Acta Tecnología - International Scientific Journal about Technologies
Volume: 5 2019 Issue: 4 Pages: 109-114 ISSN 2453-675X

doi:10.22306/atec.v5i4.68
Received: 12 Dec. 2019
Accepted: 30 Dec. 2019

VIRTUAL PRODUCTION TECHNOLOGY VS. ENVIRONMENT

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Keywords: robot, virtual, workplace, animation
Abstract: Specialized robotic workplaces or systems are not only a complex issue, but at the same time they are financially demanding in the field of production, especially, when the prototypes essential for mechanical engineering or forestry are concerned. Such a robotic workplace calls for an original project of a small series production and the proposed virtual environment meets the requirements for the verification of the technological properties, reliability and construct possibilities of the prototypes. The specialized robotic workplace is an interactively described 3D object and is programmable in accordance with the real environment requirements. Virtual technologies represent a convenient solution for the preparation of a safe ergonomic, economic and environmental workplace.

1 Introduction

Economic and global trends in mechanical engineering management in the Slovak Republic are heading to maintain the related EU conditions aimed at the sustainable development of the machine engineering production. These technologies related to the effectiveness of national economic development in accordance with the EU countries´ machine production management are accepted in the project phase of the new specialized robotic workplace. Authors focus on the implementation of the results in forestry.

In praxis of technology workplaces with robots the computing technology is used. It is important the used technology to be independent to platform on which it will be presented and to use the newest standards in computer technologies. The aim of our project is to design suitable technology to implement computer model of virtual technological workplace. The result will be to teach and test manipulation control operations. Virtual workplace model simulates simple logics derived from real robotized workplace.

The aim is to create fully functional virtual automated laboratory with industrial robot controlled as in praxis by personal computer.

Virtual industrial robot is for its simplicity of operation and simplicity of user access to functions especially suitable for teaching control and programming robots on various knowledge grades [1]. Also, it is possible to use it to train and examine industrial robot operators and programmers. The modelling theory is the part of larger project of virtual robotized technology workplace in laboratory conditions. Additional automated workplaces dedicated be the periphery to industrial robot will be possible to add to virtual automatized complex simulation [2,3].

2 Virtual control systems

It is obvious, that the information acquisition at real technical means of the control systems is financially demanding. The basic training for the plant and its structure´s project engineers is available at the control system supplier, and limited renewing courses at the customer´s control system. However, the principle problem lies in the operators´ preparation for emergency situations of the plant equipment. Virtual control systems connected with virtual models of control systems mean an effective solution of the abovementioned problems [4]. Current research results and further research development in the field of virtual control systems implementation are supported by VRML /Virtual Reality Modeling Language/, designed for interactive description of 3D objects and worlds.

VRML /Virtual Reality Modeling Language/ is designed for interactive description of 3D objects and worlds. It is also a universal variable format for 3D graphics and multimedia. The use of VRML can vary and comprises also the possibility of technical and scientific visualization, multimedia presentations, entertainment, computer-aided education, www pages and virtual worlds.

It is a standardized file system defined by ISO/IEC 14772. VRML is capable to represent static and dynamic (animated) 3D objects, multimedia objects with hyperlinks for individual components of multimedia, such as a text, sound, picture, animation and film. VRML was designed to meet the following requirements:

a. The possibility to create automated scripts. It allows for the development of computer programs for the VRML creation, editing and operation based on automated translation programs for the conversion of other common 3D formats into VRML files.
b. The arrangement provides the ability to combine dynamic 3D objects and VRML worlds.
c. The spreadability allows for the addition of new objects not explicitly defined in VRML
d. Performance
e. The scale allows for the development of arbitrary large dynamic 3D worlds.

The standard ISO/IEC 14772 does not need to define the physical equipment nor other concepts depending on the implementation, e.g. screen contrast or input devices. On the contrary, this standard is for wide range of equipment and implementations which do not include even a monitor /display/ or a mouse.

3 Basic principles of virtual robotized workplace

The main aim of automated laboratory modelling is simulation. It offers wide range of industrial robots use possibilities, enables to use the whole kinematics, which could not to be used in real robot because of manipulation equipment damage risk. The concept of virtual laboratory automated workplace has following advantages:

1 – decrease of risk in complicated and dangerous robot manipulations unlike in manual control,

2 – more transparency in robot control,

3 – elimination of the need to travel to the place of manipulation equipment and connected expenses,

4 – accessing the industrial robot control to students without access to control the real equipment,

5 – creating fully functional application that amends manual control in virtual form,

6 – the possibility to make various simplifications in control,

7 – instant availability at any time,

8 – the possibility to create components to expand the workplace peripheries,

9 – the possibility to work anywhere and anytime,

10 – generating of various statistic results that will be processed from any time interval of virtual laboratory work,

11 – more easily setting of work in various working modes,

12 – various periphery corrections and manipulations,

13 – exchange of gained knowledge and statistics between workers and the possibility of broader data executing,

14 – creating of own programming interface for more simplification.

Additional important positive is creation of such program automated laboratory control environment which fulfils all ecology, ergonomic and functional conditions.

4 The decision process for simulation algorithm definition

By the CNC program design as well as by the robots programming on the virtual scene, there are situations when for some machines it is necessary to wait for a defined time period. The movement speed, either angle or translation speed, represents the time function. It is essential to use the simulation algorithm controlled by events. For example: Figure 1 shows the real scene of a robotic technological workplace with the possibility to program the technological process of materials manipulation.

The training in control system real technical means is financially demanding. The basic training for the plant and its structure´s project engineer is available at the control system supplier, and limited renewing courses at the customer´s control system. However, the principle problem is represented by the operations´ preparation for emergency situations of the plant equipment. Virtual control systems connected with virtual models of control systems mean an effective solution of the abovementioned problems.

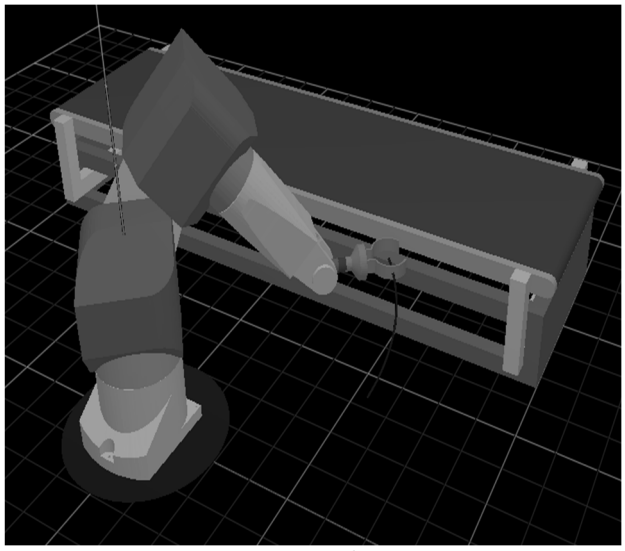

Figure 1 Virtual scene of a robotic workplace

The development process based on virtuality is at present a prerequisite for the successful process of a new product or workplace creation. In the phase of project, there exists the concept of a virtual robotic workplace model with the possibility do design real technology and define the basic principles of the technological process control system. The implementation of virtual methods in this paradigm is highly effective and leads to early decisions of real workplace effectiveness from various aspects. The original idea of a virtual technological workplace project was based on a know-how workplace. It is like the constant education level increase not only at universities - where it is necessary to implement new technologies into education.

Plant information environment as well as its system integration with the use of new IT and economic tools of IS organization and control, provides the transparency of information and knowledge processes and allows for the integration, consolidation and restructuralization of necessary information for the needs of individual plant management levels.

New trends in the IS organization and control as well as in the information and knowledge support present the creation of the whole range of new specialized functions.

They are especially informatic, economic and manager positions focused on the organizational, technical, economic and technological part of the information processes, whereas the positions focused on information processes content are missing. Drucker, a management expert, describes the lack of information responsibility. Some experts relate this field to the information and knowledge managers and comment on the difficulties with the combination of IT initiatives and knowledge management content.

The practice shows that the knowledge assurance of corporation processes calls for the need of workers interested in the information and communication processes with the emphasis on managing positions. This proves these workplaces stayed out of the system, though the work with the contents has been always the strength of IT professionals in the information databases focused on the economic growth.

Professional operator profile focused on economic and knowledge information represents an interdisciplinary problem, e.g. in the competitive intelligence or in the competences for special librarians of the 21 century for the Special library association. From the point of needs analysis, the necessary knowledge, abilities and skills are not incorporated and the information professional is missing. In the system of positions, it is necessary to create the place for an information specialist. The professional assurance of individual IS dimensions should be enhanced with the computer science, informatics, theory of information systems, information and knowledge management and information science.

Economic relations of the mentioned fields of science overlap in the professional area, though their common subject provides specialization in the assurance of plant strategic processes. It is necessary to involve the long-neglected information professionals, who are responsible for the information content, into the information and knowledge processes and consider them the key personalities of the processes.

The new possibilities of specialized robotic workplaces design, project, implementation and management allow for the simulation of the use in the project phase while meeting economic, ergonomic and sensitive environmental requirements accepted in EU countries at the same time.

It is still clear that the information acquisition in real technical means is financially demanding. The basic training for the plant and its structure´s project engineer is available at the control system supplier, and limited renewing courses at the customer´s control system. However, the principle problem is represented by the operators´ preparation for emergency situations of the plant equipment. Virtual control systems connected with virtual models of control systems offer a convenient solution of the abovementioned problems.

5 Design of actions to achieve project aims

One of additional aims is to create interface between the virtual simulation application and software interface which will directly control industrial robot by the means of hardware interface.

In the first phase the concept of project creation will be produced. Then the whole volume of work what and how to simulate will be defined. In the second phase the robotized workplace will be modelled. In this phase the actual state analysis of manipulator modes will be created and new practical functions will be designed to bypass some older non practical robot controls [5,6]. The final phase will be testing. After testing the virtual application will be used in learning.

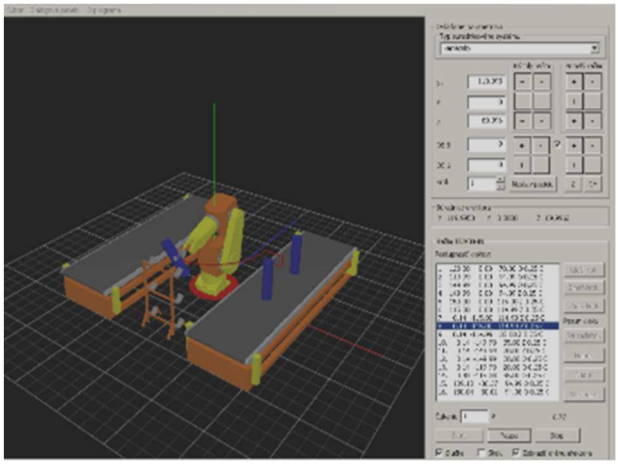

Figure 2 Virtual simulation window

The final application in Figure 2 contains virtual scene with robot in scale 1:10 and enables robot control in modes: teaching (TIN), automatic run, step by step, editing. These modes offer full control of robot's whole kinematics.

6 Application and interface

Animation as a significant part of the application illustrates the current state of all units and parts of the robotic workplace. It is impressive not only by the manual control but also by the data processing.

The animation will be carried out by the means of object-oriented Microsoft visual C+ with the use of graphic library Open GL, both providing wide possibilities of the use of a large number of orders and functions.

Library Open GL is compatible with Linux operation system and represents a standard in 3D graphics.

Interface must be compatible with the data processing generated from the virtual scene, then transformed into the real environment of a robotic workplace.

In the design phase it is important to define the interface between application and user. Additional important condition of clear control is the user not to be cluttered up with a lot of control elements. There should be few control elements and function should be clear at the first sight. In application of virtual automated workplace will be many

control elements but will be ordered and integrated in the environment so that the usability will be unassuming, clear and fulfil all the user requirements.

Communication interface: in particular project parts the following standards will be used. VRML 97 for virtual scene definition, COBRA 2.0 for assigning server vs. client communication, JAVA for programming of platform independent application.
It is important to design model parameters to be possible to expand it by adding parameters.

7 Proposal of the boundary application

In the phase of the proposal of the boundary application, it is essential to define the boundary between the application itself and the application user. The ergonomics of the boundary application is an important point, i.e. the simpler the control the better. Another important condition of an application control overview is represented by the smallest possible number of control units for the user.

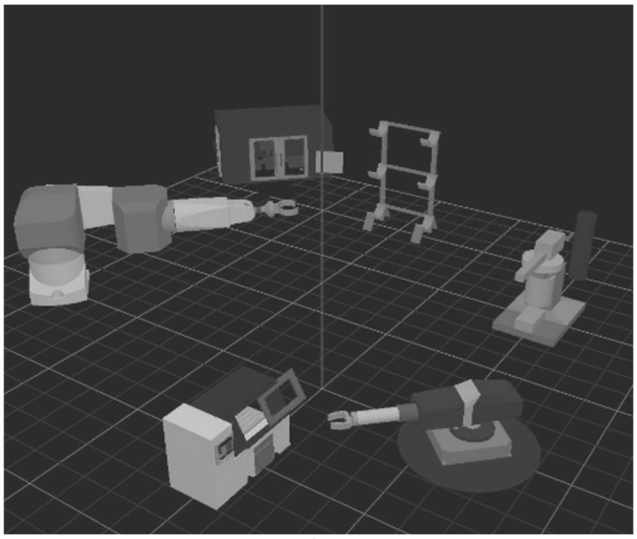

Figure 3 An example of a virtual scene creation

In the simulation application in Figure 3 of the virtual robotic workplace, there will be many control units, but they will be arranged and implemented in such a way so that they are user friendly.

It is necessary so that the application control is unified as a whole and that there is one control unit per function. Individual control units will be called by names or abbreviations and the control will be assisted by a helper.

8 The implementation of HCS model 3E in a virtual technological workplace

The concept virtual HCS model 3E of a technological workplace is designed in the phase of the project. It allows to design the technology in real as well as it permits the definition of the basic principles of the technological process control system. There are 3 acceptable aspects (3E) of sustainable development:

1 Environmental aspect - each of the technologies carry an environmental burden which also reflects to the economic aspects because of the inevitable operational measures. The advantage of the proposed virtual technology application means that it is not necessary to produce the model of a technological device, nor it is necessary to create the real technological workplace. By the production of the aforementioned devices, the environmental impact is minimized.

2 Economic aspects – there are few of them. They can be divided into partial groups and subgroups. The most important aspects that have to be in the optimization of such a technology, that are taken into consideration, are the investment costs (the amount of finances related to the specific virtual equipment purchase) and operation costs (technological devices, electricity consumption and other related costs) which can influence also the decision making in a new technology purchase.

3 Ergonomic aspects of virtual technologies – working conditions, lighting, noise, protective clothing necessary for the operation of such a technology, etc.

Work on spreading of ergonomics programs throughout Slovakia and neighbouring countries by expanding personal and completing materials for the proposed ergonomics laboratory as a part of Centre of Strategic Studies according to the proposal submitted to the scientific board of STU Bratislava, MtF.

The HCS 3E model applies the „National strategy of sustainable development of the Slovak Republic“ on the macro-level while simultaneously working on the enterprise micro-level (3E: Environmental Health, Ergonomics, Economy). This model is focusing on the effectiveness of human work and cost benefit [7]. We suppose to use this model as a tool for revitalizing the enterprises while, at the same time, revitalizing financial resources for sustainable development (Figure 4) [8].

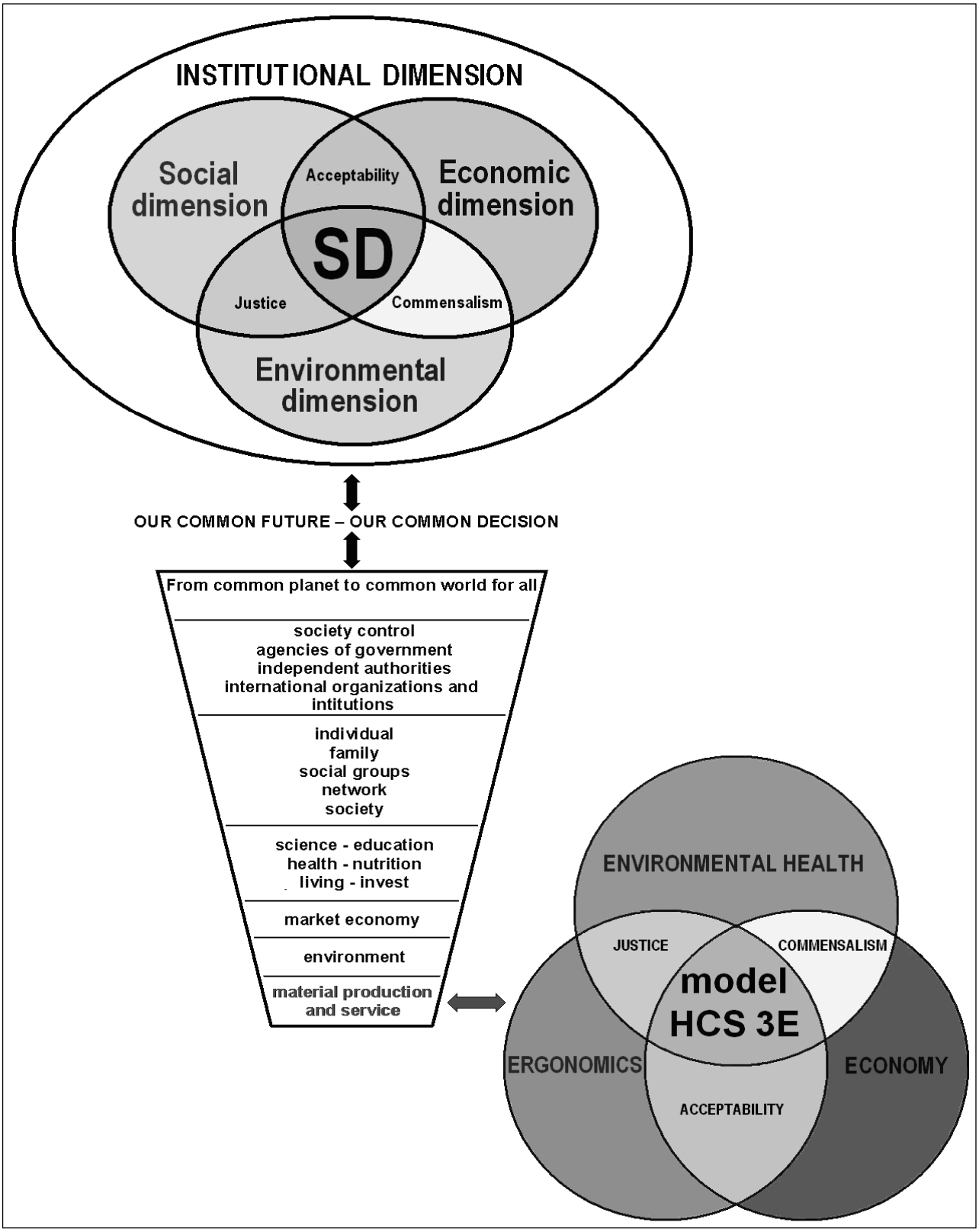

Figure 4 Model HCS 3E contribution to sustainable development (SD) – micro-solution of macro-problems

We believe this model meets our requirements in both practical and scientific areas and brings new stimuli to

economic development in Slovakia and other neighbouring countries that are in the process of adapting to the conditions in the European Community.

9 Conclusion

The new possibilities of specialized robotic workplaces design, project, implementation and management allow for the simulation of the use in the project phase while meeting economic, ergonomic and sensitive environmental requirements accepted in EU countries at the same time.

It is still clear that the information acquisition in real technical means is financially demanding. The basic training for the plant and its structure´s project engineer is available at the control system supplier, and limited renewing courses at the customer´s control system. However, the principle problem is represented by the operators´ preparation for emergency situations of the plant equipment. Virtual control systems connected with virtual models of control systems offer a convenient solution of the abovementioned problems.

By keeping basic standards of information transmission and accepting enough transmission speed it is possible the student will train manipulation sequence on remote workplace. It means finance saving, it is not needed to build several robotized workplaces physical models but only model in computer and connection to software simulators.

On one hand, the various ways of environmental protection influence the economic structure, on the other hand, they create conditions for future survival of man. At the same time, they are closely related to the environmental impact caused by the technologies in mechanical engineering. Therefore, the gradual implementation of new virtual technologies is suitable as soon as in the phase of the production and technological processes begins. Now when the energy sources are limited, the mentioned technologies can win a reasonable share on the market.

References

[1] BOZEK, P., CHMELIKOVA, G.: *Virtual technology utilization teaching,* 14th International Conference on Interactive Collaborative Learning (ICL), 11th International Conference on Virtual-University (VU), Piestany, Slovakia, September 21-23, 2011.

[2] IKEUCHI, K., KANADE, T.: Automatic generation of object recognition programs, *Proceedings of the IEEE,* Vol. 76, No. 8, pp. 1016-1035, 1988. doi:10.1109/5.5972

[3] SVIATSKIY, V.M., SENTYAKOV, B.A., SVIATSKIY, M.A.: Simulation of air flow rate at point of contact with a stream of melted polymeric material, *Acta Tecnología,* Vol. 2, No. 3, pp. 1-4, 2016.

[4] ABRAMOV, I., TURYGIN, Y., SHCHENYATSKY, A., NIKITIN, Y., BOZEK, P., HALGOS, J.: *Offline Programming of Robot Model with Virtual Environment Support*, 12th International Conference on Elektro 2018, Mikulov, Czech Republic, May 21-23, 2018.

[5] FRANKOVSKY, P., HRONCOVA, D., DELYOVA, I., HUDAK, P.: Inverse and forward dynamic analysis of two link manipulator, *Procedia Engineering,* Vol. 48, pp. 158-163, 2012. doi:10.1016/j.proeng.2012.09.500

[6] QAZIZADA, M.E., PIVARCIOVA, E.: Mobile robot controlling possibilities of inertial navigation system, *Procedia Engineering,* Vol. 149, pp. 404-413, 2016.

[7] BENNAMOUN, M., BOASHASH, B.: *A vision system for automatic object recognition,* 1994 IEEE International conference on systems, man, and cybernetics - humans, information and technology, Vols 1-3, pp. 1369-1374, 1994.

[8] HATIAR, K., COOK, T.M., SAKÁL, P.: *HCS model 3E účastníckej ergonómie,* [Online], Available: https://www.google.sk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwj53PDB4aHnAhWKzaQKHQzgDtYQFjAAegQIBRAB&url=https%3A%2F%2Fwww.mtf.stuba.sk%2Fbuxus%2Fdocs%2Finternetovy_casopis%2F2006%2F3%2Fhatiar.pdf&usg=AOvVaw2H0Pt1sfOt0uCJ5hy0Z3Kg [15.11.2019], 2006. (Original in Slovak)

Review process
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