International Science and Technology Journal
المجلة الدولية للعلوم والتقنية

Volume 36 العدد
Part 2 المجلد

http://www.doi.org/10.62341/kaba7005

Received	**2025/03/18**	**تم استلام الورقة العلمية في**
Accepted	**2025/04/17**	**تم قبول الورقة العلمية في**
Published	**2025/04/18**	**تم نشر الورقة العلمية في**

Present Trend in Risk Analysis for Robotic System in Manufacturing

Khaled .A. Aboshlesha, Belgasim F.O.Abumnighir
Abdulbasit R .S. Zrooga

GHARIAN HIGHER INSTITUTE OF ENGINEERING TECHNIQUES

GHARIAN – LIBYA

kboshlesha@gmail.com

Abstract

This review paper shows the current trend of using risk analysis for robotic systems in industry. To be more precisely, it explains the new methodology and technique to do risk analysis for robotic system. Moreover, it will illustrate how to reduce the risk in robotic systems by looking for these techniques. It shows in brief the benefit of each approach separately. Risk analysis and risk management system in relation to avoiding industrial accidents that might come up with disaster outcomes. It is also important to sustain supportable production in the industry. Current trend, as numerous novel application fields for robotic systems emerge, ensuring safety is becoming increasingly important. Up to this point in time, nevertheless, the ambition to develop and obtain robotic devices has been largely determined by the market. There is no doubt that they will become a significant instrument in the industry, but the scope of their use is still developing. This paper presents a logical method for safety analysis and integration. This method uses well-known analysis techniques for computer control systems and includes the use of a formal language (Unified Modeling Language) to combine safety analysis with the development process.

Keywords: Risk analysis, Robot system, Reduce risks, Industrial safety, Manufacturing.

http://www.doi.org/10.62341/kaba7005

الإتجاه الحالي لتحليل مخاطر النظام الآلي في مجال التصنيع

خالد أبوشليشة، بلقاسم أبومنيقير، عبد الباسط زروقة
المعهد العالي للتقنيات الهندسية غريان – ليبيا
kboshlesha@gmail.com

الملخص

تبين هذه الورقة مراجعة في التوجه الحالي لاستخدام تحليل المخاطر لأنظمة الروبوت في الصناعة. وبصورة أكثر دقة، تشرح المنهجية والتقنية الجديدة لإجراء تحليل المخاطر لأنظمة الروبوت في الصناعة. علاوة على ذلك، ستوضح كيفية تقليل المخاطر من خلال البحث عن هذه التقنيات. كما توضح بإيجاز فائدة كل نهج على حدة، تحليل المخاطر ونظام إدارة المخاطر فيما يتعلق بتجنب الحوادث الصناعية التي قد تؤدي إلى نتائج كارثية، من المهم أيضًا الحفاظ على الإنتاج القابل للدعم في الصناعة. في الوقت الراهن ومع ظهور العديد من التطبيقات الجديدة لأنظمة الروبوت، أصبحت السلامة أمرًا بالغ الأهمية. ومع ذلك فإنه يوجد طموح للحصول على الات الروبوت وتطويرها من قبل السوق. ليس هناك شك في أنها ستصبح أداة مهمة في الصناعة، لكن نطاق استخدامها لا يزال يتطور. تقدم هذه الورقة طريقة منطقية لتحليل السلامة والتكامل. تستخدم هذه الطريقة تقنيات تحليل معروفة لأنظمة التحكم في الكمبيوتر وتتضمن استخدام لغة رسمية (لغة النمذجة الموحدة) للجمع بين تحليل السلامة وعملية التطوير.

الكلمات المفتاحية: تحليل المخاطر، النظام الآلي، تقليل المخاطر، الأمن الصناعي، الإنتاج الصناعي.

1. Introduction

1.1 Robotic System in Manufacturing

Robotic manufacturing involves automated systems created to carry out tasks in the production processes of industrial operations. At the heart of robotic systems in manufacturing is automation. By utilizing industrial robots that are equipped with sensor technology or artificial intelligence, manufacturers can optimize their production processes, boost productivity, and enhance overall quality.

The word “robot” comes from the word 'robota', which means a worker who performs simple tasks [1]. The term “robot” was

http://www.doi.org/10.62341/kaba7005

originally used to refer to an automated humanoid machine [1]. The International Organization for Standardization defines robots in ISO 8373: "an automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications" [2]. Additionally, the dictionary describes automation as “the method of enabling a device, a procedure, or a system to function on its own”.
After the first use of robots as production tools in the 1950s, robots technology has increased rapidly in the various areas of engineering [1].
The scientific writer, Isaac Asimov proposes three “laws”, which were recognizes as principles in the use of robotics [1]:

- A robot must not inflict harm on a human or permit a human to be harmed.
- A robot must consistently follow the instructions of humans.
- A robot must safeguard itself against harm.

Based on these three main logics, a lot of robots have been made to assist human in modern life: helping human in earthquake to find corpse, military, at the space, power plant, underwater, under the ground, and any hazardous places that human must not get close to [2, 3]. Robots have uncountable advantages. For instance, they save a lot of humans’ time. Hence, operators have sufficient time for other important tasks. Which simply it can be defined that most reason of creating and developing robots, or automations is to eliminate, or reduce risks. Contrary, there are still a lot of risks by implementation of them, which these risks can have either a negative or positive impact on the environment, which the robots or automations have been employed for a specific purpose, for instance, robots in the military, assembly lines, and industrial places. Project risk can be succinctly described as the likelihood of an unforeseen event occurring in the future, typically with adverse (unfavorable) outcomes. The notion of risk encompasses various events, forces, and situations that pose a threat to individuals or the assets they oversee. The uncertainty associated with both general and specific objectives arises from insufficient knowledge or the unpredictability of future occurrences. The decision-making process regarding actions to be taken is highly subjective, relying on individual judgment and the risk tolerance of each person, which

http://www.doi.org/10.62341/kaba7005

must be factored into any given process. It is very crucial to understand the risk analysis when using the robots in manufacturing and different fields of industries. There has been a growing concern about industrial safety across various areas and assumed a greater responsibility in minimizing and mitigating risks within the workplace. Most of organizations over the world would like to control and manage the risk to achieve an acceptable level of risk or hazards. Currently trends, risk management takes the first priority for any organization that wants to be a global company because it has to be certified by ISO to have a position in the global market. "Risk management is the identification, assessment, and prioritization of risks. The strategies to manage threats (uncertainties with negative consequences) typically include transferring the threat to another party, avoiding the threat, reducing the negative effect or probability of the threat, or even accepting some or all of the potential or actual consequences of particular threats" [4].
The Methodology of this study mainly depends on secondary data collection sources. The main objective of this review paper is to review literature and case studies related to the risk analysis in engineering especially in using robotic system in manufacturing. This study will help us to explore the new methodologies in the risk assessments and analysis when using robotic system. In addition, this review paper will discover the role of risk analysis of robotic system that leads to success the whole project in manufacturing.

2. Literature Review

2.1 Risks and Safety in Robots and Automation:

The Oxford Dictionary defines the word "risk" as the chance of a hazard; bad consequence, loss, or risk can be defined as the chance of a negative outcome [5]. These risks could result in significant budget overruns, delivery delays, failures, financial losses, environmental damages, and even injury and loss of life [2, 5]. Furthermore, to measure risk it is required estimating of the risk. Estimation of risk is usually based on the expected result of the conditional probability of the event occurring multiplied by the consequence of the event given that it has occurred.
For an event of failure in automations and robotics, consequences can be defined as the degree of damage or loss from some failure [2, 5]. Each failure of a system has one or more consequences, for example, economic damage, environmental damage, injury, or loss.

http://www.doi.org/10.62341/kaba7005

Risk analyses are the process involves defining overseeing, and communicating the presence, characteristics, scale, and frequency of possible. In an engineering system, losses may arise from outside the system, resulting in impacts on one or more recipients, including individuals, organizations, economic resources, and the environment. [5]. Furthermore, the loss can be confined within the system, resulting in harm solely to the system itself. For example, in an assembly line, for the fully automated assembly robot, the loss can be damage to a property or a human around the robot. Possible outcome to consider are injuries or fatalities, expenses for rebuilding, decline in economic activities, environmental damage, etc. [5, 6].

- To identify the presence of faults, failures, or other dangerous traits.
- To assess the impacts of such traits.
- To take action to prevent the recognized [3]. These points are briefly addressed below.

Understanding the operational state of the system. Undeniable, fully understanding for system operation state is the first step to identify the potential risks because the main cause for risks and hazards from an autonomous robot's perspective is the failure to adequately recognize the robot and environment state of operation, and thereby acceptance the system to mitigate the probability occurring of events happening that may result in dangerous operational conditions. As a result, it is essential to specify the requirements for the perceptual and cognitive systems to guarantee that the information necessary for determining the operational safety state of the system is available. Furthermore, it is important to properly outline the uncertainties involved in the process of identifying the system's state. The system needs to evaluate the level of confidence or assurance associated with its various knowledge sources and link these levels of certainty (or lack thereof) to the system's operational state characteristics that influence safety. Gaining an understanding of the uncertainty the system faces can offer valuable insights into whether more information is needed to improve the understanding of the system's condition and ultimately its safety level, as well as how this extra information might be obtained.
Understanding Action Outcomes: Recognizing the potential results of robot actions is crucial, especially as certain actions may lead to

http://www.doi.org/10.62341/kaba7005

accidents. Evaluating the consequences of actions can be accomplished by predicting how the system state will change with each possible action, factoring in operational uncertainties and their impact on the results. This evaluation can yield insights into potential hazards associated with specific actions, thus serving to highlight the safety implications of those actions.
Modifying Actions to Mitigate Risks: A key aspect of ensuring a robot behaves safely is the ability to adapt and influence its actions based on knowledge of their consequences. Action choices must be made to address safety issues while still fulfilling the operational objectives. Criteria should be incorporated directly into the decision-making process for actions. This integration enables making necessary trade-offs in action selection to balance task completion with safety objectives. Consequently, decision-making must prioritize the elimination of unacceptable levels of risk.

2.2 Importance of risk analysis

As the public becomes more educated, informed, and affluent, it increasingly calls for much higher standards of safety, health, and security regarding the ever-growing complexity of systems. In recent times, risk analysis has emerged as a significant method to tackle these public concerns, formulate effective policies, and design strategies. [5, 6].
As a result of the developments of robots and automations, evidence appear that while the world around us is becoming more complex, we also live longer, healthier, and wealthier lives that at any time in the past. Furthermore, risk analysis and especially probabilistic risk assessment in robots and automations can play pivotal roles in making design, manufacturing, operation, policy, and regulatory decisions [5, 6]. There are 4-elements to manage risks as the following:

a. Risk Identification

"The risk analysis process begins by trying to generate a list of all possible risks that may impact the project" [6]. The group brainstorming and various problem-identification methods to pinpoint possible issues. Everyone involved is urged to maintain an open perspective and produce a wide range of potential risks. Figure 1. Risk identification chart Source.

http://www.doi.org/10.62341/kaba7005

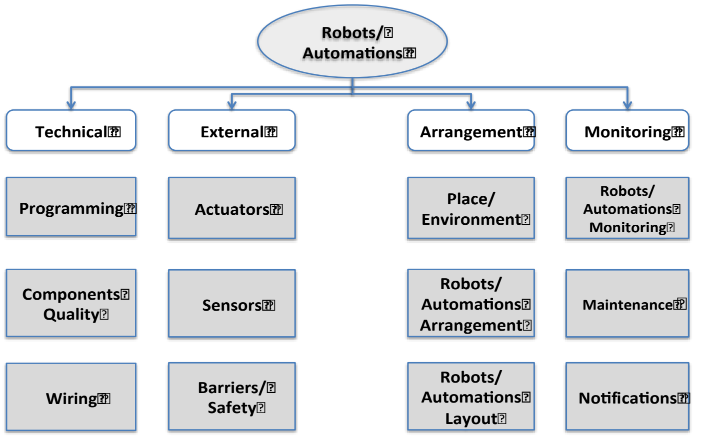

Figure 1. Risk identification chart Source.[7]

To support more for risk identification is robotics and automations: robot shape, robot motion, hazardous environmental conditions, and lack of human awareness of robots can be as examples of risk identification [7].

b. Risk Assessment

Not every risk requires consideration. Some are minor and can be overlooked, while others present significant dangers to the project's well-being. "Managers must create strategies to filter the list of risks, discard insignificant or repetitive ones, and categorize the remaining ones based on their significance and the necessity for focus". [5,6]. After identifying the risks in automation and robotics, evaluating risks is an essential part of the risk analysis process. Risk assessment serves as a crucial foundation for both risk management and communication because the outcomes of risk assessment can then be used in economic models or decision structures to perform tradeoffs among risk mitigation options available to keep risk within an acceptance level [6]. The design phase entails analyzing potential failure scenarios of the components to improve the design and reduce risks.

-**Risk Priority Number**: A risk priority number (RPN) quantifies the level of risk associated with a failure mode during the execution of a Failure Modes and Effects Analysis (FMEA).

http://www.doi.org/10.62341/kaba7005

-Risk Matrix: A risk matrix is a matrix that is used during risk assessment to define the level of risk by considering the category of likelihood (often confused with one of its possible quantitative metrics, i.e., the probability) against the category of consequence severity. This is a simple mechanism to increase visibility of risks and assist management decision-making.
The probability of harm taking place can be classified as 'certain', 'likely', 'possible', 'unlikely', and 'rare'. Nevertheless, it should be noted that a very low probability may not be particularly dependable.Table 1. Risk severity Matrix Source.

Table 1. Risk severity Matrix Source.[6]

Likelihood	Harm severity			
	Minor	**Marginal**	**Critical**	**Catastrophic**
Certain	High	High	Very high	Very high
Likely	Medium	High	High	Very high
Possible	Low	Medium	High	Very high
Unlikely	Low	Medium	Medium	High
Rare	Low	Low	Medium	Medium
Eliminated	Eliminated			

For example, the consequences of the robots, or automations depend on whether the sensors or the indicators operate successfully during the operating time.
Table 2. **Scenarios and Consequences of Robots & Automations.**shows the possible scenarios and the consequences of each scenario.

Table 2. Scenarios and Consequences of Robots & Automations.[6]

Source of Failure	Scenarios	Sensors and indicators working Successfully?	Solution has been done?	Consequences in Terms of Loss
Robots& Automations did not perform well	Scenarios 1 Scenarios 2 Scenarios 3 Scenarios 4	Yes Yes No No	Yes No Yes No	No Injury, or Loss Loss, or Injury Severe Injury Death, or Loss

http://www.doi.org/10.62341/kaba7005

c. Risk Response Development:

Once a risk event has been recognized and evaluated, it is necessary to determine the suitable response for that particular event. [6]. For instance, the Responses to risk management in robotics and automation in an industrial field can be divided as mitigating, avoiding, transferring, sharing, or retaining.

d. Mitigating Risk

Minimizing risk is typically the primary option evaluated. Essentially, there are two approaches to managing risk: (1) lower the chances of the event happening and/or (2) lessen the consequences that the negative event would have on the project. [5, 6]. For instance, in an industrial field for robotics and automation, either the team must reduce the likelihood of the event or reduce the impact of it [7]. Say, the team can change the “sensor” to a better-quality sensor for a robot, which it is reduce the likelihood of causing the robot to kick a human around its scope, or put a barrier around a robot for reducing the impact [7].

e. Avoiding Risk

Risk avoidance involves modifying the project plan to remove the risk or condition. While completely eliminating every risk event is not feasible, certain specific risks can be circumvented prior to deploying the robots or automation for their tasks. Say, designing a good system for robots, or automations to avoid any risks: install a lot of sensors to detect any human that passes by, which it makes the robot to stop operating until the human passes. For instance, robot stopping, limits to operation space, and safety related speed control.

f. Transferring Risk

Transferring risk to another entity is a common practice; this shift does not alter the nature of the risk. Usually, transferring risk to another party requires paying a premium for this protection. [5,6]. For instance, putting all the robots and automations to be under insurance.

g. Risk Response Control

Typically, the results of the first three steps of the risk management process are summarized in a formal document often called the risk

http://www.doi.org/10.62341/kaba7005

register. Risk control involves executing the risk response strategy, monitoring triggering events, initiating contingency plans, and watching for new risks: the design of user interface, and indicators in robots and automations can be an example to response. Project managers need to monitor risks just like they track project progress, for instance, Management by Walking around (MBWA).

2.3 Hazard Identification

All in all, hazard can be well-defined as a situation that results from an undesirable transfer or obstruction of energy or material, that results in injury to persons, and damage to objects or processes. The main point of this step is to make a record of all the hazards of the system, approximation their severity and their likelihood of existence, after that calculate the related risk (defined as the product of those two factors) [8]. Any application field, standards usually guide the assessments. In this revision we choose four stages of severity: catastrophic (death or total destruction), minor (defect just noticed) hazardous (injury), moderate (inconvenience). A matrix is commonly employed to assess the hazard risk level based on those four phases and the potential hazard. Results can be displayed in tabular form, including an additional box for clarifications or suggestions for explanations. All the hazards can be classified according to their energy source (mechanical, electrical, climatic, etc.) [9]. This assessment helps engineers to investigate the main risks and consider the overall risk stage of the system. First of all, The most significant risks can be managed, minimized, and subsequently reassessed; this examination cannot cover every aspect, and the hazard table is filled out in the subsequent phases. Table 3. **Example of Hazard assessment.** appears example of physical and chemical hazard assessment.

Table 3. Example of Hazard assessment.[9]

HAZARDS		
Physical	Mechanical	Robot pressure on the patient too high, friction on patient body, collision, and the robot falls on the patient.
	Electrical	Electrocution, static electricity.
Chemical	Toxic air (from artificial muscles), toxic gel (from echography gel).	

http://www.doi.org/10.62341/kaba7005

2.4 Limitation:

ISO FDIS 13482 also states the additional requirement for the case where protective measurement are implemented through the control system. Additional requirements are explicitly stated for the following ten major safety related control systems [10].

- Limits to operational spaces
- Safety related speed control
- Safety related environmental sensing
- Stability control
- Safety related force control
- Singularity protection
- Design of user interface
- Operational modes
- Manual control devices

2.5 Psychological Factors of Robot Operators

A significant proportion, specifically two-thirds, of injuries resulting from robotic accidents can be attributed to the psychological and personal characteristics of the operators. Nevertheless, the evaluations conducted in the three assessment cases did not address the identification of these personal factors. Consequently, it is imperative that future risk assessments concerning robotic operations incorporate the personal attributes of operators, which have previously been neglected. Kangdon Lee [11].

Fault Tree Analysis (FTA)

FTA is a common tool that uses graphics and statistics to analyze an event and predict how and how often it will fail. The FTA method is completely different from the previous methods; it is starts by investigating assumed failures of the functionality of a product or process. This instrument assesses failures of systems (or subsystems) individually but can integrate several failure causes by pinpointing causal sequences. The outcomes are illustrated visually as a tree of fault modes. Each tier of the tree delineates combinations of fault modes using logical operators (AND, OR, etc.). FTA depends on the knowledge of experts regarding the process to recognize causal factors.

Failure Mode Effects Analysis (FMEA)

http://www.doi.org/10.62341/kaba7005

FMEA is generally used in evaluating the potential failure modes for processes on Robot performance. Once the failure mode is identified, the expert can use the available data to reduce the risk of the system and monitor its effectiveness. It is considered as one of the most powerful tools to identify the failure and the factor causing it. Figure 2. Steps in a failure mode and effects analysis shows that the findings from FMEA can serve as a foundation for design, additional analysis, or to inform resource allocation.

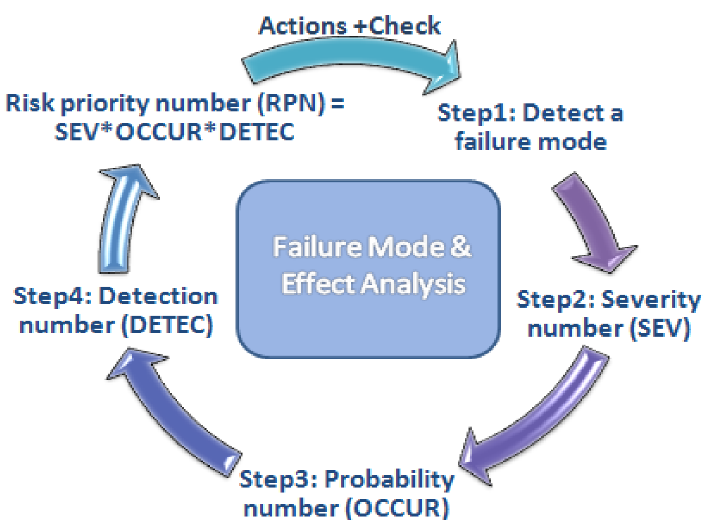

Figure 2. Steps in a failure mode and effects analysis [11]

Preliminary hazard analysis (PHA)

PHA is a semi-quantitative analysis that is performed to identify all potential hazards and accidental events that may lead to an accident, rank the identified accidental events according to their severity, and identify required hazard controls and follow-up actions.

It can be used as an initial risk study in an early stage of a project. Accidents primarily result from the release of energy. The PHA determines potential energy release points and the possible accidental events that could happen, providing a preliminary assessment of the severity of each event. The findings from the PHA are utilized to compare key concepts, concentrate on significant risk factors, and serve as a foundation for more thorough risk evaluations. Additionally, it can serve as a preliminary phase in a comprehensive risk assessment of a system concept or an existing system. The aim of the PHA is to pinpoint accidental events that

http://www.doi.org/10.62341/kaba7005

warrant a more in-depth risk assessment. Ultimately, it can function as a thorough risk analysis for a relatively straightforward system.

The integration of robots into the manufacturing process enhances the physical engagement of workers while automating production, leading to a substantial boost in economic efficiency, albeit with a fundamental transformation of the design structure of processes. In traditional manufacturing setups, errors that accumulate during the design and production phases are typically rectified post-purchase and installation of the system. However, this method is not applicable to robotic systems due to their inherent technical complexities. The primary goals of robotic technology include the production of goods that meet an acceptable quality standard, neither excessively high nor unacceptably low, while minimizing costs and ensuring timely completion. A relevant study titled "Project Risk Assessment Regarding Industrial Robots Implementation in Production Systems" addresses these considerations. The study talks about the robots' implementation in a production system must be analyzed at a project level in which the specific risks will be examined. Project analysis employs simulation techniques that illustrate the impact of risks on project objectives. For effective simulation, it is essential that the project is structured to encompass all relevant data required for comprehensive analysis. Nevertheless, a project is not merely a precise replication of the model; rather, it utilizes extrapolated insights derived from prior activities. The main contribution of this study that it is summarize the risk analysis in robotic system to be risk identification, Qualitative risk analysis evaluates the significance of identified risks by examining their likelihood of occurrence and the potential impact on project objectives should these risks materialize. In contrast, quantitative risk analysis is conducted on those risks that have been prioritized through the qualitative process, particularly those that could significantly affect the competing demands of the project. This analysis quantifies the effects of these risk events and assigns numerical values to them. The study highlights that simulations are typically executed using the Monte Carlo method, which is adept at analyzing complex, multidimensional scenarios. A key advantage of simulation lies in its capacity to conduct numerous simultaneous analyses, thereby enhancing decision-making efficiency. This paper focuses on the formulation of effective strategies for project risk assessment by identifying risks and

http://www.doi.org/10.62341/kaba7005

employing various methods and techniques to systematically address uncertainties [12].
Most of manufacturing organizations are starting to apply robotic in their firm because these organizations understand the importance of robotic that having wider range of performance capabilities to produce products faster, cheaper, flexible and more effectively. However, they don't know the way to solve different robotic problem in real-time industrial applications and how to make risk analysis for robotic systems. The first current trend for risk analysis is investigating of these problems.
There is a study published in 2012 talks about an experimental design approach using TOPSIS method for the selection of computer-integrated manufacturing technologies. The purpose of this study is exploring the applicability of an integrated TOPSIS and DoE method to eliminate the problem at computer integrated manufacturing system. This study addressed four CIM selection issues, which encompass choosing an industrial robot, a rapid prototyping process, a CNC machine tool, and designing a plant layout. The TOPSIS method and Design of Experiment (DoE) were utilized in conjunction to determine the key selection characteristics (factors) and their interactions across all these scenarios by fitting a polynomial to the experimental data using multiple linear regression analysis. The primary contribution of this research is to assist decision makers in employing a flexible, systematic, customizable, and rational scientific approach or mathematical tools that can accommodate a wide range of selection features and options through the proposed method, which aims to mitigate the issues and risks associated with the use of robotics in manufacturing.[13].
A significant trend is the integrated remote management of process capability, particularly within robotic systems, to minimize potential defects. A study published in 2014 discusses this trend. The focus of this research is on the simultaneous control of two vital process parameters from a particle site, including the process capability of robotic assembly tasks and the precision of vision calibration. Process capability is viewed as an indicator of the accuracy in robot positioning. When the vision camera controls the robot, the accuracy of the process capability largely relies on how well the vision-guided robot system is calibrated. This research introduces a new vision calibration technique that successfully addresses the fundamental challenges posed by lens distortions. The proposed methodology significantly improves the positioning

http://www.doi.org/10.62341/kaba7005

accuracy, which can be performed over the network from are particle site. Global manufacturing companies are now operating their production facilities in many countries. To be practical, the users should be able to calibrate the vision system without a complete knowledge of mathematical background.
The proposal developed in this study allows remotely located engineers to evaluate the process capability and positioning accuracy of assembly robots. The suggested remote quality control system can significantly enhance company efficiency while minimizing defects caused by insufficient information regarding the process capability of vision-guided robotic operations. Furthermore, this study employs a 2D calibration grid for the experiments, using a fixed focal distance. "In different scenarios where various part shapes and heights need to be managed, the proposed model must be adjusted to account for changes in the image settings." The future study should address the dynamic changes in the 3D space, which manifests the natural extension of our current work" [14].

3. Results and discussion

From this review paper, it was noticed that there is no specific subject that talks about risk analysis for robotic systems in the manufacturing field. All these studies are based on how the applying the concept and principle of risk management (risk analysis) in specific field such as robotics in manufacturing. It was observed that risk analysis tools are sufficient way to reduce the risk may happen while using robotic system in manufacturing. Moreover, it will increase the trust on people to use the robotic system in any field by showing them how you can control the risk by this methodology.

Risk Analysis for Robotic Systems in Manufacturing leads to:
1. Hazard Identification and Mitigation
Balancing Safety and Productivity: Stricter safety protocols (e.g., reduced robot speed) sometimes lowered throughput by 10–15%,
2. necessitating optimization via adaptive risk models
3. Implementation of emergency stop systems reduced collision incidents by 40–60% in automotive assembly lines.
4. Force-limiting robots compliant decreased injury rates by 30% in electronics manufacturing.

Future Research Needs

http://www.doi.org/10.62341/kaba7005

1. Real-time risk monitoring tools for autonomous mobile robots (AMRs).
2. Standardized frameworks for ethical AI in robotics.
3. Cost-benefit analysis of cyber security investments for SMEs.

4. Conclusion

This review paper shows that some considerations must be taken when applying risk analysis to robotic systems. Knowing the recent methodology and techniques for risk analysis for robotic system may help any organization to increase their productivity by reducing the risk and defective parts during production.. Risk and uncertainty are inherent characteristics of all project types, including those of a technical nature. Consequently, it is essential to articulate the project objectives with clarity and to pinpoint potential sources of risk. Furthermore, employing appropriate tools and methodologies is crucial for effectively carrying out the risk assessment process. The results from this review show how the risk analysis is very important and sensitive in the manufacturing fields.

References

[1] John M. Evans, Ph.D. (N.D.) 'Helpmate: An Autonomous Mobile Robot Courier for Hospitals', 1, Pp. 1-6.

[2] M. P. Kabra, D. Kabra and G. Somani, "International Journal of Institutional Pharmacy and Life Sciences".

[3]M.Y.Shieh J.C.Hsieh C.P.Cheng (2004) 'Design of An Intelligent Hospital Service Robot And Its Applications', IEEE International conference On Systems,Man A N D Cybernetics, Pp.1-6.

[4] Chan, K., & Chan, A. H. (2011). Understanding Industrial Safety Signs: Implications For Occupational Safety Management. Industrial Management & Data Systems, 111(9), 1481-1510.

[5] Ayyub, B. M. (2003). Chapter 1. Risk Analysis in Engineering and Economics, Washington, D.C: Chapman& Hall/Crc.

[6] Larson, E. W., & Gray, C. (2011). Project Management the Managerial Process. (5th Ed.) Chapter 7. New York: Macgraw-Hill Irwin.

[7] C. Pace And D. W. Seward, "A Model For Autonomous Safety Management In A Mobile Robot," In Computational

http://www.doi.org/10.62341/kaba7005

Intelligence For Modeling, Control And Automation, 2005 And International Conference On Intelligent Agents, Web Technologies And Internet Commerce, International Conference On, 2005, Pp. 1128-1133.

[8] E.Alp. "Consequence Analysis Methods For Hazards Associated With Releases Of Hazardous Materials", Risk Assessment And Management Short Course Notes, Presented At The Middle East Technical University, August 2007.Pp11

[9] Satava RM. Surgical Robotics: The Early Chronicles: A Personal Historical Perspective. Surg Laparosc Endosc Percutan Tech. 2002;12:6–16.

[10] Birgit Graf, Ulrich Reiser, Martin HäGele, Kathrin Mauz, And Peter Klein (2009) 'IEEE Workshop On Advanced Robotics And Its Social Inpacts', Robotic Home Assistant Care-O- Bot® 3, Pp. 1-6.

[11] Kangdon Lee,Critical Hazard Factors in the Risk Assessments . of Industrial Robots: Science Direct. December 2021. Pp. 499.

[12] Ispas, C., & Lungu, B.-I. (2010). Project Risk Assessment Regarding Industrial Robots Implementation In Production Systems. University" Politehnica" Of Bucharest Scientific Bulletin, Series D: Mechanical Engineering, 72(2), 97-106.

[13] İç, Y. T. (2012). An Experimental Design Approach Using TOPSIS Method For The Selection Of Computer-Integrated Manufacturing Technologies. Robotics And Computer-Integrated Manufacturing, 28(2), 245-256.

[14] Kwon, Y. J., & Hong, J. (2014). Integrated Remote Control Of The Process Capability And The Accuracy Of Vision Calibration. Robotics And Computer-Integrated Manufacturing, 30(5), 451-459.

