An-Najah National University

Faculty of Engineering

Computer Engineering Department

Graduation Project 2

Automated Guided Vehicle

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Presented in partial fulfillment of the requirement for Bachelor degree in Computer Engineering

Jan 13, 2023

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Acknowledgment

With our hearts filled with gratitude, we would like to thank our supervisor, Dr. Anas Tomah, for his time, knowledge, and patience, and for all the help he could afford in this project. the computer engineering department and all its professors. And last but not least, we would like to thank our families and everyone who had an effect on our project.

Disclaimer

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Abstract

The Automated guided vehicle robot is a lifting machine used in warehouses to speed up the arrangement and movements of goods, products and wood pallets. So this robot will automate the arrangements of wood pallets in the warehouses to speed up the process, minimize the human recourse and effectively do the requirements in the warehouses. In addition, to arrange the wood pallets, the robot will be asked to prepare exploration orders.

As a forklift robot, it should have a suitable design and size to do the requirements that are asked. We built the body of the robot using Arduino, motors and sensors in a good manner.

This kind of robot is used in some modern warehouses to effectively and fastly do the requirements in the warehouses.

Chapter 1: Introduction

1.1 Statement of the problem:

Big companies usually have large warehouses to store their products. So, it is hard to manage the products in these warehouses because it needs a large effort.

Using such robots will save the human effort widely, because rather than hiring hundreds of workers for charging, it could be a better way to use tens of these robots to achieve the same aim.

1.2 Description

In this project, the automated guided vehicle robot was built to help load from warehouses. The warehouses are represented using a grid of black lines, so each intersection in the grid represents a storing point, in other words, one good pallet will be on one intersection.

The robot is built using 4 infra-red sensors. The first two sensors are used to track the line normally and the second two are used to detect if there is any intersection so the robot has to make decisions either forward, backward, left or right. And for sure 4 motors and their wheels and 1 driver the two right wheels connected with each other so they have the same moment and the same for the two left motors.

The lifting component is built using mechanical stuff and a stepper motor and its driver. Also, an RFID sensor and ultrasonic sensor are used to detect the good pallet, the RFID sensor is used to know if the current good pallet is ordered or not and the ultrasonic is used to make sure that there is a good pallet in that intersection or not (known that the good pallets are placed and centered on the intersections).

The Bluetooth component is used to communicate between a mobile Bluetooth application and the robot so a user can send the good pallets order to the robot.

For sure a controller is used to control all of the components mentioned above which is the Arduino Mega controller.

1.3 Report Organization

The next chapter will discuss the constraints and the difficulties we faced in developing our project and earlier coursework as well.

In the Methodology chapter, we explain the process of development, what hardware tools we used in building this project, the results, and the outcome of this project. The Conclusion and Future work chapter will discuss the final Conclusion of this project, the recommendations, and the future work.

Chapter 2: Problems and Constraints

This chapter documents the main constraints we faced during this project. Moreover, we will discuss different coursework and topics that have been useful while doing this project.

2.1 Constraints

- Advanced line follower: To make our project different from previous ones, and instead of building our scenario to be a line follower manner, the robot has been implemented to move on grid line follower, it was hard to deal with that for a long time and to make the motion accurate through the whole space.
- Rotating the robot by 90 degrees: We have had issues with this process, it was difficult to understand the idea at first, but we reinstalled the infrared black line sensors many times below the robot body to make the robot able to detect the grid intersection well.
- Weights effects: The robot's body has been constructed by heavy woods, and all the system had to be put on the robot structure, such as stepper motor, the heavy crane which is made of stainless metal. The heavy weights caused the wrong and bad rotation and made the robot drift from the line.
- Loss of the rubber tires due to large amounts of rotations.
- Designing the mechanical crane.
- Using cameras and Raspberry PI in our project due to the high expensive price.

2.2 Standards, codes, and hardware modules

- **Hardware Modules**

We used the following hardware components in our system design:

IR infrared black line sensor: this sensor is used to detect black lines by detecting the reflected infrared radiation. It will correct the robot's movement along the path.

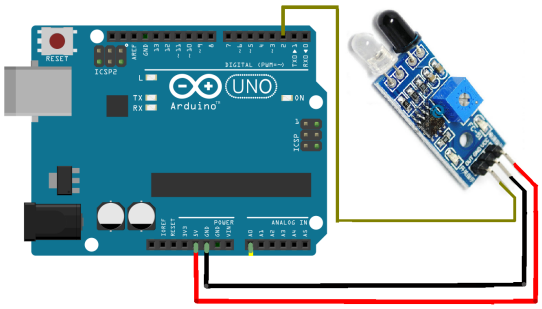


Fig.1 IR sensor circuit

L298N DC driver and DC motors: The driver is for DC motors used for the robot's wheels. It is a H-Bridge to control both motor direction and speed.

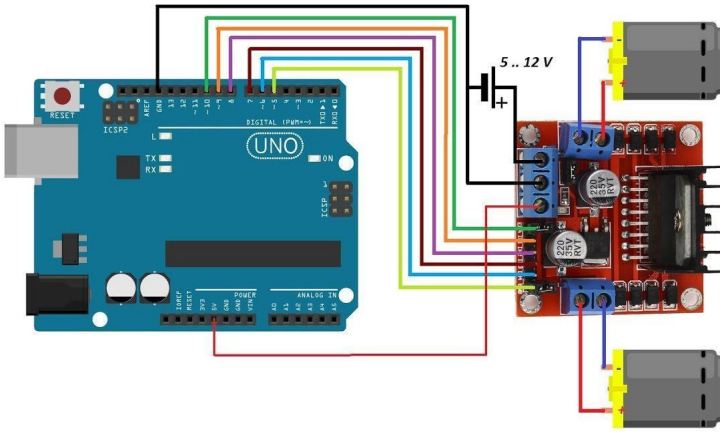


Fig.2 L298N driver and DC motors circuits

DRVA4988: It is a driver shielded expansion board on top of A4988 driver for stepper motor

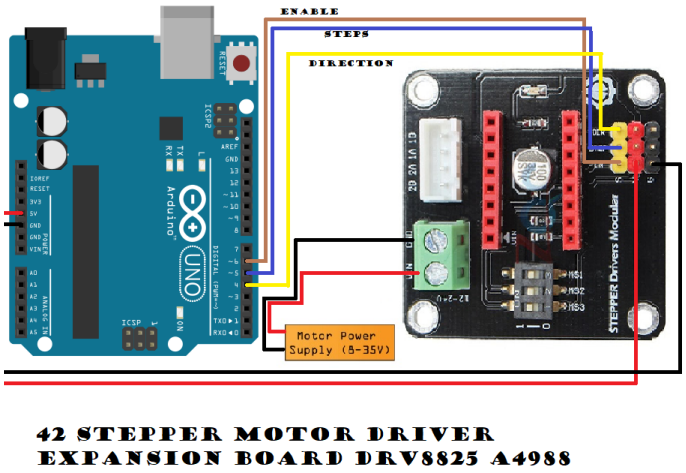


Fig.3 DRVA4988

Stepper Motor with A4988 driver: The driver was connected to 12V.

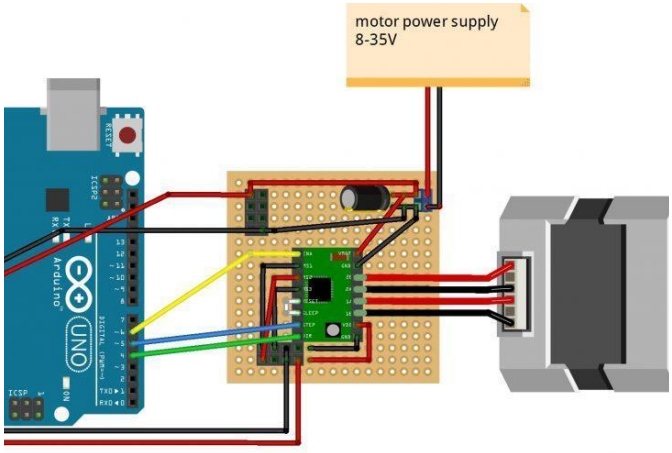


Fig.4 Stepper motor with A4988

Bluetooth HC-05: It is a simple wireless communication device based on bluetooth protocol. It is based on BC417 single chip bluetooth IC that is compliant with Bluetooth v2.0 standard and with support for both UART and USB interface.

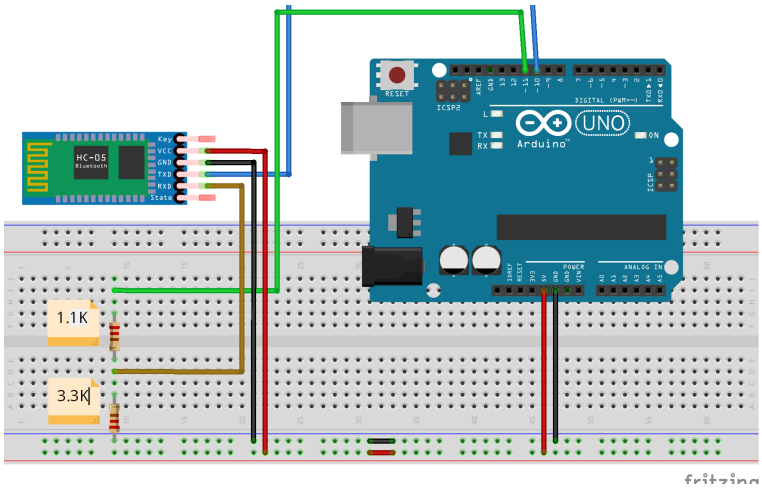


Fig.5 HC-05 bluetooth module

RFID: a simple buzzer connected o a relay to complete the fire alarm system which triggers whenever a fire goes off

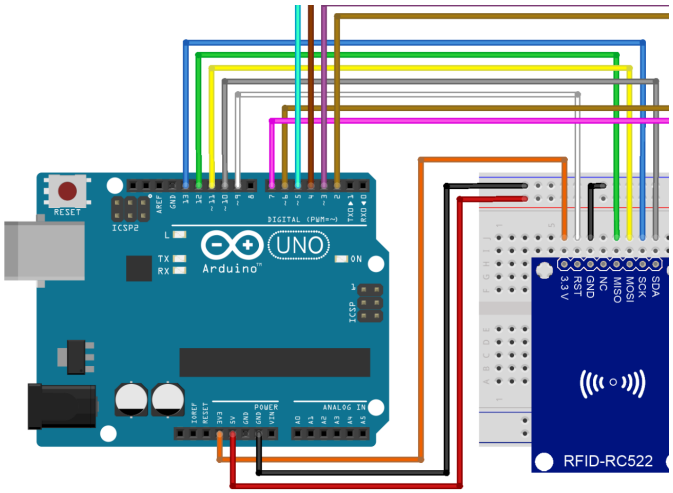


Fig.6 RFID

Ultrasonic sensor: electronic devices that calculate the target's distance by emission of ultrasonic sound waves and convert those waves into electrical signals. The speed of emitted ultrasonic waves traveling speed is faster than the audible sound.

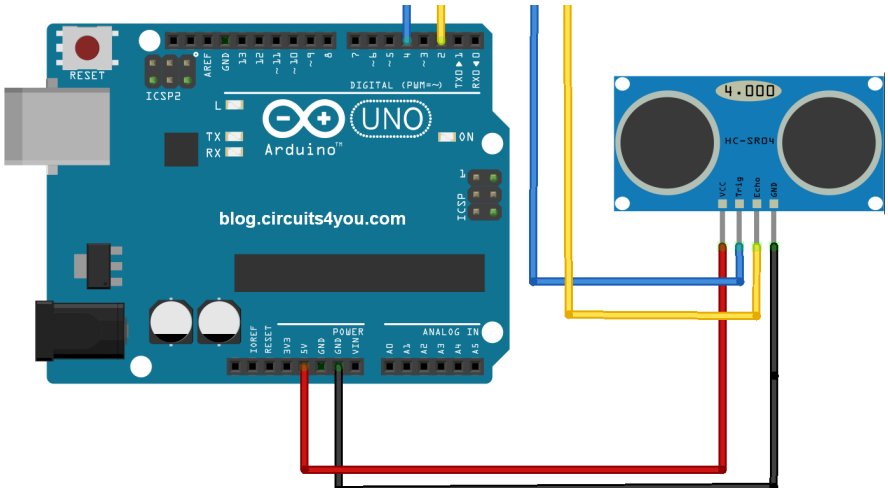


Fig.7 Ultrasonic sensor

Jumpers and wires

Fig.8 Jump wires

Arduino Mega

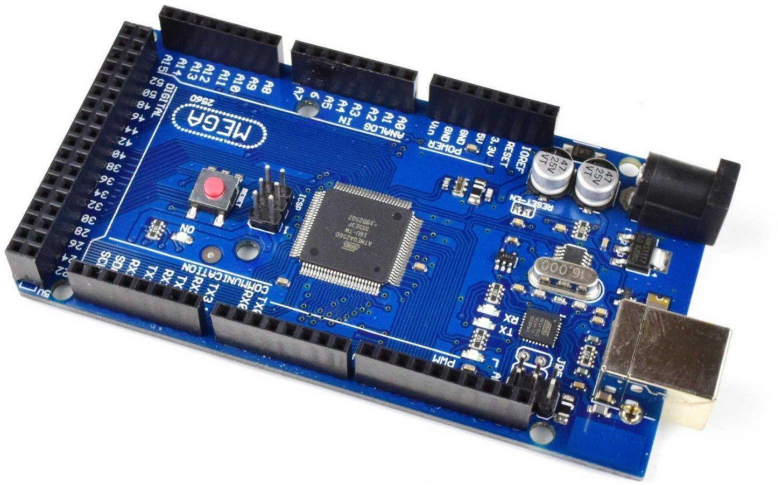


Fig.9 Arduino Mega

Standards and codes

We used HC-05 as our communication protocol which is the standard for bluetooth protocol, it is bidirectional, the HC-05 client can control the robot via a mobile application.

We used **Arduino IDE** for the coding process of the sensors and motors.

2.3 Earlier Coursework

There are many courses we have learned in the Computer Engineering Department, and some courses that we had to take to complete our knowledge and helped us to complete this project, for example:

- Microcontrollers and its lab: this course helped us with the work with chips and how to configure them and use their features.
- Wireless course: the course helped us with the communication between nodes since we are using wireless communication.
- Arduino course: helped us with the work with Arduino ide since we didn't use Arduino before.

Chapter 3: Literature Review

This project's system is an all-in-all system to monitor your facility, with all the features and the communication protocol used, classifying the contents of boxes, and with the feature grid line follower, our system adds more new features, enabling the perfect monitoring for your use.
Other robot projects are line follower. Which is an advantage over other projects in this field. And the crane system is more complicated. The robot can be used in large warehouses or smaller like stores in pharmacies and restaurants.

Chapter 4: Methodology

In this chapter, we will explain the overall process of development, and what hardware tools and techniques we used in building the project.

4.1 Data collection

We had the idea of building a robot that can carry heavy boxes and charge them in the warehouses and stores, but we were searching for new features to overcome the many projects that were made in the same field. So, we watched a documentary program called “Ihsan min al-mustaqbal”. The robotics systems work as Amazon robots. We also searched for proper scenarios for the whole system. We searched how to make the robot as an advanced grid line follower, we thought about how to rotate the robot by 90 degrees in all directions using four IR sensors. We searched about mechanics to know how to design a crane which can carry boxes and raise them a few centimeters above the ground. We got some valuable and useful tutorials. We also read the previous projects concerned with robots to improve on them and try to avoid their constraints.

4.2 System development and building

In this phase, researching the tools needed and their availability was done, also the design of the system before implementing it and testing the tools on their own. Then during the phase of building the system, we started with using wood to construct the robot body and put the wheels. After that started connecting the component together and creating scenarios for the system to improve it as much as possible.

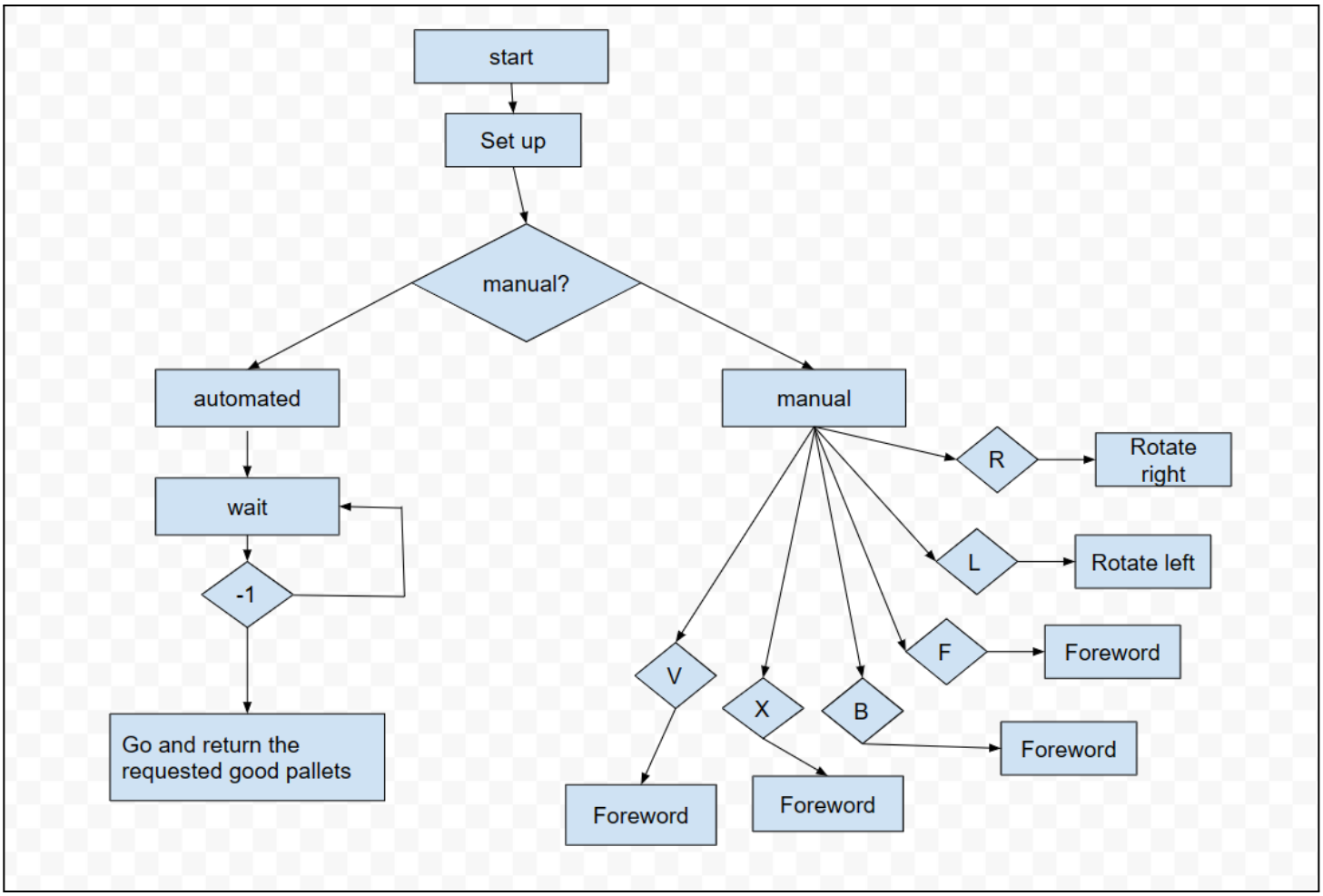
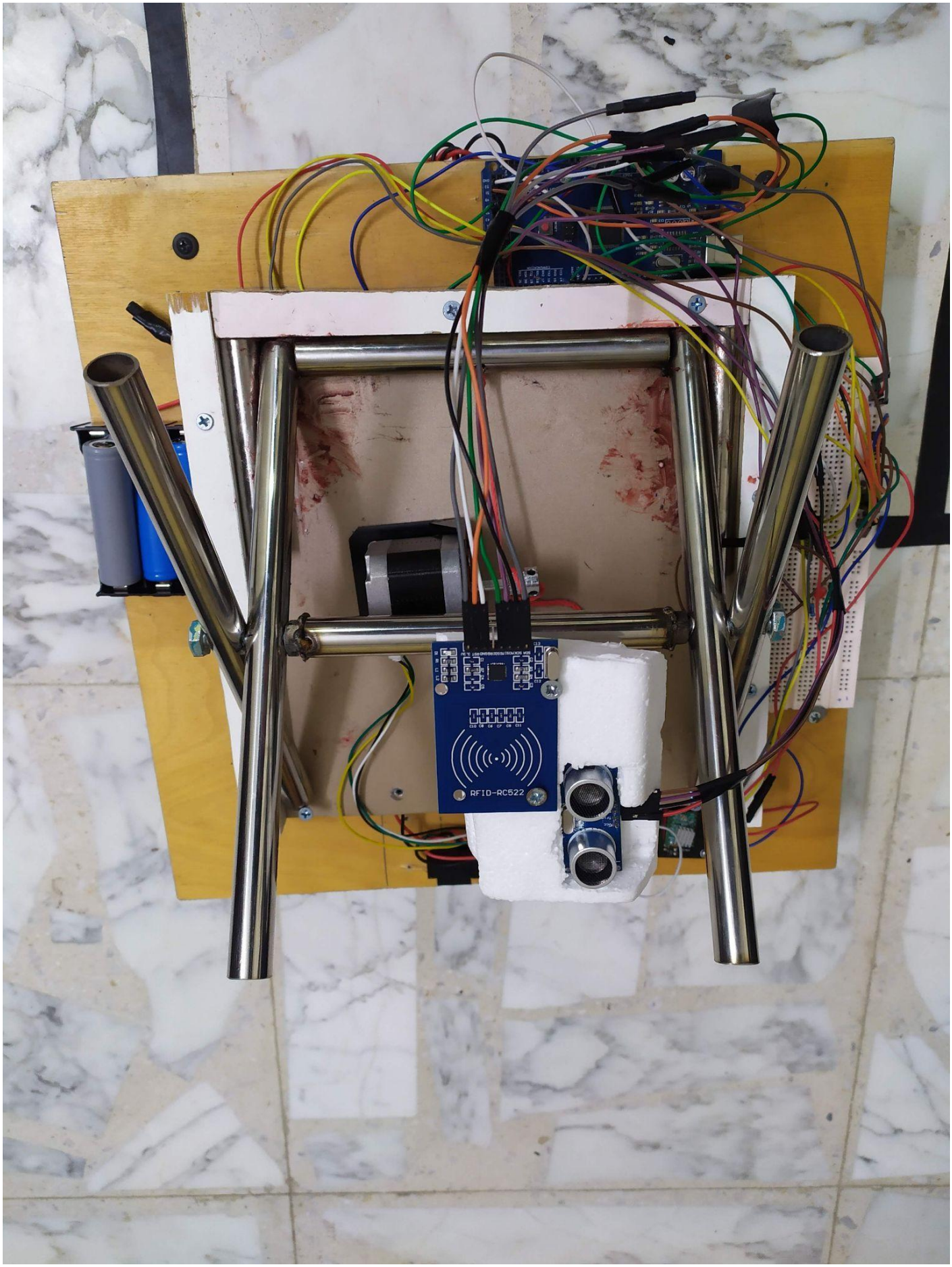
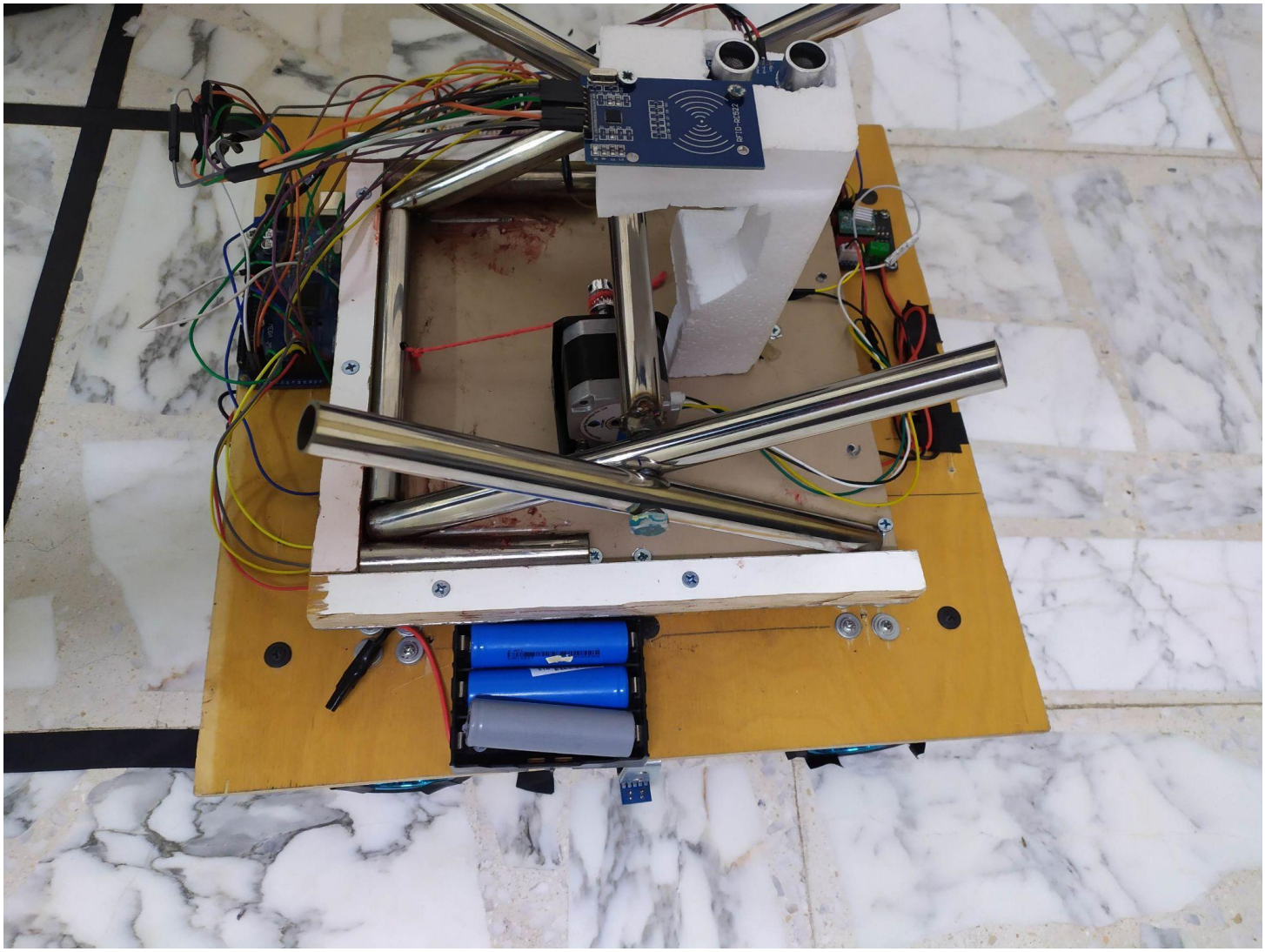
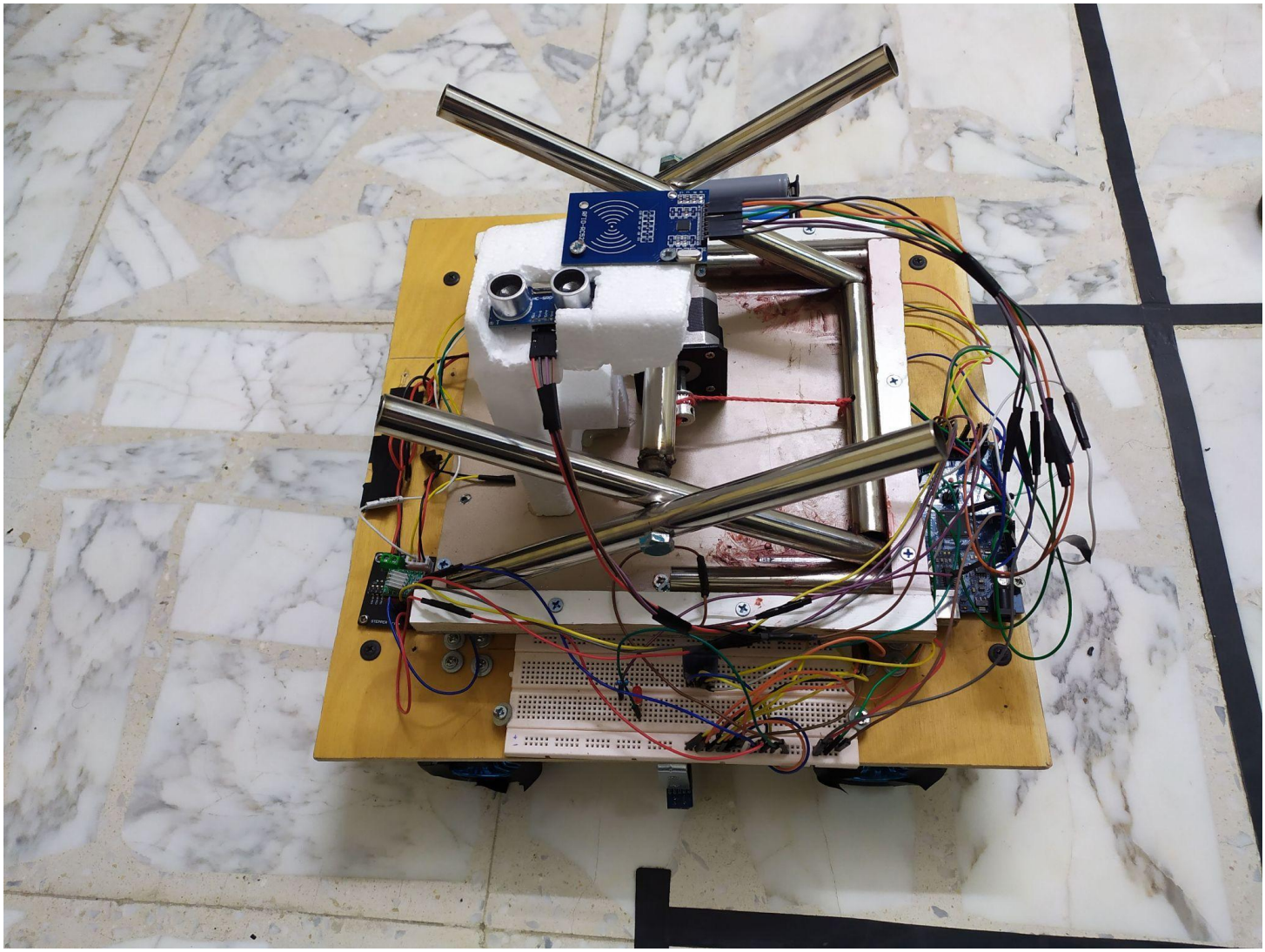


Fig16: Code flow chart


RFID-RC522





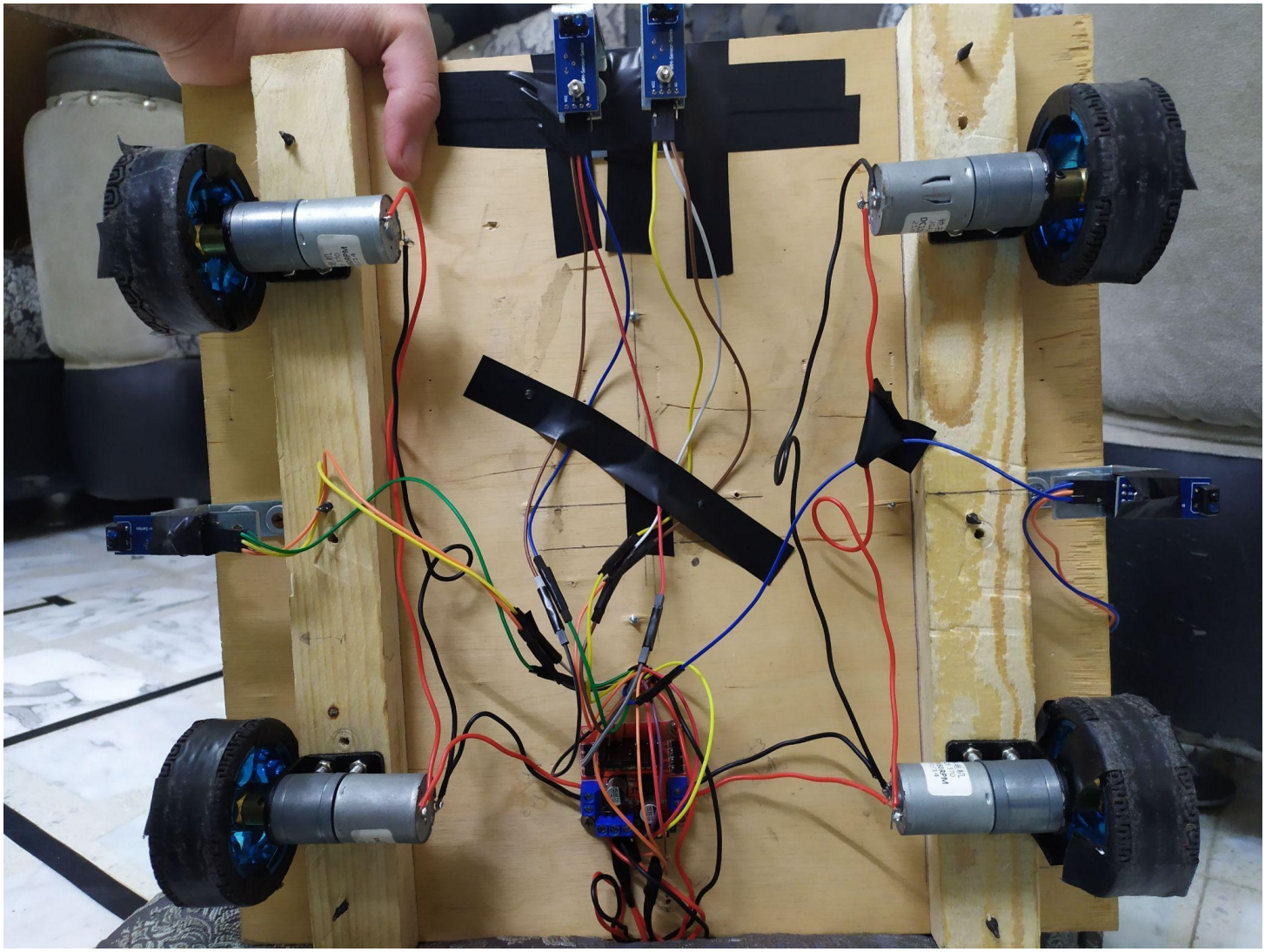


Fig 17 : overall view of the system

4.3 Results and Discussion

The results after finalizing the project were as expected, every scenario was tested and had the desired outcome.

Now the results and benefits you may expect when you install our system as a customer are the following:

- Ease of access and use.
- Scalability.
- Low cost.
- Simplicity.
- Two modes: autonomous and manual controlling.

Chapter 5: Conclusion and Future Work

In conclusion, after the process of building and testing the system, our project delivers a functional system to the customer, and all the sensors and the hardware tools we used in our system are ready to use. We achieved all of this and learned a lot in the process.

Future work:

- Using image processing to detect the contents of boxes.
- Expanding the grid size and scenario.
- Adding voice recognition feature.

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