



Integrating virtual reality into robotic systems

Juraj Kováč

assist.prof., Technical University of Košice, Letná 9, Slovakia, juraj.kovac@tuke.sk

Juraj Šebo

assoc.prof., Technical University of Košice, Letná 9, Slovakia, juraj.sebo@tuke.sk

Abstract

The article deals with the interconnection of virtual reality and robotic systems. It describes software and hardware resources that are used in virtual reality and their subsequent application and use in robotic systems. It also provides an example of this interconnection using a multi-modular system that was developed in Japan by NTT and own designed system of interconnection between data glove and robotic hand.

Key words: robotics, virtual reality, data glove, robotic hand

1. INTRODUCTION

The need to integrate and combine different technologies is based on the growing demand and expectations of the performance of various devices and systems not only in robotics but also in other industries. The progress made in information, communication and computer technologies has significant manifestations in the realization of virtual reality. Technical and software support for systems using digital and virtual technologies is a significant innovation trend in the field of robotics and robotic systems. Virtual reality allows the user to interact with real-time simulation of the environment through multiple sensing channels. Such a simulation is done using devices such as a data glove, a virtual helmet, and so on. The main component of virtual reality is its means that are necessary for its application. They consist of a workstation that must have a powerful processor and a powerful graphic card. User-to-virtual interaction consists of inputs and outputs of devices that record user inputs and simulation of motion and feedback. Virtual reality is a breakthrough technology that allows you to enter 3D simulated worlds through technical and software resources. It has the ability to provide interactivity and immersion in one user environment. Virtual reality is an artificially created environment generated by a computer that is perceived by man as a trusted imitation of real reality. The created visual experience is provided to the user with appropriate 3D imaging means. In more sophisticated cases, such an experience is extended to other systems that also affect senses such as smell, hearing and touch. The reliability of the reproduced reality depends on the quality of the hardware and software used. [1, 2]

The virtual reality scheme is depicted in Figure 1 where virtual reality means are described.

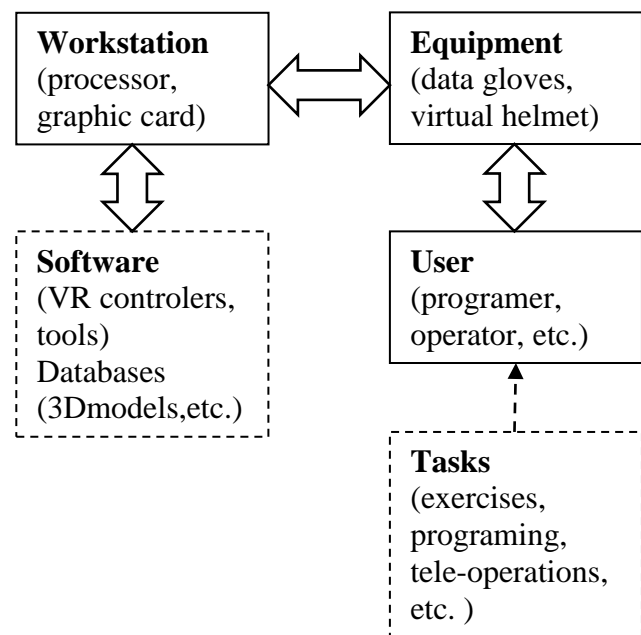


Figure 1. Virtual reality system

2. VIRTUAL REALITY AND ROBOTICS

The use of virtual reality in robotics can be beneficial, for example, in programming of manipulation tasks. The multi-modular system developed in Japan by NTT is used to weld complicated car body welds. As shown in Figure. 2, the system consists of a robot and a laser distancer. The human operator is captured by two CCD cameras and the robot is controlled by the data gloves and virtual helmet. All information is processed at the workstation. The operator is connected from other systems and controllers via Ethernet. [3]

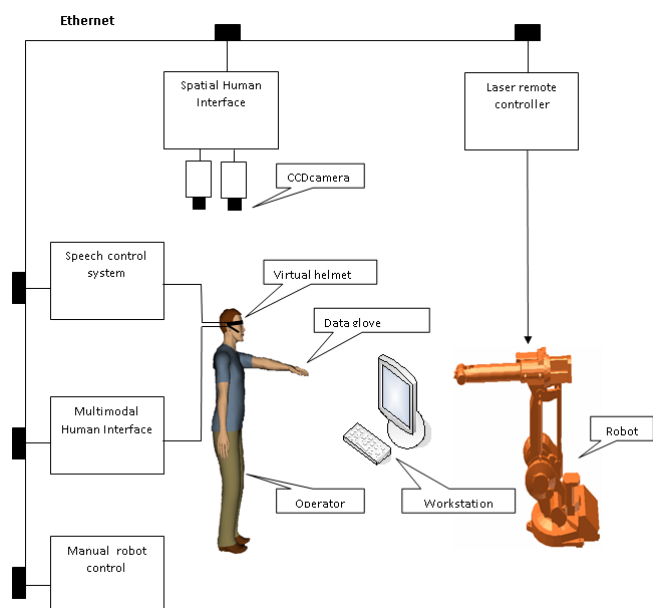


Figure 2. Multi-modular system with interconnected virtual reality and robot [adapted from 3]

Robot programming is in the virtual environment. Interaction is mediated through devices such as a data glove, a treadmill, a motion sensor and a virtual helmet. With these tools, the programmer knows how to precisely mimic the robot's movements and look at it from any angle and can see details that may not be visible in a real environment. Trajectories of the motion of the programmer's hand are automatically stored in the virtual reality toolkit system. These tools can identify and simulate dynamic behaviour of components and parts of a robot, determine its paths, acceleration and interpolations. After the moves are finished, they can be saved as a program and downloaded directly to the robotic device.

3. DESCRIPTION OF OWN DESIGNED SYSTEM

For experimental verification under laboratory conditions has been used simplified interface of the MechatRobot robotic hand from Custom Entertainment Solutions and the CyberGlove II data glove from Immersion Corporation (Figure 3 and 4). The robot hand is controlled by a servo controller that is connected to the workstation via the usb interface. The robot hand has 5 servo motors and has 14 degrees of freedom. Each servo motor can be controlled independently and it is possible to adjust the different sensitivity of its control. The CyberGlove II data glove contains 18 motion sensors and is connected to the workstation with bluetooth technology.[4] The entire system is controlled by own CyberGlove2 RoboticHand software that was created in the C ++ programming language. Its environment is shown in Figure 5.

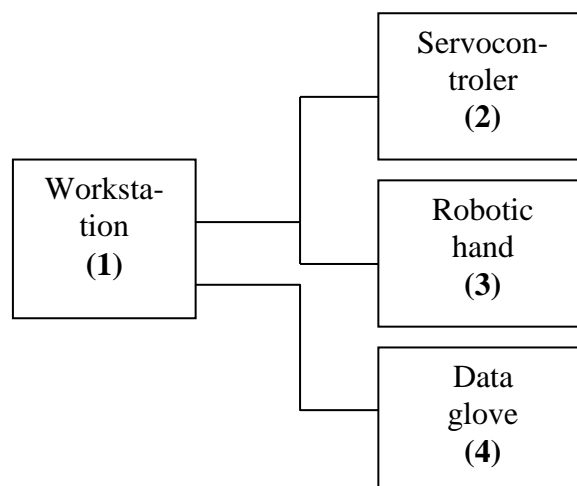


Figure 3. System connections scheme

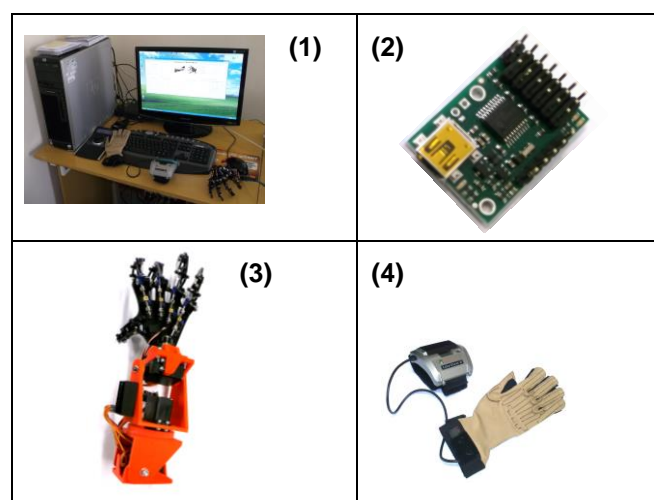


Figure 4. Integrated system means

4. SYSTEM ACTIVATION

The CyberGlove II data glove must first be activated to start the system. After activating it in Immersion Corp. Device Configuration Utility, the data glove connects to the workstation using Bluetooth technology and starts transmitting the data needed to connect to the robot hand. Subsequently, the CyberGlove2 RoboticHand software is started, in which data receiving from data glove is activated, and then attaches the robotic hand using the servo controller and usb port. After connecting the data glove and the robot hand, it is necessary to set the servo motor scales and determine them the range of motion. Each of the five servo motors can be calibrated separately.[5] Figure 5 shows the calibration of the data glove sensors and robotic hand servo motors.

After the calibration, which you need to do once, you need to save the data to a file for reloading the values so that the servo motors do not have to be re-set after every start up. After reading the values, it is possible to control the robotic hand with a data glove. The

MechateRobot robot hand repeats the movements of the hand of a person who has a CyberGlove II data glove in real time. Figure 6 shows the finger movement of the robotic hand in the same way as operator's fingers.

In the second phase of the project solution should be built a system, on which the robotic hand MechateRobot will be installed. The robotic hand will be complemented by wrist movement and additional servo drives to simulate real human hand movements.

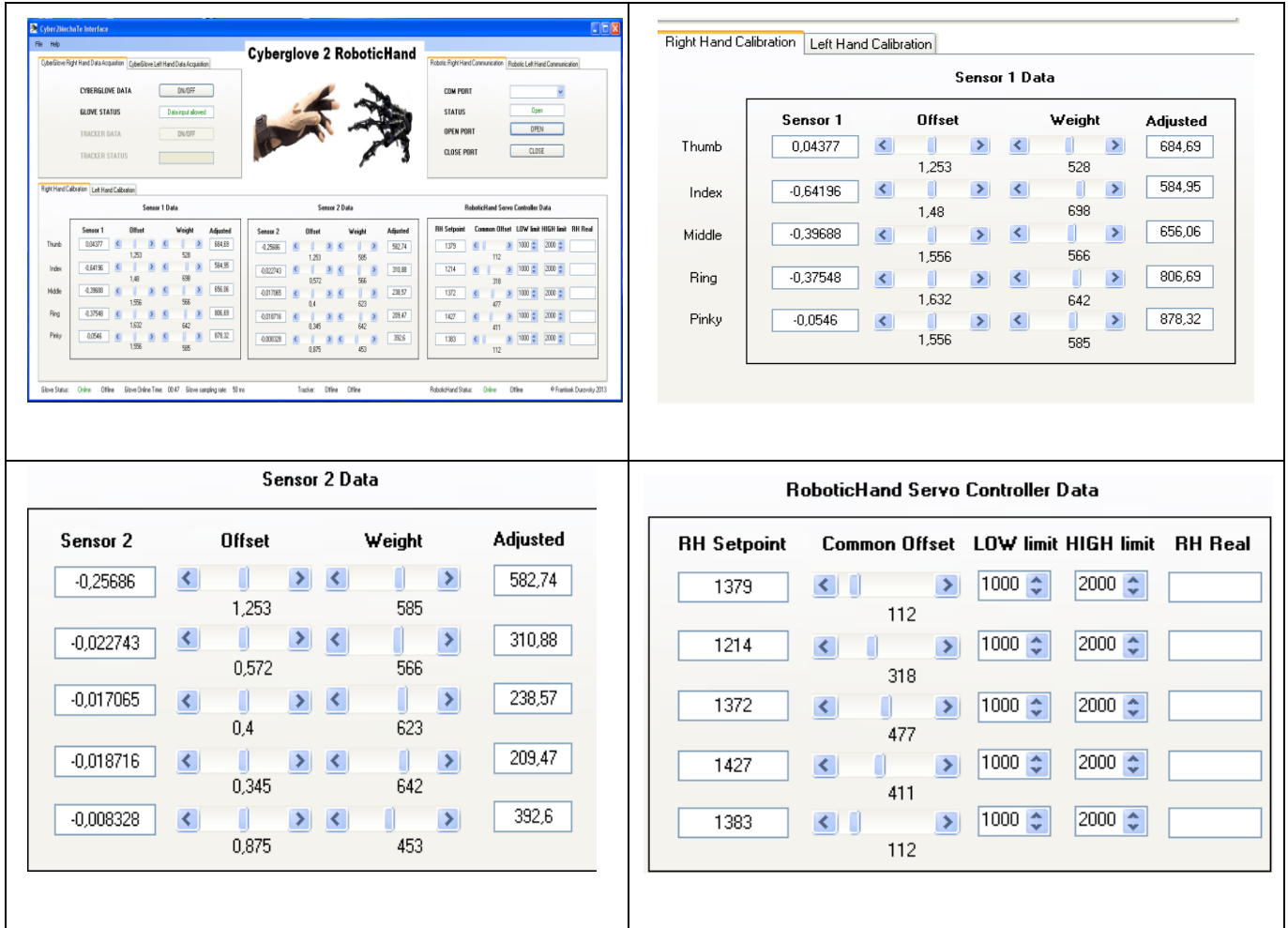


Figure 5. Calibration of the data glove sensors and robotic hand servo motors



Figure 6. Experimental verification of robotic hand movements

5. CONCLUSION

The potential of virtual technologies in the current period greatly affects innovation activities in many areas of human activity. Progress that is recorded in the development of technical and software tools significantly influences the hitherto used routine work methods and procedures applied in robotics.

The results of the experiments carried out with data gloves and robotic hands so far in laboratory conditions point to a significant application area of this interconnection, which can be used both in robotics and other areas.

Acknowledgement: This contribution was supported by the research grant VEGA 1/0853/16 (New Project Technologies for Creating and Implementing Plants of the Future)

6. REFERENCES (Arial, bold, 11 pt)

- [1] W. Strommer, J. Neugebauer, and T. Flaig (1993) Transputer-based virtual reality workstation as implemented for the example of industrial robot control, In Proc. Interface Real Virtual Worlds Conf., Montpellier, France
- [2] Grigore C. Burdea (1999) Invited Review: The Synergy Between Virtual Reality and Robotics, IEEE Transactions on Robotics and Automation, vol.15, no.3,
- [3] Y. Yanagihara, T. Kakizaki, K. Arakawa, and A. Umeno (1996) Task world reality for human and robot system — A multimodal teaching advisor and its implementation, In Proc. 1996 IEEE Int. Workshop Robot Human Commun., Tsukuba, Japan
- [4] Mareš, A., et al. (2008), Analýza pohybu rukou při ruční montáži pomocí datové rukavice. In: IT CAD. Vol. 18, no. 3, p. 29-31.
- [5] Kováč, J. (2009), Inovatívne projektovanie štruktúr výrobných systémov. diz. práca, SJF TU v Košiciach