THE USE OF ARTIFICIAL INTELLIGENCE AND INTERNET RESOURCES IN THE DESIGN OF A SIMPLE MECHATRONIC SYSTEM

KORIŠTENJE VJEŠTAČKE INTELIGENCIJE I INTERNET RESURSA PRI DIZAJNU JEDNOSTAVNOG MEHATRONIČKOG SISTEMA

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ABSTRACT
This paper presents the design of a simple mechatronic model with two mechanical toys. The design goal is for the toys to be activated when a position sensor registers a person approaching the system. The paper describes how artificial intelligence can provide design ideas and how resources of ready-made models from the Internet can accelerate the creation of the system's 3D model. Also found on the Internet was a wiring diagram for connecting the stepper motor with the Arduino board and the motor driver.

Keywords: design, AI, mechatronic system, Internet sources

REZIME
Ovaj rad predstavlja dizajn jednostavnog mehatroničkog modela s dvije mehaničke igračke. Cilj dizajna je da se igračke aktiviraju kada senzor položaja registruje osobu koja se približava sistemu. Rad opisuje kako umjetna inteligencija može pružiti ideje za dizajn i kako resursi gotovih modela s Interneta mogu ubrzati izradu 3D modela sistema. Na Internetu je također pronađen dijagram ožičenja za spajanje step motora s Arduino pločom i upravljačkim drajverom motora.

Ključne riječi: dizajn, umjetna inteligencija, mehatronički sistem, internetski izvori

1. INTRODUCTION

In November 2022, ChatGPT appeared as the first artificial intelligence that became available to Internet users. In December 2023, Gemini appeared, an artificial intelligence on the Google platform. In a period of two years, artificial intelligence has become routine in many human activities. Children use it to write stories and songs in schools. Adults for text editing, translation, expert advice.

CAx systems can replicate the different phases of the life cycles of individual components as well as complete machines and equipment in the virtual environment. However, it is the machine designer who transforms an idea into reality. It is their responsibility to ensure that the device works properly, has the right features, and is as cheap as possible. The designers often make mistakes, i.e., they are pressed by time, small budgets, or insufficient knowledge of the issue. This is one of the reasons why a modern designer should not only rely on outdated catalogues, machine tables, and outdated procedures, but should strive for progress by adapting

to modern methods that are available today thanks to the rapid evolution of information technology [1, 2].
For a designer engineer using SolidWorks modelling software, the question arises how artificial intelligence can help with the concrete design of a simple mechatronic system consisting of two mechanical toys, a stepper motor, shafts, pulleys and belts. The system should be activated when the position sensor registers the approach of a person to the system. Databases of ready-made, standard parts that exist on the Internet, on the GrabCAD website [3], were used for the design. There are: belt, pulleys, coupling, and stepper motor. The motor mount itself had to be designed, as well as the bearing mount and the entire system mount.

2. THE STEP MOTOR MOUNT

A mount had to be designed for the ordered NEMA 17 stepper motor [4]. The mount itself was not ordered because the workshop drawing of the mount (Fig. 1) did not include the distance between the motor shaft axis and the base, which was important information for the design.

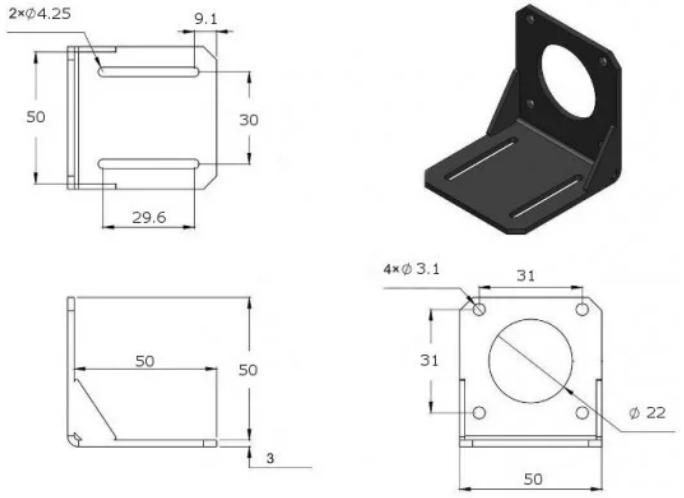

Figure 1. Steel L-type Step Motor Mount [5]

The dimensions of the stepper motor are given in Fig. 2 and the mount was designed according to them.

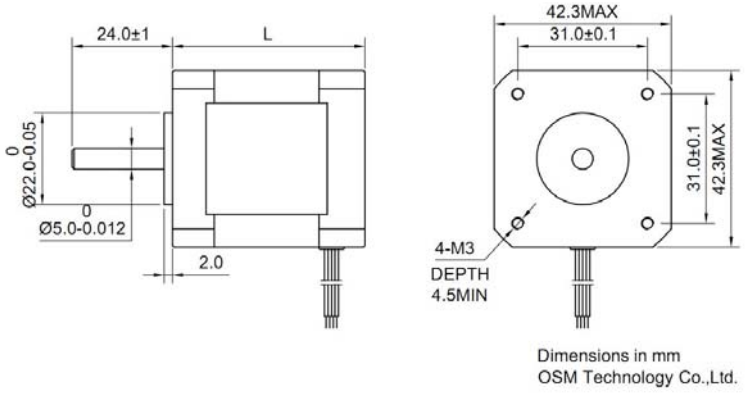

Figure 2. Dimensions of the step motor NEMA 17 [4]

Not knowing what a 4mm plywood mount should look like, the question was posed to the Gemini AI: Give me a design of a NEMA 17 step motor holder from 4mm plywood. The answer included: Design Concept as Basic L-Bracket with Faceplate, CAD Sketch (Conceptual), Design Considerations for 4mm Plywood.
Wanting a 3D model of the plywood mount, another question was posed: Can you give me a sketch? The answer was in the Fig. 3:

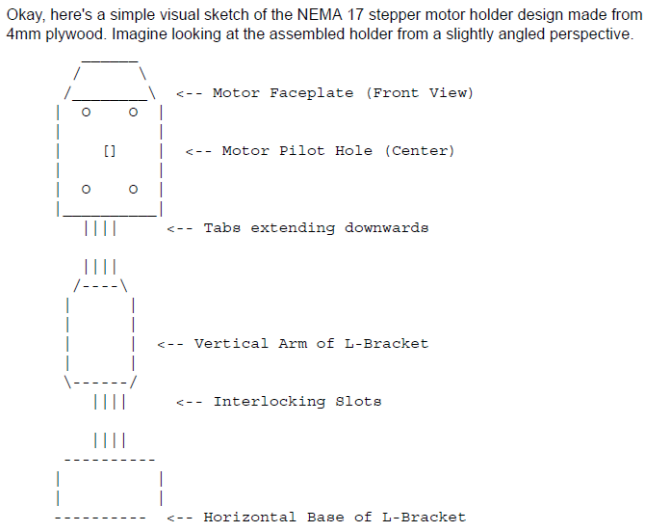

Figure 3. Sketch of the mount made by AI

Without a clear idea of what the mount would look like, the third question was: Can you find a similar existing picture? That response listed the search terms to find the image:
"Laser cut plywood NEMA 17 mount"
"DIY plywood stepper motor bracket"
"Interlocking plywood motor mount"
"CNC plywood motor holder"
The combination of words: "laser cut plywood motor mount" led to the requested image of the mount (Fig. 4-left) [6].

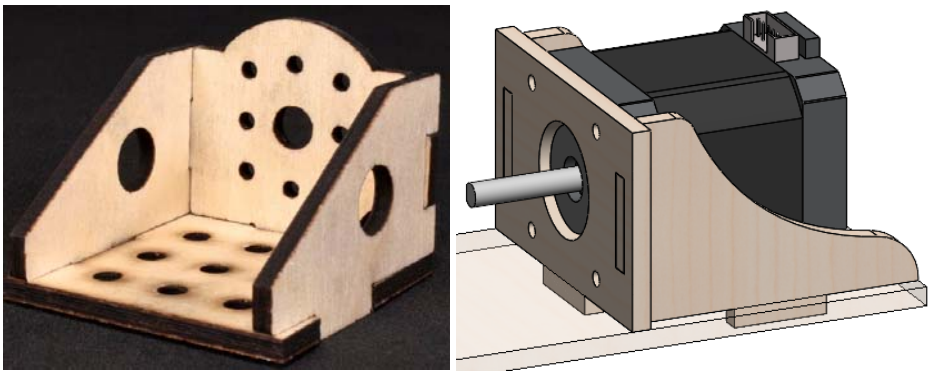

Figure 4. Plywood stepper motor mount a) the idea from the Internet – left [6] b) the created design - right

Figure 4-left gave a full idea of how the mount should be designed from plywood, and on the right side of the figure the design of the motor mount is given.

3. 3D MODEL OF THE MECHATRONIC SYSTEM

On the Internet, on the GrabCAD website, 3D models were found for the NEMA 17 motor, the D19L25 Flexible Aluminium Stepper Motor Shaft Coupling, and the 20-36T-W6-B5 pulley. A 685ZZ bearing (dimensions 5x11x5mm), belts with a length of 200mm and a width of 6mm, and a shaft with dimensions ∅5x200mm were modelled. To find the distance between the pulley axis on the motor shaft and the pulley on the toy shafts, the website GT2 Pulley Calculator [7] was used, where the distance was determined based on the belt length and the number of teeth on the pulleys. The toy models were arranged, and the base of the system with the necessary slots was modelled. Toy models were Swinging Bird and Simple Marble Machine (SMM) which were described in paper [8]. The bearing mount for the shaft was also modelled. The 3D model of the system is shown in Figure 5.

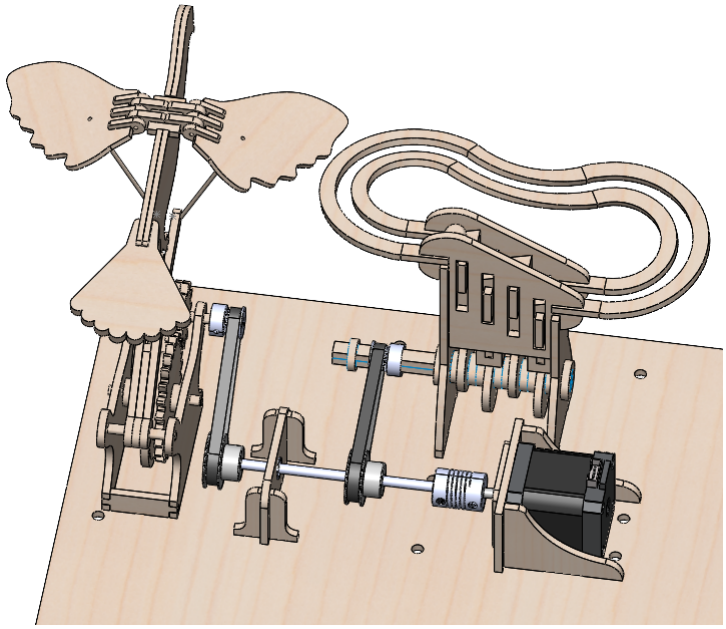

Figure 5. 3D model of the mechatronic system

Based on the 3D model of the system, laser cutting of the plywood was performed. The laser kerf, or the thickness of the burned line, was taken to be 0.2mm. Figure 6 shows the assembled model of the system. The model is fully functional. Recommendations for the next design are to increase the centre distance between the motor shaft and the toy shafts by two millimetres to ensure the belt is fully tensioned, and to create a bearing support on the pulley side for the SMM toy shaft to reduce radial displacement of the toy shaft.

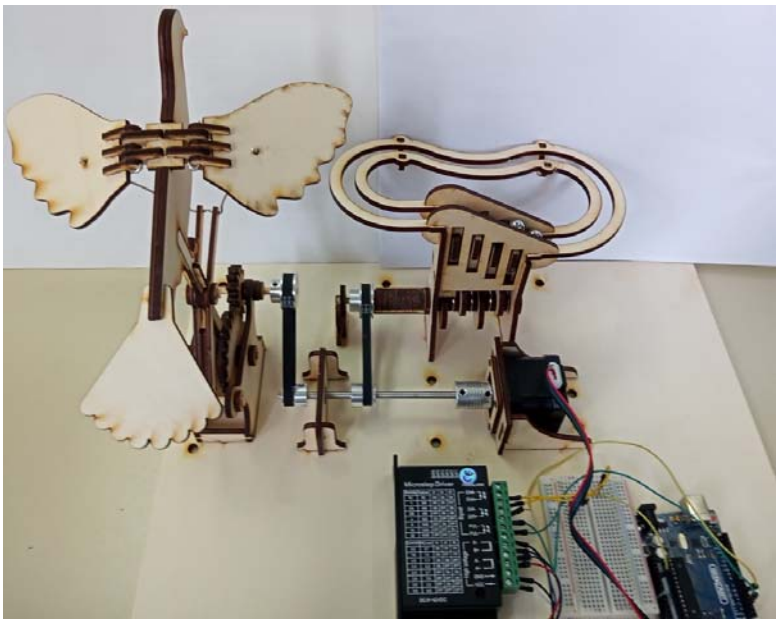

Figure 6. The completed mechatronic system

4. WIRING DIAGRAM OF THE MOTOR WITH THE DRIVER AND ARDUINO BOARD

The stepper motor was ordered together with the driver. The stepper motor driver acts as an intermediary between the control system and the motor, providing the necessary power, signal processing, and protection to precisely control the stepper motor's movement. Without a driver, it's generally not possible to directly control a stepper motor with a low-power digital controller. Connecting the TB6600 stepper motor driver to an Arduino and stepper motor is shown on the picture (Fig. 7), taken from web site [9]. This site also recommends how to adjust the current that goes to the motor when it is running by setting the dip switches S4, S5, and S6 on or off on the driver. It is recommended to start with a current level of 1 A.

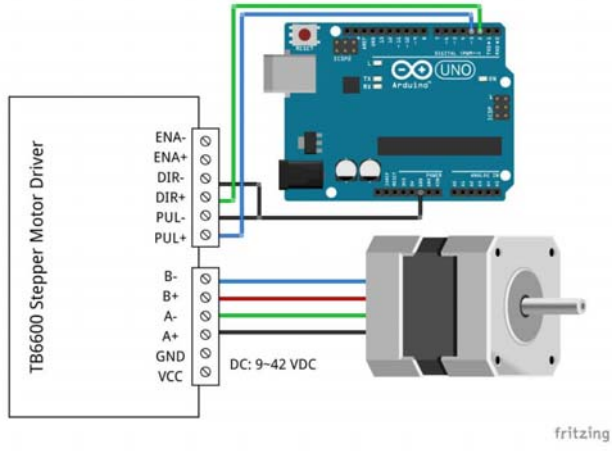

Figure 7. TB6600 stepper motor driver with Arduino UNO and stepper motor wiring diagram [9]

5. CONCLUSION

This paper demonstrated the design process of a simple mechatronic system with two mechanical toy which should be activated by a position sensor. The design process emphasized how artificial intelligence can be used to conceptualize designs and how readily available online resources can expedite the creation of 3D models. Specifically, the research showed how AI can assist in generating initial design ideas and how online databases can provide access to pre-existing models of standard parts, significantly accelerating the design workflow. Furthermore, the paper detailed the integration of a stepper motor with an Arduino board and motor driver, using a wiring diagram sourced from the Internet.

It should be emphasized that the entire paper was translated and edited with the help of artificial intelligence. Also website references are made using the website citation generator [10].

6. REFERENCES

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