

Nerf Turret

Ben Andrews

Dept. of Electrical and Computer Engineering
u0756709@utah.edu

Abstract—The Nerf turret is being done for an embedded systems course. The turret uses stepper motors to rotate the Nerf gun. The gun's rotation and firing will be controlled through two Arduinos connected wirelessly.

I. INTRODUCTION

This project is being done through an embedded systems course. The Nerf gun turret will consist of two stepper motors and two DC motors. The stepper motors are used to rotate the gun in either the X or Y direction. The DC motors are used to fire the gun. While one motor spins inside the barrel of the gun the other will push the bullet through the barrel. These motors will be driven through an Arduino. The Arduino will receive commands from another Arduino wirelessly telling the direction to rotate or to fire the gun. The Arduino used as the controller is connected to a joystick and two buttons. These are used to control the rotation of the turret and to fire the gun.

II. BACKGROUND

The purpose of this project as mentioned above is for an embedded systems course. The requirements for the project are to do a project that consists of: some type of motor, some communication protocol, and some microcontroller. Just over a month was given to work on this project, and the project can be worked on with a group of two to four people. Ben Andrews, Terry Kingston, and Nick Martin are the ones working on this project. The project goal is to have a motorized Nerf gun on top of a mount that can rotate the gun in the X and Y direction. Stepper motors will be used for the rotation of the mount. An Arduino will be used to drive each motor and to fire the gun. The Arduino will be controlled wirelessly through another controller that the user will have. Inside the controller is another Arduino. This project was chosen because it met the project requirements and one of the group members already had material to build the Nerf gun mount.

III. HARDWARE COMPONENTS AND IMPLEMENTATION

A. Arduino Uno Nano

The micro-controller used to rotate and fire is the Arduino Uno, which was already owned by a member of the group. The Arduino Uno was chosen because it has pulse width modulation (PWM) capability and is very simple to program. It is powered through a 9V power supply, and outputs 6 pins for driving two stepper motors. Four pins are

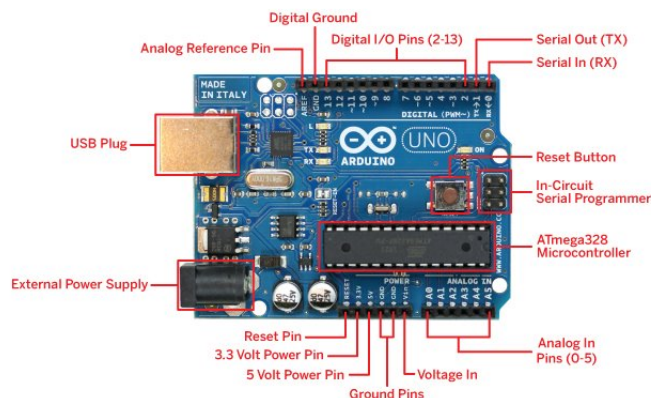


Fig. 1: Arduino Uno label schematic. [1]

used for input from the motor, two from each motor. The input pins tell the Arduino Uno how many rotations have occurred. Fig. 1 is a schematic for the Arduino Uno with labels on each pin. The Arduino Nano is very similar, but is much smaller.

PWM output pins are used for driving the two stepper motors. The pins are used to control the direction and speed of rotation. Two digital signal outputs are used as an enabler for each motor. This will tell the motor controller circuit which motor needs to be driven. Seven pins are connected to the wireless transceiver. Two of which are used for power and ground, and the others used for transmitting/receiving.

B. Wireless Transceiver nRF24L01+ 2.4GHz

This wireless transceiver was chosen because it is compatible with Arduino. As mentioned above the transceiver has seven pins that connect to the Arduino. Fig. 2 shows eight pins, but one of them is not used. It is powered with 3.3V that come from the Arduino. Data is transferred as a string between two transceivers both connected to their own Arduino. The Arduino controlling the motors will wait to receive data from the transceiver connected to the controller. Once valid data is received the Arduino will start the turret in motion to rotate or fire.

C. Motor Controller and Power Supply

The motor controller is made up two main parts. The H-Bridge L293D motor driver and the Arduino that takes the inputs from the controller. Two H-Bridges similar to the one in Fig. 3 are used to drive two stepper motors. Each

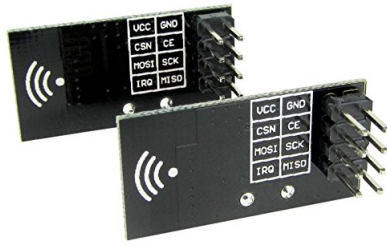


Fig. 2: Wireless transceiver with 8 pins. Only 7 pins are connected to Arduino. For communication to occur an Arduino must be connected to each wireless transceiver.[2]

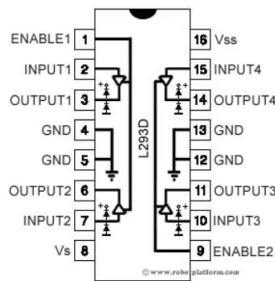


Fig. 3: Pinout for H-Bridge chip that is used to drive the stepper motor. The pinout says it can drive two motors, but as the circuit was tested it was found the H-bridge could only drive one stepper motor. [3]

H-Bridge takes three inputs: an enabler, and two drivers. The drivers are used to determine what direction the motor rotates. For example, if one driver input is grounded and the other is driven the motor will rotate one way. If the grounded and driven inputs are swapped the motor will rotate in the opposite direction. Once the motor receives input it will send out two outputs telling the Arduino how many rotations have occurred. Two motor output wires are needed to determine the number of rotations for each direction. Once the Arduino has received input from the motor it will be used to limit the rotation in the Y direction because the turret is limited by how much it can rotate. Fig. 4 is an image of the circuit that is used to drive the two stepper motors.

To power the Arduino and the motors voltages of four and nine are needed. Using a 9V power supply the voltage is split to output two different voltages. The two voltages that are used to power and drive the circuit are 4V and 9V. The 9V is also used to power the motors inside the nerf gun, the Arduino, and drive the stepper motors. Fig 4 is an image with the power supply circuit that outputs both voltages 4V and 9V to power and drives each of the motors.

D. Nerf Gun

Fig 5 shows the Nerf gun that is being used, and shows where each of the motors are located in the gun. This Nerf gun was chosen because it can be fired by driving the motors inside the gun. The Nerf gun has two motors. One inside the

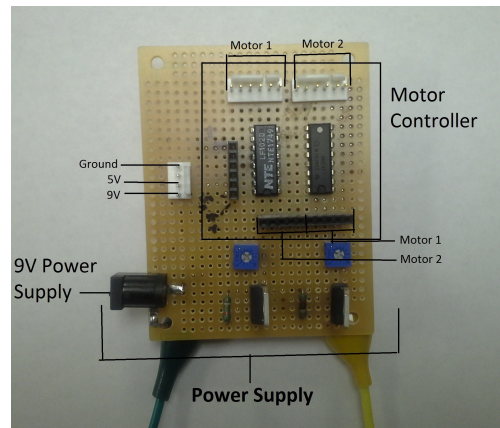


Fig. 4: Power supply circuit has two output voltages that can be adjusted by changing the potentiometer. Next to the power supply is the stepper motor driver circuit. It can drive two motors at once and is controlled through an Arduino.



Fig. 5: Nerf Gun chosen to be used in this project. Contains two motors: one for pushing the bullet into the barrel and the other to launch it. [4]

barrel that spins, and another that pushes the bullet through the spinner to launch it. Both motors need to be running to fire. The motors are powered from the power supply circuit, and will be driven by the Arduino. Switches were put into the Nerf gun to control when the motors are running.

E. Software

The only software used for this project is Arduino's built-in programmable language. Its very similar to C, but has custom function calls designed for Arduino. There are two major programs. Both Arduino will have a transmitter/receiver program to send and receive data. One Arduino will take input from a joystick and two triggers. It will send the data it gets to the other Arduino through wireless. Once the data is received the second Arduino will manipulate the motors the way the controller specified.

IV. TASKS SCHEDULE

Just under a month was given to work on this project, and the time-line in Fig. 6 shows what was worked on, who worked on it, and when it was finished. Also, Fig. 6 shows the milestones for when all the parts needed to be assembled and when the project is due. Terry and Nick were in charge of getting the transceiver between the two Arduinos working. Ben was over researching and building the motor controller and power supply circuit. Terry built and mounted the gun, and also assembled the controller with the Arduino Nano inside.

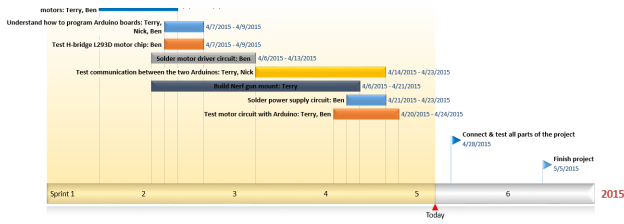


Fig. 6: Project time-line with two major milestones. First when all the parts need to be assembled and when the project is due.

Parts	Cost
Two Stepper Motors	\$...
Motorized Nerf Gun	\$39.00
Motor Controller	\$15.00
Two Arduinos	\$...
Transceiver	\$7.00
Nerf Gun Mount	\$...
Total	Roughly \$80.00

TABLE I: Bill of Materials

V. BILL OF MATERIALS

Most of the parts used in this project were already owned by one of the group members, so the overall cost for this project wasn't too high. The most expensive part was buying the Nerf gun. Each member of the group pitched in to cover the expenses.

VI. CONCLUSION

This project was done for an Embedded Systems course's final project. Just under a month was given to work on this project, and the due date is May 5, 2015. This project had a mix between programming microcontrollers, and driving motors. The bulk for this project was understanding how to drive the stepper motors using the Arduino. The stepper motors rotate the Nerf gun in the X or Y direction depending on the input that is received from the controller. The controller is an Arduino Nano connected to a joystick for rotating the Nerf gun. Also, the controller has two triggers: one for starting up the motor in the barrel and the other for pushing the bullet into the barrel. The communication between the Arduino Nano in the controller and the Arduino directly connected to the motors is done wirelessly.

REFERENCES

- [1] Element14, "Arduino uno." [Online]. Available: <http://www.element14.com/community/groups/arduino/blog/2014/03/28/getting-to-know-arduino-part-1-hello-world>
- [2] Newegg, "Wireless transceiver." [Online]. Available: http://images10.newegg.com/NeweggImage/ProductImageCompressAll300/A2C5_130270738612265625tpJugAnvhR.jpg
- [3] R. Platform, "L293d pinout." [Online]. Available: http://www.robotplatform.com/howto/L293/img_1/L293D_Skeleton.jpg
- [4] T. R. Us, "Motorized nerf gun." [Online]. Available: <http://www.toysrus.com/buy/toy-blasters-foam-play/nerf-n-strike-elite-rapidstrike-cs-18-a3901-20631436>