DESIGN AND IMPLEMENTATION OF AN EXPERIMENTAL EQUIPMENT MODEL FOR ADHESIVE DEPOSITION ON CURVED TRAJECTORIES

DOGEANU Ileana-Georgiana, SAVU Tom
Faculty: Industrial Engineering and Robotics, Study program: Applied Computer Science in Industrial Engineering and Robotics, University POLITEHNICA of Bucharest, Year of study: 4, e-mail: georgianadogeanu05@gmail.com

ABSTRACT: Depositing adhesives on curved trajectories finds applications in a variety of industries, including the automotive industry, aerospace industry, electronics manufacturing, medical device production, and many other. Currently, there are automated and robotic systems capable of handling and applying adhesive on curved trajectories with high precision and repeatability. These systems can be programmed to follow complex trajectories and adjust application parameters, such as quantity and speed according to specific application requirements. Present research work aims to design an experimental model of equipment for depositing adhesives on curved trajectories with the help of the existing CNC router, to demonstrate the feasibility and effectiveness of using this equipment in the production process. The study intends to explore innovative methods and techniques that can improve the adhesive application process on curved trajectories, ensuring a uniform distribution of the adhesive and strong adhesion between components.

KEYWORDS: adhesive deposition, curved trajectories, industrial applications.

1. Introduction

In modern industry, depositing adhesives on curved trajectories is a primordial technique as it involves the precise application of adhesive materials to complex surfaces, with numerous advantages:

- Efficiency and time saving utilizing this technique allows for the rapid and precis application of adhesives on complex curved surfaces, without the need for other complex methods or tools. This saves time and resources in the production process.
- Strong adhesion: depositing adhesives on curved trajectories ensures a strong bond between assembled components, providing a secure and durable connection. This is essential in various industrial applications such as automotive, aerospace, electronics, and medical industries.
- Versatility and adaptability: the technique of depositing adhesives on curved trajectories can be used in a wide range of applications and industries due to its versatility and adaptability. It can be applied to different materials and complex shapes, offering flexibility in the production process.
- Elimination of mechanical elements: using adhesives instead of mechanical fasteners like screws or rivets brings numerous benefits to the industry. This includes eliminating the need for holes or surface damage, reducing weight and production costs, as well as creating aesthetically pleasing appearances.
- Precision and repeatability: automated systems and robots used in depositing adhesives on curved trajectories are capable of high precision and repeatability. They can follow complex trajectories and adjust application parameters such as quantity and speed, ensuring consistent and high-quality results.[4]

With advances in automation and robotics, there are now sophisticated systems capable of handling and applying adhesives on curved trajectories with high precision and repeatability. These systems can be programmed to follow complex paths and adjust application parameters such as adhesive quantity and application speed to meet specific requirements.[3]

However, the industry requires continuous research in the field to ensure the most efficient deposition of adhesives on curved trajectories [12]. For this purpose, the research work aims to develop a deposition of adhesives on curved trajectories as precise as possible by using a CNC router that realizes

the displacement of the syringe, a syringe for storing and applying the adhesive on the desire surface, and a stepper motor that makes it possible to precisely deposit the desired amount of adhesive.[5]

2. Current stage

2.1. Functional diagram of equipment

A functional component diagram was created to design, assemble, and define the basic elements involved in the construction of the entire equipment system.[6] The purchased components are highlighted in color, as shown in Figure 2.1.

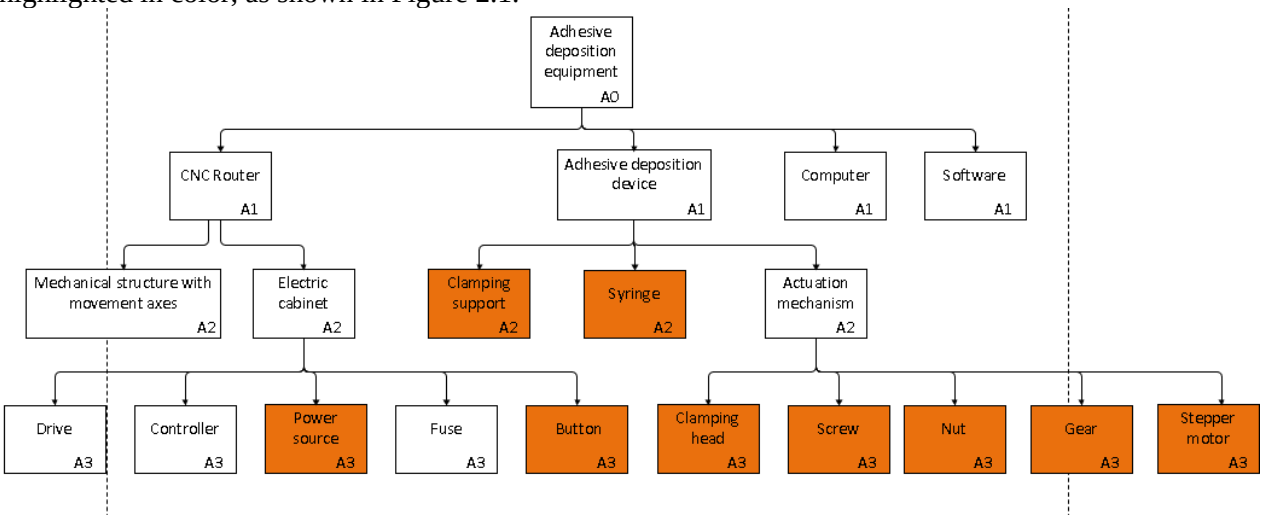

Fig. 2.1. Functional diagram of the components

2.2. Assembly process and the role of components

Proper deposition of adhesives is essential for achieving high-quality finished products and depositing them on curved trajectories poses a technical challenge due to difficulties in controlling the movements of the deposition mechanism. For the development of the project, 3D design was used, especially the CATIA software [1], used for the design of the component parts and for making the assembly. The existing CNC router, with its mechanism capable of movement and equipped with a clamping plate, served as the initial foundation for this system, as shown in figure 2.2.

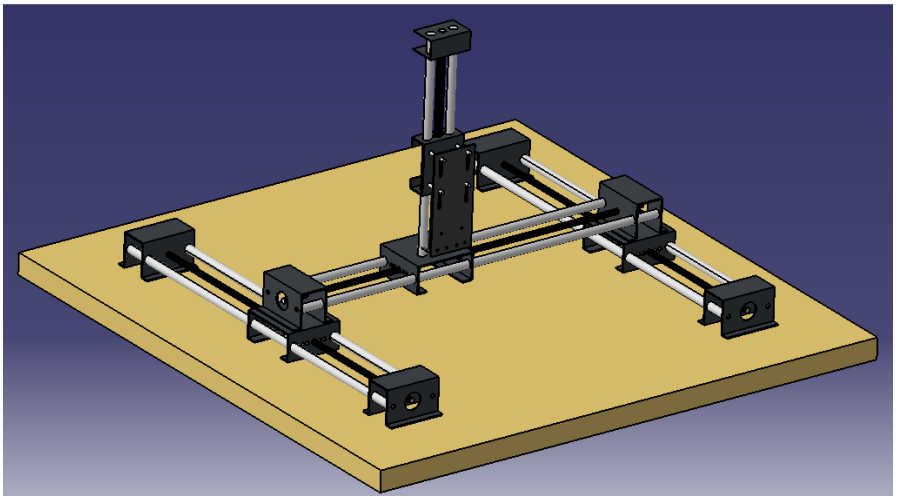

Fig. 2.2. CNC Router

The assembly involves the acquisition and design of components. Two clamps are attached to the mounting plate. The upper clamp supports the collar of the syringe, preventing vertical movement,

while the lower clamp is positioned to secure the syringe in place. Both clamps are fastened with two screws, at the ends of which two nuts are attached, designed to facilitate easy removal of the syringe for refilling purpose, as shown in figure 2.3.

The syringe is the acquired and designed tool with a maximum storage capacity of 300 milliliters, serving the purpose of storing and depositing adhesive on curved trajectories, presented in figure 2.4.

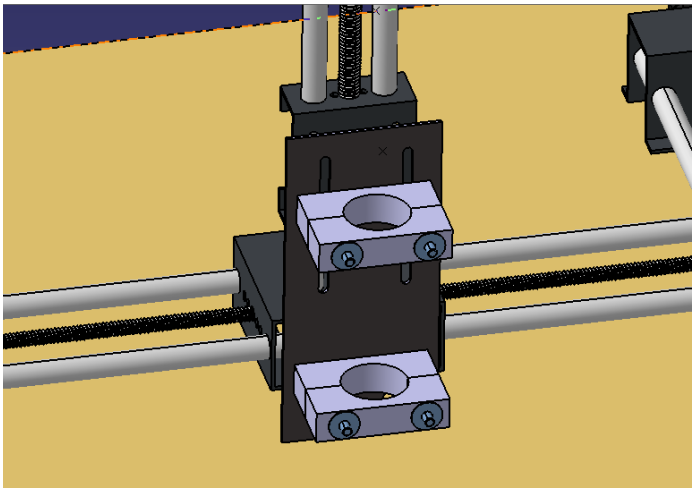

Fig. 2.3. Clamping collars

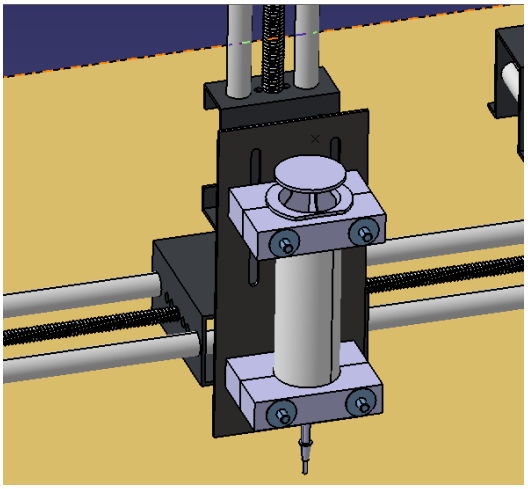

Fig. 2.4. Syringe

For operating the syringe plunger and supporting the screw, the clamping head was designed. The screw moves only vertically, without rotation, and is operated by the clamping head and a nut, as shown in figure 2.5.

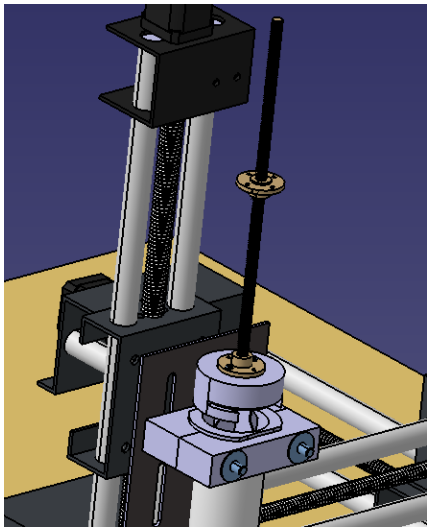

Fig. 2.5. Clamping head and screw and nut

The nut is connected to the motor by two gears: a gear attached above the nut secured two bolts above it, and another gear attached to the motor. The gear connected to the nut engages with the one on the motor, enabling the operation of the syringe clamping head, presented in figure 2.6. and figure 2.7. To prevent the nut from moving vertically, it needs to be secured in place using a bracket. This bracket is attached to the existing support plate on the CNC router. To ensure proper fixation of the motor, a support was designed to hold the motor and is attached to the existing motor in the z direction on the

router. The motor used to actuate the syringe is a stepper motor provides precis position control, as shown in figure 2.8.

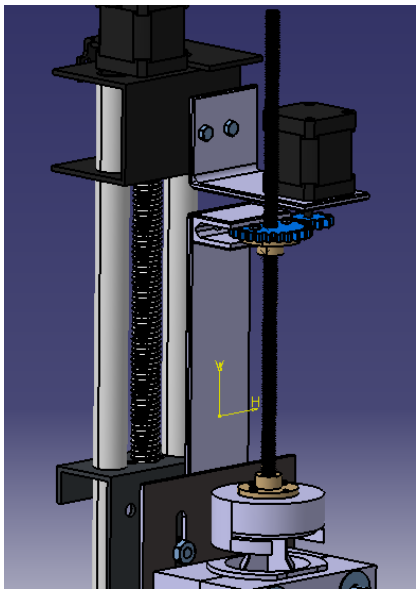

Fig. 2.6. Presentation of gears and stepper motor

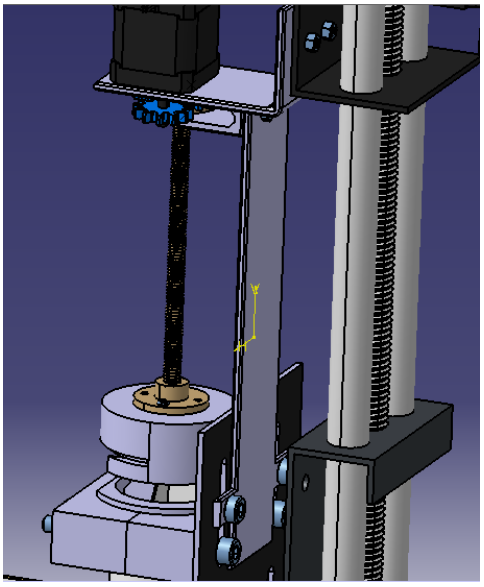

Fig. 2.7. Presentation brackets

Once the components were purchased and designing, they were assembled to build the system, presented in figure 2.8.

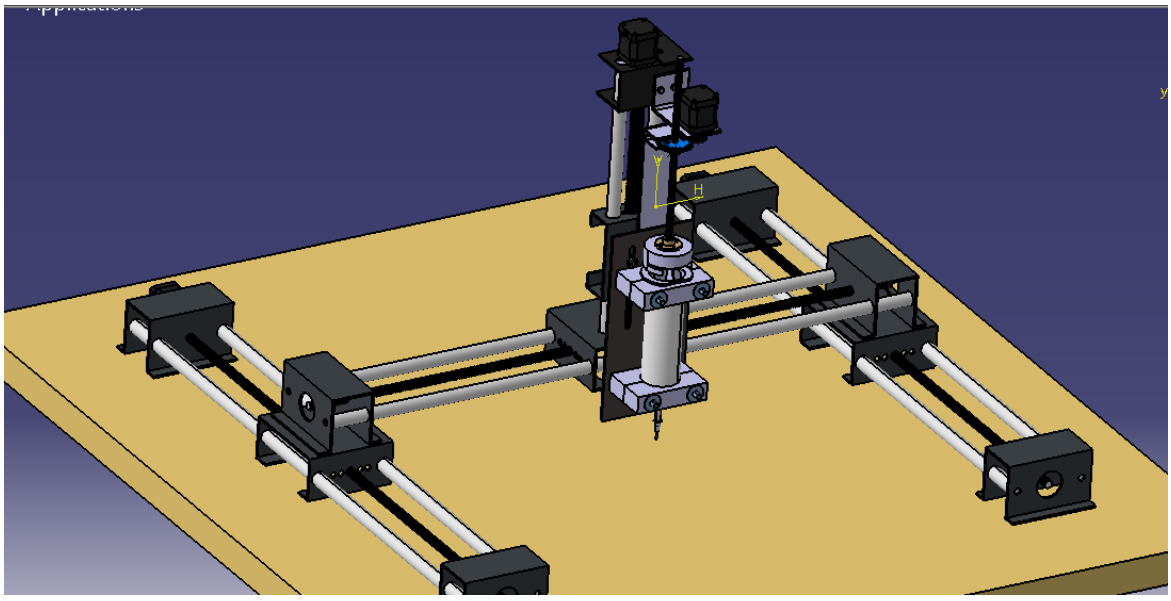

Fig. 2.8. Component assembly

2.3. Presentation of the electrical connection diagram

The CNC router is a mechanical structure with motion axes controlled by 4 stepper motors that are connected to the electrical cabinet [2], figure 2.9. and the list of main electrical components can be found in Table 2.1.

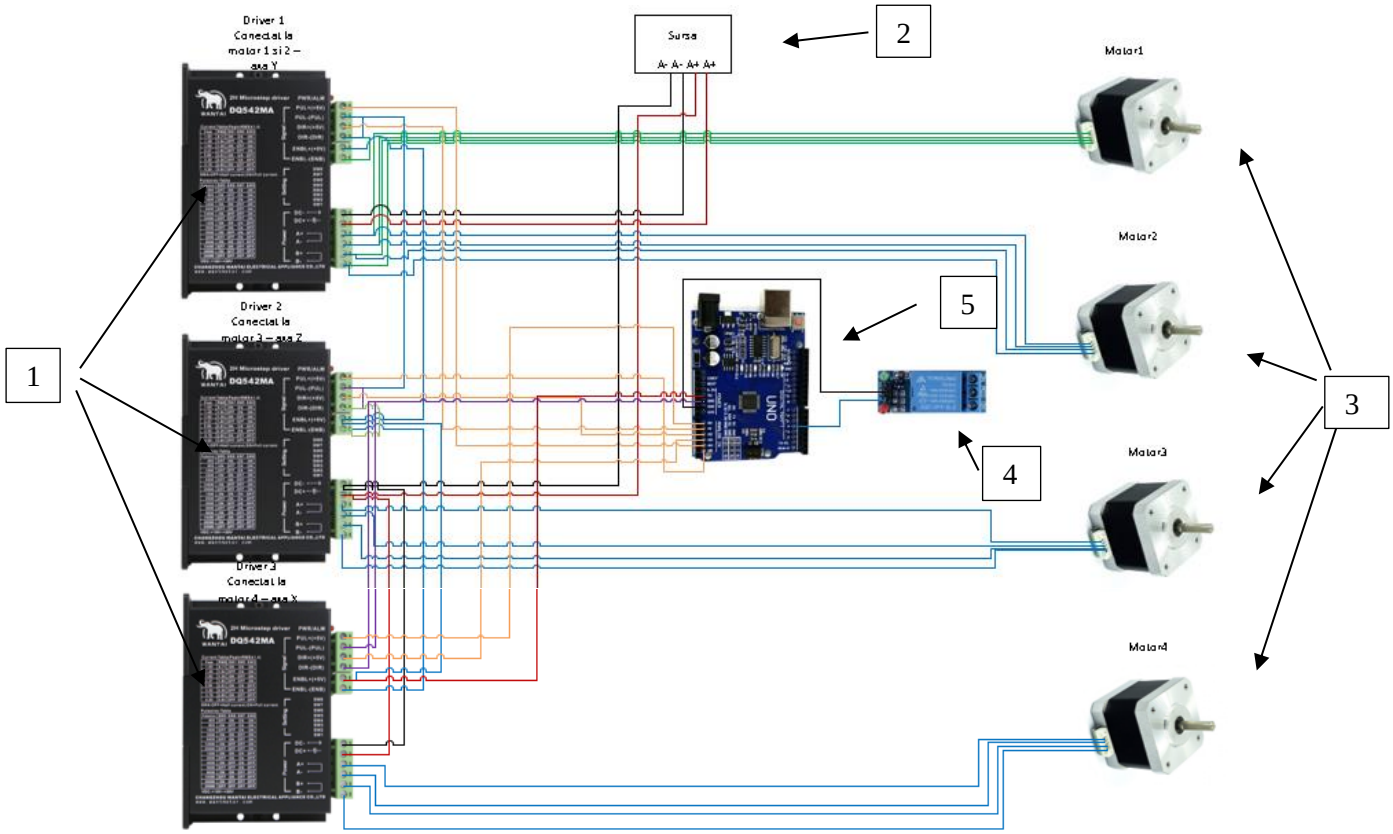

Fig. 2.9. Presentation of the electrical connection diagram

Table 2.1. CNC router electrical components

No. crt	Figure	Description
1		3 drivers-DQ542MA [7]
2		Power Source-FSP-300W [8]
3		4 stepper motors - Nema17 [9]

No. crt	Figure	Description
4		Relay-SRD-05VDC-SL-C [10]
5		Arduino Uno [11]

3. Conclusion

This research work aims to contribute greatly to the development of efficient solutions for adhesive deposition on curved trajectories, with the potential to improve the quality and performance of structure in various fields. In this study, a few design experiments have been carried out to find the most efficient solution can withstand the demands and provide proper functioning of the equipment. Additionally, based on the completed electrical connection diagram, the next step in advancing the project is to assemble the designed and acquired components onto the existing router. This involves adding the necessary motor and connecting it to the appropriate drive to enable the actuation of the syringe and the deposition of adhesive on the desired surface. Further experiments will also be carried out to ensure the optimal functioning of the equipment.

4. References

[1].http://www.catia.ro/?page_id=4536
[2]. https://assefair.ro/drivere/33-driver-motor-pas-cu-pas-tb6600.html
[3].https://www.researchgate.net/publication/345357627_Parametric_study_of_composite_curved_adhesive_joints
[4]. Author, Raul Campilho and Author, Ricardo Jorge Braga, „ Parametric study of composite curved adhesive joints",The international Journal of Advanced Manufacturing Technology, December 2020.
[5]. Author, Dieter Muhs, Author, Herbert Wittel, Author, Dieter Jannasch and Author, Joachim Vodiek (2009), *Roloff/ Matek Organe de Mașini*, Publishing house MATRIXROM, Bucharest, ISBN 978-973-755-412-3.
[6]. Author, W. Beitz (1998), *DUBBEL. Manualul inginerului mecanic: fundamente*, Publishing house Technica, Bucharest, ISBN 9733112712, 9789733112716.
[7].https://www.diyelectronics.co.za/store/stepper-motor-drivers/3826-dq542ma-stepper-motor-driver-4a.html
[8]. https://my.rs-online.com/web/p/pc-power-supplies/1366054
[9]. https://www.pololu.com/product/2267
[10].https://ardushop.ro/ro/home/48-modul-releu-1-canal.html?gclid=Cj0KCQjwmZejBhC_ARIsAGhCqneUO9kq0Edcig3Fkxr3EHsmW1B_7e89LHO08vmugIhFGdinUgIwcuUaAo7jEALw_wcB
[11]. https://www.nooelec.com/store/development-modules/arduino-uno-r3.html
[12]. https://chat.openai.com/