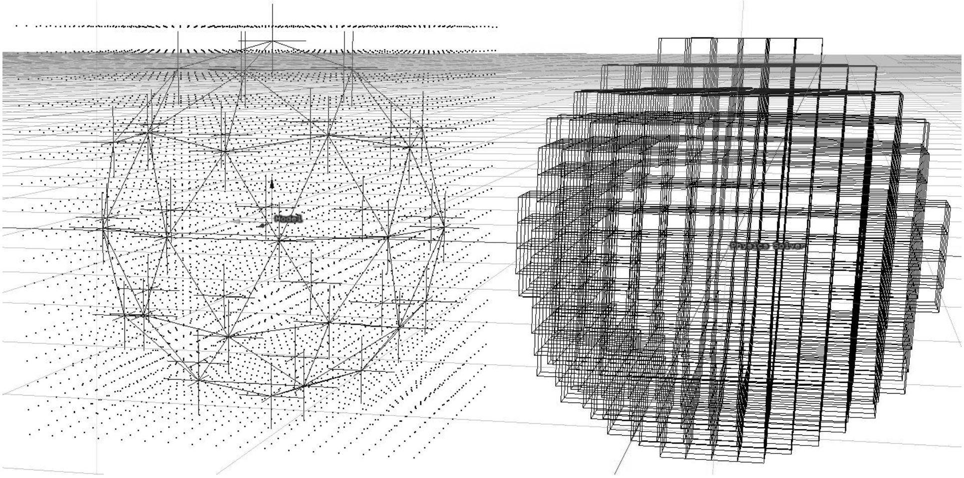

Fig. 4. Collision representation of the sphere

When two object interact, simplest solution is to compute the collision of every ctriangle of one object with every cpoint of the other. This raw force approach is very CPU demanding. When two objects with 1000 ctriangles and cpoints interact, 1000 000 collisions are computed every simulation step. More complicated 3d scene requires to much GFlops than today's CPUs or GPUs can handle. Therefore we had to find a way to lover the count of collision computed every simulation step.

We solved this problem by dividing local space of every object to certain amount of cubic subspaces (ccubes). This is displayed in fig.4 right. This cube system serves as a look-up table during collision computing. Each of these ccubes holds information about a special set of ctrinagles, than interfere with this particular cube. When a cpoint lies in this cube, there is no need to test its collision with any triangle, that does not belong to this special set. This lowers the number of collision computed per step by a considerable amount. In certain cases up to 100 times. The downside of this solution are its high memory requirements. To create a 100x100x100 ccube system, it is necessary to allocate at least 10 MB of memory. In the future we plan to further optimize the collision system, in order to lower its memory and computing requirements.

2.3 Virtual sensors

To test a control system in virtual reality, it is necessary to emulate actuators and sensors of the real robot (fig. 5). As a virtual counterpart to the real world actuators, we used the virtual servo motors. These were briefly described in other section of this article. To emulate the real world sensors, we used so called virtual sensors.

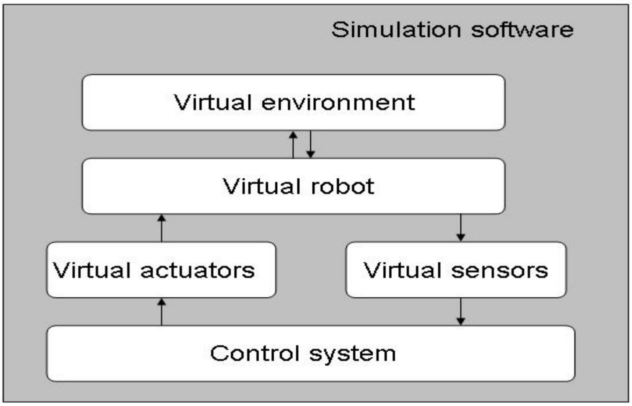

Fig. 5. Interactions inside the simulation software

Three basic types of virtual sensors were created:

- **Virtual touch sensors** - these sensors are reporting contact between the robot body and its surroundings. Touch sensor is connected to a cpoint and gets the information about any occurring collision from it. A control system receives a boolean value and a floating point value from every touch sensor. Boolean value holds an information about the collision occurrence and float value informs the control system about the size of a force vector generated during the collision.

- **Virtual distance meter** – this sensor scans distance between itself and nearest object in virtual world. It can be used as model for an ultrasound or infrared distance sensor.

- **Virtual camera** – grabs images of virtual world. This data an be used to develop, optimize and test image recognition algorithms. Robot with distance meter and virtual camera is displayed in (fig.6). The quality of virtual sensors output is very high. It is often necessary to add some noise to the signal, in order to get its quality closer to real world sensors output.

2.4 Communication interface

Peripheral devices communication interface is a fundamental element of the application. It allows image acquiring from an external USB of FireWire video camera. Real robot models are be controlled via RS232 protocol. When a lower bit-rate is acceptable, the wireless data-transfer modules are used. If necessary, the software can communicate via Internet using TCP/IP protocol too

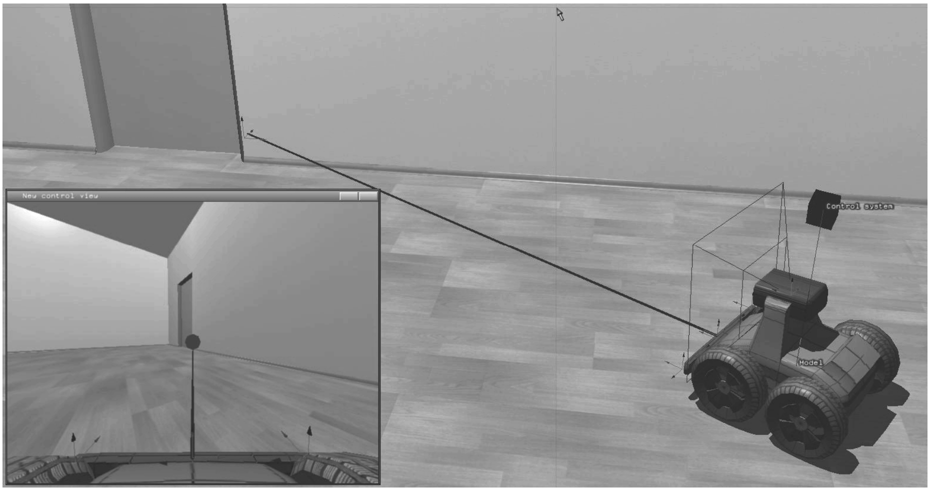

Fig. 6. Wheeled robot with a distance meter and a virtual camera

3. CREATED ROBOTS

For the purpose of practical tests we have constructed a real 6-legged walking robot. Its body is built from komatex plastic. Each leg is being moved by 3 servo motors. Whole construction has 18 DOF. A micro-controller AT Mega 16, which is placed inside the robot body, receives information about a desired position of each servo via RS232 interface. Then it encodes information into PWM for the servos.

Every servo motor contains integrated analog regulator, which rotates joint to angle encoded in the PWM signal. This regulator is acting similarly to its virtual counterpart integrated in virtual servo motors.

Current supply of the robot is provided by PC-ATX power supply or a set of Li-Pol batteries. Servos and micro-controller are operating with voltage +5V. The current consumption is up to 20A. The real robot is shown in Fig. 7.

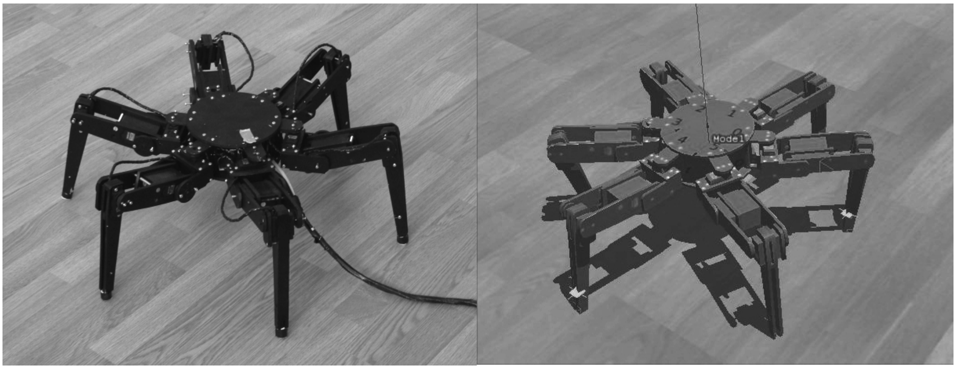

Fig. 7 Walking robot prototype and its virtual counterpart

When the construction of the real robot had been finished, its virtual copy was created. Geometric parameters of real and virtual robot are nearly identical. Parameters of virtual servo motors can be changed in order to improve its performance and speed up testing in virtual reality. The virtual model is shown in Fig. 7.

Virtual robot is equipped with six touch sensors. One on a tip of each leg. These sensors are used as a source of information about the terrain the robot is walking over uneven terrain. Each of these sensors reports contact between the leg and the surface. These sensors are We plan to mount directional touch sensors on our real prototype in near future.

4. CONTROL SYSTEM

In order to test the behavior of robots, a simple control system was developed (Fig. 7.). It allows the robot to walk in any direction, rotate and change distance between its body and a surface. The control system is divided into three cooperating blocks:

- **Central control**
- **6 individual leg controllers**
- **Inverse and forward kinematics solver**

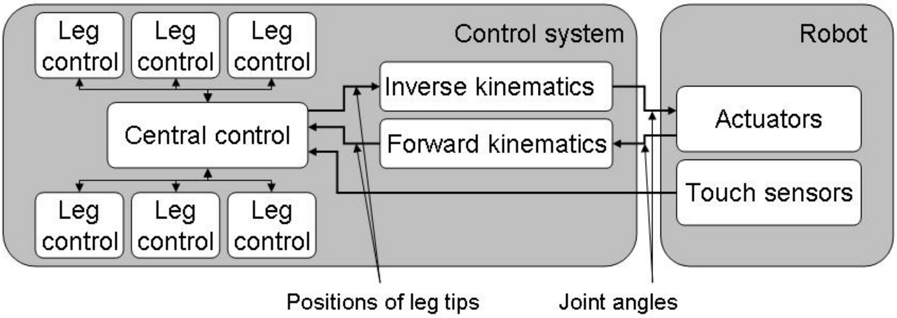

Fig. 8. Control system

The central control block coordinates steps of legs and its primary duty is to keep the robot balanced. At least three legs must be on the ground to ensure stability during walk. The individual leg controller must request permission from the central control before it can lift the leg from the ground. If the request of the leg controller is rejected, movement of the robot body is stopped until sufficient number of other legs is placed on the ground.

The individual leg controller generates vector $\vec{w}_i$, that defines direction in which the leg sole is supposed to move, relatively to the robot body. For example, if an expected movement of the robot body is $\vec{m}$ and the leg is on the ground, then $\vec{w}_i$ is given by an expression:

$$\vec{w}_i = -\vec{m}_i \tag{6}$$

The actual position of the sole $\vec{s}_i$ is then given by:

$$\vec{s}_i(T) = \vec{s}_i(0) + \int_0^T \vec{w}_i(t)dt \tag{7}$$

Leg controller acts as a simple state machine. Its states are UP, LAYING, DOWN and LIFTING When the leg controller is in LAYING state and corresponding touch sensor informs it about contact with the ground, it changes its state to DOWN.

Each leg has its own boundaries were its tip can be moved. These boundaries depend on geometric configuration of the leg. When the leg lying on the ground is about to leave its boundaries, it is lifted and moved in the opposite direction. Initially, the cylindrical boundaries were chosen in order to simplify a control system creation. More complex shape will increase the future algorithm performance.

The inverse kinematics block transforms expected positions of the leg tips to expected angles of the joints. A simple algebraic solution is used for this purpose. This prevents any unwanted oscillations. Expected angles are used to control the motors directly. This approach allows us to change geometric configuration of the robot without the need of changing any part of the control system except inverse kinematics solver.. The state DOWN is the only one of the four that grants support for the robot body. Leg controller must request permission from central control block, to leave the DOWN state.

The size of the leg movement vector $\vec{w}_i$ varies, depending on the current state of the leg . Lifting of the leg is faster than laying and the leg on the ground moves slower than lifted one.

5. EXPERIMENTAL RESULTS

The initial tests and optimizations of the control system were made exclusively on the virtual model. Then, without further changes, the control system was connected to the real robot. During this test, the response of the real robot was very similar to the response previously observed in virtual reality. Only minor differences in specific situations were observed. This fact made doing changes of the control unit very easy, because no intensive testing on the real model was needed.

When both robots were simultaneously connected to the same control system, difference between positions of their bodies became visually recognizable after 20-25 seconds. Simultaneous control was used to find hardware and software errors. When power supply of one servo, for example, was partially unplugged, the behavior of the real robot changed, but the virtual model behavior remained the same. This directed us to a possible hardware problem, rather than a control system inconsistency. When the behavior of both robots changed in a wrong way, the control system was checked first.

Resulting speed of the robot walking is given by expression:

$$v = \frac{l_s}{t_u + t_d + \frac{l_s}{v_f} + \frac{l_s}{v_b} + t_s} \qquad (8)$$

Where v is speed of the robot body movement, l_s is length of each step, t_u is time needed to lift leg from the ground, t_d is time needed to lay leg on the ground, v_f is speed of body supporting leg tip, v_b is speed of the lifted leg tip, t_s is additional time depending on current leg synchronization state. When the robot is walking straight in one direction, synchronized walking is possible and three legs move simultaneously. But when robot is moving and rotating at the same time, synchronization is lost and resulting movement is slower. This issue will be hopefully fixed during further control system optimization. Maximum walk speed achieved during our experiments with real prototype was approximately 1 m/s. Besides horizontal movement we also observed vertical movement of the virtual robot body during walking (fig.9). This movement is a result of low servo-motor torque and touch sensor signal delay. We hope it will be improved soon.

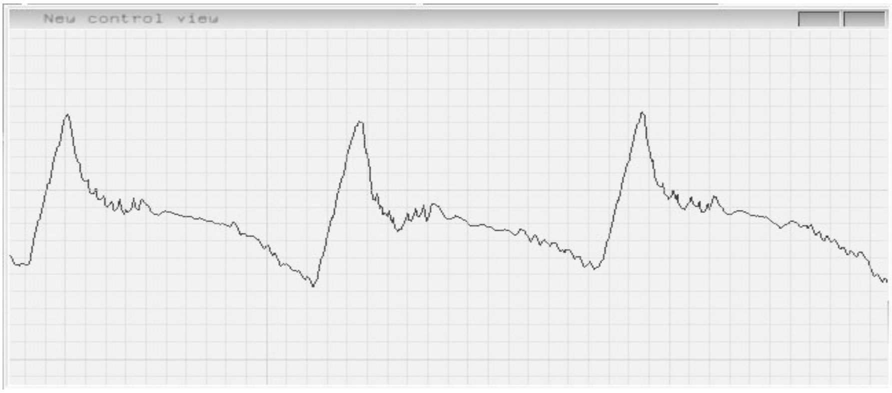

Fig. 9. Vertical body movement

6. CONCLUSIONS

In this paper we demonstrated possibilities of using virtual reality for walking robot control system development and a walk control solution. Our results can be used for further research in the field of walking robot control system development. In our further work we plan to combine our recently achieved results with artificial intelligence methods.

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