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ROMO (The robotic mop)

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Prepared For:

Hardware Graduation Project

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Abstract

The world is observing great technological developments, especially in the field of industries. Robots are one of the important industries due to their benefits in serving humans and saving time and effort.

In this project, we will make a special floor cleaning robot (ROMO), the user can control its movement and pump water. Also he can make the robot work automatically, so the robot senses obstacles and pumps water every certain period of time, bearing in mind that the water does not collect in one place. To ensure the sterilization process, a sensor was added to see bacteria by ultraviolet rays, which is important to protect against diseases, especially in the case of children at home. Therefore, Romo can help the housewife, especially if she is an employee, and guarantees her sterilization, hygiene and speed.

The user can control the robot's movement and water pumping, or make it work automatically through the mobile phone.

Introduction

Robots can work at any time of day or night. They don't require vacations or health insurance. It also saves effort and time, as human efforts alone are no longer sufficient to keep pace with the rapid improvement in technological progress. A trend towards robotics solutions has emerged in the current century, exploiting the development of technology and communications in all walks of life.

Robotics has already begun to permeate everything in the world, from the smallest systems that a human eye cannot see, such as Nano-robotics that enter the human body, to the largest systems, such as planes without a pilot and space robots that have enabled humans to further explore the universe. Robots are not limited in size or location, and they have given birth to relatively new but extremely important concepts like Machine Learning and the Internet of Things. Robots will eventually take over millions of traditional jobs. They have already begun to do so, with automation becoming a major component in the field of robotics.

Romo is a self-driving vacuum and one of the most popular consumer robots on the market. It cleans your floors by navigating around clutter and under furniture, and allows you to monitor the vacuum from your phone.

It is equipped with sensors to sense obstacles. Pump for pumping water and ultraviolet rays for sterilization. Its importance lies in saving time and effort for housewives, especially employees.

It employs "random" navigation. To ensure that your floor is completely covered. This means that once the robot has left its dock, it will begin vacuuming in one direction until it encounters an obstacle. Then it turns a random number of degrees away from itself and moves in that new direction. This procedure is repeated until your home is thoroughly cleaned. Although it may appear chaotic, this "drunken sailor" approach to vacuuming results in fairly thorough coverage of your living area.

Literature Review

The general aim of robots and their continuous evolution is what was explored in [1]. This research concludes the importance of robotics in getting closer to human needs and solving technical problems is emphasized. According to another research [2], Human-robot interaction (HRI) is now well understood enough for us to create useful systems that can operate outside of the laboratory.
Moreover, any robotics application needs a high level of intelligence in order to be successful, as Feigenbaum stated in his research, “Various systems that have achieved expert level performance in scientific and medical inference illuminate the art of knowledge engineering and its parent science, Artificial Intelligence.” [3].

As mentioned on a research [4], cleaning robot has four generations as of 2012: the first-generation original models, the second-generation "Discovery" series, the third-generation 500 series, and the fourth-generation 600/700 series. To pick up debris from the floor, all use a pair of brushes that rotate in opposite directions.
The definition of desired functions and the design of the ultimate versatile personal robot are still under discussion[5]. In the meantime, precursors to this yet-to-evolve species are well on their way to becoming commercial products. Cleaning robots for public spaces as well as private homes appear to be capable of providing the breakthrough that non-industrial robot system designers have long sought.

The home provides challenges from both technical and interaction perspectives. In addition, the home is a seat for many specialized human behaviors and needs, and has a long history of what is collected and used to functionally, aesthetically, and symbolically fit the home. To understand the social impact of robotic technologies, a paper [6] presents an ethnographic study of consumer robots in the home.

Methodology

Because of the importance of robotics in the modern world in general, and cleaning systems in particular, a strong, robust robotics structure is required to demonstrate the proposed system. This system should include important aspects such as hardware, software, and the surrounding environment.

Hardware

Firstly, the process starts with building the robots. In order to build an efficient and effective structure that minimizes the cost and at the same time acquires the best available materials that serve the needs and requirements of the system.

Two-storey cart was used so that the water and the pump are placed in the basement and the electronic parts on the upper floor, to ensure the safety of the electronic parts as illustrated below:

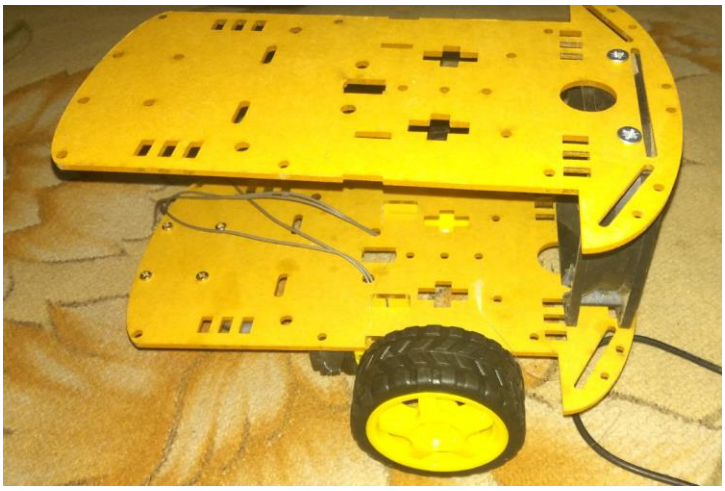


Figure 1: cart

The robot is controlled by mobile or automatic operation using Bluetooth technology by using Bluetooth switches application.

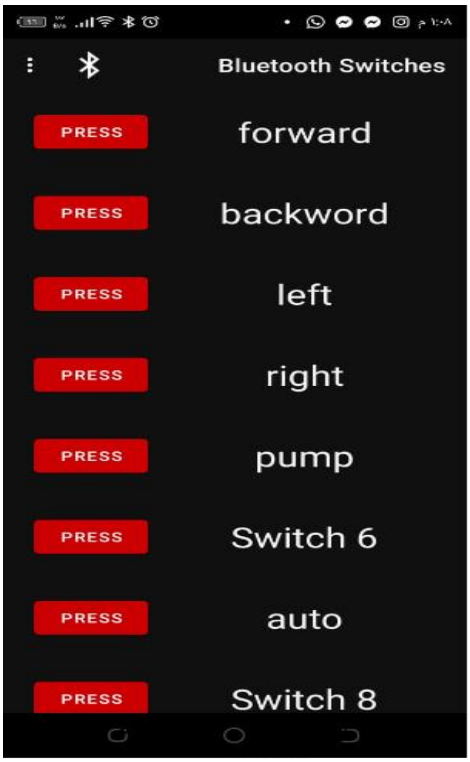


Figure 2: Bluetooth switches application

The hardware parts that were chosen to develop the robot include two wheels, two DC Motors and one H-Bridge Motor Drivers for the movement of the wheels. These are illustrated below:

Figure 3: Wheels

Figure 4: H-Bridge

Figure 5: DC motor

It should be noted that 2 DC Motors were used in the robot in order to accurately steer the car in the four directions needed.

Next, the two microcontrollers chosen for the robot were Arduino UNO and Arduino Nano. These were chosen because they provide a sufficient number of pins that accommodate the many number of inputs that are needed in our system.

Figure 6: Arduino UNO

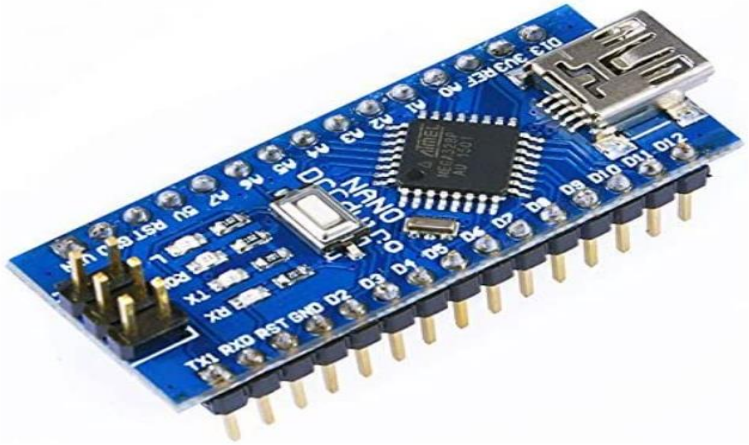


Figure 7: Arduino Nano

Next, the parts needed for communication will be shown, which include HC-05 Bluetooth module that was used for controlling the robot.

Figure 8: HC-05 Bluetooth

In addition, Ultrasonic modules and a Servo Motor were used for obstacle detection in the robot. The Ultrasonic module is shown below:

Figure 9: Ultrasonic

Figure 10: Servo motor

The power coming from the Arduino UNO is not enough to operate the pump, as the Arduino UNO produces approximately 4-5 volts and 100 mA of current, while the pump needs at least 300 mA to 0.5 A.

Therefore, the transistor was used so that the command to run the pump was taken from the Arduino Uno and it was connected to a regulator to provide the power consumed by the pump.

Figure 11: pump

Autoplay

The command to start the autoplay is given from the Arduino Uno to the relay then to the Arduino Nano, and in order to avoid a conflict between the commands from the autoplay and the self-control, we connected the Arduino Nano and Uno to 4 diodes for each and then connected them with H-bridge to move the wheels.

Figure 12: Relay

It is known that ultraviolet rays are used for sterilization, so we added it.

Figure 13: Ultraviolet

The power bank was used to operate the robot to reduce the weight because its size is small, in addition it's easy to charge and preserves the environment.

Figure 14: Power bank

To finalize the hardware section, it should be mentioned that the chosen parts were the best available, given the limited access to materials in Palestine.

Software

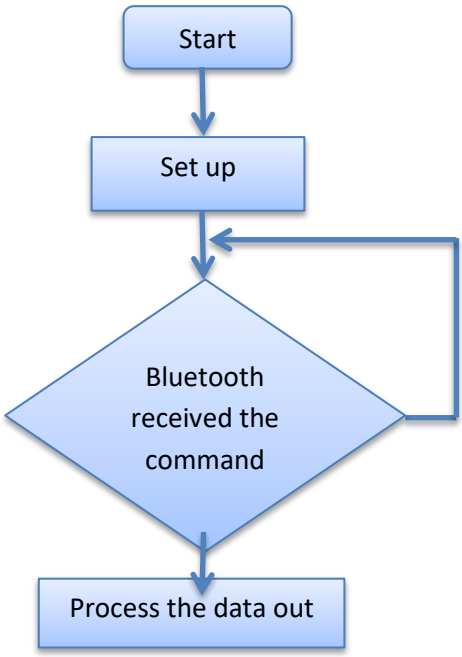
The software part will be discussed. This included the development of an Android mobile application for the Bluetooth control of the robot.

Android Application

The android application provided user control for the robot used in this system, by using Bluetooth switches application to connect to the address of the Bluetooth module situated on the robot, then guiding the needed movement according to the buttons available on the screen.

We used Arduino IDEs for programming the microcontrollers.

Code Flows:



Results and Discussion

In the final stage, we got a robot that wipes and sterilizes floors controlled via mobile application.

Initially, we divided the project into steps. The first is for manual control of the robot. Below is a circuit showing manual control:

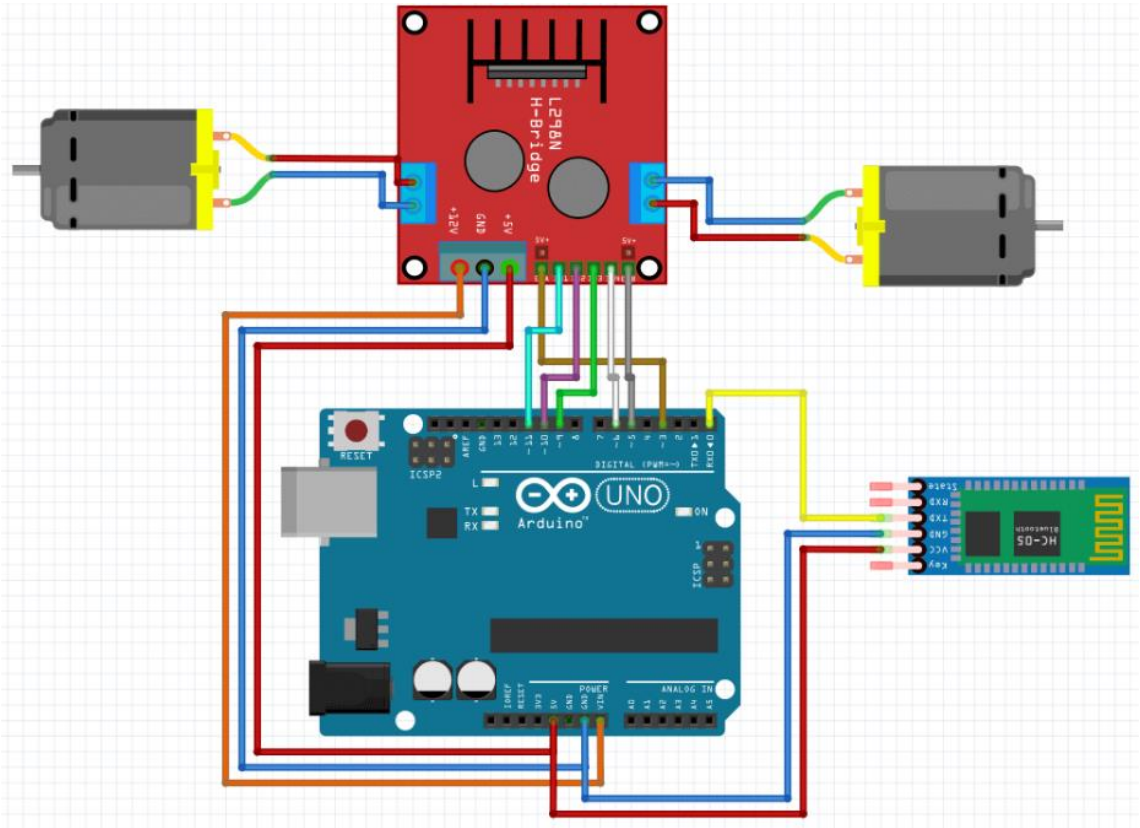


Figure 15: Manual control circuit

At this part we connected H-Bridge, Arduino Uno and HC-05 Bluetooth.

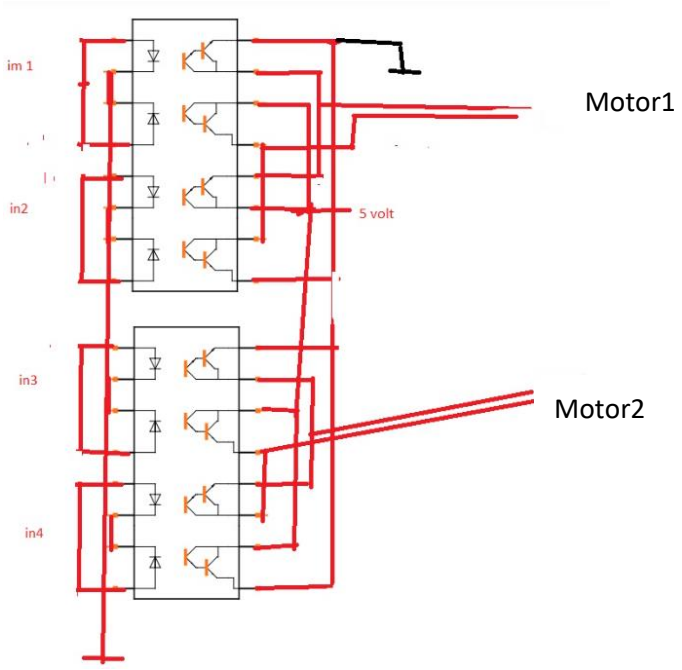


Figure 16: ILQ55

After that we connected Arduino Nano, transistor, servo motor and Ultrasonic with H-bridge to start the automatically part. Below is a circuit showing our connection:

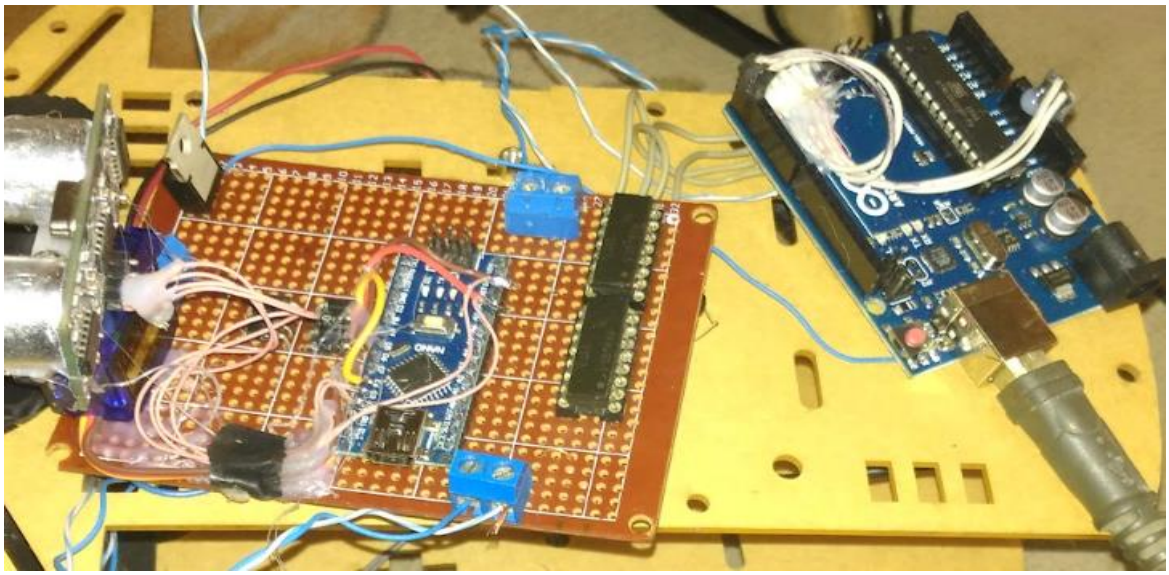


Figure 17: connection (1)

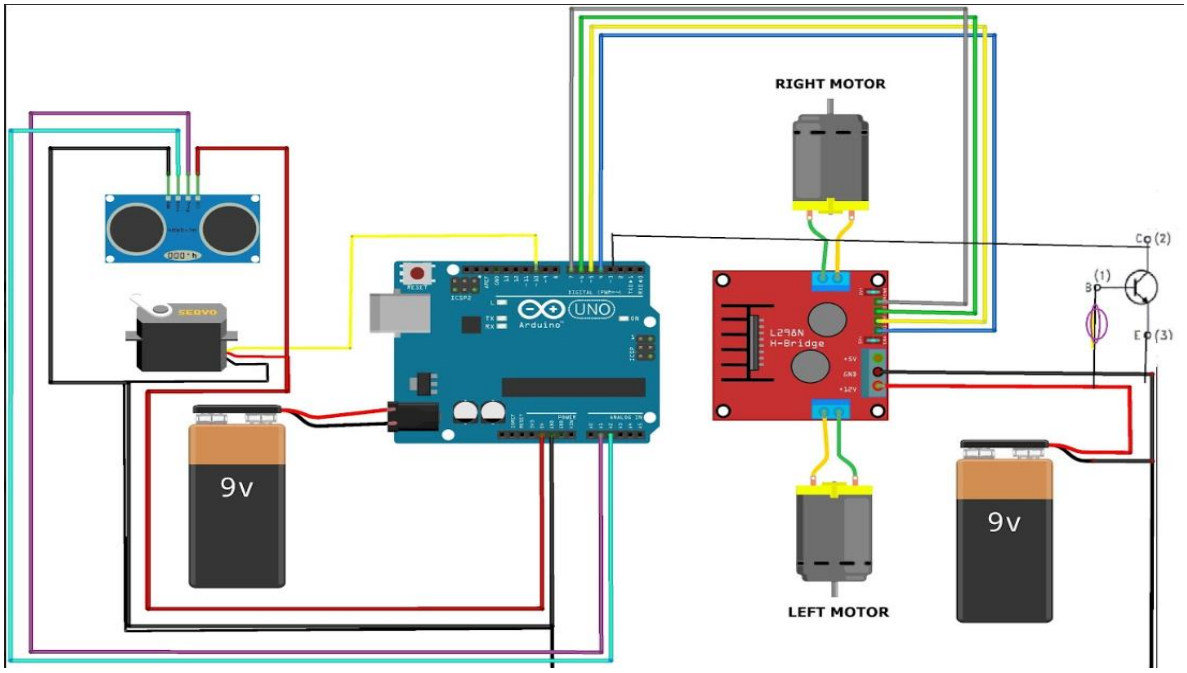


Figure 18: Approximated connection

Next, 8 Diodes used to avoid a conflict between the commands. As shown below:

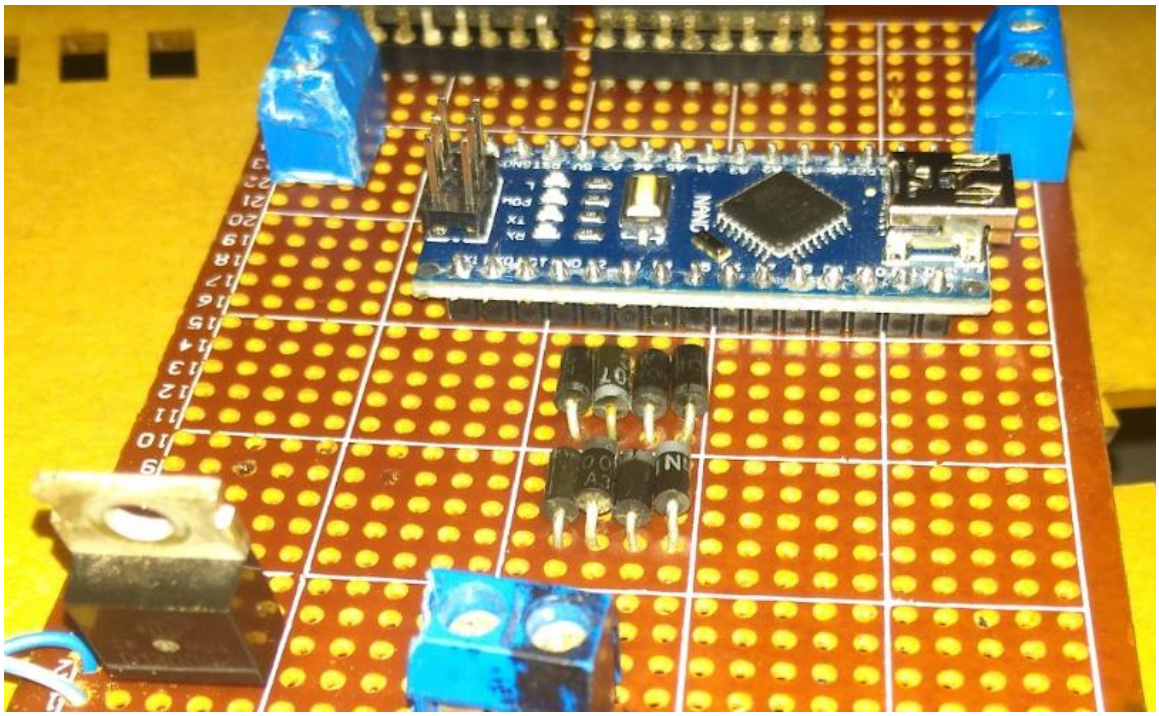


Figure 19: Connection (2)

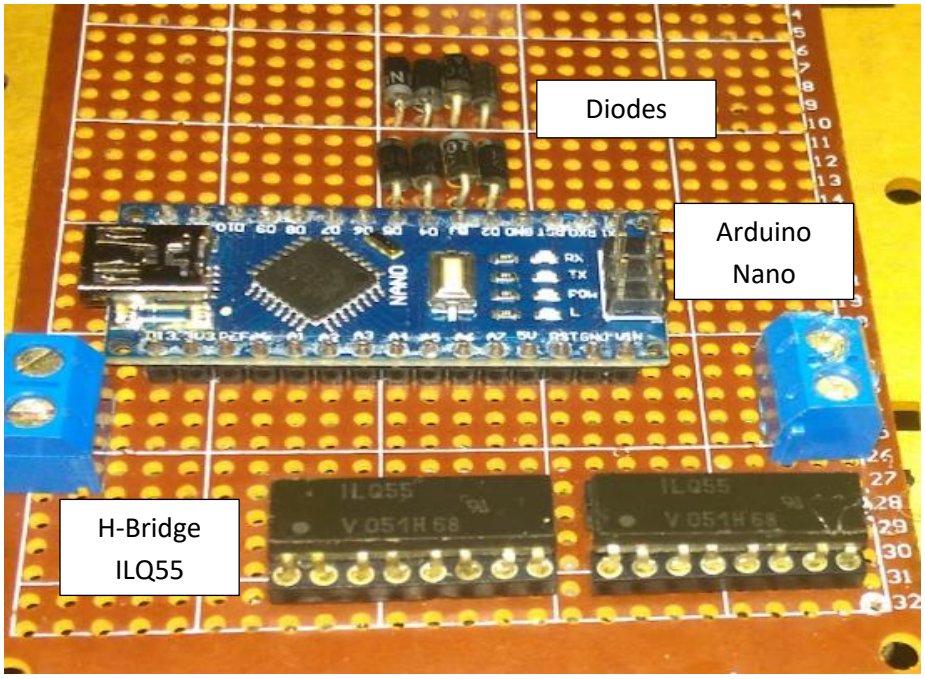


Figure 20: Connection (3)

Figure 21: pump

Conclusion

In conclusion, Romo is a floor cleaning robot, and like other robots, its main goal is to save human time and effort. Ultraviolet rays have been added to the sterilization feature to be different from other previous projects.

The microcontroller can easily be used to modify and enhance any bot's various capabilities, evolving its capabilities to explore new pathways of efficient working. In our work we learnt new things about hardware components also we learnt how to use Arduino and program it.

Limitation

We faced some limitations, such as the lack of time for the summer semester, and the hardware available in Palestine, which is imported at a low cost, is not completely reliable, resulting in numerous problems, also we wanted to use Raspberry Pi but couldn't find it in the market.

Future work

The significance of robot systems for human future is undeniable. As a result, the development of this system does not stop here, we hope to make the robort respond to voice commands and using camara to more accurately identify obstacles.

Reference List

1. Garcia, E., et al., The evolution of robotics research. IEEE Robotics & Automation Magazine, 2007. 14(1): p. 90-103.
2. C. D. Kidd and C. Breazeal, "Robots at home: Understanding long-term human-robot interaction," 2008 IEEE/RSJ International Conference on Intelligent Robots and Systems, 2008, pp. 3230-3235, doi: 10.1109/IROS.2008.4651113.
3. Liu, B., et al., Controllability of a leader–follower dynamic network with switching topology. IEEE Transactions on Automatic Control, 2008. 53(4): p. 1009-1013.
4. Building a Mobile Robot for a Floor-Cleaning Operation in Domestic Environment.
5. H¨agele, M. 1994. *Serviceroboter—ein Beitrag zur Innovation im Dienstleistungswesen*. Technology Study, Fraunhofer Institute for Manufacturing Engineering and Automation IPA, Stuttgart, Germany.
6. J. Forlizzi, "How robotic products become social products: An ethnographic study of cleaning in the home," 2007 2nd ACM/IEEE International Conference on Human-Robot Interaction (HRI), 2007, pp. 129-136, doi: 10.1145/1228716.1228734.
7. [2] Jordi Palacín, Member, IEEE, José Antonio Salse, Ignasi Valgañón, and Xavi Clua, IEEE transactions on instrumentation and measurement, vol.53, no. 5, Spain 2004, pp. 1420-1423