Smart Garage Goor - Electronics

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0. Abstract

This project is designed in order to create a better garage door that is able to function autonomously by including several different components including sensors, actuators and microcontrollers. We have created a fully function garage door that is able to be controlled through analog touch sensors and a mobile application. This provides more control of such a mechanical machine, and with the addition of a proximity sensors, we managed to make even more secure and able to execute commands that will stop it from closing when someone is in the way.

1. Introduction

Today's technologies are advancing day by day with the need for which electronic devices can make our life easier and the information can be obtainable and available from everywhere all the time. Every moment of our life is under control and supervision with these intelligent devices that emerge with this advancing technology. The fact that these intelligent devices with which we encounter every day from our mobile phone, our car, our fridge in our home, television, washing machine to microwave have affected our life by operating has existed with the development of technology continuously up to now together with curiosity and need.

The heart of these smart devices is microcontrollers. In other words, the microcontrollers are heavily used in embedded applications. As well as mobile phone, tablet and laptop, everybody has almost an intelligent device such under their hands, and they are basically created from hardware components like processor, ram/rom/flash memory/display/input-output ports. In this system, an operating system that controls the hardware is needed in order that the electronic card can work. The microcontrollers have the necessary structure so that we can simply prepare and control this operating system [13].

Arduino is an electronic card that has already one microcontroller and is ready to work with pins and communication ports, the control elements of which can be connected.

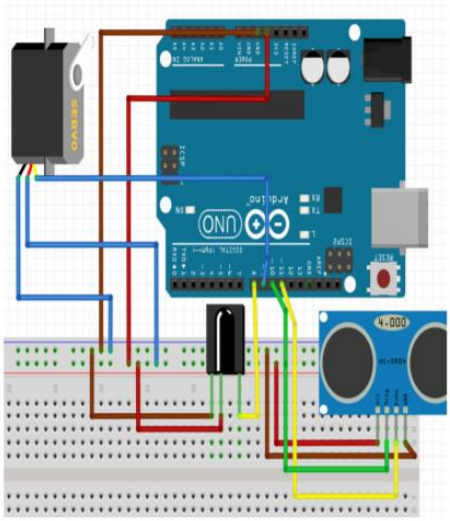
In this project, a garage door system which enables the car garage door to be opened and closed automatically according to the click of a single button from the mobile application via the Arduino platform with a microcontroller, has been developed

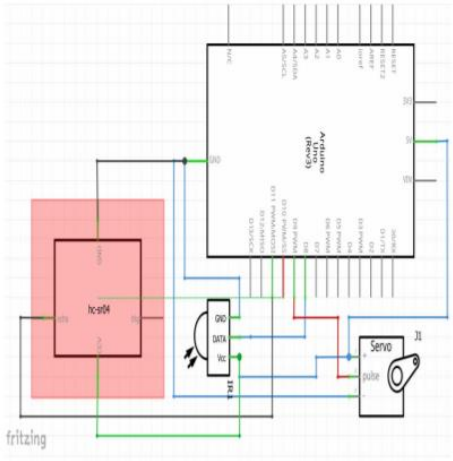
2. Purpose and Scope of Work

The purpose of the electronics system comprising of various components (ultra-sonic sensors, circuit board: Arduino etc) is to give the user complete control of the garage door autonomously. Reducing the amount of physical work required to open and close the garage door manually, as well as the risk of injury. The control system was designed taking different scenarios and factors into consideration, targeting the planned market group(consumer), so that its specifications would match the consumer's needs and wants to satisfy the user.

3. Overview of Existing Solutions

1) Automatic Garage Door System with Arduino for defined licence plates of cars

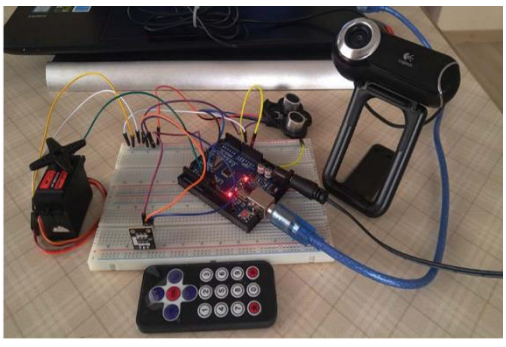




The breadboard scheme that enables the motor to move according to parking sensor and IR remote controller kit.

Existing solution 1 : A circuit created from an IR remote controller kit receiver, a parking sensor and a motor that has been connected to the Arduino Uno. Thus, this enables the vehicle to control the motor that provides the motion of the garage door both for the distance to the sensor and by pressing the reverse and forward buttons of the IR remote controller kit.

Uses: motor drivers, camera, parking sensor, Arduino board, servo motor, Keyes IR receiver module .



The integrated view of motor, parking sensor, IR remote controller kit and camera.

Personal Remarks: the idea behind this solution is marvellous, it uses a camera to read off the numbers on the number plate of the car and if the number plate is enlisted in the program the garage door opens with use of the parking sensor and the motor. Not only that but, there is the option of using the remote to open and close the garage door. As a team we loved the idea of using a camera to read off the numbers on the number plate of the car and only if the number sequence is enlisted in the program the garage door would open, this feature strengths the security of the garage door. As much as we loved this

solution, it also has its disadvantages such as, use of a remote to open the garage might cause problems in the sense that the remote is easily damageable and easy to lose. Also, the control system can be affected when its now dark outside making it hard to read the number plate or the number plate itself could be covered in dirt such as mud.

4. Morphological Chart

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

	Morphological Chart				
	Components	Solutions			
		1	2	3	4
	Electronic				
1	Central Processing Unit	Arduino Uno	Arduino Mega	LEGO NXT Brick	Rasberry Pi
	Criterium (Price)	$	$$	$	$$$
	Criterium (Code Complexity)	Medium	Medium	Easy	Hard
	Criterium (Ease of Controll)	Easy	Easy	Easy	Medium
	Criterium (Component Compatibilty)	All	All	Some	Most
2	Garage Door Motor	LEGO NXT DC Motor	DC Motor	Stepper Motor	Servo Motor
	Criterium (Price)	$$$	$	$	$
	Criterium (Ease of Control)	Easy	Easy	Medium	Medium
	Criterium (Ease of Implementation)	Easy	Hard	Medium	Medium
3	Proximity Sensor	Infrared Sensor	Ultrasonic Sensor	LEGO NXT Ultrasonic Sesnor	Optical Sensor
	Criterium (Price)	$	$$	$$$	$$
	Criterium (Ease of Implementation)	Hard	Easy	Easy	Hard
	Criterium (Size)	Small	Medium	Large	Small
4	Bluetooth Module	HC-06 Module	BLE Module	HC-05 Module	
	Criterium (Price)	$	$$	$	
	Criterium (Ease of Implementation)	Easy	Easy	Easy	
	Criterium (Size)	Small	Small	Small	
5	Motor Driver	L298n Motor Driver	SprakFun Motor Driver		

	Criterium (Price)	$	$		
	Criterium (Ease of Implementation)	Easy	Medium		
	Criterium (Size)	Medium	Medium		
6	Touch Sensor	NXT Touch Sensor	Switch with lever	Button	
	Criterium (Ease of Implementation)	Easy	Medium	Medium	
	Criterium (Size)	Large	Small	Small	
	Criterium (Code Complexity)	Easy	Easy	Easy	

5. Model and Simulations

Many components were used in order to assemble this project with careful consideration for how it will be functioning. We noticed that the components needed to control are a microcontroller, a DC motor, a motor driver, a proximity sensor, a Bluetooth module, and two buttons. Therefore, we picked these sensors and actuators bases on what's most compatible with our project and our main microcontroller.

a. Arduino Uno Microcontroller

First, we start with the mind of the robot, the Arduino UNO shown in Figure 1. This is a microcontroller that was developed by Arduino.cc. This board is equipped with sets of digital and analog input/output pins that can be connected to various expansion boards and circuits. It has 14 digital I/O pins and can be programmed using the Arduino IDE program; but it has to be connected to the PC via a USB cable. This connection can be its source of energy or a 9V battery can be used to power this device. The word "Uno" in "One" in Italian and it was named after the first release of a USB-Based Arduino board. [1]

Figure 1 shows the Arduino UNO microcontroller

b. The L298n Motor Driver

The L298 is a motor drive, shown in Figure 2, is a chip that is used to give commands to motors to work. It receives logic signals and is needed to operate motors, solenoids. It has two inputs to enable and disable the particular device attached to its output. It can take up to 46V but we are giving it 9V only in the project. [2]

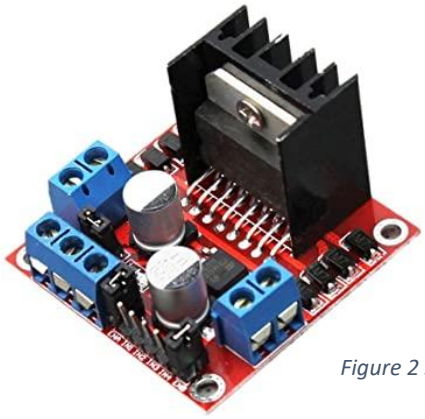


Figure 2 shows the L298n motor driver.

c. The Ultrasonic Sensor HC-SR04

This proximity sensor, shown in Figure 3, can detect the distance of objects from its sensors and can feed this information to the microcontroller in order for the IC to check it and act based on its programming for certain distances. It has 4 pins, an echo and trigger pin that are connecting to digital INPUT pins and a ground and VCC pin. [3]

Figure 3 shows the HC-SR04 ultrasonic sensor.

d. The LEGO NXT motor

It is a typical DC motor that can rotate in both directions by converting direct current into mechanical energy. It can do 160 to 170 rounds per minute. [4] Shown in Figure 4.

Figure 4 show the LEGO NXT motor

e. The LEGO NXT Touch Sensor

The analog EV3 Touch Sensor, shown in Figure 5, is a simple but exceptionally precise tool that detects when its front button is pressed or released and is able to count single and multiple presses. Students can build start/stop control systems, create maze-solving robots and uncover the technology's use in devices such as digital musical instruments, computer keyboards and kitchen appliances. [5] Two touch sensors were used in this project.

Figure 5 shows the LEGO Mindstorms touch sensor

f. The Bluetooth Module HC-05

The HC-05, shown in Figure 6, is an easy to use, fully qualified Bluetooth modulation designed for transparent wireless serial connection setup. It uses a 2.4GHz radio transceiver and baseband. We use the module in order to connect the application that we create to control the garage door into the Bluetooth module [6].

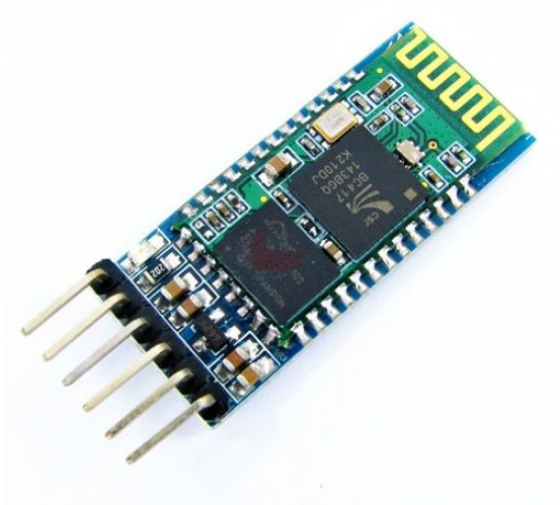
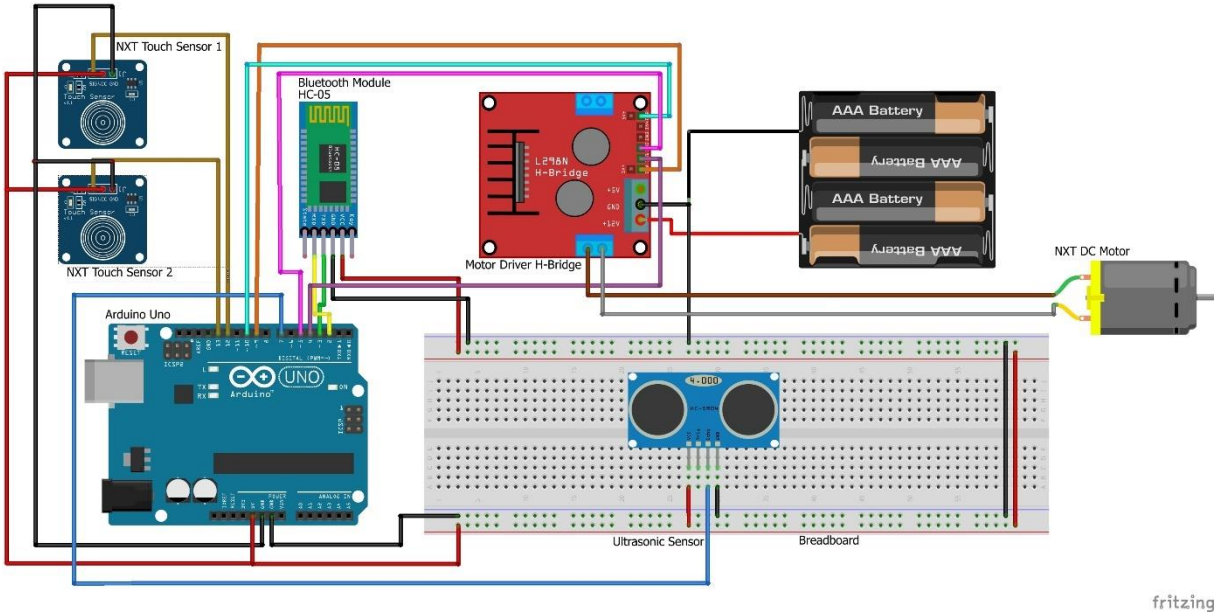


Figure 6 show the HC-05 Bluetooth module

Each of these components were connected to the Arduino using specific pins shown in Figure 7. We gave this circuit a power of 9V to the motor driver and motor and a 9V power to the Arduino. The touch sensors' wires were stripped and connected using some guides online, they were connected to jumper wires, connected to the Arduino and made compatible. The connection of NXT touch sensor is shown in Figure 8.



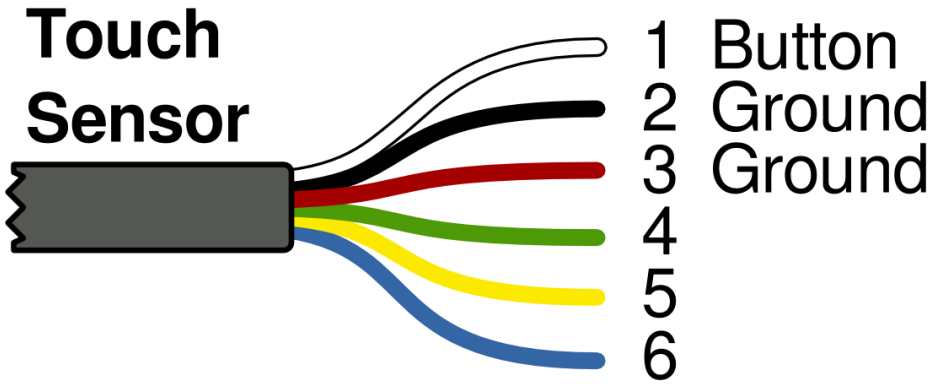


Figure 8 shows the connection schematic for the touch sensor

6. Prototype and Testing

A real prototype has been built for the project, shown in Figure 9. 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.

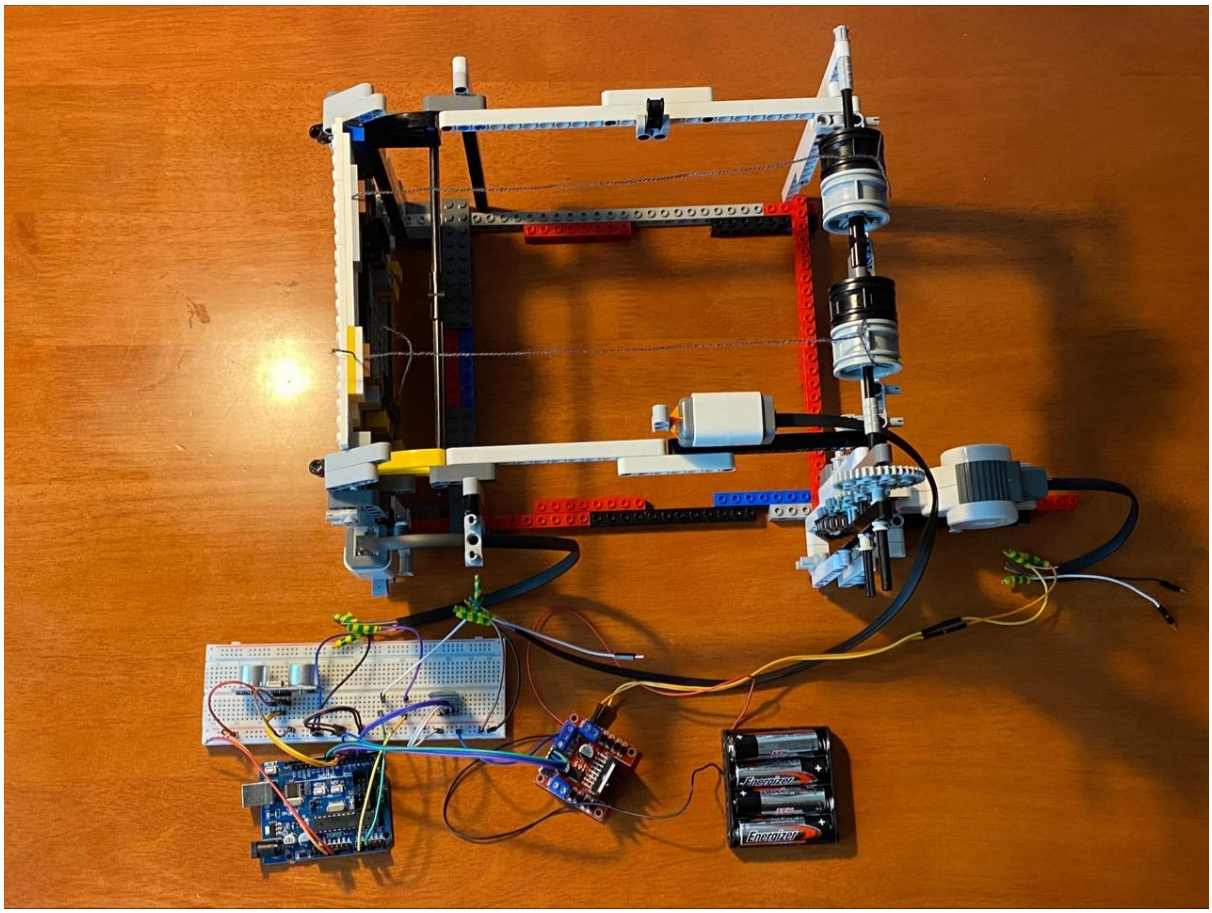
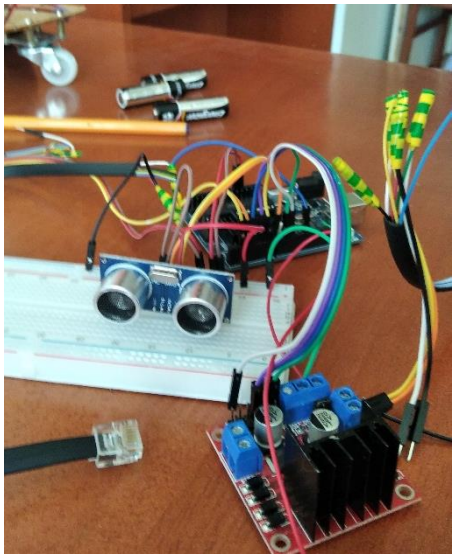


Figure 9 shows the first connection of the real prototype



7. Summary and Conclusion

To sum up, we assembled all the right parts and managed to find ways to make them all compatible with each other. We connected them and conducted tests that showed us were to change the connections. All the parts were carefully picked and rightfully placed.

We have created and developed 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 user operating it to have full control over the garage door. A fully functioning prototype was built and all the electronic components were implemented into the design (mechanical chassis) to fully test the code and provide us with the necessary feedback needed on how to apply such a project in real life with all the required equipment. As for the code, we started with small algorithms to test each component. After we tested all the components and made sure that all the codes are functioning individually; we then moved on to combining the code altogether and started testing how the algorithms of each component will function as one unit.

The most interesting part of our project was how we managed to create a functioning prototype within the limited time frame we had. We managed to work as one unit to finish all the different parts of the project. However; on the technological side, the most interesting part was the Bluetooth implementation into the project and the fact that a dedicated mobile application was generated in order to control the garage door in the most suitable way to the user. This project gave us insight on how we can to find ways to make a system work together, mechanically, electronically, and artificially.

In conclusion, using Arduino's work platform, a garage door system was developed, that opens and closes automatically according to the click of a single button on the mobile application or the push sensors to close only for security reasons. In addition, while the garage door is moving down in case any entity approaches the door too close, the control of the door motor has been also considered as to provide the security through the ultra-sonic sensor, the sensor will read the entity that is within proximity and thus stops the motor for rotating.

Furthermore, we plan on keep developing this garage door and allow more control by including components like that NodeMCU [7] 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, [8] which can be implement as a lock to the garage door that only opens to specific ID tags. These implementations will also have an effect on the mobile application, because as we add new components to the project; we can find ways that allow the mobile application to control them and provide the user with the at most efficient use of the project.

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