DESIGNING AND BUILDING AN EXPERIMENTAL MODEL OF A ROBOT THAT MEASURES DISTANCES IN A ROOM

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Abstract: This paper presents the design, construction and programming stages of a robot that can measure distances in a room. In the first stage, each component was designed using 3D software, followed by assembly for testing. In the second stage, the parts were manufactured using 3D printers and electronic components were acquired. The third stage involves testing the electronic components, with the final stage being the assembly of the robot and testing its performance.

KEYWORDS: robot, sensor, measurement, manufacturing

1. Introduction

This project presents the design and assembly stages of a robot that can measure distances in a room. This project can be useful for understanding the process of designing and building a robot, as well as developing programming skills.

The objectives of this project are to familiarize with the functioning of the robot, to adapt the robot to any kind of enclosure, to understand and develop applications to perform necessary tests, to control the robot and to improve and optimize the system. In order to achieve these objectives, various design and programming methods were used for the robot, and the optimal solution was chosen.

2. Current status

There are several technologies and methods currently used for distance measurement with the help of robots, such as the following examples:

• Ultrasonic distance sensors - they work by emitting sound waves with a very high frequency and measuring the time it takes for the waves to bounce back to the sensor after encountering an object [7];

• Lidar - is a sensor technology that uses lasers to measure the distance to an object. This technology has been implemented mainly in self-driving vehicles and autonomous robots [8];

• Infrared distance sensors - they emit and detect infrared radiation, and the distance to an object can be calculated based on the time it takes for the radiation to bounce back to the sensor[9].

The technologies and distance measurement methods presented are very advanced and are used in a wide range of applications. However, the continuous development of artificial intelligence and other technologies could lead to the improvement of these approaches.

3. Designing and building the robot

The prototype of the measuring robot was made using specialized software. The first objective of the project was to take the measurements from the datasheet of the components that were placed on the chassis, and then design them to simulate the assembly.

The modeled components are shown in Figure 1.

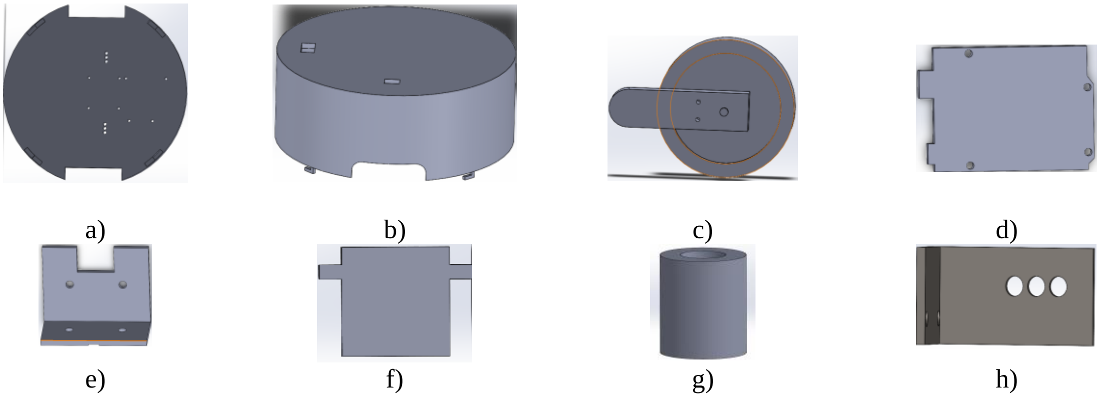


Fig. 1 Modeled components: a) bottom casing, b) top casing, c) wheel and motor,
d) Arduino Uno R3, e) sensor holder, f) SG90 servo motor, g) spacer, h) motor holder

The figure bellows shows the assembled robot containing the components presented in Fig. 1.

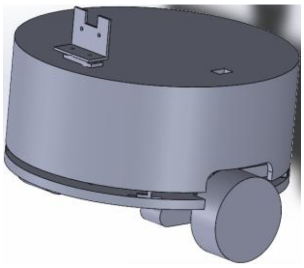


Fig. 2 The final assembly of the robot

4. Additive manufacturing

The next objective of the project was to 3D print the components using the most optimal printing method. To configure the settings and choose the printing material, the Z-Suite program was used (Fig. 3a). In terms of cost and printing time, PLA (Polylactic Acid) material was chosen for the print.

a) b)

Fig. 3 Bottom casing: a) part presentation on the printer, b) physically produced casing (finished product)

After manufacturing the bottom casing, the next step was to verify the closure of the top casing. A sample was created to check the closure of the lid on the chassis, as shown in Fig. 4.

After testing, the settings for the top casing were adjusted, and different 3D printing technologies were compared to choose the best one in terms of cost, printing time, and strength.

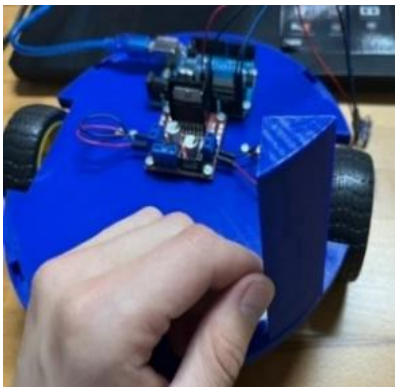
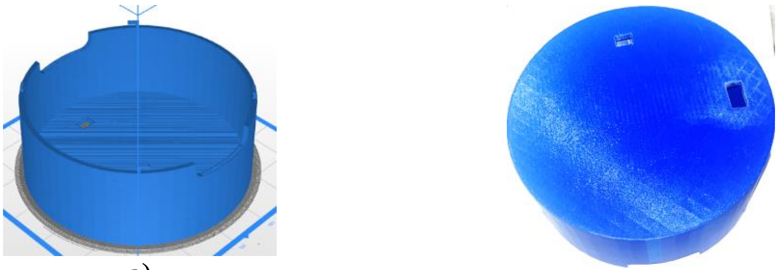


Fig. 4 Sample test for closure

The printer used for manufacturing the components is Zortrax M300 Dual, and the material chosen after the study was PLA.



a) b)

Fig. 5 a) Part presentation on the printer, b) Physically produced top casing (finished product)

The next step after printing the casings was the acquisition of the electronic components presented in Table 1.

Table 1. The components

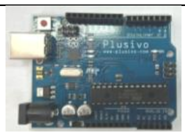
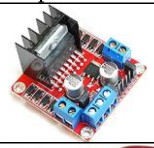
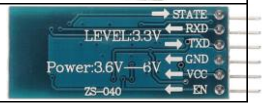
No.	Category	Quantity	Representation	No.	Category	Quantity	Representation
1.	Whell	2		4.	Sensor VL53L0X	1	
2.	Motor	2		5.	Battery case	1	
3.	Plusivo controller	1		6.	Battery	2	

Table 1. The components (continued)

No.	Category	Quantity	Representation	No.	Category	Quantity	Representation
7.	L298N	1		10.	Breadboard	1	
8.	Servomotor SG90	1		11.	Motor holder	2	
9.	Start/Stop button	1		12.	Bluetooth module hc-05	1	

5. Testing the DC motors and servomotor

The next stage consists of testing the functionality associated with both the DC motors and the servomotor – as shown in Table 1. The DC motors are responsible for providing a means for locomotion for the robot, by engaging the two wheels presented in Figure 9b, and the servomotor is tasked with controlling the position of the VL53L0X sensor [4].

5.1 Testing the DC motors

The first step was to create a program that would be very easy to use for testing the DC motors. To use the Plusivo board, compatible Linx and Arduino modules were installed. The program in Fig. 6 shows the use of the Linx module. On the left and right side of the While loop, the connection is opened/closed. The While loop is used to continuously run the program until the user presses the STOP button. Inside the loop, three functions are used to start the motors and set their speed.

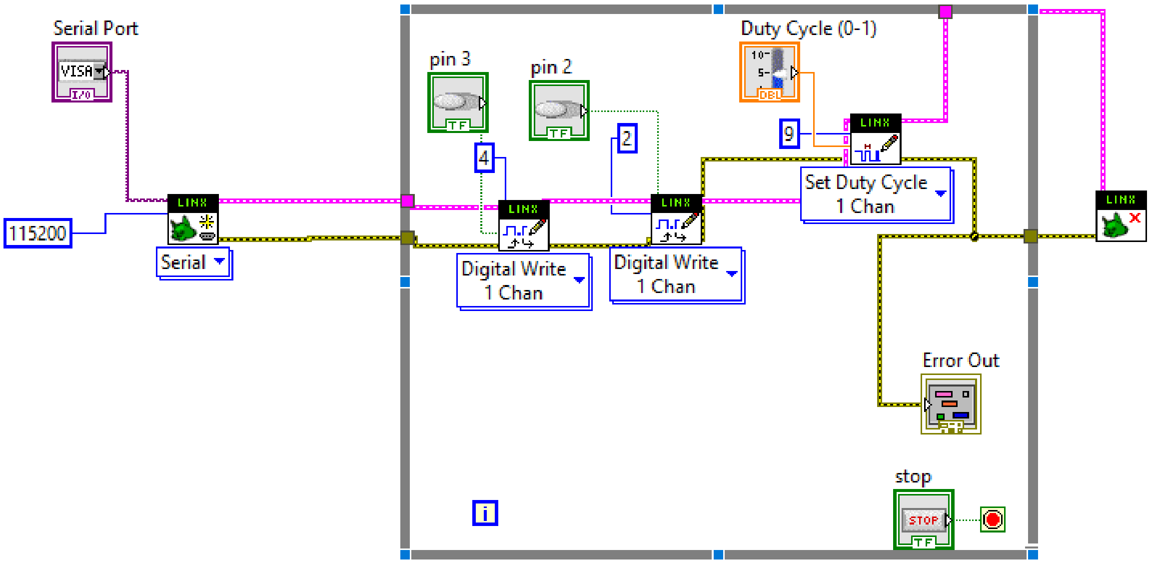


Fig. 6 DC motor programming schematic

5.2. Testing the SG90 Servomotor

The second step is to create a program for testing the SG90 servomotor, for which a sub VI was developed. This subprogram was designed to continuously run the servomotor until the STOP button is pressed. To establish the connection between Arduino and the specialized software, the Linx function can be used. The program's open/close functions are located outside the While loop. Also, outside the loop is the Servo Open One Channel function, through which the servo sends data to Plusivo board, via digital pin 10. Inside the While loop in Fig. 7, calculations are made to rotate the servo from 0 to 180 degrees with a delay of 10 ms.

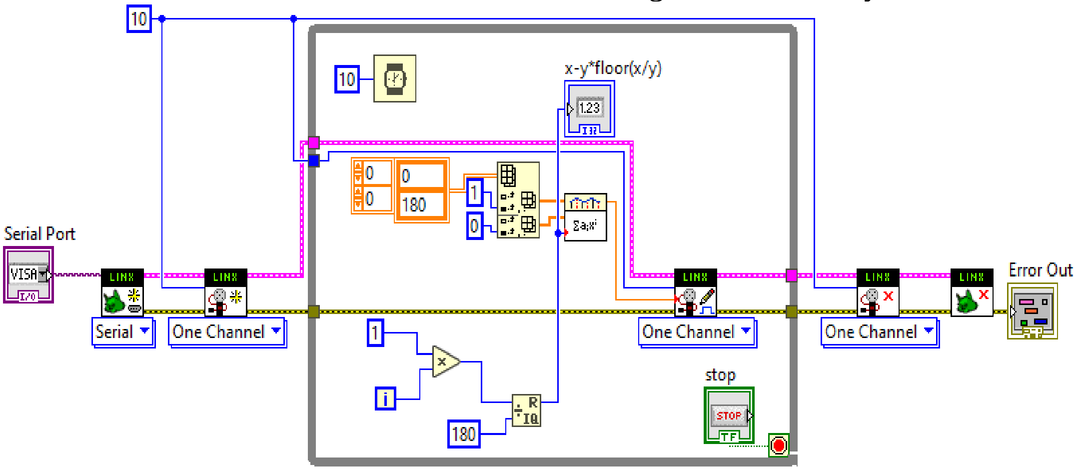


Fig. 7 Servomotor Program schematic

6. Robot assembly and connection diagram

The first step in assembling the electronic components of the robot was to create the connection diagram presented in Figure 8. In this figure, the connection mode between the motors, servomotor, sensor, Bluetooth HC-05 module, and Arduino Uno R3 board can be identified.

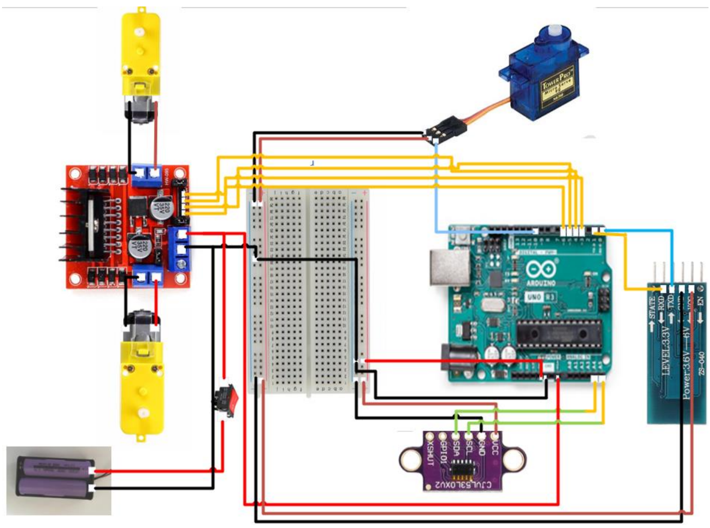
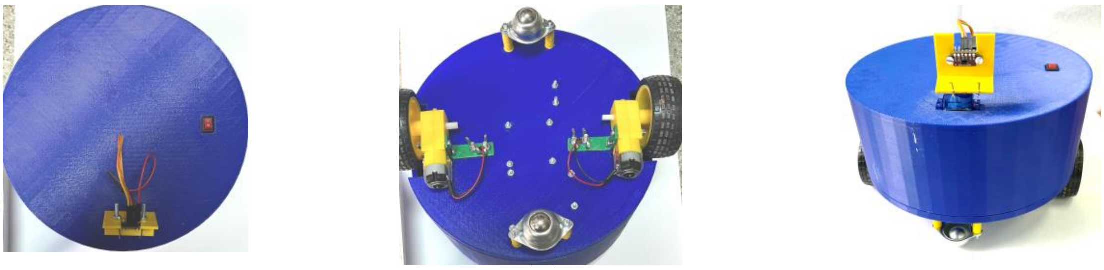


Fig. 8 Electrical diagram

In Figure 9 the final assembly of the robot can be seen. When constructing the electrical diagram from Figure 8, the component parts presented in Table 1 were taken into account.

The third step involves developing a program necessary for controlling all of the electronic components. Following the completion of the tests, a program was developed that measures distances in a room and runs continuously until the user presses the STOP button.



a) b) c)

Fig. 9 Bottom case: a) top view of the robot, b) bottom view of the robot, c) front view

7. Conclusions

In conclusion, this project has practical applications in various fields, such as construction industry and land surveying. The project involved the development of a robot capable of measuring distances in a room. The work that went into developing the prototype included the use of a VL53L0X sensor, DC motors, and servomotor in a practical context – distance measurement. Practical concerns also regarded the use of additive manufacturing for physical prototyping, sensor calibration for measurement accuracy in order to achieve an autonomous operation of the robot.

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