Western European Journal of Modern Experiments and Scientific Methods
Volume 2, Issue 12, December, 2024
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

OBTAINING SCIENTIFIC RESEARCH RESULTS ON THE METHODOLOGY FOR IMPROVING THE PERFORMANCE SYSTEM OF COLLABORATIVE ROBOT ASSEMBLIES BASED ON STANDARDIZATION

I.Normatov[1], B. Askarov [2].
[1]Andijan machine-building institute, Andijan, Uzbekistan
[2]Andijan machine-building institute, Andijan, Uzbekistan
E-mail: islombeknormatov1@gmail.com

Abstract
In recent years, the use of Human-Robot Collaboration (HRC) in manufacturing systems has grown significantly, within the framework of Industry 4.0 and emerging Industry 5.0. Collaborative robots, thanks to their ability to reduce physical and mental stress of operators, enable increased productivity and quality performance. Expedite services is a great enhancement to all current systems as their efficiency will increase. Therefore, standards are essentially required and must be implemented to improve performance systems of HRC. The purpose of this study is to obtain scientific research results.
Key words: Human-Robot Collaboration (HRC), Lucas method, international standards, Lego mind storm.

Introduction

The increasing integration of collaborative robots (cobots) into manufacturing processes requires a robust research methodology to improve their performance systems. This article focuses on using international standards to improve the efficiency, quality, and safety of collaborative robot assemblies. Specifically, by applying complexity calculations and empirical evaluations of assembly tasks using Lego Mindstorm robots.

Research objectives

- Analyzing the complexity of collaborative robot assemblies by applying the Lucas method.
- Identify and implement relevant international standards that will improve the assembly process.
- Assessing the impact of standardization on assembly efficiency and defect reduction.

Research project

In this study, we use mixed methods, combining quantitative and qualitative data collection methods:

Quantitative methods

Experimental campaign: An experimental campaign will be conducted using experienced operators to assemble three different variants of Lego Mindstorm robots. Each variant will be designed with different amounts and types of components to represent different levels of complexity.

Complexity Assessment: The Lucas method is used to calculate complexity, evaluating each assembly option based on:

$$\mathbf{C = C1 + C2 * C3}$$

Western European Journal of Modern Experiments and Scientific Methods
Volume 2, Issue 12, December, 2024
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

Where:
C1: Complexity of product components; **C2:** Complexity of assembly connections; **C3:** Product architecture complexity
This represents the complexity arising from the number and types of components in the product. It can be calculated using a weighting scheme where different types of components are assigned specific weights. For example:
Large parts = w1; Small parts = w2; Wires = w3
Formulas:

C1 = w1 * (Large parts) + w2 * (Small parts) + w3 * (Wires)

Where:
w1 = 3; w2 = 2; w3 = 1

C2 = Total parts – 1

C3 = Total parts

Data collection: Quantitative data is collected on assembly times, defect rates, and operator assessments of complexity.

Qualitative methods

Interviews and surveys: Conduct interviews and surveys with operators to gather insights about their experiences, challenges they face during collection, and suggestions for improving collaboration processes.

Observations: An expert monitors the operators during assembly and records the quality of the process and assembly time.

Data analysis

Statistical analysis: We analyze quantitative data using statistical methods to assess the relationship between complexity metrics and performance outcomes.

Tools such as regression analysis are used to assess the impact of standardization on assembly performance.

Thematic Analysis: A thematic analysis of qualitative data is conducted to identify recurring themes and concepts related to the operational effectiveness of collaborative robot assemblies.

Application of international standards

Identify and apply relevant international standards to improve the performance of collaborative robot assemblies:

ISO 10218-1 and ISO 10218-2: Implementation of safety requirements and best practices for the design and operation of collaborative robots.

ISO/TS 15066: Use this specification to assess collaborative operations, ensure safety, and minimize risks in human-robot interaction.

ISO 9001: Establish quality management practices to streamline the assembly process and improve overall product quality.

Six Sigma: Applying the Six Sigma methodology to identify defects in the assembly process and implement corrective actions to reduce variability and improve efficiency.

Western European Journal of Modern Experiments and Scientific Methods
Volume 2, Issue 12, December, 2024
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

Results and discussion

Figure 1.Collaborative Robot (UR5)

The results of the experimental campaign are as follows:

Figure 2. Lego mind storm assembly of simple complexity

Figure 3. Lego mind storm assembly of medium complexity

Figure 4. Lego mind storm assembly of extreme complexity

Western European Journal of Modern Experiments and Scientific Methods
Volume 2, Issue 12, December, 2024
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

Complexity scores for each Lego Mindstorm variant and their relationship to assembly time and defect rate.

Operator feedback on the effectiveness of standardized practices in improving assembly efficiency and safety.

Discuss the implications of these findings for the broader field of robotics and manufacturing, highlighting how standardization can serve as a key strategy for improving collaborative robot assemblies.

Table 1. Complexity values of the obtained results

Component	Option A	Option B	Option C
Large parts	2	3	3
Small parts	5	9	16
Wires	1	2	2
Total parts	8	14	21
C1	17	29	43
C2	7	13	20
C3	8	14	21
C	73	211	463

Conclusion

The proposed research methodology provides a comprehensive framework for improving the performance of collaborative robot assemblies based on standardization. By using complexity calculations and international standards, manufacturers can improve the efficiency, quality, and safety of assembly processes, paving the way for more effective collaboration between humans and robots in manufacturing.

References:

1. Babbie, E. (2020). *The practice of social research* (15th ed.). Cengage Learning.
2. Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
3. Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners* (5th ed.). SAGE Publications.
4. Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (8th ed.). Pearson Education Limited.
5. Silverman, D. (2016). *Qualitative research* (4th ed.). SAGE Publications.