Smart Garage Goor - Software

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0. Abstract

This dissertation will present a new method of controlling a garage door in a smart and more developed way. It will be focused on the software part of this project. It can be fully controlled autonomously through multiple control devices including control of humans by analog buttons and a mobile application, which is programmed fully by the developer. This project aims at enhancing the functionality of a garage door and make it more secure by inserting some sensors and actuators to ensure more safety of the overall method for this mechanical device.

1. Introduction

Nowadays, almost all our lives have started being developed and worked on in order to improve on their functionality and overall performance, and digitization and controlling everything using computers has helped a great deal is making this goal easier. Computers managed to break the barriers of manual or human control to full on automatic, autonomous, and smart controls over entire projects without the need of being in the same country. This has allowed engineers to create different algorithms and programs in order to control the most complex machines and prevent them from fatal accidents and flaws that were harmful to the people using them or even around them.

In our project, we present a new smart way to operate a garage door autonomously while taking in consideration the risks that are usually accompanied with garage doors and operating them. We have worked on ways to give people total control of the garage door with a click of a button as well as control over the risks of someone being in the way of the door and might be in danger of an accident with the door. This project introduced microcontrollers like the Arduino Uno microcontroller. [1] This central processing unit, along with other electronic components manages to provide order to all the actuators operating the garage door and authorize full control for users.

The Arduino Uno microcontroller uses an open-source software and requires specific C++ programming for the board on an integrated development unit called Arduino IDE. This entirety of the code is programmed on that IDE and sometimes it requires the inclusion of additional libraries that provide better control of the components connected to the Arduino.

2. Purpose and Scope of Work

This project aims at bettering the way a garage door functions and how computers and smart sensors and actuators can help improve its functions. In this dissertation, we will discuss how we managed to improve on the functionality using the coding and the types of algorithms used in order to control all the components and allow them to work together coherently as one unit to perform all the programmed functions on the microcontroller. By perfecting the code for the Arduino to easily control all the components without any complication, we would have reached our main goal of the best software solution.

The scope of our work starts with a small introduction, followed by the specification of the purpose of our work, afterwards, an overview of some existing solutions is provided and then a morphological chart explaining all the solution choices we picked. Furthermore, we start discussing our model and simulations, followed by the testing phase of the code. Finally, we finish with a conclusion that summarizes our work and provides reader with all the necessary information about the project. We then cite all the resources that we have gotten our information from and used in this dissertation about the software design if the smart garage door project.

3. Overview of Existing Solutions

As mentioned before, almost everybody is working on smart solutions for the different mechanical machines that we have, and the garage door is not different. Many different smart garage door systems are present out there. Firstly, there is the Tailwind iQ3 Smart Automatic Garage Controller, [2] it is considered one of the best technologies out there for garage control and it can provide great hardware components with great integration to the homes of people. Shown in Figure 1.

Figure 1 shows the TailWind smart garage controller and mobile app.

Another solution is the Chamberlain MyQ Smart Garage Hub and Controller. [3] This device is considered to be also one of the most advanced garage door control system in the US and it allows the user to also control the garage door through a mobile application that is directly connected to the garage door through the cloud. It can also be synced to smart home systems like Amazon's Alexa or Apples's Home Pod. Shown in Figure 2.

Figure 2 shows Chamberlain smart system.

4. Morphological Chart

Shown in the following table the morphological table for the software solutions of the Smart Garage Door project.

	Morphological Chart				
	Components	Solutions			
		1	2	3	4
	Software				
1	Operating System	Windows	Ubuntu	Mac OS	
	Criterium (Ease of use)	Easy	Hard	Medium	
	Criterium (Compatibility)	All	All	All	
2	Programming Software	Microsoft Visual Studio	Arduino IDE	Netbeans	
3	Programming Language	Python	C++	C#	Java

5. Model and Simulations

The code written in order to control this structure is generally common, shown in Figure 4Figure 4. It includes if statements and conditions that allows the ultrasonic sensor to check if there is any thing in the way of the garage door, if the way clear, the door opens and closes normally, however; if something is standing in the 20cm range specified, the garage door can open but not close. The buttons were defined as analog pins and they were defined using the Arduino analog pin standard code. [4] The ultrasonic sensor is defined by digital pins. The also send digital signals to the motor driver.

The algorithms are all written with consideration to the flow of the code and for the parts to all work without interfering with each other. The "if" statements were followed by each other and if the condition does not apply to the condition, it directly goes to the next statement until it checks all the statements and if nothing applies; it signals the motor to stay off. And then enters the "while" loop again.

A mobile application was developed using MIT App Inventor platform [5]. Two buttons were added to the application, an Up button that is touch-down and a Down button that is also touch-down and a Bluetooth button to establish the connection, design is shown in Figure 3. If the up button is clicked, it sends 1 to the Arduino, if the down button is clicked, it sends 2 to the microcontroller. Code shown in Figure 5.

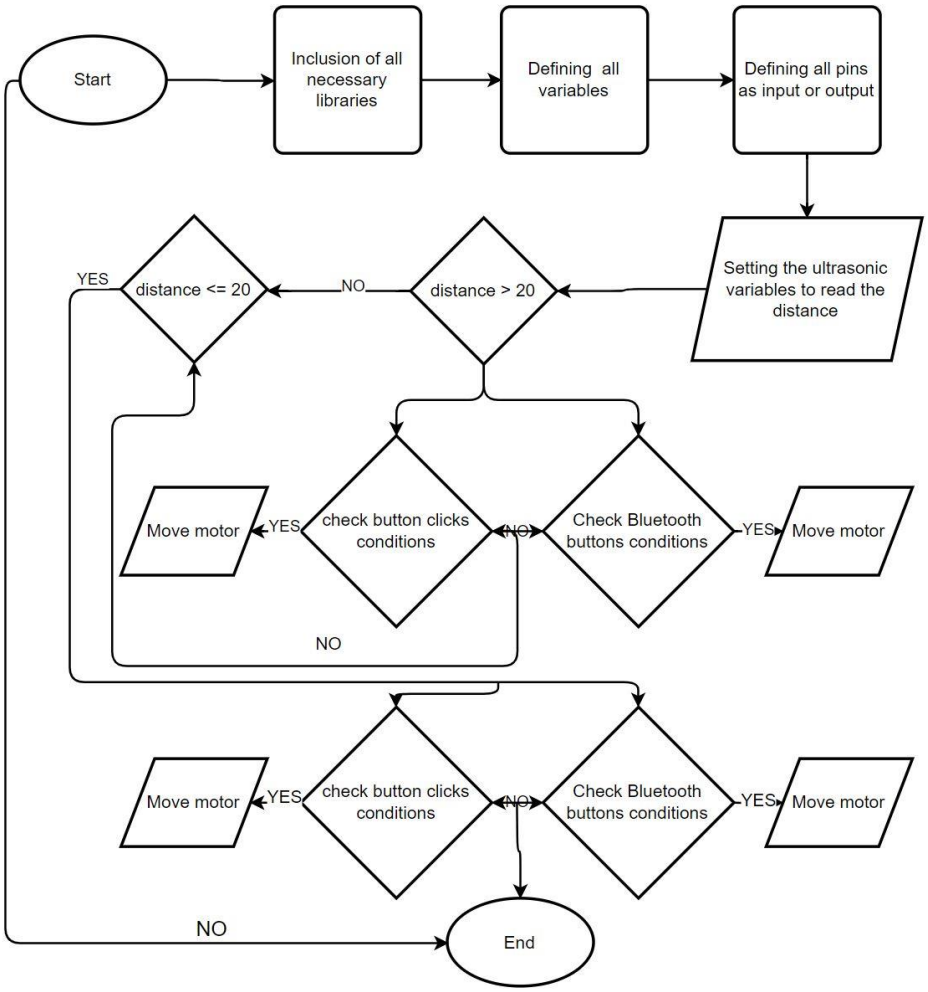

Figure 3 shows the flowchart of the code

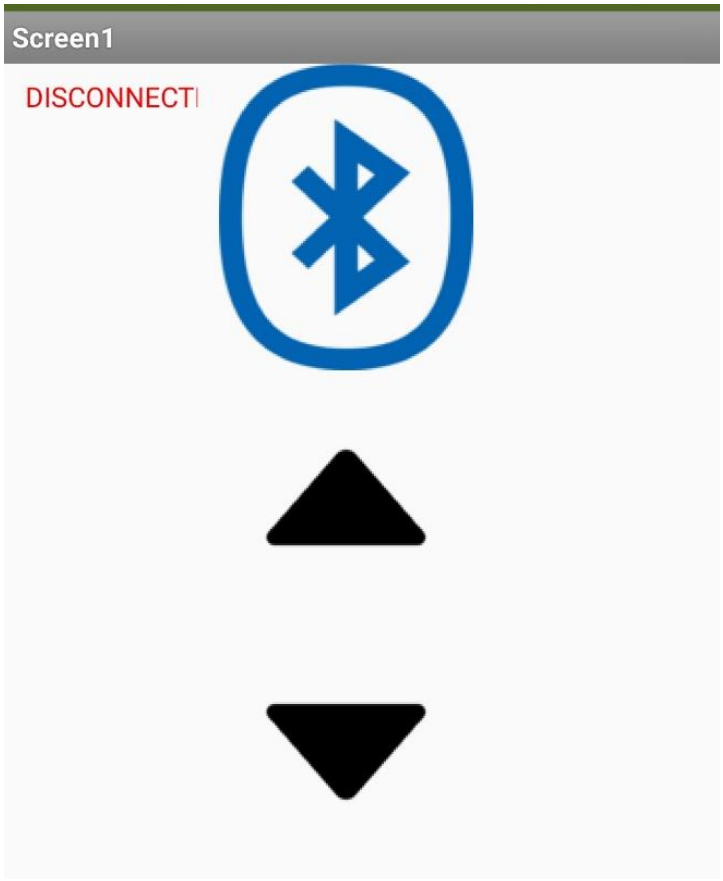

Figure 4 shows the App design

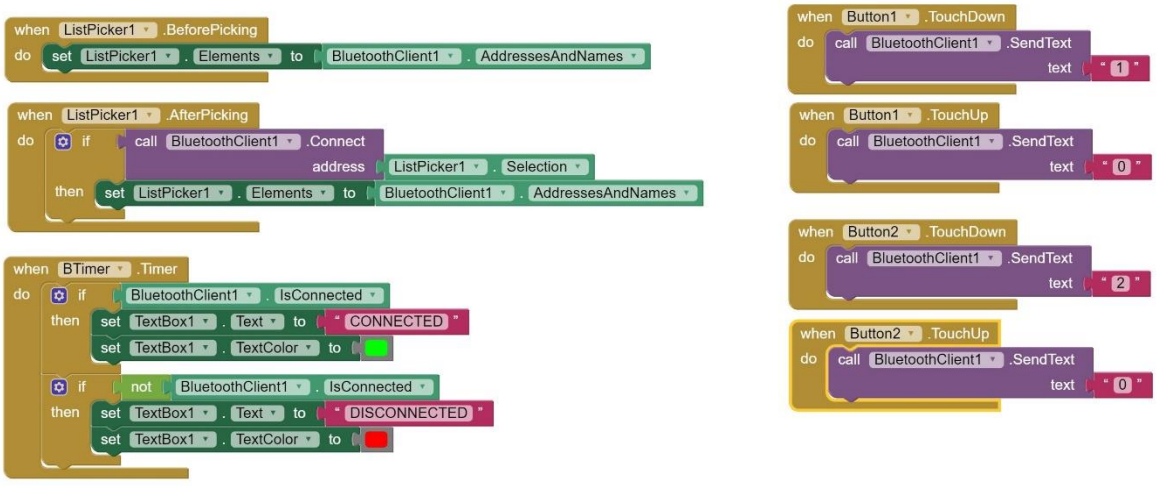

Figure 5 shows the app code.

6. Prototype and Testing

A real prototype has been built for the project, shown in Figure 6. It includes one NXT DC motor, and ultrasonic sensor HC-SR04, Bluetooth module HC-05, and two NXT touch buttons. We tested the Bluetooth connection; link is provided in the appendix. We were able to control all the motor movement through it. We also tested the ultrasonic sensor and it was functioning according to the specified code, when it detects a certain distance, it opens the garage door.

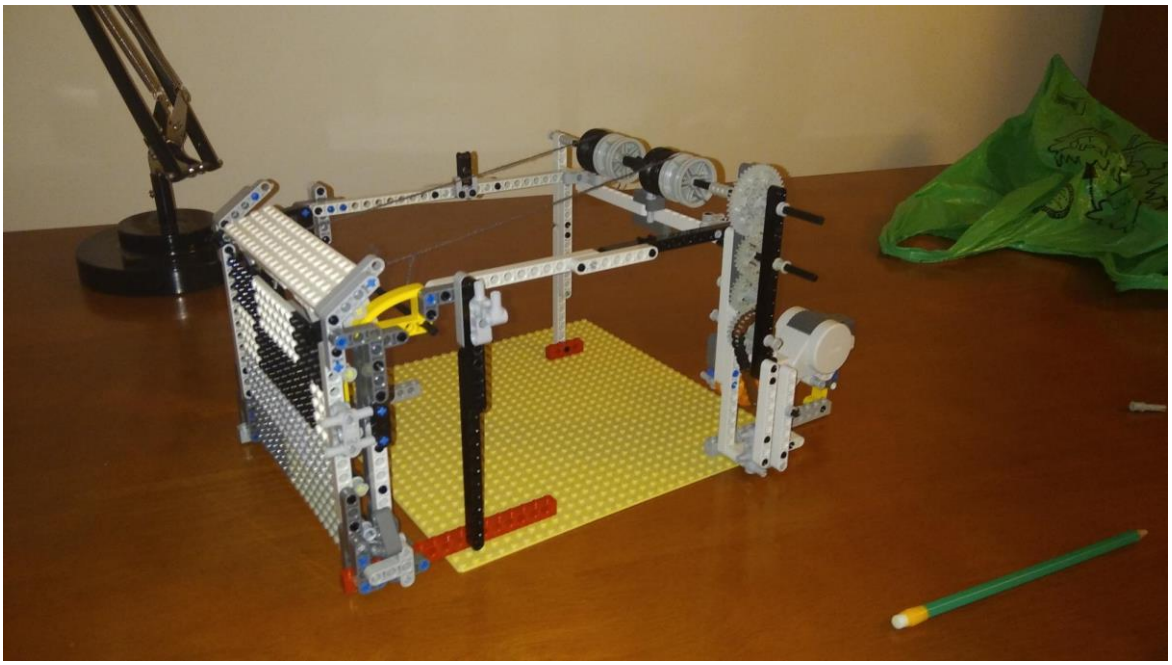

Figure 6 The prototype without the electronic components.

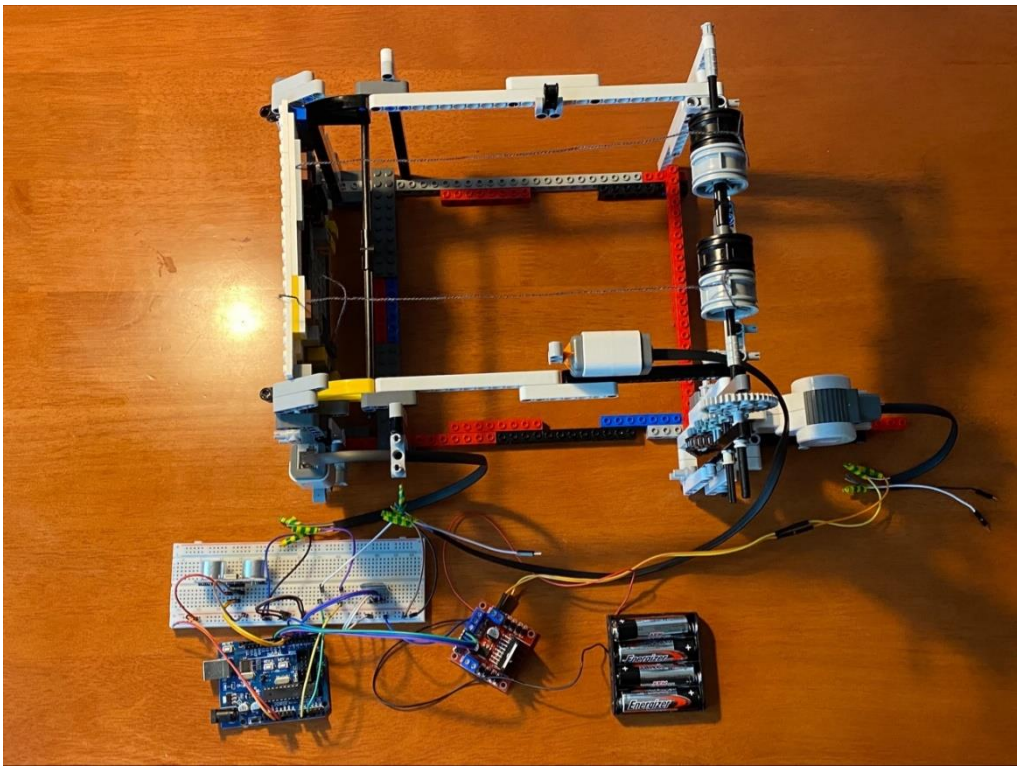

Figure 7 shows the prototype with electronic components

7. Summary and Conclusion

In conclusion, we have created a fully functioning smart garage door. This project was based on the idea of improving on the mechanical function of the garage door and it is a smart way of controlling the garage door by providing control through Bluetooth connection and through touch buttons that allow the person operating it to have full control over the garage door and open as much as he/she wants. A fully functioning prototype was built as well as all the electronic components being implemented in the design to fully test the code and provide us with the information needed on how to apply such a project in real life with all the necessary equipment. As for the code, we have started with small algorithms to test each component. After we have tested all the components and made sure that all the codes are functioning individually; we then moved to combining the code altogether and started testing how the algorithms of each component will function as one unit.

Finally, we managed to create a fully integrated unit of code and components that controls the garage door and manages the specific conditions of when it should open and close to ensure that it provides safety and security to the people operating it. It is the ultimate goal of this project and it was somewhat achieved in the small scope it was worked in under the limitations of size and components used to assemble, connect, and program this mechanical object.

The most interesting part of our project is that we managed to create a functioning prototype with time that is very limited. We managed to work as one unit to finish all the different parts of the project. However; in the technological side, the most interesting part was the Bluetooth implementation to the project and the fact that a dedicated mobile application was created in order to control the garage door in the most suitable way to the user. This project gave us insight on how we need to find ways to make a system work together, mechanically, electronically, and artificially. We managed to observe our progress and try to always tweak the project to fit the recommendations of the supervising professors to achieve a high academical outcome from it.

For our work; we plan on keep developing this garage door and allow more control over by including components like that NodeMCU [6] which allows us to control the robot through the cloud. We also plan on adding more sensor to create better security and safety to the project like the Radio Frequency Identification (RFID) reader, model number RC522, [7] which can implement as a lock to the garage door that only open on a specific ID tag. These implementations will also have an effect on the mobile application, because as we add new components to the project; we can find ways allow the mobile application to control them and provide the user with the most efficient use of the project.

8. Bibliography

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[9] Ultrasonic sensor test link: https://www.youtube.com/watch?v=JZH10RQqQGc

[10] Bluetooth and Ultrasonic test: https://youtu.be/YOh6elzM6mw

[11] Buttons and Ultrasonic test: https://youtu.be/jubtG0mif0c

[12] Full project code on GitHub: https://github.com/khaldounfayad/Garage-Door-BoM