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Integrative project: CNC technology and micro-wire (MIG) welding for precision and efficiency in industry

Proyecto integrador: Tecnología CNC y soldadura de microalambre (MIG) para la precisión y eficiencia en la industria

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Abstract

In this scientific divulgation article, the impact of Computer Numerical Control (CNC) welding machines in the welding industry will be explored through an integrative project carried out at the Universidad Tecnológica Cadereyta. The main objective is to analyze the importance and added value of this technology in terms of control and automation of welding processes, as well as the power plant that supports its implementation and the safety of the developed prototype. In this sense, the significance of the variables involved in the project will be discussed and the criteria used for their evaluation will be compared. In addition, an overview of the results obtained and the conclusions derived from this project will be shared. Also, possible areas for improvement in this field will be highlighted, considering future research opportunities. In summary, this popular science article examines the impact of CNC welding machines in the welding industry, highlighting their importance, the problems they address and the relevance of safety in their implementation. In addition, it presents the results obtained, the conclusions of the project and the prospects for future improvement.

Welding, Industry, Technology

Resumen

En este artículo de divulgación científica, se explorará el impacto de las máquinas soldadoras de Control Numérico por Computadora (CNC) en la industria de la soldadura a través de un proyecto integrador llevado a cabo en la Universidad Tecnológica Cadereyta. El objetivo principal es analizar la importancia y el valor añadido de esta tecnología en términos de control y automatización de los procesos de soldadura, así como la central que respalda su implementación y la seguridad del prototipo desarrollado. En este sentido, se discutirá el significado de las variables involucradas en el proyecto y se compararán los criterios utilizados para su evaluación. Además, se compartirá una visión general de los resultados obtenidos y las conclusiones derivadas de este proyecto. Asimismo, se destacarán las posibles áreas de mejora en este campo, considerando las oportunidades de investigación futuras. En resumen, este artículo de divulgación científica examina el impacto de las máquinas soldadoras CNC en la industria de la soldadura, resaltando su importancia, los problemas que aborda y la relevancia de la seguridad en su implementación. Además, presenta los resultados obtenidos, las conclusiones del proyecto y las perspectivas de mejora para el futuro.

Soldadura, Industrial, Tecnología

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Introduction

In the field of welding, precision and efficiency are crucial aspects to ensure quality and productivity in manufacturing processes. With the aim of improving these aspects, a project has been developed that seeks to reduce the working time in the welding process and increase accuracy by implementing a CNC (Computer Numerical Control) welding machine prototype.

The overall purpose of this project is to design and implement an efficient and safe prototype for the operator, using computer numerical control to control and monitor the movements of the prototype. This automated approach will provide greater accuracy compared to manually operated machines, resulting in improved surface finish on the parts, reduced production time, reduced operator effort, increased speed and productivity, as well as greater adaptability and safety.

The methodology used in this project is based on a sequence of ordered and proven steps, known as cascade methodology. This methodology has been divided into six staggered steps to facilitate the development of the project.

The first stage of the project focuses on the design of the prototype CNC welding machine. During this stage, a thorough analysis of the operation of the X, Y and Z axes is carried out, and a lightweight structure of considerable size and high speed is developed. The design is carried out using SolidWorks software, which provides a three-dimensional perspective of the machine and facilitates the visualization and modification of components.

The next stage is the selection of materials and components required for the construction of the prototype. Suitable materials are selected for the structure, including supports, guides, bearings and PTR tubes, which allow the joining of all the elements of the base and the creation of the mobile mechanism.

The programming of the prototype is carried out using the MACH-3 software, which allows the machine to be operated both manually and automatically through the G language. This programming allows to control and coordinate the movements of the CNC welder in a precise and efficient way.

Once these initial stages are completed, tests are performed to verify the movements, the operating limits and the calibration of the distance between the torch and the mold. These tests allow the speed and operation of the axes to be adjusted, as well as adjustments to the TB6600 controllers to control the speed of the welder. In terms of the results obtained so far, the first stage of the project, which focuses on the development of the prototype CNC welder, has been satisfactory. The prototype meets the intended performance and represents a significant advance in terms of accuracy and efficiency compared to manually operated machines. However, certain inconveniences have arisen during the process, such as mechanical vibrations, temperature increase and the presence of noise, which required additional adjustments.

Development of Sections and Subsequently Numbered Sections of the Article

First, a thorough investigation of the CNC welding machines available on the market is carried out and their characteristics, advantages and disadvantages are analyzed. Information is gathered on the operating principles of CNC welding machines and the necessary requirements for the design and construction of the prototype are identified. This research helps to establish a solid foundation for the development of the project.

Conceptual design:

Based on the established requirements, a conceptual design of the CNC welder prototype is carried out. Computer-aided design (CAD) software is used to create a three-dimensional representation of the proposed design. During this stage, special attention is given to the integration of key components such as motors, controllers and mechanical structures.

Selection of materials and components

Once the conceptual design is finalized, a careful selection of materials and components to be used in the construction of the prototype is made durable, heat resistant and high quality materials are sought to ensure optimum performance of the prototype. Different component options, such as bearings, guides and fasteners, are also evaluated, taking into account factors such as availability and cost.

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Development of the control software

The next step is the development of the control software for the CNC welding machine prototype. Suitable software is selected that allows programming the axis movements and welding operations accurately and efficiently. The G programming language used in CNC machines is learned and the necessary code is written to control the movements and welding operations.

Prototype construction

Once the materials and components have been selected, the CNC welding machine prototype is built. The different parts are assembled according to the conceptual design and the motors, controllers and control software are integrated into the system. During this stage, special attention is paid to the correct installation and connection of the components, as well as the initial calibration of the operating parameters.

Testing and adjustments

Once the prototype is built, extensive testing is performed to evaluate its operation and performance. The precision and smoothness of the axis movements are verified, as well as the quality of the welds made. Adjustments and improvements are made according to the results obtained in the tests, with the objective of optimizing the performance of the prototype and guaranteeing high quality welding results.

Optimization and refinement

Based on the test results and adjustments made, an optimization and refinement stage is carried out. The data collected is analyzed in detail and fine adjustments are made to improve the performance of the prototype. Optimal configurations are sought to maximize the efficiency of the CNC welder.

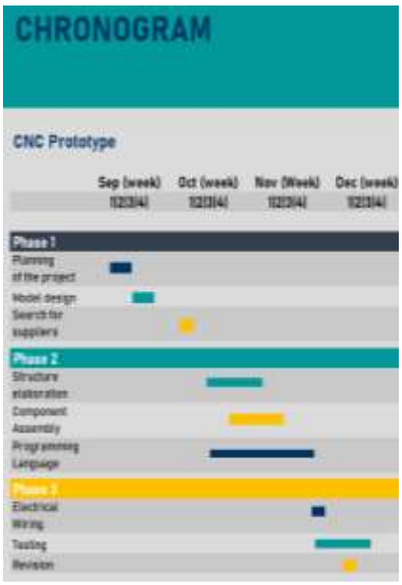

Figure 1 Schedule of activities
Own source without attribution required

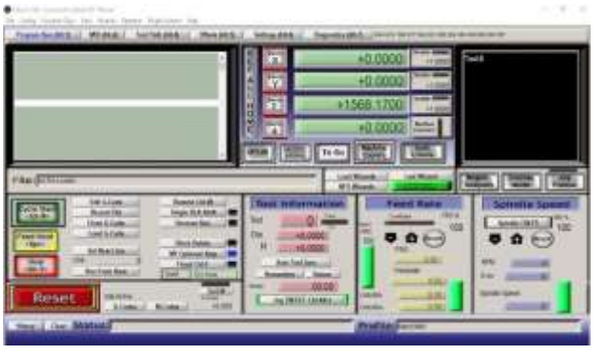

Figure 2 Control panel
Source Mach 3 Software

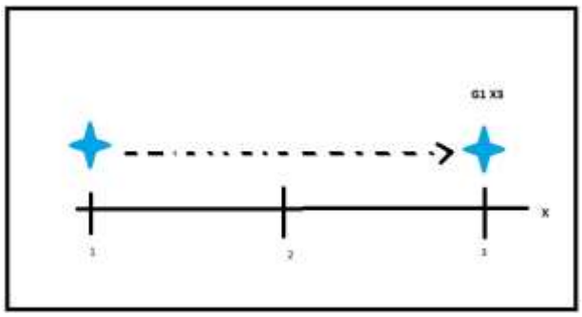

Figure 3 G-coded displacement
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Chech List CNC Welding Machine				
#	Inspection point	Yes	No	Remarks
1	General cleaning of the machine (5s)			
2	Lubrication of shaft support			
3	Loose or torn cables			
4	Emergency stop Runs			
5	Placement of grounding clamp			
6	Operation of X-axis			
7	Operation of Y-axis			
8	Operation of Z-axis			
9	Operation of X- axis operation (fourth)			
10	Voltage and Amperage Adjustment Control			
11	Limit switch sensor operation			
12	Vibration free			
13	Noise free			
14	Gas Extraction			
15	Power wiring in good condition			
16	Check of torch free of burrs			
17	Motor overheating during the process			

Table 1 Initial inspection table
Source: Own table without required attribution

Methodology to be developed

In the project, the objectives were clearly established and consisted of designing and developing a prototype that integrates mechanical movements and micro wire welding. The success criteria and technical requirements necessary to meet the project expectations were determined.

Extensive research was conducted to become familiar with the fundamental concepts and principles of micro wire welding and mechanical motion systems. Information was gathered on available technologies, required materials and components, as well as best practices in the implementation of similar systems.

Based on the preliminary research, a conceptual design of the prototype was developed, considering aspects such as the mechanical structure, the movement axes, the welding machine and the required electronics. Team meetings were held and design iterations were carried out until a solid and viable proposal was obtained.

Materials and components needed for the construction of the prototype were identified. A shopping list was made and the required elements were purchased, making sure to obtain required elements, making sure to obtain quality products that complied with the established technical specifications.

The assembly and construction of the prototype was carried out following the conceptual design. The displacement axes were assembled, the welding machine was integrated and the necessary electronic elements were connected. Partial functional tests were performed during the construction process to verify that each component was correctly integrated.

Once the assembly was completed, the prototype parameters were calibrated and adjusted. Extensive testing was performed to determine the optimal axis travel speed, micro wire feed speed, and proper configuration of the electronic components. Fine adjustments were made to optimize the performance and accuracy of the prototype.

Rigorous tests were carried out to evaluate the performance of the prototype. Test welds were performed on different materials and the quality of the joints was analyzed. The execution times were measured and the results obtained were evaluated in comparison with the established standards.

The results obtained during the tests were analyzed and compared with the established objectives and requirements. The strengths and weaknesses of the prototype were identified, as well as possible areas for improvement. The results were documented and decisions were made based on the analysis performed.

Within the framework of this research project, significant results were obtained that contribute to the development and operation of the designed prototype. Correct axis displacement was achieved, proper operation of the micro wire welding machine was obtained, and most of the electronics performed satisfactorily. Although challenges and complications arose, it is recognized the importance of addressing the identified difficulties to optimize the prototype and ensure its optimal performance in future applications and related projects.

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Funding

The integrative project has been possible thanks to the valuable financial contribution of the student body. Each student has contributed personal funds and has sought external financing through crowdfunding campaigns and sponsorships. Their financial commitment and efficient resource management has been key to the successful development of the project and the creation of the prototype. Her dedication reflects her passion and belief in this initiative.

Conclusions

In conclusion, the projects developed have represented an important step in the implementation of CNC micro wire welding prototypes. Throughout the process, satisfactory results were obtained in terms of the operation and performance of the prototypes, demonstrating their viability and potential to improve welding processes in the industry.

Each member of the work team had the opportunity to face and learn from different challenges. Areas for improvement were identified in the design, programming and configuration of the electronic components used in the prototypes. These challenges provided valuable experience in problem solving and optimization of the implemented systems.

Although the prototypes showed a performance in line with initial expectations, it is important to highlight that there are still aspects that need to be improved. The need to improve the precise calibration of the displacement axes was identified, especially in the case of the z-axis, where some vibrations were present during the movement. In addition, the importance of having a more effective clamping system to avoid errors in the execution of the welds was recognized.

The recommendations arising from the experience gained are of great relevance for the future development of the prototypes. It is suggested to carry out a more exhaustive research regarding the components used, in order to have a better knowledge of their operation and to be able to face possible challenges more effectively. It is also recommended to implement a periodic maintenance program to guarantee the optimal performance of the control elements and minimize the risk of failures.

In addition, the importance of acquiring a better command of the specific programming language for CNC controllers, such as the G language, is emphasized in order to maximize the capabilities and precision of the prototypes. This will allow taking full advantage of the functionalities of the software used, in this case, the MACH-3 program.

Regarding safety, it is recommended to implement an additional protection system for the operator, since at the current stage the prototypes are in the open. It is essential to ensure the integrity and health of the personnel involved in the operation of the machines.

In summary, the CNC welding projects with micro wire represent a significant advance in the field of automation and improvement of welding processes. The results obtained demonstrate the feasibility and potential of these prototypes to optimize productivity and quality in the joining of metal parts. However, it is necessary to continue working on calibration, research, technical knowledge and the development of support and maintenance systems to achieve optimal performance and greater efficiency in the automated welding process.

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