# EXPERIMENTAL RESEARCH ON THE DESIGN AND CONSTRUCTION OF AN EDUCATIONAL STAND WITH AUTOMATIC GUIDED VEHICLE FOR THE TRANSPORT AND TRANSFER OF PALLETS

SCARLAT Andrei Daniel[1], ȘTEFAN Theodora-Mihaela[2], POPESCU Constantin-Adrian[3]
[1]Faculty of Industrial Engineering and Robotics, Study program: Industrial Logistics, Academic year: 4, e-mail: nouageneza@gmail.com
[2]Faculty of Industrial Engineering and Robotics, Study program: Industrial Logistics, Academic year: Master 1
[3]Faculty of Industrial Engineering and Robotics, Robots and Production System Department, University POLITEHNICA of Bucharest

*Summary: For this research the purpose was making an AGV which is used for carrying pallets. It was used: an Arduino board, a motor driver L293N2,2 gear motors with 2 wheels, a distance sensor HC-SR 04 for avoiding obstacles that show up on the path, 2 modules of infrared sensor for following the guidance line, a holder for 2 LI-ion batteries and its batteries. A storage system located on the upper housing of the AGV is used to take over the pallets.*

*KEY WORDS: AGV, remote sensor, Arduino, 18650 Li-ion battery*

## 1. Introduction

Such vehicles are used in the deposit to transport products or goods. AGVs look like small moving cars controled in a warehouse. Moving control is provided by special software. With the help of this software AGVs know what they have to do is orient themselves in the deposit and avoid collision between them and other static objects.

There are many types of automatic vehicles produced by companies. Every one of them can be used to move pallets or even in picking operations. Some of the automated vehicles having the ability to move product shelves to be picked up.

The most commun uses of these Automatic vehicles are in the production area at the supply working points with raw material. They are also used for picking finished products or semi-finished products and bringing them to the storage area.

Industrial pallets are like some storage buffers for different products that can be taken by different equipment and perform equipment picking operation.

## 2. The current stage

Traditionally, human operators have many disadvantages compared to automatic guided vehicles. In the warehouse storage system, this problem arises because humans work with emotions which means that their work depends on emotions. This causes problems, for example in warehouses operators usually take or leave objects to the nearest storage. While they may not take or leave the furthest storage and cause the furthest object to dust because it was never taken.

Another example, human operators might forget to record data storage. However, this problem can be solved by automated guided vehicles. AGV removes some of the potential for inaccurate workflows, reduces non-productive time and increases output, making operations more accurate and productive. When operators

have limited time, to increase production usually companies need 3 shift operators while AGV is able to operate 24 hours a day and 7 days a week. In addition, AGV is able to simplify warehouse management systems.

The research is successfully completed and operational. In the next page I will describe how to achieve it and how it works.

Let's start by presenting the scheme of principle and connection of the AGV created:

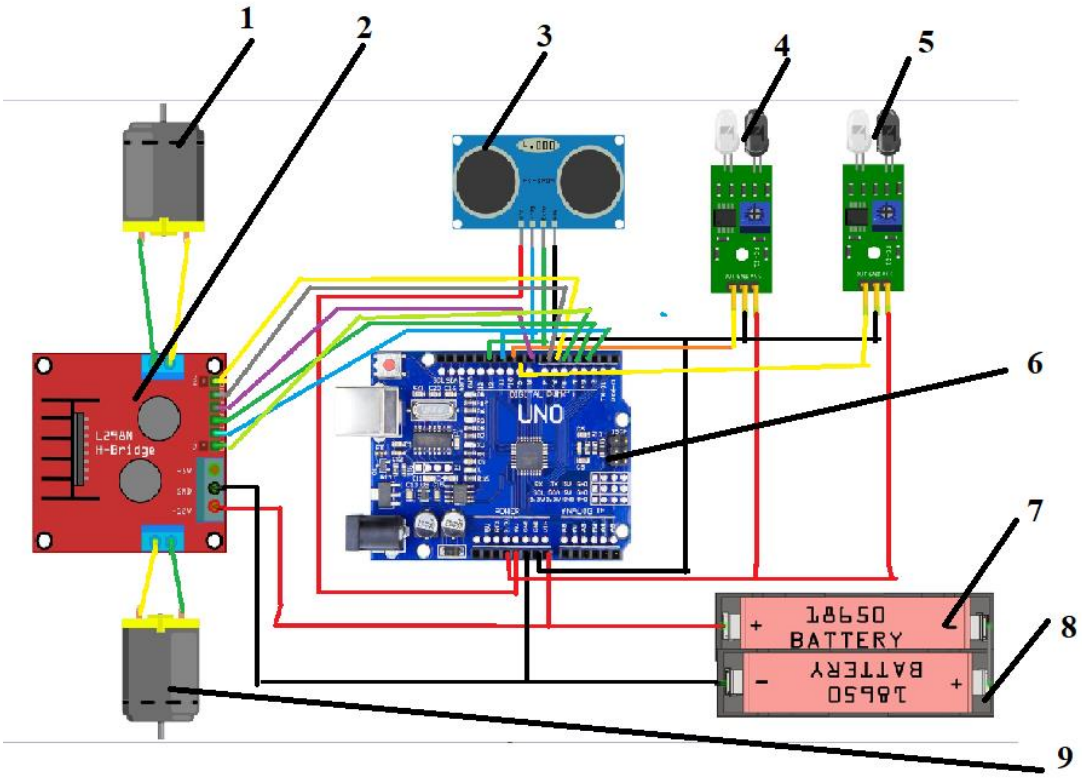


Fig. 1. Wiring diagram

Table 1. Component table

| Nr.crt | |
|---|---|
| 1. | Gear motor 1 ( left ) |
| 2. | L298N driver |
| 3. | sensors inside HC-SR04 |
| 4. | Left IR sensor module |
| 5. | Right IR sensor module |
| 6. | Pleasant ARDUINO |
| 7. | Battery Li-ION 18650 |
| 8. | Support battery |
| 9. | Gear motor 2 ( right ) |

The AGV 3D virtual model was made in Catia V5R21, looking like this:

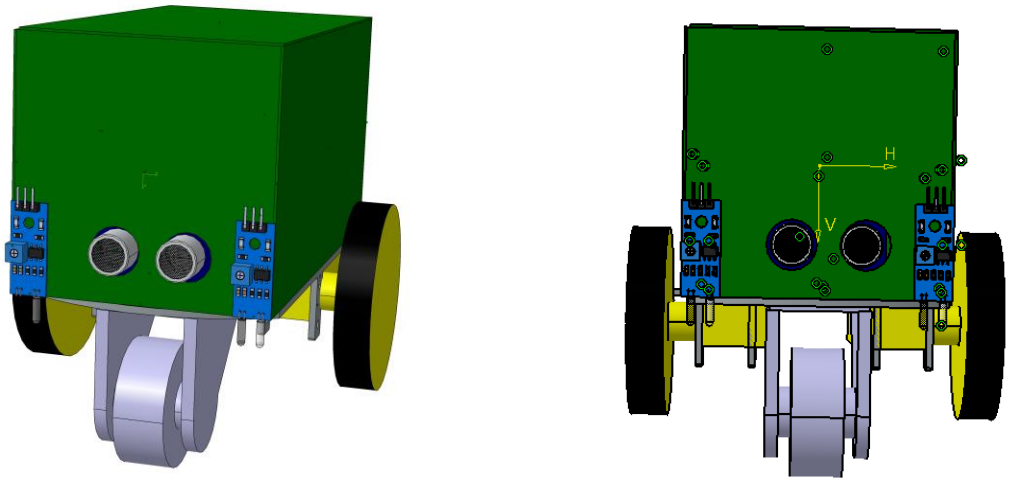


Fig. 2. The 3D model of the AGV

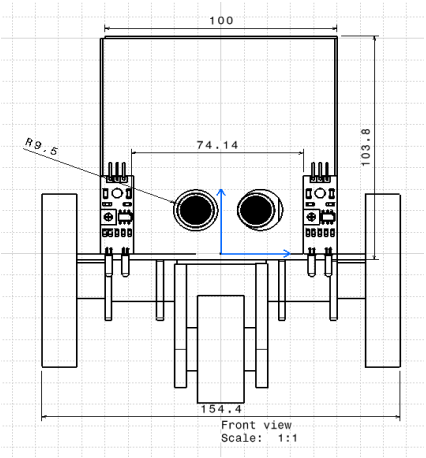


Fig. 3. The front of the AGV

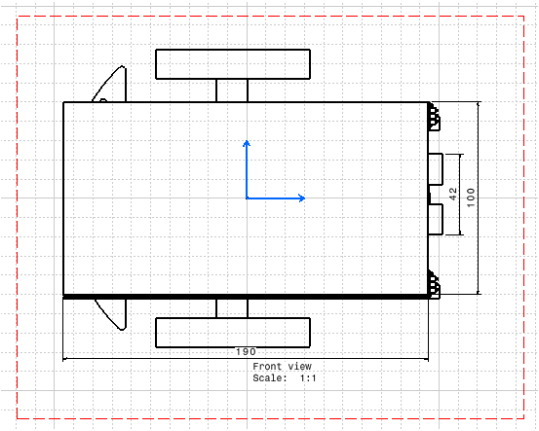


Fig. 4. Top view of the AGV

The pattern of the chassis is made of plexiglass, measuring 20x10, on the back of which the 2 gear motors with the 2 wheels was attached, and on the top surface the Arduino board was attached, an L293N motors driver, which was interconnected with Arduino board, the support for the batteries with batteries 2 Li-ION batteries.

The HC-SR04 distance sensor was also connected to the board to avoid obstacles and the 2 infrared IR sensor modules to follow the AGV guide line.

The links between the driver, board and sensors were done via jumper wires. The case was made of cardboard that later was painted to give it a more pleasant unique look, according to the virtual model.

First, the input variables need to be defined (ex.: pins of the distance sensor, pins of the motor and IIR's pins). Then the calculus algorithm for object detection is introduced.

```
void loop() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance= duration*0.034/2;
  Serial.print("Distance: ");
  Serial.println(distance);
```

Fig. 5. Calculus algorithm

```
if(right_sensor_state == HIGH && left_sensor_state == LOW)
{
  Serial.println("turning right");

  digitalWrite (motorA1,LOW);
  digitalWrite(motorA2,HIGH);
  digitalWrite (motorB1,LOW);
  digitalWrite(motorB2,HIGH);

  analogWrite (motorAspeed, vSpeed);
  analogWrite (motorBspeed, turn_speed);

  }
```

Fig. 6. The AGV' s movements

So the AGV knows when to continue the path and when it should stop, it calculates the distance of objects depending of the minimum distance set to avoid collision. If it's smaller, it stops and if it's bigger it will continue.

The principle of operation is:

L293N driver is working the 2 gear motors through the transmission and splitting the supply voltage received from the battery.

Arduino board orders AGV movement through the transmission of the commands from the board's microprocessor to the driver. The HC - Sr04 distance sensor detects objects that appear on the route and if it is at a distance of 10 cm, it redirects the AGV from the route for avoiding collision.

IR infrared sensor modules detect the base color of the floor and follow the black band, and when the band is perpendicular on the direction of moving it will give a command to the Arduino board to stop the moto-reducers because the AGV has reached its destination.

Fig. 7. AGV physical model

After completion of connecting items between them, uploading the code in the Arduino board I got a prototype as in the FIG. 9

## 3. Conclusions

In conclusion, the AGV is functional and easy to handle. It can carry easily the pallets from a processing point to a storage point, making life easier for the human operators. And due to the fact that it can detect obstacles which appear on the route it makes so they may avoid potential accidents at the work place and perform successfully its tasks.

## 4. Bibliography

[1]. Traian Anghel (2020), Programming plaii Arduino, Editura Parallel 45, ISBN 978-973-47-3204-3
[2]. O'Reilly (2012), Environmental Monitoring with Arduino, ISBN 978-1-449-31056-1
[3]. https://logistic-specialist.ro/logistica-automatizata-ce-sunt-agv-urile/
[4].https://www.researchgate.net/publication/347805525_Development_of_Low_Cost_Pellet_Loading_and_Unloading_AGV