Journal of Artificial Intelligence, Machine Learning and Neural Network
ISSN:2799-1172
Vol: 02, No. 03, April-May 2022
http://journal.hmjournals.com/index.php/JAIMLNN
DOI: https://doi.org/10.55529/jaimlnn.23.34.38

Acceptability Level of Operator Interface Controller of Robotic Arm

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Received: 29 January 2022 **Accepted:** 20 April 2022 **Published:** 25 May 2022

Abstract: ***The main purpose of this study was to design, assemble and assess the Acceptability Level of the Operator Interface Controller of Robotic Arm. It is a device that provides students an experience identical to an actual work in the industry. Through the use of this device, the student will gain knowledge and ideas on the operation of robotic arm, Programmable Logic Controller, Human Machine Interface programming, and the learning competencies of the students will be enhanced. The researcher believes that developing the device addresses the diverse needs of learning material in automation and industrial process control. The study utilized the experimental research design in the assembly of the device. Various trials and errors were done until the device was 100% functional. Questionnaire was given after the experiment for the acceptability level to gather the necessary data. The level of acceptability of the Operator Interface Controller of Robotic Arm gained an average weighted mean of 3.84 with the description "very high". The performance of the device was rated the highest with weighted mean of 3.88. Second was the safety with weighted mean of 3.84 which means device was adequately assembled and guarantees safety. Convenience was rated third, which was described as "very high, and has an average weighted mean of 3.82. However, cost ranked the lowest with an average weighted mean of 3.80 since the materials used in constructing the device were of guaranteed quality. Based on the findings, the researcher conclude that the Operator Interface Controller of Robotic Arm was highly acceptable by the respondents in terms of performance, safety, convenience, and cost.***

Keywords: ***Automation, Human Machine Interface, Programmable Logic Controller, Programming***

1. INTRODUCTION

The fourth industrial revolution – also named Industry 4.0 – is one of the most trending topics in both professional and academic fields [1],[4]. This concept has Smart Manufacturing as its central element. It also considers the factory's integration with the entire product lifecycle and

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supply chain activities, changing even the way people work [6]. Industry 4.0 relies on digital technologies to gather data in real-time and analyse it, providing useful information to the manufacturing system.

In addition, industry 4.0 makes full use of emerging technologies and rapid development of machines and tools to cope with global challenges to improve industry levels. The main concept of Industry 4.0 is to utilize advanced information technology to deploy internet of things (IoT) services. Production can run faster and smoothly with minimum downtime by integrating engineering knowledge. Therefore, the product built will be of better quality, production systems are more efficient, easier to maintain, and achieve cost savings [8].

The requirement for sustainable development in the twenty-first century is closely linked to automation. "Doing More with Less" is one of the concepts of sustainability, and it is also one of the purposes of automation. Automation boosts productivity and product quality beyond what people can achieve by replacing routine human labor with the use of machines. It also allows humans freedom, time, and energy to focus on the new, non-routine task of developing innovative and technological breakthroughs [3].

Human-Machine Interface also known as Operator Interface is one of the hottest topics in Industrial Automation. It would appear that the future of this field lies right in the hands of this technology. HMIs are used to optimize an industrial process by digitizing and centralizing data for a viewer. By leveraging HMI, operators can see important information displayed in graphs, charts, or digital dashboards, and view and manage alarms. Before, operators would need to walk the floor constantly to review mechanical progress and record it on a piece of paper or a whiteboard. By allowing PLCs to communicate real-time information straight to an HMI display, HMI technology eliminates the need for this outdated practice and thereby reduces many costly problems caused by lack of information or human error [9].

Because of that, operators and users are increasingly moving toward high-performance HMI, a method of HMI design that helps ensure fast, effective interaction. By only drawing attention to the most necessary or critical indicators on the interface, this design technique helps the viewer to see and respond to problems more efficiently, as well as make better-informed decisions. Indicators of high-performance HMI are simple, clean, and purposely cleared of any extraneous graphics or controls. Instead of buttons and switches, modernized HMIs allow operators to tap or touch the physical screen to access controls [10].

On the other hand, Bohol Island State University as a technology-based institution employs theoretical and actual hands-on exercises. BISU provides the technical environment necessary for students in the Digital Age. The institution focuses on adapting technology to ensure that the knowledge generated is geared towards industry practices. With this goal, course offerings are organized to give attention and training to future human resources of the country to propel economic development [5].

[2] asserts that the training environment should emulate or be the working environment in order to develop the necessary skills. Students are trained to develop competencies through the actual practice of clearly defined skills and are given the knowledge of an industry standard of performance under specified conditions.

For this reason, the researcher will design, assemble and assess the acceptability level of the Operator Interface Controller of Robotic Arm through the use of this device, the student will gain knowledge and ideas on the operation of the robotic arm, Programmable Logic Controller, Human Machine Interface programming, and the learning competencies of the

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students will be enhanced. The researcher believes that developing the device addresses the diverse needs of learning material in automation and industrial process control.

Research Elaboration

The main purpose of this study was to design, assemble and assess the Acceptability Level of the Operator Interface Controller of Robotic Arm. It is a device that provides students an experience identical to actual work in the industry. The device was developed at Bohol Island State University Main Campus, Tagbilaran City, Bohol. BISU is a technological school that offers courses such as Engineering and Industrial Technology.

The study utilized the experimental research design in the assembly of the device. Various trials and errors were done until the device was 100% functional. A Block diagram, Pictorial, and ladder diagram were created for the wiring installation and programming of the device. The tools were properly identified according to their functions and the materials were canvassed from different electrical and electronic shops to guarantee high quality. The researcher formulated a self-made questionnaire for gathering the data from the selected respondents. The questionnaires serve as the basis for determining the Acceptability Level of the device. After that, pilot testing was conducted and an observation guide was provided reflecting their description of the performance of the device. The collective data were computed and analysed.

The researcher selected twenty (20) respondents. Ten (10) technology experts which include electrical instructors from different BISU campuses namely Main Campus, Calape Campus, and Balilihan Campus. Ten (10) experts from different private industries tested and validated the Acceptability level of the device.

The Operator Interface Controller of the Robotic Arm was composed of the programmable logic controller (PLC) human machine interface (HMI) which serves as the operator interface controller. A linear actuator, DC electric motor, and the pilot light indicator were the output devices, and limit switches, sensing devices, and push buttons were the triggering devices that serve as input. A computer with a monitor as a programming device. This device was used in training the students for PLC and HMI programming, motor control analysis, PLC and HMI program interfacing, problem-solving, operation of the robotic arm, and robotic arm controls. The assembly of this device was done in the electrical shop because the facilities, tools, and equipment required during the assembly of the project were available.

2. RESULT AND DISCUSSION

The base, lower arm, upper arm, linear wrist, rotating wrist, and gripper were the six degrees of freedom of the robotic arm. The panning movement was possible with the base, tilting movement with the lower arm, pitch movement with the upper arm, linear movement with the linear wrist, rotational movement with the rotating wrist, and lastly picking, holding, releasing, and placing with the gripper. Each axis' performance was tested three times in a row, and no faults were found during the process. This indicates that each axis functioned satisfactorily and was classified as functional. The robotic arm's pick and place performance was found to be functional. This operation was completed successfully and without a problem. This operation went as expected and with no faults. It demonstrates that the device was successful at picking and placing things.

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Using the weighted mean, the performance of the Operator Interface Controller of Robotic Arm as a device had an average rating of 3.87 which was interpreted as "very high" which means that the device successfully functioned to its desired operation without any problem and trouble occurred.

Table 1 Summary of the acceptability level of Operator Interface Controller of Robotic Arm

Acceptability Level of Operator Interface Controller of Robotic Arm			
	Average WM	Description	Rank
Performance	3.88	Very High	1st
Convenience	3.82	Very High	3rd
Safety	3.84	Very High	2nd
Cost	3.80	Very High	4th
General Average WM	3.84	Very High	

On the other hand, the performance of the Operator Interface Controller of Robotic Arm as a device used for instruction had an average rating of 3.88 which was interpreted as "Very High". The students were able to apply theoretical knowledge to hands-on skills using the instructional device. This device was found effective in imparting knowledge to students and the performance ranks 1st with a general average of 3.88. The result was supported by Experimental Learning Theory which stated that trying and doing contribute much to the development of students' skills and ideas [7]. In addition, the device enabled educators to deliver education much easier in the field of automation and robotics.

Furthermore, accidents may occur at any time; hence, safety is paramount. It was ranked second with an average weighted mean of 3.84. This means that the instructional device was adequately assembled and guarantees safety to both the device and the students. The result was interpreted as highly acceptable by the respondents. This means that the students were convinced of the safety that the device guarantees.

Moreover, convenience was rated third, which was described as "very high". It has an average weighted mean of 3.82. This means that the Operator Interface Controller of Robotic Arm was easy to use and easy to operate as evaluated by the expert respondents.

In addition to the given statement, the price of supplies and materials depends solely on their quality, and the materials used to produce them. The total cost of the device ranked fourth with an average weighted mean of 3.80. It was interpreted as "very high". Since the materials used in constructing the device were of guaranteed quality, it was expected to have high costs.

3. CONCLUSION

Based on the findings, the total weighted mean was 3.84 which interpreted as "Very High" and the researcher conclude that Operator Interface Controller of Robotic Arm was highly acceptable by the respondents in terms of performance, safety, convenience, and cost.

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Recommendation

- The researcher may introduce the device to the training center which offers training related to programmable logic controllers and human-machine interface programming as one of the requirements in National Certification 4 (NC 4).
- The researcher may showcase the device to BS Electrical students at Bohol Island State University's Main Campus, Calape Campus, and Balilihan Campus to let them comprehend the critical relevance of employing programmable logic controller and human-machine interface in various applications.
- For the Instructors, the device can be served as an additional instructional device used in teaching the students in the program, installing and operating of Operator Interface Controller of Robotic Arm
- For future researchers, innovations, and upgrades of the device shall be developed. A related study may be conducted for more sophisticated designs for the device.

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