

Remote Controlling of Automated Systems Based on Client – Server Architecture

Marek Sukop*, Marek Vagaš, Jan Semjon, Rudolf Jánoš, Peter Tuleja, Peter Marcinko, Ondrej Juruš

Department of Robotics, Faculty of Mechanical Engineering, Technical University of Košice, Slovakia

*Corresponding author: marek.vagas@tuke.sk

Abstract The fast technological changes and the resulting shifts of market conditions require the development and use of educational methodologies and opportunities with moderate economic demands. Today, distance education is primarily performed through the Internet, which is the biggest and most powerful computer network. For teachers and instructors offers an ideal novel way for distance teaching and learning, creation of classroom pages, and a suitable medium for developing remote virtual laboratories and remotely controlling physical plants and experiments. In distance education programs the traditional face-to face teacher communication and interaction are replaced by technological tools (i.e., voice, video, data print, and multimedia). In the area of control and robotic engineering education we have today available the important results of several efforts toward the development of interactive web based platforms that provide e-course material with on-line theoretical and laboratory exercises, course management, virtual classes etc., as well as virtual (simulation) laboratories and Web-based remote physical laboratories.

Keywords: *web based control, industrial robot, distance training, Moodle portal*

Cite This Article: Marek Sukop, Marek Vagaš, Jan Semjon, Rudolf Jánoš, Peter Tuleja, Peter Marcinko, and Ondrej Juruš, “Remote Controlling of Automated Systems Based on Client – Server Architecture.” *Journal of Automation and Control*, vol. 5, no. 2 (2017): 69-72. doi: 10.12691/automation-5-2-8.

1. Introduction

Distance learning is rapidly gaining ground. Courses can be efficiently delivered to meet the students own timetable and work or domestic needs [1]. It enables students to work when they want to, not when somebody else wants them to. It also lets them re-cover ground they might need help with, in their own time, and with no embarrassment [2]. Today’s technology lets them put their questions to their tutors, and the tutors can answer them either in real-time or at some other time, especially when multiple time zones are involved. It makes the learning experience very much easier [3].

Web-based control and robotics distance education is a growing field of engineering education with a substantial amount of educational material and many teaching tools and platforms already available [4]. Many educational institutes are adopting distance education programs in most of their courses including those which must be followed by hands-on experimentation [5].

In distance education programs the traditional face-to face teacher communication and interaction are replaced by technological tools (i.e., voice, video, data print, and multimedia). Through a number of studies it was demonstrated that with the proper care (selection of method, technology, student/teacher interaction means, etc.), teaching and studying at a distance can be equally successful as traditional face-to-face instruction [6].

The original concept of distance learning involved a student connecting with a course via correspondence with

no personal communication with tutors or professors. However, today’s technology enables brilliant connections to be made between professors and students, as well as between students themselves [7]. Advantages of distance learning:

- Flexibility is the major benefit of distance learning courses. Specifically for working professional. Not everybody has the situation of pursuing a regular course. For those who had to start working right after graduation such courses is a blessing and give the chance to pursue higher education.
- Everyone does not have the same speed in learning. Some students are quick learners, while others need time to grasp a subject. One of the largest benefits of distance learning is that you can read at a pace that is comfortable for you. In regular classes the peer pressure and constant tests and homework’s given by professors would seriously handicap the learning speed.
- It is very tough to get into course in a good school the marks required for acceptance is high. Distance learning courses do not demand the same high percentage of marks. It is relatively lesser so the horizon for students who can pursue the course broadens.
- Distance learning courses are convenient to pursue. Exams are held only once a semester and if there are any classes they are held only for a few days or in weekends. These make it quite convenient for a working professional to continue his education without interrupting his office work.
- If the course is one of the online courses you have the added bonus of virtual leaning and access to

study materials and virtual lectures at any time you want. Virtual lectures save a lot of time and effort as there is no need to travel for classes. Also paperless exams are the recent development which has made it very easy for the students.

- Cost effective. Distance course have much lesser fees compared to regular courses. This is the major reason why it is easier for working professionals with family commitments and financial burdens to pursue such courses.

Distance learning is delivered via electronic platforms (Figure 1), often supplemented by Skype calls and other technology sharing [8]. So the distance aspect is being removed, but the student is not physically attending an institution. It is the way forward for international students to gain world-class qualifications [9].



Figure 1. E-learning via Moodle system

Distance learning experiment can be used in following fields:

- Distance learning for part time and remote students without time and distance limitation,
- Pre-experiment for undergraduates before they go to the actual laboratory,
- Enable students to use expensive laboratory experiments which they actually have no access,
- Share expensive laboratory equipment with other university.

Simulation based labs cannot provide a feel for real things. Students need to use real devices and execute commands on real tools to gain necessary practical skills. Distance education institutes need to find a solution to provide the students with meaning full and relevant practical experiences while at the same time it being online [10].

2. Distance Training Based Moodle System

Moodle is one secure, all-inclusive system which provides students, teachers, and administrators with all the tools they need to tailor personalized learning atmospheres which are conducive to productive learning [11]. The Moodle can be easily downloaded onto your existing system, and offers courteous, knowledgeable customer support from Moodle partners. [12].

The control menu located in the upper part allows users to save the experiments performed both in image format and in MATLAB m-file format (e-Journal option), see Figure 2. This permits users to share experiment results with other users by means of the collaborative environment [13]. The Home page allows the users of the implemented application to connect as a “guest” or as a “standard user” (students, teachers of secondary vocational schools and company workers), asking to standard user for corresponding “login” and “password” and maintaining these authentication variables during the whole session. In “Home” the standard user can link to the “RUSOS” page, which gives general information about the Erasmus + project.

Just by looking the number of features and improvements that are introduced in the latest addition, one can quickly get a grasp on how much Moodle focuses on making the open source LMS so much loved by the users [14]. Features for all Moodle users:

- An interactive user menu
- Email to save privately. This feature allows the user to email documents and other important correspondence with attachment directly to themselves, which in turn automatically saves the correspondence and attachment in a private file for future use.
- Auto-save feature for text. Anything you are working on, be it a fairly minor assignment or important article or thesis Moodle’s auto-save feature allows you to securely store any content you have written, keeping it safe until you are ready to edit or publish it.
- ‘Like’ rating ability. Simply put, this allows you to share what you choose with social media sites you use by taking all of the benefits of social media and bringing them together with Moodle in harmonious integration.
- Improved Gradebook Features.

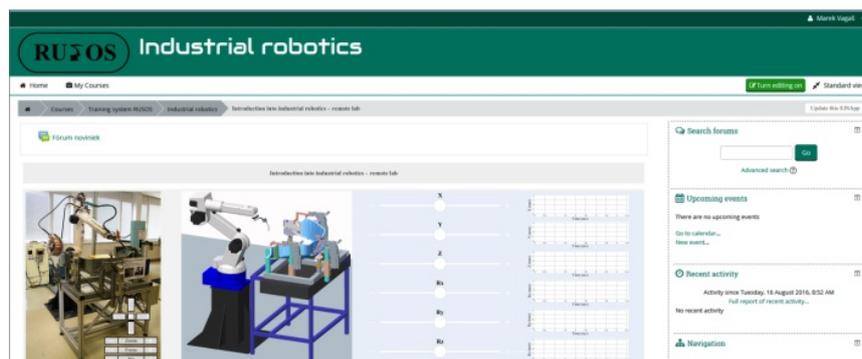


Figure 2. Example of distance training based Moodle system

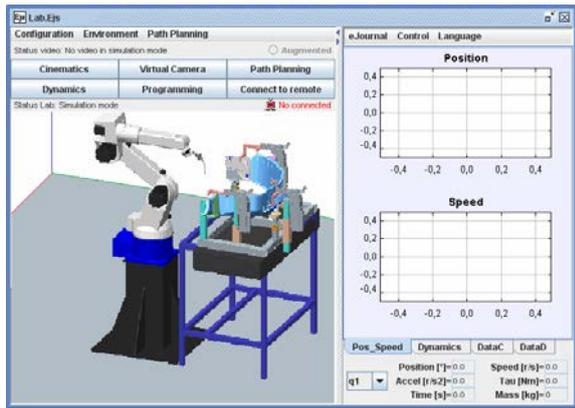


Figure 3. Experiment of virtual lab to control an industrial robot

A system that adopts computer-based technique to interface the students with the physical world is needed, a laboratory that could provide access through a Web browser to the real equipment in laboratory, see Figure 3 [15]. This lab enables student to send commands, which can be pre-processed on the student's side [16]. Then, it will go through the server and execute the experiment in the real lab on real equipment. The results of the experiment will be appeared at the student's side [17].

3. Structure of Virtual Laboratory

The structure of the laboratory is based on a client-server architecture [18], shown in Figure 4. On the client's side there is the graphical user interface built using Easy Java Simulations. EJS is a freeware open-source tool for rapid creation of applications in Java with high-level graphical capabilities and with an increased degree of interactivity. The EJS interface is the core of the system. It integrates the measurements from the vision subsystems and the robot measurements, invokes the user code that is executed in a MATLAB server, and sends the resulting control inputs to the robot. The applications created by this tool can be standalone Java applications or applets. The sources of these applications are saved in a customized XML format. The resulting applications can connect to external tools like MATLAB/Simulink [19]. The connection with MATLAB is quite interesting because MATLAB is a well-known technical software tool in the engineering community. This link uses the JMatlink 3 library and the engine library to control MATLAB from EJS applications [20].

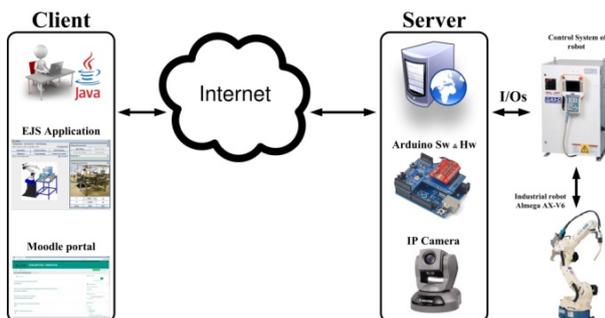


Figure 4. Structure of virtual laboratory

The client requires Internet access, a web browser, Java and Java 3D runtimes components as software that consists of an EJS jar file with all the resources needed to execute the remote lab. This allows them to use different kinds of computers or operating systems in order to run the application [21].

Platform for client software is required, and any necessary additional software should be provided for free, see Figure 5. The interface between the user and the real lab is the (user) web browser. Browser loads the user software as Java applets from the server and starts them [22]. Clearly, due to modularity any new features needed are easy to be added and implemented.

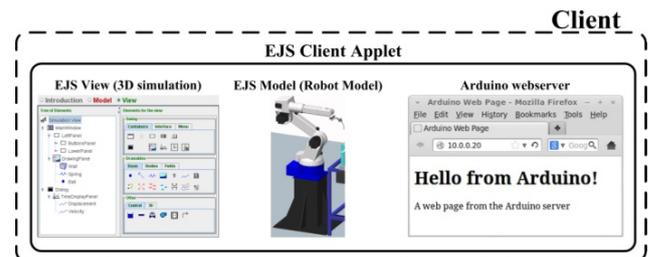


Figure 5. The architecture of client – server laboratory

On the server's side, there is a real lab with three main components: industrial robot ALMEGA AX-V6, its control system and server (PC). For the development of this robotic lab, a robot has 6 DOF with a welding gun used for simulation of welding [23].

The server is a PC which includes the web site, from where users can download the Java applet. Server validates the commands from a client's computer and sends them to the Arduino board [24]. The IP camera allows users to receive video streams by means of the HTTP protocol as feedback during the operation processes. The experimental setup is depicted in Figure 6.



Figure 6. The architecture of client – server laboratory

4. Conclusion

Lab classes are undoubtedly essential in engineering studies to make that the future engineer obtains a suitable training. Although these lab classes have been traditionally carried out in the lab classroom, the current evolution of communications and computing resources in general, allows the conducting of remote practices to be faced with increasing means.

Among others, in areas such as automation, robotic or electronics, different approaches of remote laboratories are emerging, which allows the access to didactic or professional material of different kind.

Acknowledgements

This contribution is the result of the project implementation: “Automation, Technology transfer and Managerial practices for the growth of SMEs, a better employability and the promotion of the entrepreneurship (acronym AuToMa)” has been funded with support from the European Commission under the ERASMUS+ Programme.

The authors would like to thank to Slovak Grant Agency – project VEGA 1/0872/16 financed by the Slovak Ministry of Education.

References

- [1] Fabregas, E., Farias, G., Dormido-Canto, S., Dormido, S. & Esquembre, F. (2011). Developing a Remote Laboratory for Engineering Education. *Computers & Education*, 57(2), 1686-1697.
- [2] Duchoň, F.: Výrobné systémy a CIM, Bratislava: Nakladateľstvo STU, 2015. 311 s. ISBN 978-80-227-4446-1.
- [3] Kłosowski G., Gola A., Risk-based estimation of manufacturing order costs with artificial intelligence [in:] Ganzha M., Maciaszek L., Paprzycki M. (eds.), Proceedings of the 2016 Federated Conference on Computer Science and Information Systems (FEDCSIS), IEEE, 2016, pp. 729-732.
- [4] Tůma, J., Wagnerová, R., Farana, R., Landryová, L.: Základy automatizace. Ostrava: VŠB - Technická univerzita Ostrava, 2007. 288 s., ISBN 978-80-248-1523-7.
- [5] D. Deniz, A. Bulancak, and G. Ozcan, A novel approaches to remote laboratories, ASEE/IEEE Frontiers in Education Conference, November 2003.
- [6] Palenčár, R., Kureková, E., Halaj, M.: Meranie a metrológia pre manažérov. Bratislava: STU, 2007, 252s. ISBN 978-80-227-2743-3.
- [7] Belavý, C.: Základy automatizácie a merania. Bratislava: Nakladateľstvo STU, 2012. 183 s. ISBN 978-80-227-3839-2.
- [8] S. Dormido. Control learning: present and future. *Annual Reviews in Control*, 28:115-136s, 2004.
- [9] Olaru, A., Oprean, A., Olaru, S., Paune, D. Optimization of the neural network by using the LabVIEW instrumentation, IEEE ICMERA 2010 Proceedings, ISBN 978-1-4244-8867-4, IEEE catalogue number CFP1057L-ART, pp.40-44, 2010.
- [10] Hajduk, M., et al.: Trends in industrial robotics development. In: *Applied Mechanics and Materials*, Vol. 282, ISSN 1660-9336, pp. 1-6. (2013)
- [11] Beniak, J.: Rapid prototyping and accuracy of created models. In: ERIN. - ISSN 1337-9089. Roč.5, č. 6 (2012), s. 2-8.
- [12] Zubrzycki J., Świć A., Opielak M.: Modeling of dynamic system characteristics of deep hole drilling with tools of varying stiffness. *Applied Mechanics and Materials* Vol. 613 (2014) pp 333-339, (2014).
- [13] Poppeová, V., Čuboňová, N., Uriček, J., Kumičáková, D.: Automatizácia strojárkej výroby. Žilina EDIS, vydavateľstvo ŽU, 2002, ISBN 80-8070-009-5.
- [14] Vítečková, M., Víteček A.: Základy automatické regulace. Ostrava: VŠB - Technická univerzita, 2006. ISBN 80-248-1068-9.
- [15] Brabazon, D., Donovan, L., Egan, A., O'Mahony, M., Melia, M., Smyth, B.. (2017). Content on demand for fourth year advanced materials and manufacturing students.
- [16] Staš, O., Tolnay, M., Kravec, D., Jedinák, M.: Robotic manipulation system with adaptive effector reflecting different steel plate diffraction analysed by machine vision algorithms. In: *MM Science Journal*. - ISSN 1803-1269(P). – Special Edition: Proceedings of the RAAD 2011. 20th International Workshop on Robotics in Alpe - Adria-Danube Region (RAAD), October 5-7, 2011, Brno, Czech Republic., 2011, s. 78-83.
- [17] <https://xeois.com/lms-learning-managment-system-with-moodle/>.
- [18] A. Piotrowski, T. Nieszporek. Setting up a work centre based on the Profibus network, In: *Applied Mechanics and Materials*, Vol. 282 (2013), pp. 51-58.
- [19] Urban, F., Muškát, P., Závodný, Z.: Zostavenie energetických a ekonomických charakteristík energetických strojov a zariadení. In PETRÁŠ, D. -- ŠVECOVÁ, Z. *Vykurovanie 2015: elektronický zdroj zborník prednášok z 23. medzinárodnej vedecko-odbornej konferencie na tému Vykurovanie a budovy s takmer nulovou potrebou energie*, Stará Ľubovňa, SR, 2. - 6. 3. 2015. 1. vyd. Bratislava : SSTP, 2015, s. 113-117. ISBN 978-80-89216-70-3.
- [20] Ďuriš, S., Palenčár, R., Ranostaj, J.: Application of ISO Guide for uncertainties in measurement to the interpolating equations of the ITS-90. In: *CAMET-JM 2006: Proceedings. International conference on metrology. Casablanca/Morocco/*, April 4-6, 2006.
- [21] Šolek, P., Sztankay, J.: *Inžinierska mechanika I*. Bratislava: Nakladateľstvo STU, 2013. 114s. ISBN 978-80-227-4024-1.
- [22] Novák, P. *Mobilní roboty - pohony, senzory, řízení*. Praha: Nakladatelství BEN – technická literatura, 2005. 248s. ISBN 80-7300-141-1.
- [23] Semjon J., Vagaš M., Baláž V.: The process projecting automated and robotized system based on CA methods and modularity In: *International Scientific Herald*. Vol. 3, no. 2 (2012), p. 156-160.
- [24] Rákay, R., Višňovský, M., Galajdová, A., Šimšík, D.: Testing properties of E-health system based on Arduino. In: *Journal of Automation and Control*. Vol. 3, no. 3 (2015), p. 122-126. - ISSN 2372-3033.