Here are the Procedure and Materials for my demonstration:

Materials:

-A 22 AWG Hookup wires

-10 k resistors (3)

-A3144 digital hall effect sensors(3)

-Alligator Clip Leads

-6V lantern batteries(3)

-4 channel MOSFET driver module

-22 AWG enameled magnet wire

-A clear acrylic tube

-A 1/4" diameter steel rod\(please do not buy stainless steel, as it may not be magnetic)

-A Wire strippers

-A Soldering iron or soldering supplies

-A Fine or medium grit sandpaper Electrical tape

-A Optional: heat shrink tubing

-A Hacksaw

-A Ruler

-A Small Phillips head screwdriver

-A Pencil

-A Thin permanent marker

-A Tape measure

-A Lab notebook

You will also need the

ELEGOO UNO Project Super Starter Kit with Tutorial and UNO R3 Compatible with Arduino IDE

Here is the Procedure for my demonstration.

1. Use a hacksaw to cut a steel rod into a couple centimeters long to create your projectile.
2. Wrap the magnetic wire around your acrylic tube to create your coils.

The coils should not be longer than your projectile-that way you may easily tell when your steel rod has passed the center of your coils.
Make sure you wrap each coil in the same direction.
Leave at least 30 cm of wire at each end of your coils so you can connect them to your drive board.
Use sandpaper to strip insulation about 1cm of each wire.
Hold your coils in place by using electric tape so they will not unravel.

If you want to make winding the coils easier, you can make a simple wire holder with a cardboard box and a pencil. You can also use a power drill to help wind the coils.
3. Solder extension wires to 3 of your hall effect sensors.Make the wires at least 30 cm long so you can add your sensors on the tube and connect the wires to your Arduino.

 a.With the writing on the sensor facing you, from left to right the pins are power, ground, and output. It helps to color-code your wires. For example, I used red for power, black for ground, and blue for output.
(For the sensor, make sure the bottom is stretched a little bit so you can fit everything.)

b.Wrap the connections to the pins in electrical tape or heat shrink tubing to prevent short circuits.(I used heat shrink tubing.)
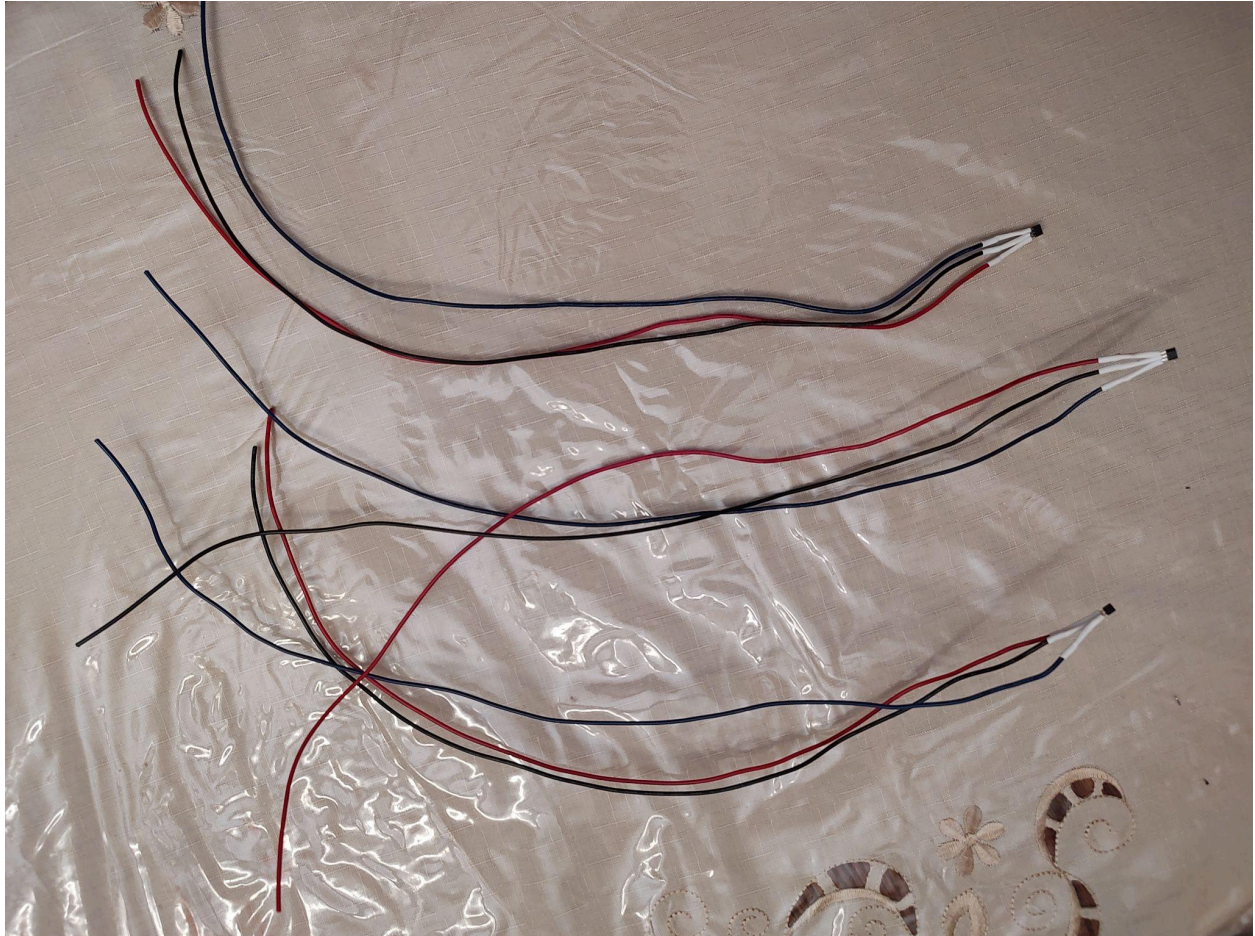
4.Tape a hall effect sensor to the tube, with the flat side (the side without any writing) against the tube,and put it

immediately after each coil.
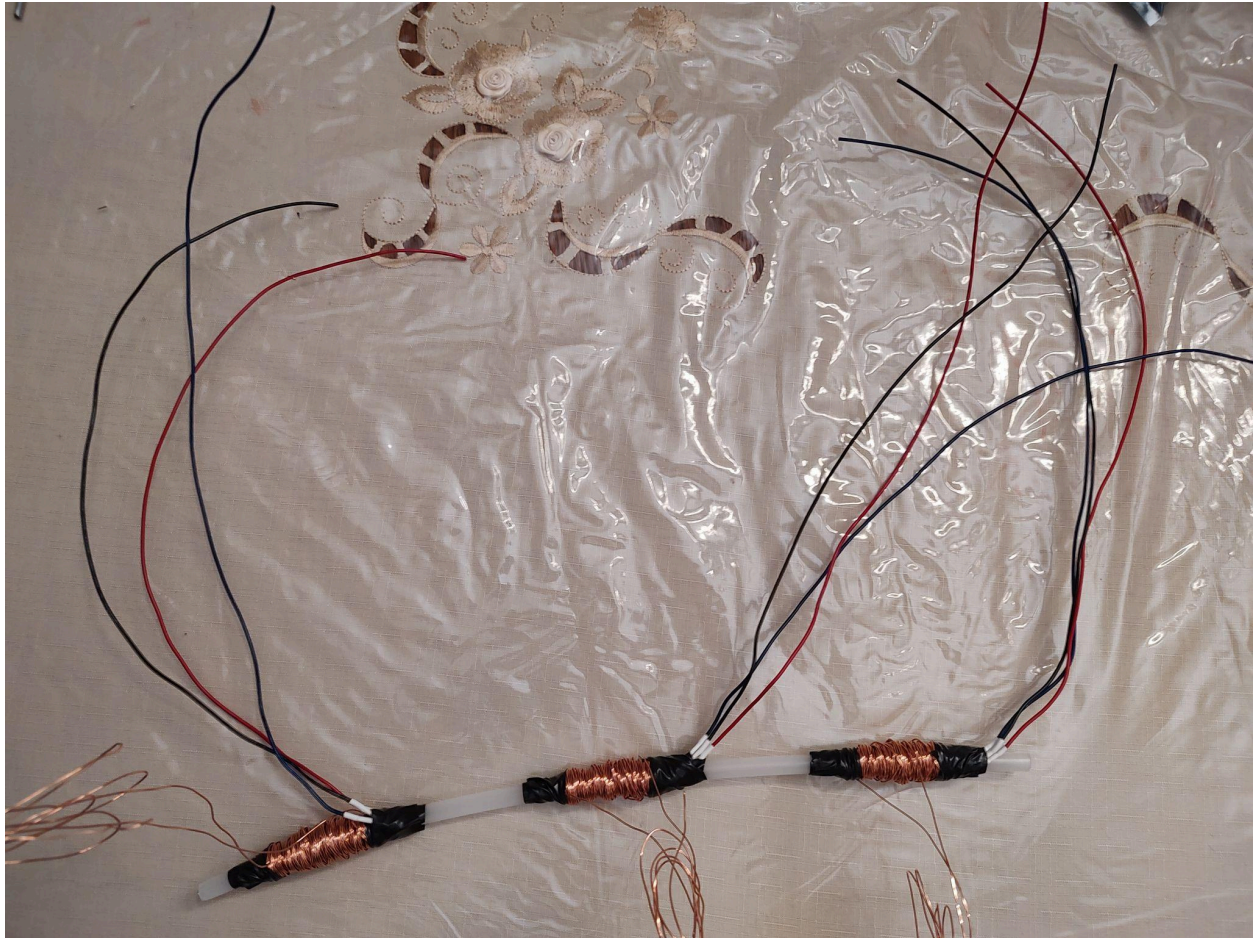
5. In this step we will build the electric part. The steps are:

a.Slightly unscrew the screws on the drive board.

b.Connect the first coil to OUT1+ and OUT1- to your drive board.

c.Connect the second coil to OUT2+ and OUT2- to your drive board.

d.Connect the third coil to OUT3+ and OUT3- to your drive board.

e.Use alligator clips to connect your three batteries in a series (Make sure it goes from positive to negative.)

f.Prepare to connect your battery bank's positive terminal to your DC+ on your drive board, but make sure to leave the alligator clip disconnected for now so the circuit is not powered on.

g.Connect the Arduino's pin 2 to PWM1 on the drive board.

h.Connect the Arduino's pin 3 to PWM2 on the drive board.

i.Connect the Arduino's pin 4 to PWM3 on the drive board.

j.Connect GND1, GND2, and GND3 on the drive board to the breadboard. Then add a male-male jumper wire and connect that to the GND on the Arduino.

k.Connect the first, second and 3rd stage Hall effect sensors:

Add the pin 1's (The 3 red wires) to the breadboard and then connect them with the male-male jumper wires to 5V.
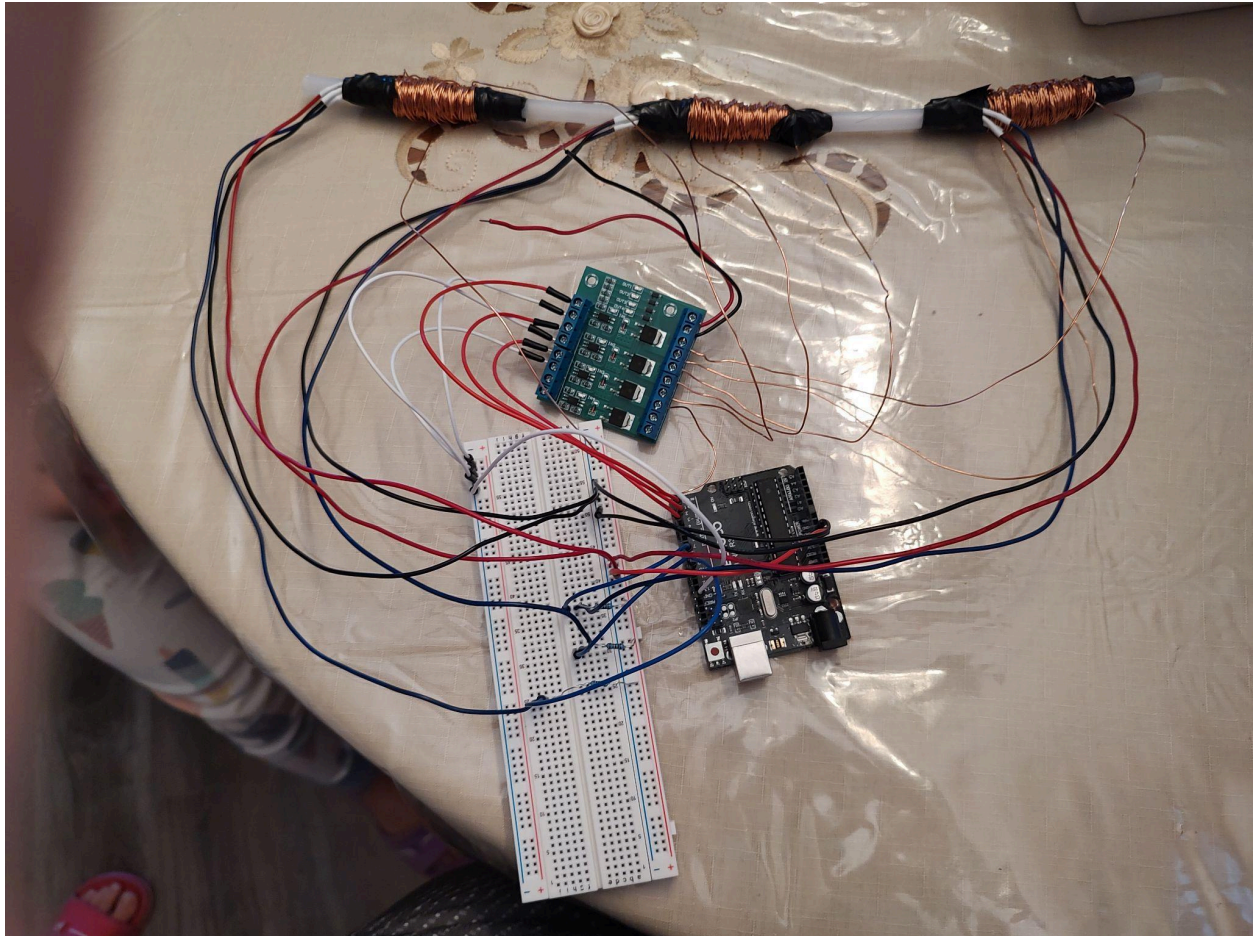
Add the pin 2's (The 3 black wires) to the breadboard and then connect them with the male-male jumper wires to the GND.

Add the pin 3's (The 3 blue wires) to the breadboard and then connect them with the male-male jumpers wires to the Arduino pin 8.

Add the 3 10 kΩ pull-up resistors from the sensors to pin 3

to 5V.

Your project should look like this now:

6. Download the mass_driver_3_stage.ino and read through the commented code. Make sure you understand how it works. The code starts by turning on your first coil, then uses the hall effect sensors to know when to turn each coil on and off so your project can run properly.
7. Upload the code to your Arduino.
8. Make sure your mass driver tube is not pointed at any people, animals, or anything it might damage. A pillow or

cardboard box is a good target.

9.Place your projectile partially into the entrance of the tube (near coil 1), as shown in .

10 .Connect the final alligator clip to your batteries, providing power to your circuit.

11. Press the reset button on your Arduino. Your projectile should be sucked in, then launched through the tube!

12. If your mass driver did not work, you might need to do some troubleshooting. A multimeter can be a very useful tool for debugging circuits, if you have one available. A. This is a complicated circuit. Double-check all of your wiring. Sometimes it can be hard to spot your own mistakes, so it can help to have another person double-check your wiring as well.

B. If your projectile did not get sucked into the tube at all, make sure it is not simply stuck in the entrance. Try placing it slightly farther inside the tube, then press the reset button on your Arduino again.
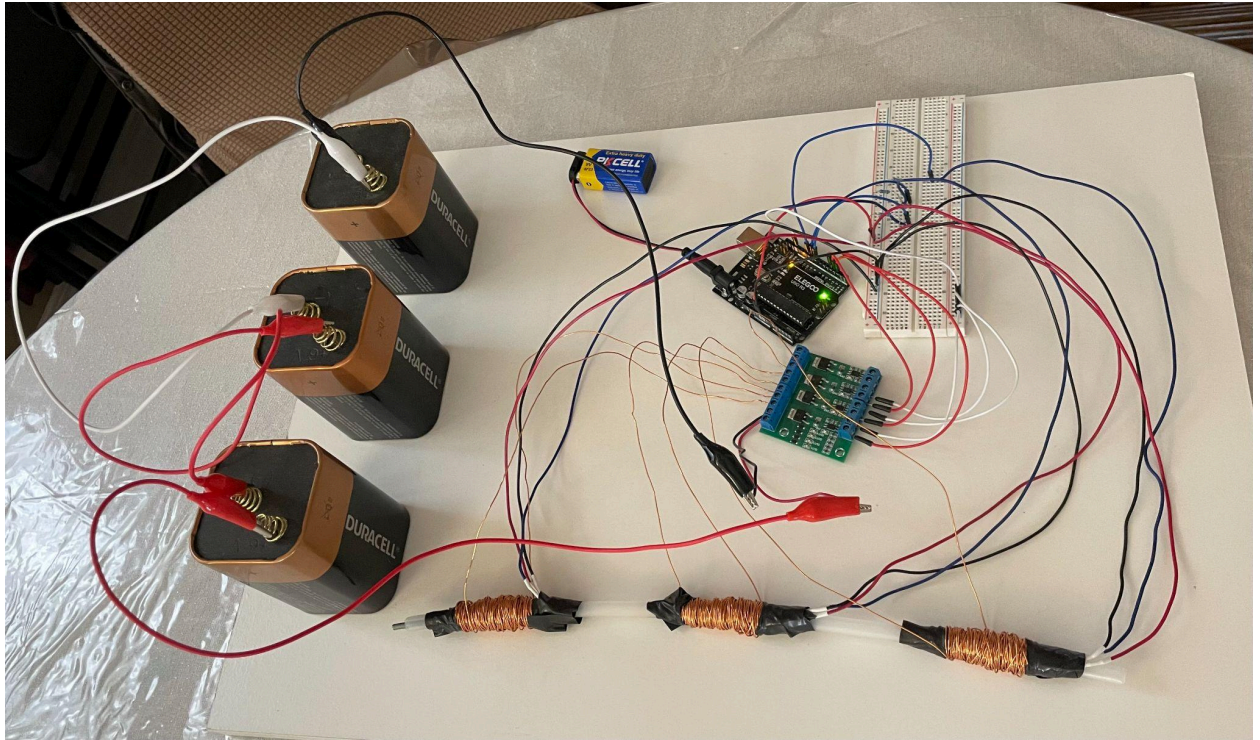
C. You can confirm that your coils are working by disconnecting them from the drive board and connecting them, one at a time, directly to the battery bank. If you place the steel projectile near a coil and then connect the coil to the battery, the projectile should be sucked into the middle of the coil. If you only briefly touch the battery contact with an alligator clip then remove it, the coil will un-energize and the projectile should continue to travel

through the tube.

D. You can test your Hall effect sensors using a permanent magnet and a multimeter. Measure the sensor's output pin with a multimeter and bring a permanent magnet near the sensor. Its output should change from 5V to 0V. If you do not have a multimeter available, you can also debug the sensors using the Serial.print command in your Arduino program. For example, make the program print out "high" or "low" depending on whether the sensor reading is high or low.

E. The drive board has onboard LEDs that turn on when each respective input is active. Watch the board closely and you should see the LEDs light up in sequence as the projectile travels through the tube. If all three LEDs do not light up in order, you might have a problem with one of your sensors.

I hope you enjoy the project!