DESIGNING AND BUILDING AN EXPERIMENTAL MODEL OF A SYSTEM FOR MEASURING THE WEIGHT AND TRANSPORTING TOOLS

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ABSTRACT: The object of this study is the development of an experimental model used for measuring the weight and transporting tools, which can be achieved using an Arduino microcontroller, a load cell, an HX711 module, two DC motors, a motor driver, two infrared sensors, and an LCD screen. This system for measuring weight and transporting tools is designed to facilitate work in a workshop and consists of transporting tools from one place to another using a line-follower system and IR sensors. The experimental model takes the form of a vehicle, composed of a chassis, two wheels, and a box where the tools are placed.

KEY WORDS: weight-measuring sensor, designing, printing

1. Introduction

The project aims to develop a transportation system that is used for measuring weight and transporting tools.

In order to achieve the end result of this project, firstly a thourough research on the robotic transportation systems was made. After the purpose was established, several design ideas were created using a CAD software. From these ideas, an optimal design was chosen. This design was then 3D printed in order to test its resistance and to check that the sensors fit inside according to the models that were made. After the assembly was made, the functionality of the system was tested, and the obtained results are presented in this paper.

2. Current stage

An Automated Guided Vehicle (AGV) system is an autonomous transport platform that uses sensors and algorithms to move and manipulate objects without requiring human intervention.

Fig. 1 Example of an AGV robot that handles the management and transportation of boxes in an industrial environment [https://howtorobot.com/expert-insight/agv-robots]

The robots continue to evolve and become more advanced, being capable of navigating the surrounding environment and communicating with each other to efficiently and safely accomplish transportation tasks. Furthermore, robot's control technology has become more sophisticated, enabling users to program and monitor these vehicles in real-time.

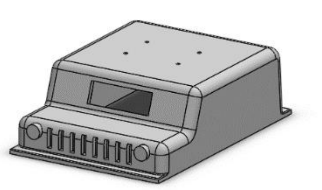
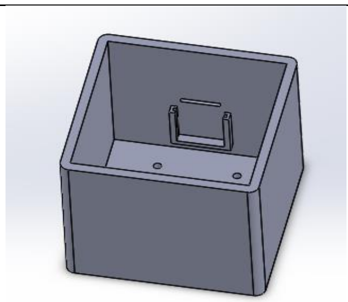
AGVs are a technology that has rapidly evolved since the 2000s, thanks to a progress made in sensor technology and control algorithms. These improvements have made AGVs more precise, faster and safer in their operating environment. Today, they are used in a variety of applications, ranging from transporting goods in warehouses and factories to moving food products in the food industry, as well as transporting equipment and medications in hospitals, among many others. AGVs are available in various shapes and sizes, including wheeled vehicles, tracked vehicles, counterbalance vehicles, and even AGV drones.

In recent years, AGV robots have benefited from additional improvements due to the development of machine learning and artificial intelligence technology, which has allowed them to become more flexible and adaptable to changes in their operating environment.

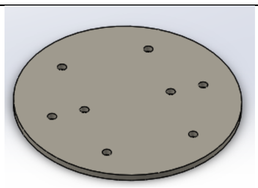
3. Designing the experimental model

In order to build this experimental system, the first step is designing the following parts: a toolbox, a load cell support and the robot's case. These parts are shown in Table 1.

Table 1. 3D parts

Nr.	Part name	Number of parts	Graphic representation	Functional role
1.	Case	1		Protection and assembly
2.	Toolbox	1		Depositing

Tabelul 1. 3D parts (continuation)

Nr.	Part name	Number of parts	Graphic representation	Functional role
3.	Load cell support	2		Supporting and fastening the load cell

The following image represents the assembly for the upper part of the experimental model.

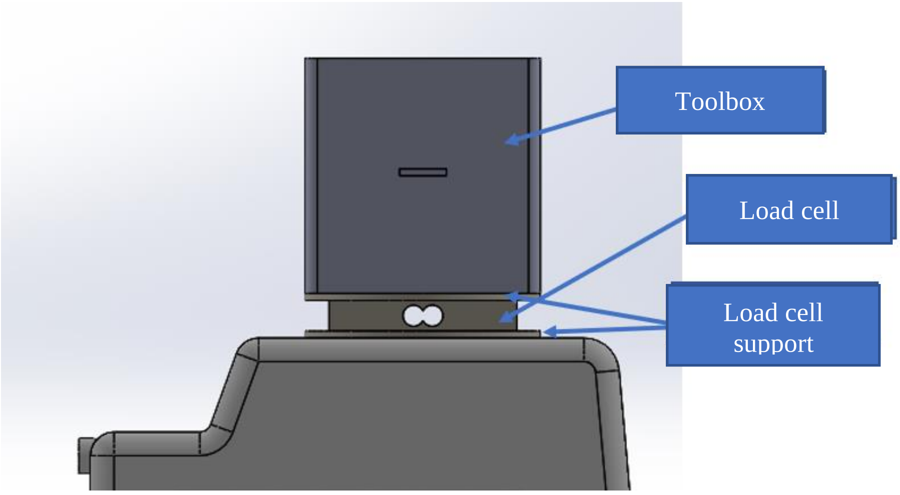


Fig. 2. The upper part of the experimental model

4. Motors and sensors. The operating mode

To measure the weight, a load cell and an HX711 module are used, with the module connected to the microcontroller through the serial interface. After transforming the data received from the weight sensor, the weight value is displayed on an LCD screen also connected to the microcontroller, allowing the user to check the load weight.

For transportation two DC motors are used, which are controlled through the L298N motor driver. The driver is connected to the microcontroller through 6 digital pins and can be programmed to actuate the motors based on instructions received from the infrared sensors.

To track the direction, two infrared sensors are used, placed in the front of the vehicle, in the left and right parts of the experimental model. They detect a black line on the floor and send signals to the microcontroller to adjust the speed and direction of the motors so that the sensors can follow the line.

A weight limit is set in order to limit the load that is added to the cart. In case the weight exceeds this limit, the motors will no longer be actioned, resulting in stopping the experimental model.

The aforementioned components are then connected to an Arduino Mega development board as shown in the following image.

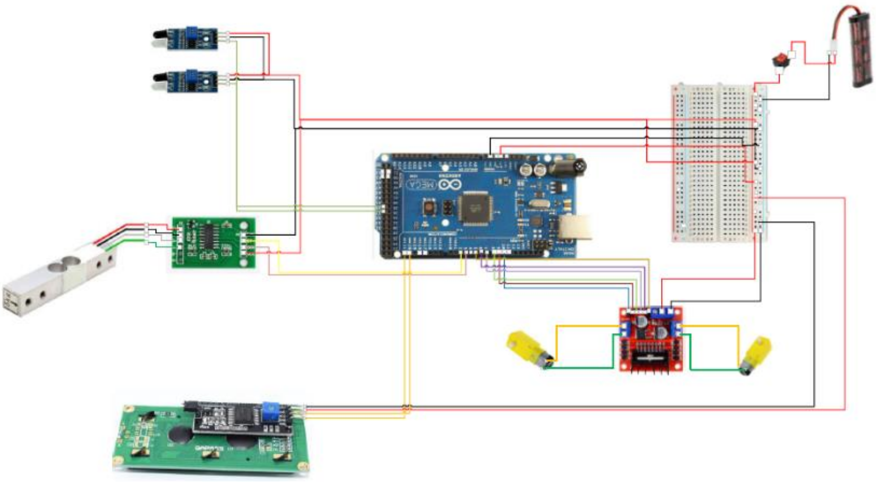


Fig. 3 Connection scheme

For testing the load cell and motors functionallity were used individual programs written in the specialized software as shown as is Fig. 4.

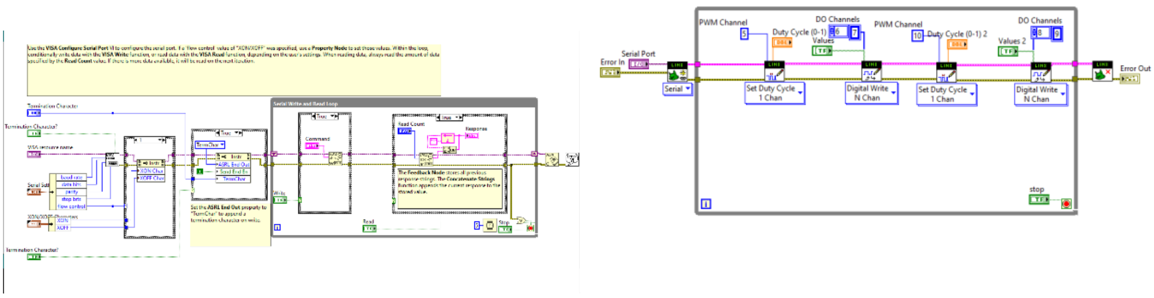


Fig. 4. Programs for serial reading from the load cell and for testing the motors

5. Construction of the prototype

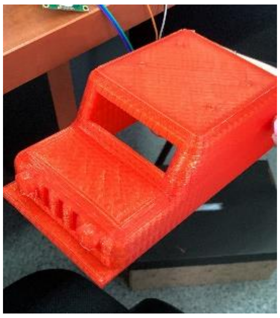
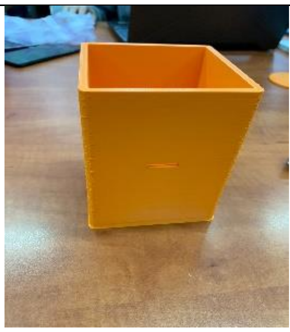
5.1 3D printing of the parts

The parts were created using 3D printing technology. The steps of the process are as follows:

- Saving the parts with the .STL extension;
- Uploading the parts into the Z-Suite program, where the appropriate parameters for each part were configured;
- Saving the generated code and uploading it to a ZORTRAX M300+ printer;
- The chosen material for additive manufacturing was PLA.

In the following table the final result of the printed components can be seen.

Table 2. 3D printed components

Case	Toolbox	Load cell support
		

5.2 Assembling the components

The last stage of the project involved assembling the component parts of the experimental model. In order to obtain the final result, the electrical components were assembled with the 3D printed parts, to check the resistance and the functionality of the model, and also to check if the electrical components fit correctly inside the case.

Figure 4 highlights the circuit composed of the components that will be mounted on the experimental model: Arduino Mega board (1), breadboard (2), two motors (3), L298N motor shield (4), weight sensor (5) and module (6), IR sensors (7), LCD display (8), and the power supply (9V battery) (9).

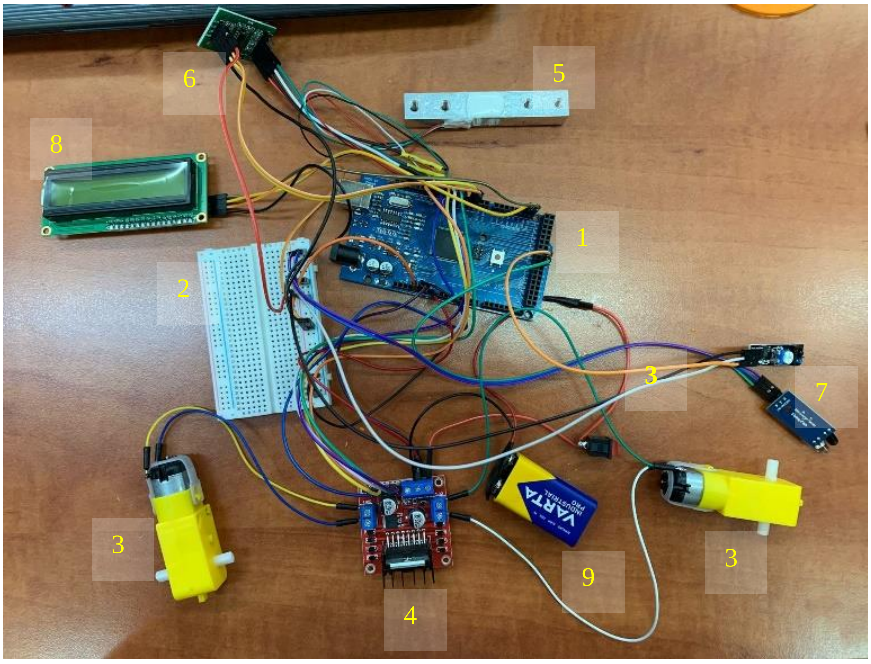


Fig. 4 The initial connection scheme

The figure below shows the prototype obtained after assembling the component parts.

Fig. 5. The experimental model

6. Conclusions

The experimental model of a system for weight measurement and tool transportation can be used in various fields, especially in industrial environments where automation streamlines processes in a factory.

After establishing the purpose of the paper, several design ideas were made in order to choose the optimal design for this paper. After the design was chosen, the parts were then designed in a CAD software and 3D printed. The circuit was then designed, and assembled in the 3D printed case. The system functions optimally and can transport small objects and display their weight on a LCD screen by reading and transforming the data received from the sensors.

An improvement to this experimental model could involve adding a weight limit that stops the motors to prevent the system to damage due to overloading.

7. Bibliografie

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