

Developing a Low-Cost Microcentrifuge Using E-Waste

Submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Biotechnology

Submitted By

39230033 Preethi

39230054 V.S Sneha

39230056 Varada

39230058 Viswanathan



Department of Biotechnology Engineering

School of Bio and Chemical engineering

SATHYABAMA

Institute of science and Technology

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC JEPPIAAR NAGAR, RAJIV GANDHI SALAI,
CHENNAI - 600 119



SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with "A" grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119
www.sathyabama.ac.in



APRIL 2022

DEPARTMENT OF BIOTECHNOLOGY

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Preethi G (39230033)**,
V.S. Sneha (39230054), **Varada (39230056)**, **J. Vishwanathan (39230058)** who carried
out the project entitled **“DESIGNING MICROCENTRIFUGE FROM E-WASTE”**
under the supervision of **DR.R.P. OVIYA** and **Ms A. SABARIVANI**.

Internal Guide

External Guide

Head of the Department

DR. V RAMESH KUMAR

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

I Preethi (39230033), V.S Sneha (39230054), Varada (39230056), J Vishwanathan (39230058) hereby declare that the project title entitle **“Developing a Low-Cost Microcentrifuge Using E-Waste”** done by me under the guidance of **Dr. R.P Oviya** and **Ms Sabarivani** at **Sathyabama Institute of Science and Technology** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Biotechnology.

DATE:

PLACE:

Signature of the candidate:

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to Dr. Ramesh Kumar., Dean, School of Bio and Chemical Engineering and Dr. Ramesh Kumar , Head of the Department, Dept. of Biotechnology for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide Dr.R. P Oviya for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work. I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Biotechnology who were helpful in many ways for the completion

ABSTRACT

Microcentrifuges are an essential piece of equipment in a laboratory used for spinning a variety of samples at high speed for example to separate organelles and nucleic acid such as DNA. However, equipment like this generally too expensive for most research aspirants to afford, so we have developed a low-cost centrifuge from E-waste. This project aimed underprivileged schools, and underfunded hospitals that cannot afford proper equipment. we hope this project will be useful to many, and can open up opportunities in areas that cannot provide them otherwise.

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INTRODUCTION

A microcentrifuge is a device that spins samples at very high RPM in order to separate and purify materials in the samples. A common use for a microcentrifuge is Differential Centrifugation, which is used to separate organelles and nucleic acids (such as DNA) from cell samples. High quality, reliable microcentrifuge prices start from \$1,000, and entry-level microcentrifuges cost around \$300-\$700. This is way too expensive for many hobbyists and other people, so we set off to develop my own open-source microcentrifuge.

and generally, results in total destruction of the centrifuge. While centrifuges generally have safety shielding to contain these failures, such shielding may be inadequate, especially in older models, or the entire centrifuge unit may be propelled from its position, resulting in damage to nearby personnel and equipment. Uncontained rotor failures have shattered laboratory windows and destroyed refrigerators and cabinetry. To reduce the risk of rotor failures, centrifuge manufacturers specify operating and maintenance procedures to ensure that rotors are regularly inspected and removed from service or derated (only operated at lower speeds) when they are past their expected lifetime.

Another potential hazard is the aerosolization of hazardous samples during centrifugation. To prevent contamination of the laboratory, rotor lids with special aerosol-tight gaskets are available. The rotor can be loaded with the samples within a hood and the rotor lid fixed on the rotor. Afterwards, the aerosol-tight system of rotor and lid is transferred to the centrifuge. The rotor can then be fixed within the centrifuge without opening the lid. After the run, the entire rotor assembly, including the lid, is removed from the centrifuge to the hood for further steps, maintaining the samples within a closed system.

LITERATURE OF SURVEY

Developing a Low-Cost Microcentrifuge Using E-Waste © CERN-OH(kemfic), A practical home-made microcentrifuge for teaching purposes(Paloma Morán,Juan Galindo), Microcentrifuge-Based Method for Measuring Water-Holding of Protein Gels(P.N. KOCHER,E.A. FOEGEDING) Spinning Liquid Marble and Its Dual Applications as Microcentrifuge and Miniature Localized Viscometer(Xuemei Han, Hiang Kwee Lee, Wei Chun Lim, Yih Hong Lee, Gia Chuong Phan-Quang, In Yee Phang, and Xing Yi Ling*) Microcentrifuge or Automated Hematological Analyzer to Assess Hematocrit in Exercise? Effect on Plasma Volume Loss Calculations(Rafael Alis, Fabian Sanchis-Gomar)

AIM AND SCOPE

This project aimed underprivileged schools, and underfunded hospitals that cannot afford proper equipment. we hope this project will be useful to many, and can open up opportunities in areas that cannot provide them otherwise. Microcentrifuges are an essential piece of equipment in a laborarory used for spinning a variety of samples at high speed for example to seperate organelles and nucliec acid such as DNA. However, equipment like this generally too expensive for most research aspirants to afford, so we have developed a low-cost centrifuge from E-waste.

MATERIALS AND METHODS USED

Design Process

1. Hardware

For this project, We will be using an ARDINO UNO, In order to make a centrifuge, needed a motor that could spin at very high RPM in order to create enough centripetal force to separate a cellular sample. we decided to use a dead 3.5" hard drive we had in our basement, as it would spin at 7200 RPM, and should be able to generate up to 4400 g's - enough to tear apart most cells! As we wanted to make this centrifuge as user-friendly as possible, while giving users the most control they could get, I opted to add an LCD, potentiometer, and a few buttons so we could develop a useful interface to the device. we would like to also add an internet-controlled interface to the centrifuge to make the device easier to use.

Wiring

To control the hard drive, we must add an ESC (Electronic Speed Controller) to the device. we are using a standard hobby ESC that is commonly used in hobby aircraft, as it runs off 12v, and the hard drive runs off 12v too. To supply enough power to the ESC and Hard Drive, you can use any 12v power supply, but I couldn't find any, so we used a standard computer power supply. We connected a jumper to the green wire and a GND terminal, so that it would power on as soon as it was plugged in. You can also add a power switch to add some extra control to the device.

Testing/Basic Prototype

Upload the following code to the Arduino 101:

```
///  
// refer https://howtomechatronics.com/tutorials/arduino/arduino-brushless-motor-control-tutorial-esc-bldc/  
///  
  
#include <LiquidCrystal.h>  
#include <Servo.h>  
  
// Creates an LCD object. Parameters: (rs, enable, d4, d5, d6, d7)  
Liquid Crystal lcd(12,11,5,4,3,2);  
Servo esc;  
int throttlePin = A0;  
void setup() {
```

```

// set up the LCD's number of columns and rows:
lcd.begin(16, 2);

// Clears the LCD screen
lcd.clear();

esc.attach(9);
}

void loop()
{
  // to rotate the motor
  int throttle = analogRead(throttlePin);
  throttle = map(throttle,0,1023,0,179);
  esc.write(throttle);

  // calculations
  int throttlepercent = (throttle*100)/179;
  int myRPM = 7200/(100-throttlepercent);

  // to display the LCD
  lcd.clear();
  lcd.print("Speed: ");
  if(myRPM == -1){
    lcd.print("7200");
  }
  else if(myRPM <= 100){
    lcd.print("0");
  }
  else{
    lcd.print(myRPM);
  }
  lcd.print(" RPM");
  delay(50);
}

```

To connect the motor to the ESC, you must either do a continuity test by checking to see if the pins on the bottom of the hard drive are connected or not. You can also randomly solder on the wires of the ESC to the pins on the hard drive motor, and switch them up if the motor does not work, as there are 6 possible combinations, and only 2 of them work properly. This code and wiring should be enough to develop a basic centrifuge.

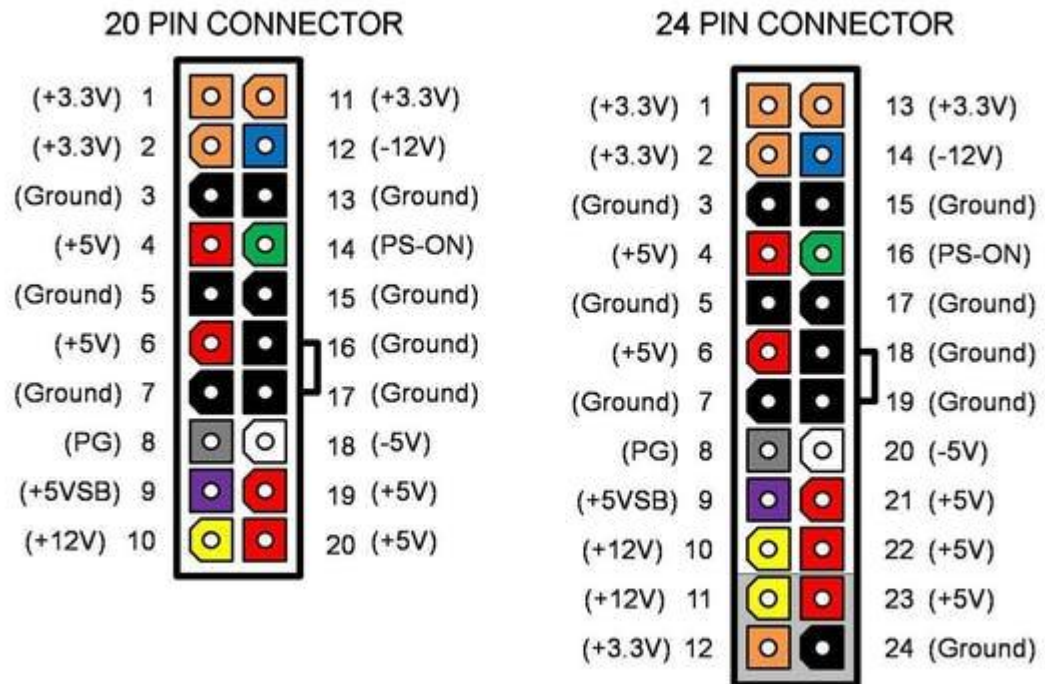


Fig: 1 Wiring diagram for standard ATX Power Supplies (Make:)

Once mounted and tested, we can finally improve our code and interface. I added a Grove Shield and LCD to the Arduino, and added an RPM indicator to the program. It is not reliable as it provides an estimate based on the reading on the potentiometer, not the motor. I will add an encoder once it ships.

RESULT

The centrifuge had successfully constructed.

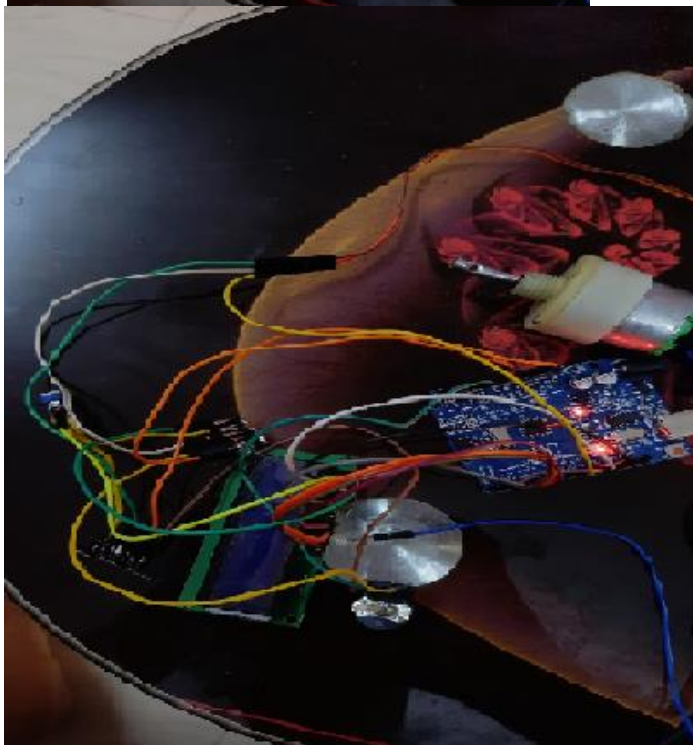
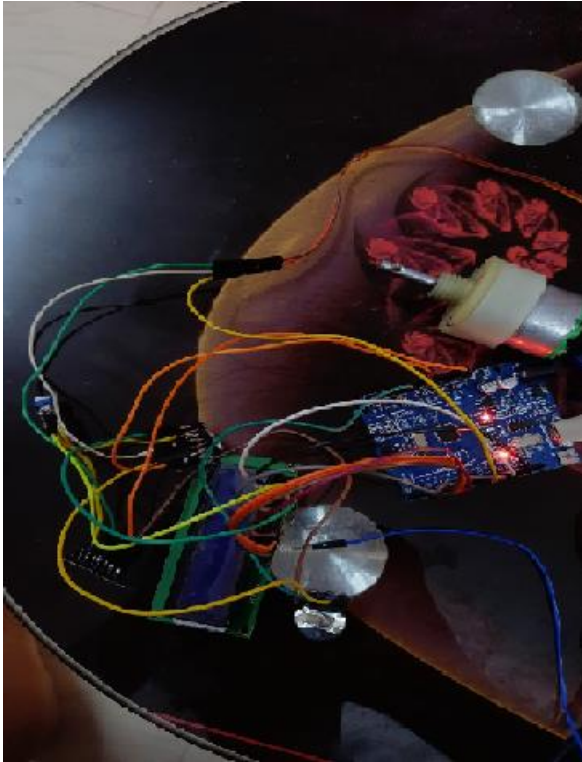


fig:2 centrifuge

CONCLUSION

This project has a huge impact on many people, and it is very useful in many contexts. I mainly use centrifuges for DNA experiments, as it separates organelles and many other parts of cells very easily and effectively. Centrifuges are also used commonly in blood samples to prepare them for disease testing procedures. A good centrifuge will help doctors and researchers speed up the testing process, and lower risks and costs. A low-cost device like this can inspire biohackers to develop their own solutions and improve upon current procedures. This DIY approach is also very useful in STEM education, as it can inspire students to engage in scientific research and find solutions to problems we see in everyday life. Another interesting aspect of this project is the fact that it uses e-waste, and is more environmentally friendly than throwing out old power supplies and dead hard drives.

REFERENCE

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INTERDESCIPLINARY PROJECT

Developing Microcentrifuge from E-waste

BY

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ABSTRACT

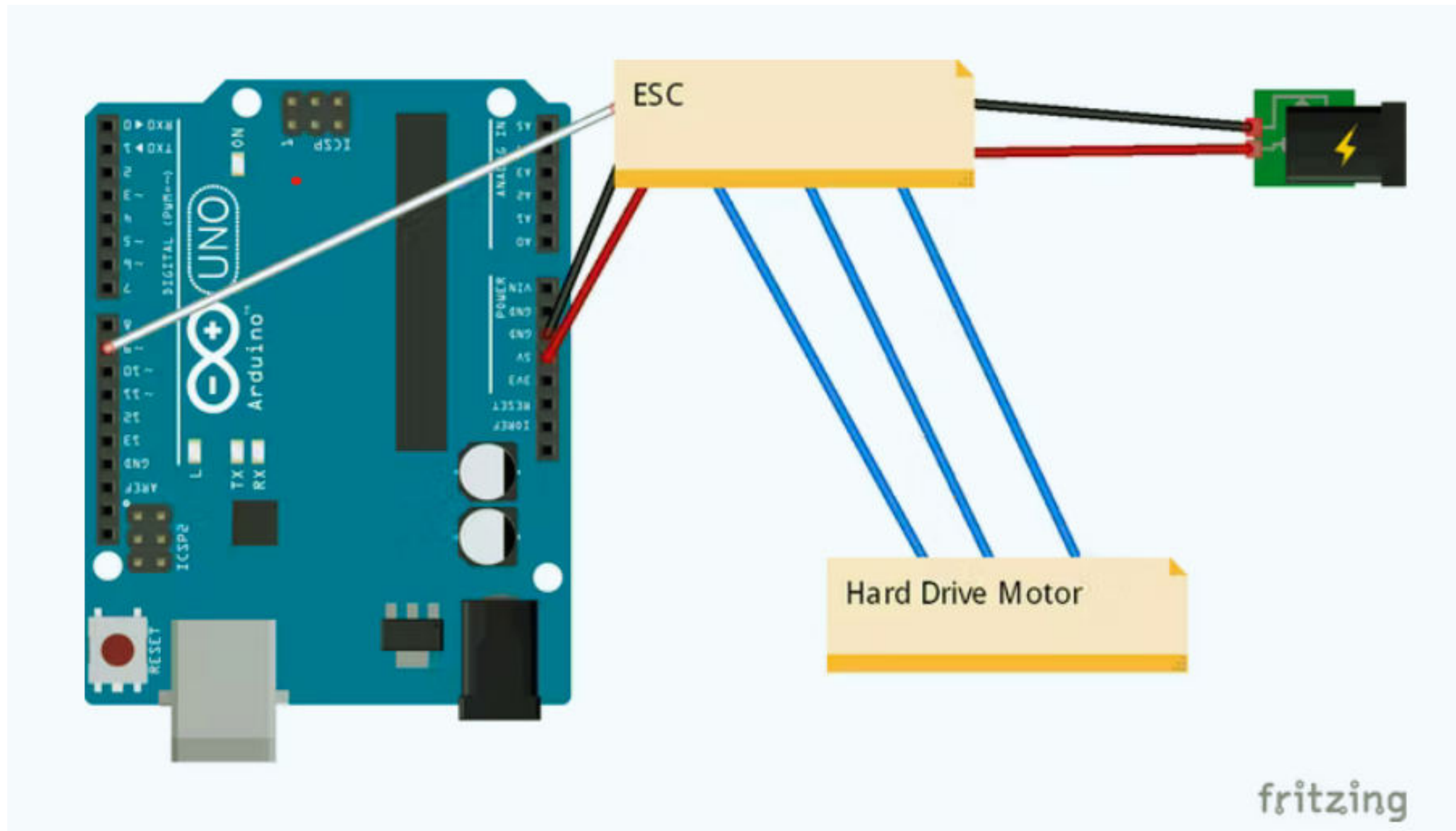
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INTRODUCTION

Microcentrifuge is equipment which will spin at high RPM in order create the enough centripetal force to separate the sample. For that we used a hard drive which would spin at 7200RPM which is enough to separate most of the biological products. We used a microcontroller called Arduino UNO a open source hardware platform and also we have opted to add an LCD which will display the RPM ,potentiometer 3 terminal resistor, Electronic Speed Controller (ESC) to set the RPM

PROTOTYPE

For this Microcentrifuge we are using the hard drive motor which will be connected to the electric speed controller, to supply enough power to the hard drive and ESC we opted to 12v power supply and also we connected a jumper to the green wire and a GNF terminal, so that it would power on as soon as it was plugged in. Then wired up the ESC to 12v rail and GND. Connect a potentiometer from 5v and GND and connect the middle terminal to A0



MODEL REPRESENTATION

CONCLUSION

A good low cost device like this can inspire lot of aspirants to develop their own solutions. This DIY (do it by yourself) approach will inspire lot of students to engage in scientific research and find solutions to their problems. The most important fact about the project is we are using E waste to develop the centrifuge which is eco friendly