Automation Of Windshield Glass Gluing

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Abstract- *Traditional automotive companies' The manual procedure for gluing and mounting windshields in commercial vehicles has introduced notable inefficiencies in the production process. This method not only escalates production durations and yields inconsistent product quality but also introduces potential safety hazards. Compounding these challenges is the logistical inefficiency wherein windshield glass sub-assembly is situated a significant distance away from the main assembly line, mandating manual transportation. This project with the Robot Kuka KR16 R2010 with KRC4 model robot as the core robot, combined with an industrial vision system and gluing system, completed a vehicle windshield assembly workstation, to improve the degree of automation while greatly improving the efficiency and degree of operational safety, and can both improve the visibility of companies while establishing a good image of the enterprise.*

Keywords- Automotive manufacturing, Windshield assembly, Robotics, Automation, Gluing system.

I. INTRODUCTION

The manual methods employed in the past have, however, posed several challenges. These range from inconsistencies in the application of adhesive, leading to potential leakages or structural vulnerabilities, to longer production cycles that can hinder the overall manufacturing throughput. Furthermore, the human-centric approach, while possessing its own merits in terms of adaptability and problem-solving, is inherently prone to variability, which can compromise the quality and reliability of the end product. Recognizing these challenges, the initiative to automate the process of windshield glass gluing emerges as a transformative endeavor. By integrating advanced robotic systems, precision application techniques, and state-of-the-art adhesive technologies, this project aims to redefine the standards of windshield installation in automotive manufacturing. The overarching goal is to achieve a seamless, consistent, and high-quality bonding process that not only enhances the structural robustness of vehicles but also significantly elevates the safety benchmarks.

In this project exploration, we delve deeper into the intricacies of windshield glass gluing, the technological advancements driving automation, the anticipated benefits in terms of efficiency and quality, and the broader implications for the automotive industry. In this regard, this project is based on practical applications, with actual production operations as the blueprint for the design of the system, integrated with the robot's high-precision, multi-degree-of-freedom control technology, and gluing equipment, industrial vision technology.

Finally, online programming to set the gluing speed, turning radius, offset height, and other parameters to meet the needs of the actual production process, improve the adaptability and robustness of the gluing process, effectively improve production efficiency, and contribute to achieving the production intelligence of enterprises.

OVERALLDESIGNSCHEME

The functional requirements of this project lie in the assembly of windshields of automobiles in actual automobile manufacturing operations, so the windshield installation system based on Kuka KR16 R2010 with KRC4 industrial robots is designed according to actual needs, and the overall design scheme is shown in Figure 1.

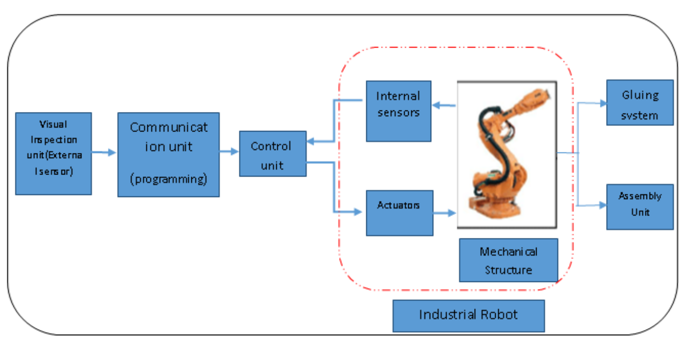

Fig.1.Blockdiagramofthesystemscheme

The integration of Industry 4.0 paradigms into the craft footwear industry through the development of a robotic cell for automating glue deposition on shoe uppers. The key takeaway is the shift from traditional methods to a more advanced extrusion system akin to Fused Deposition Modeling

(FDM). The study compares two cell layouts and emphasizes their impact on efficiency, quality, and potential for collaborative applications. [2] the significant impact of technological advancements, particularly in the context of Industry 4.0, where automation and technologies like Robotic Process Automation (RPA) and Artificial Intelligence (AI) play crucial roles. The integration of RPA with AI algorithms enhances the accuracy and efficiency of processes, particularly in information extraction, recognition, classification, forecasting, and optimization.

Tools can improve organizational processes in the Industry 4.0 framework by leveraging Artificial Neural Networks, Text Mining techniques, and Natural Language Processing for information extraction, optimization, and scenario forecasting, thus enhancing operational and business processes. [1] the significant impact of automation and robotization on productivity in the Romanian automotive manufacturing industry. It emphasizes the need for disruptive changes to sustain GDP growth, citing a specific case study of an automotive airbag manufacturing facility that achieved a remarkable productivity increase of 320%-480% over two years through automation. The paper also suggests that existing technologies could automate 50% of activities in automotive manufacturing factories for the airbag gluing process in Romania today. [3] microscale, traditional gluing processes face challenges, especially when the glue film is relatively thick compared to the components being assembled. The paper proposes a novel method involving a thick glue film (>50 µm) and active micro robotic control, which allows for highly precise positioning during assembly. This approach is versatile, flexible, and can achieve a positioning accuracy of 200 nm, making it potentially valuable for industrial applications. [4] a framework for programming in-contact tasks through learning by demonstration, focusing on an industrial gluing task. Key takeaways include the development of a unified controller structure, real-time estimation of task constraints, adaptation of controller gains based on human behavior during demonstration, and a strategy to minimize contact forces during task transitions. The framework's effectiveness is demonstrated through experiments showcasing accurate geometry estimation, improved teaching efficiency compared to standard controllers, and reduced impact forces while adapting to surface geometry during execution. [5]

II. METHODOLOGY

1. ROBOT MOVEMENT INSTRUCTION:

Utilizing the MoveAbsJ command, the robot is directed to return to its initial position, synchronized with the defined six-axis angle coordinates. This movement is crucial for recalibrating the robot's position and aligning it accurately for subsequent tasks, including place detection, activation of the suction cup, and initiation of the gluing process.

2. SIGNAL GENERATION AND GLASS SHAPE IDENTIFICATION:

Random signal generators are employed to simulate the diverse appearances of glass shapes. These signals trigger industrial cameras to capture images of the glass components within the workspace. Subsequently, advanced image processing algorithms are utilized to analyze and identify the specific shapes of the glass pieces detected by the cameras.

3. GLASS RECOGNITION AND MATERIAL LIBRARY SEARCH:

Following the completion of shape recognition, the robot proceeds to match the identified glass shapes with entries in the predefined glass material library. This process involves interpreting the received signals to determine the exact type of glass required for the task at hand. By referencing the material library, the robot efficiently locates the corresponding type of glass needed for further processing.

4. GLASS PICKUP AND GLUING PROCESS:

Upon successfully identifying the required type of glass, the robot's suction cup gripper is engaged to pick up the glass piece from its designated location.

The gripper securely grasps the glass, facilitating its manipulation throughout the gluing process. With precise control, the robot applies adhesive to the edges of the glass, ensuring proper bonding and structural integrity.

5. INSTALLATION OF GLUED GLASS:

Once the gluing process is completed, the robot proceeds to install the glued glass component into the designated slot within the cab assembly. This step ensures seamless integration of the glass into the overall structure, fulfilling the intended function of the assembly. By accurately placing the glass in its designated position, the robot contributes to the assembly's efficiency and quality.

III. RESULT & DISCUSSION

The implementation of automated windshield assembly workstations utilizing robotic systems such as the Robot Kuka KR16 R2010 with KRC4 model, combined with industrial vision and precision gluing technology, has yielded significant improvements in productivity and cycle time reduction within commercial vehicle manufacturing. Through this transformative endeavor, the traditional manual procedures, which were plagued by inefficiencies and safety concerns, have been replaced with a streamlined and technologically advanced approach.

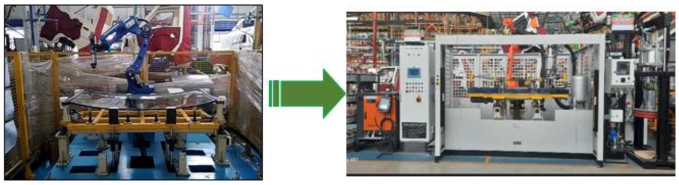

Fig:2 Automated Gluing system with safety precautions

The results of this project demonstrate a tangible increase in productivity, with a notable increment from 128 to 145 windshields per shift. This improvement can be attributed to the enhanced efficiency of the automated system, which minimizes downtime associated with manual handling and application of adhesive.

By integrating advanced robotics and precision gluing equipment, the assembly process has become more streamlined, allowing for a higher throughput of windshields within the same timeframe. Furthermore, the reduction in cycle time from 3 minutes to 1.5 minutes per cabin underscores the substantial enhancements in operational efficiency achieved through automation.

This significant time-saving is a direct result of the optimized workflow facilitated by robotic control systems and precise application techniques.

Fig – 2 Robotiazation for Windscreen Gluing

By minimizing the time required for each assembly step, the overall manufacturing throughput has been greatly enhanced, leading to a more efficient production line.

The discussion of these results highlights the transformative impact of automation on traditional manufacturing processes. By replacing manual procedures with advanced robotic systems, automotive companies can achieve higher levels of productivity, consistency, and operational safety. The adoption of state-of-the-art technologies such as industrial vision systems and precision gluing equipment further enhances the quality and reliability of the end product.

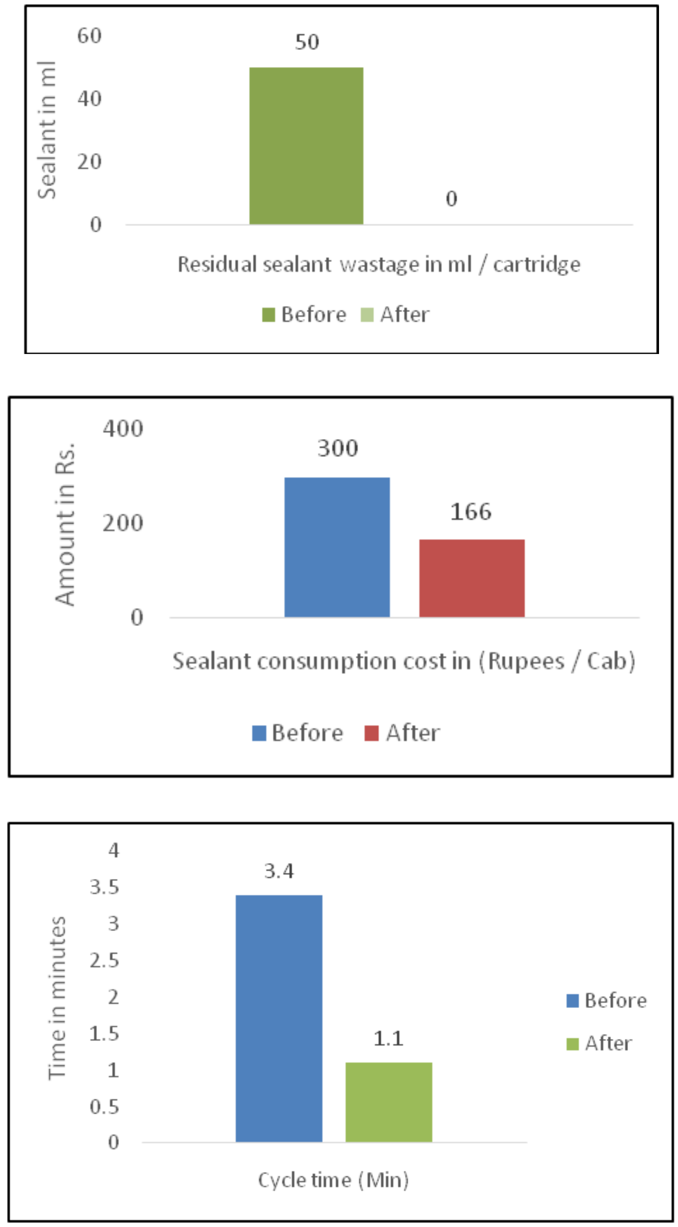

Fig:3. Graphical representation of benefits of the Gluing system

Moreover, the success of this project underscores the importance of practical applications and real-world production operations in driving innovation within the automotive industry.

By leveraging the capabilities of modern robotics and automation technologies, manufacturers can not only improve their visibility and competitiveness but also establish a reputation for excellence and reliability

IV. CONCLUSION

The implementation of advanced robotic systems and automation technologies in commercial vehicle windshield assembly represents a significant milestone in the evolution of automotive manufacturing processes. Through the integration of the Robot Kuka KR16 R2010 with KRC4 model robot, industrial vision systems, and precision gluing equipment, this project has successfully addressed longstanding inefficiencies and challenges associated with manual assembly methods.

The results of this study demonstrate tangible improvements in productivity and cycle time reduction, with a notable increase from 128 to 145 units per shift and a halving of cycle time from 3 minutes to 1.5 minutes per cabin. These achievements underscore the transformative impact of automation on manufacturing efficiency, quality, and safety.

By ensuring consistent application of adhesive, precise mounting of windshields, and optimized workflow, automation has not only enhanced productivity but also elevated the reliability and structural integrity of vehicles. Moreover, the integration of online programming capabilities has enabled adaptability and customization, further enhancing operational efficiency and flexibility.

The success of this project highlights the broader implications of automation in driving operational excellence and competitiveness in the automotive industry. As manufacturing ecosystems continue to evolve towards Industry 4.0 principles, the adoption of smart technologies will be paramount for meeting the demands of an increasingly dynamic market landscape.

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