SUMMER INTERNSHIP
PROJECT REPORT

INDIAN INSTITUTE OF TECHNOLOGY, HYDERABAD.

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PROJECT TITLE

ARDUINO IN SCIENCE

1.)Accleration Due to gravity by Free fall
2.)Speed of Sound Using Ultrasonic Sensor
3.)RC circuit analysis

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Preface

Objective of this project was how to make SCIENCE experiments more interesting using Arduino microcontroller.Arduino is Open-source electronic prototyping platform enabling users to create interactive electronic objects.. All things one need to know is basic circuits and little bit coding. In this project first part I have made experiments setup for determining value of **g**(acceleration due to gravity) by getting time of travel of freely falling object using photo interrupter and piezo electric sensors. In second part of project speed of sound is determined by using ultrasonic sensor. In this part I have connected clap switch with it to activate transmitter and receiver of ultrasonic sensor to detect time of travel of sound wave. In third part of project, I have done RC circuit analysis. In this part, charging and discharging of capacitor with time is observed and its graph is obtained.

This project shows some applications of Arduino in designing experimental setups of science experiments by own. By this project we get an idea how interesting it is when we understand science by our own designed experiments. Main goal of this project was to understand the science with help of engineering just like "learning by doing it".

ARDUINO IN SCIENCE

1.) Experimental setup for determining value of acceleration due to gravity:

OBJECTIVE: finding time of travel by the freely falling object to determine Its acceleration.

COMPONENTS REQUIRED:

- Arduino UNO
- 4 - piezo electric sensors
- 1 - photo interrupter
- 1-LED
- 4-resisters(1k ohm)
- two boxes

CONNECTIONS:

- photo interrupter has three pins: GND, VCC, OUT

  connect GND to GND of Arduino, VCC to 5V of Arduino, OUT to A4 of Arduino
- we have 4 piezo electric sensors. Connect positive terminal to one end of 1k ohm resister and negative to ground of Arduino. Connect other end of resister to negative of piezo electric sensor. Connect pin A0 of Arduino to positive terminal of piezo-electric sensor.
- Make similar connections for other piezo electric sensors and connect their positive terminals to A1, A2, A3 of Arduino.
- Connect LED: positive to digital pin 13 of Arduino and negative to ground.

PREPARTION OF SETUP:

- In one box fix photo interrupter sensor. On other box fix 4-piezo electric sensors and cover them with card board so that when object will fall on card board piezo sensor can detect it and send signal to Arduino.

- The box having piezo electric sensor is kept at ground and box containing photo interrupter is kept on the top of the table. Make sure that the gap of photo interrupter should of exactly on the piezo sensors so that when object will pass through this gap,it directly falls on piezo sensors.
- After preparation of setup and connections, now connect Arduino to computer and upload the Arduino code which is given after circuit diagram

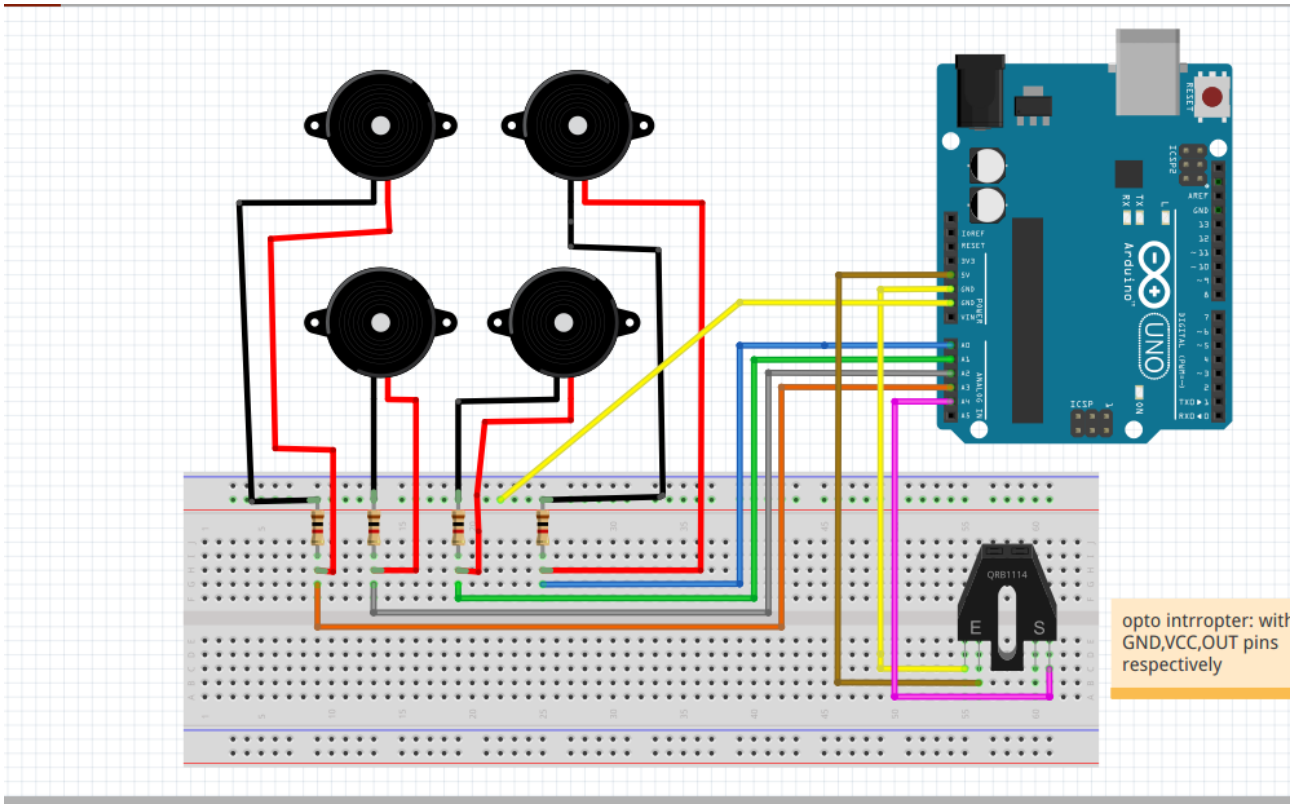
FORMULA:

From equation of motion of particle in straight line,

d=V_0 t+ (1/2) at^2.
for freely falling object with V_0=0 has a=(2d)/t^2. And this a=g

CIRCUIT DIAGRAM:

Connections of piezo electric sensors and photo interrupter with Arduino.



ARDUINO CODE:

```
const int ledPin= 13;
```

```
const int threshold=1;
long int endTime=0,startTime=0;
double Time;
float d=0.9; //hight of photointerrupter from piezosensors
int count=0;

void setup()
{
 Serial.begin(9600);
 pinMode(ledPin, OUTPUT);

}

void loop()
{
 int val= analogRead(A0); //analogpin connected to piezosensor-1
 int val2=analogRead(A1); //piezosensor-2
 int val3=analogRead(A2); //piezosensor-3
 int val4=analogRead(A3); //piezosensor-4
 int val5=analogRead(A4); //analogpin connected to photointerrupter
 Serial.print(val);                                    // printing values of each sensor
on serial monitor
 Serial.print(" ");
 Serial.print(val2);
 Serial.print(" ");
 Serial.print(val3);
 Serial.print(" ");
 Serial.print(val4);
 Serial.print(" ");
 Serial.println(val5);

 if(val5 >1000)  //when some object come in between interrupter analog pin
becomes high
 {
   startTime=millis();
 }
if (val>=threshold| | val2>=threshold| |
val3>=threshold| | val4>=threshold)
 {
  endTime=millis();
  Serial.print("EndTime : ");
  Serial.print((float)endTime/1000);
  Serial.print(" ");
  Serial.print("StartTime : ");
```

```
 Serial.println((float)startTime/1000);
 Serial.print("Time Of Flight : ");
 Time=(float)(endTime-startTime)/1000;
 Serial.println(Time);
 Serial.print("Acceleration of particle : ");.
 Serial.println((d* 2.0)/(Time* Time));

digitalWrite(ledPin, HIGH); // LED glowing
delay(3000);
digitalWrite(ledPin, LOW);
delay(5000);
}
else
{
digitalWrite(ledPin, LOW);
}
delay(1);
}
```

OBSERVATION:

After uploading code, now open serial monitor and observe values of each sensor detecting. Now leave object from gap of photo interrupter and observe serial monitor. It will print the acceleration of the object.

RESULT:

Using this setup acceleration of freely falling object can be determined easily. And the result I got was in between 9-10 m/s^2 which is near to exact value 9.81 m/s^2.

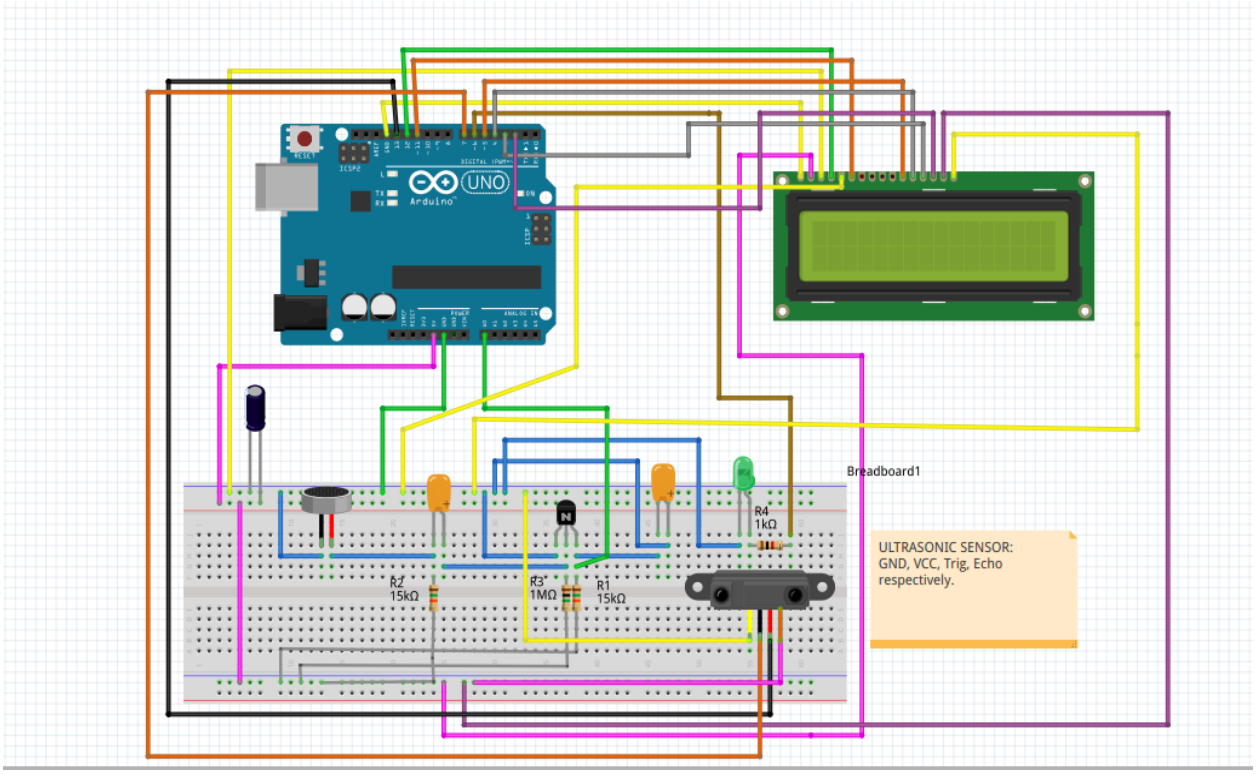
2.) Measurement of speed of sound using ultrasonic sensor and its activation using clap switch

OBJECTIVE: measuring speed of sound. Making and using clap switch.

COMPONENTS:

- Arduino UNO
- Ultrasonic sensor
- LCD (16x2)
- Electret microphone
- 15k ohm 2 resister
- 1M ohm 1 resister
- 1k ohm -1 resister
- 1 LED
- 1-Capacotor (100 micro F)
- 2-capacitor(100nF)
- 2N3904 NPN transistor

CIRCUIT DIAGRAM:



connection of ultrasonic sensor, clap switch and LCD to Arduino UNO.

PERPARATION OF SETUP:

After making connection according to circuit diagram keep ultrasonic sensor against some barrier at measured distance and note this distance of barrier from sensor. Use this fixed distance in code of Arduino.

After preparing setup, upload following code to Arduino board.

ARDUINO CODE:

```
# include¡LiquidCrystal.h¿
LiquidCrystal lcd(12,11,5,4,3,2);
int sensorValue = 0,sensorValue1=0;
int trigPin=13,echoPin=7;
int distance=60; // fixed distance in my case is 60cm.
int p=0,time;
void setup()
{
 lcd.begin(16,2);
 lcd.setCursor(0,0);
 lcd.print("Setup is ready");
 pinMode(6,OUTPUT);
 pinMode(trigPin,OUTPUT);
 pinMode(echoPin,INPUT);
 Serial.begin(9600);
}
void loop()
{
sensorValue = analogRead(0);
if(sensorValue¿50) // when microphone sense sound of high intensity
 {
 digitalWrite(6,HIGH);
 delay(1000);
 digitalWrite(6,LOW);
 delay(1000);
 p++;
 }
 if(p==1) // when clap switch becomes active then sensor becomes active
 {
```

```
  digitalWrite(trigPin,LOW);
  delayMicroseconds(2000);
  digitalWrite(trigPin,HIGH);
  digitalWrite(trigPin,LOW);
  time=pulseIn(echoPin,HIGH);
  p=(double)time/1000000;
 Serial.print("Speed of sound is :");
 Serial.print((float)(distance* 2)/(p* 100));
 Serial.println("m/s");
 lcd.setCursor(0,0);
 lcd.println("Velocity of sound");
 lcd.setCursor(0,1);
 lcd.print((float)(distance* 2)/(p* 100));
 lcd.print(" ");
 lcd.print("m/s");
 delay(4000);
 lcd.setCursor(0,0);
 lcd.println("-setup is ready-");
 lcd.setCursor(0,1);
 lcd.println("               ");
 p=0;
 }
}
```

FORMULA:

Ultrasonic sensor is emitting sound wave of frequency higher than 20kHz which cant be detected by Human ears. Due to its high frequency it distorts less and gets reflected if some barrier comes in between transmitter. After reflecting, this wave is detected by receiver.

Here we have fixed distance of barrier from transmitter and time taken by wave to come back to receiver is twice than time taken to travel fixed distance.

Time of travel= (time detected by sensor)/2

Speed = (fixed distance)/Time of travel.

Which is speed of sound.

WORKING PRINCIPLE OF CLAP SWITCH CIRCUIT:

Clap switch circuit consists of filter circuit and amplifier. Electret microphone when detect presence of sound waves it sends elecrical signals to RC

filter. RC filter removes noise from signals and send filtered signals to NPN transister. NPN transister amplifies signals it getting from RC filter and send it to analog pin of Arduino board where it's presence is detected and at appropriate signal strength, switch becomes active.

OBSERVATION:

After uploading code, clap loudly. Due to clap, clap switch becomes active and it will turn ON Ultrasonic sensor and LCD display and start calculating speed of sound depending upon the time taken by ultrasonic sound wave to travel fixed distance.

RESULT: Speed of sound measured using this setup is about 336 m/s^2. Which is closer to exact value 343m/s^2.

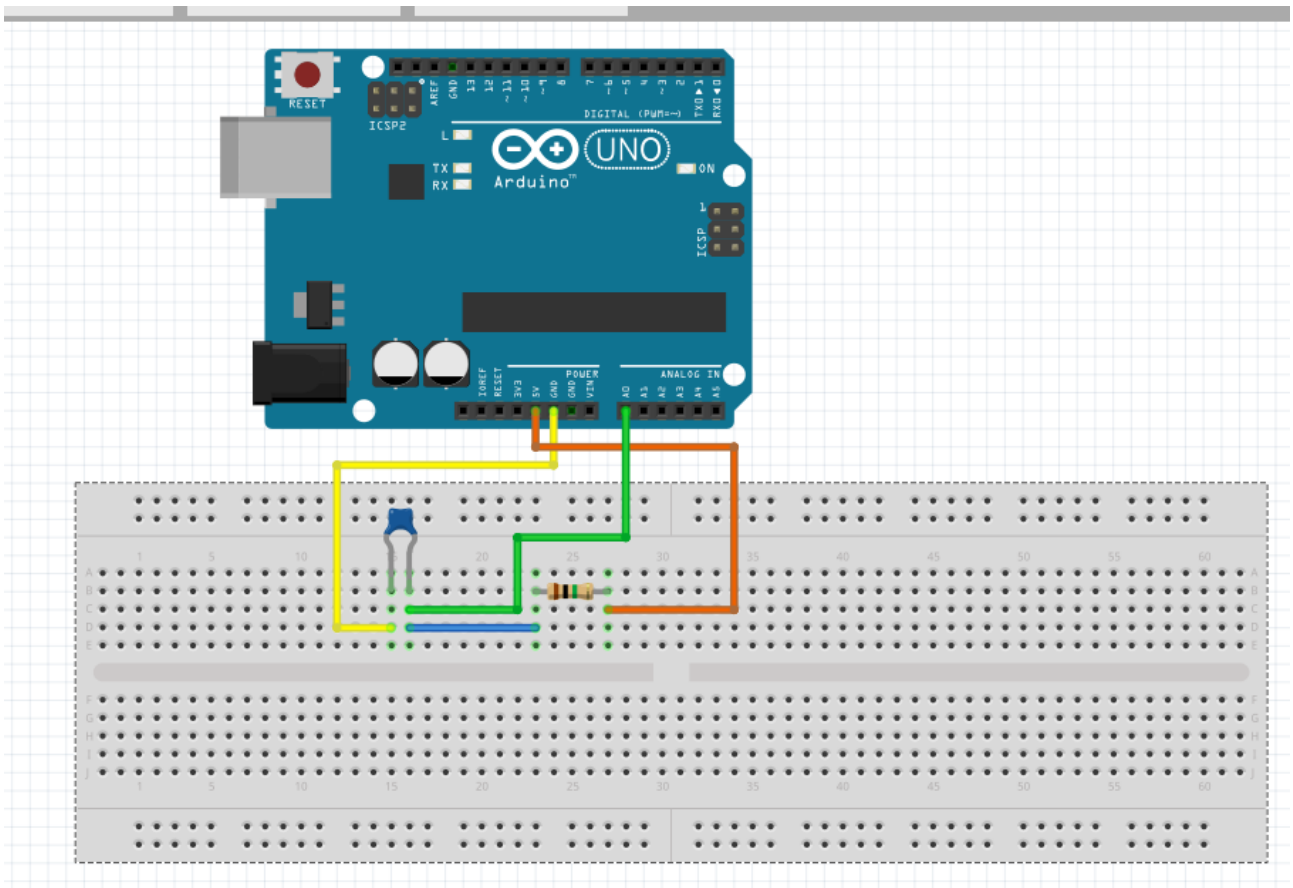
3.) analysis capacitors charging and discharging curve from data obtained by Arduino.

OBJECTIVE: analysis of charging and discharging values of voltages with time.

COMPONENTS:

- 10 M ohm resister
- Capacitor of 0.44 micro F (use plastic film capacitor but dont use electrolytic capacitor)
- Arduino UNO

CIRCUIT DIAGRAM:



After making connections according to circuit diagram, upload following code to Arduino.

ARDUINO CODE:

```
float v1=0;
void setup() {
 Serial.begin(9600);
 Serial.println("CLEARDATA");
 Serial.println("LABEL,Computer Time,Time (Milli Sec.),Volt");

}

void loop() {
 v1=(float)5.0* analogRead(A0)/1024.0;
 Serial.print("DATA,TIME,");
 Serial.print(millis());
 Serial.print(",");
 Serial.println(v1);
 delay(100);
}
```

HOW TO OBSERVE CHARGING AND DISCHARGING VALUES OF VOLTAGE:

After uploading code open serial monitor, we will observe values of voltage across capacitor on serial monitor.

To observe charging value of voltage, first discharge capacitor by connecting its both ends and then connect it to circuit.

To observe discharging value of voltage, disconnect 5V pin from Arduino after full charging of capacitor and connect extreme end of capacitor to another end of resister.

This way we can observe charging and discharging values of voltage on serial monitor.

How to print charging and discharging values of voltage directly to MS EXCEL:

MS Excel provides features to connect serial monitor directly to excel sheet. It provides better way to analyse data we are getting from Arduino and obtain results quickly.

For that we need to install "PLX-DAQ" in our windows.

We can refer following links to know how to install and use "**PLX-DAQ**" :

To install "PLX-DAQ" refer: https://www.parallax.com/downloads/plx-daq

To know how to connect PLX-DAQ to excel refer:
https://medium.com/@islamnegm/quick-start-to-simple-daq-system-using-plx-daq-excel-arduino-d2457773384b

FORMULA:

During charging voltage varies as

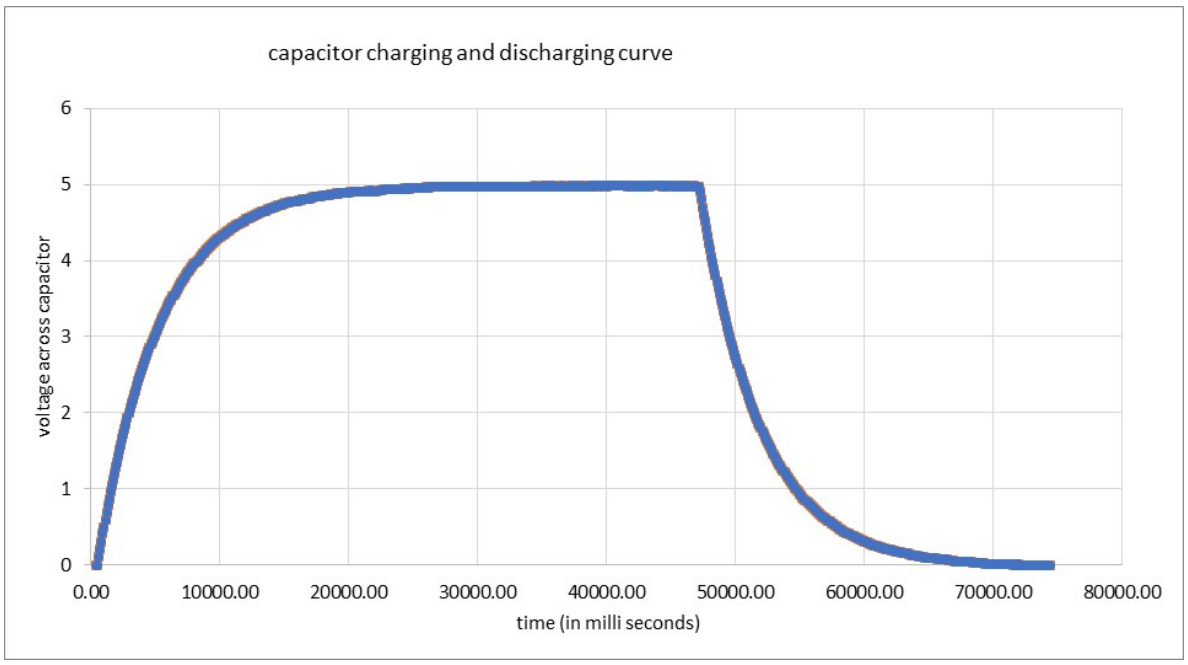
$$\mathbf{V(t)=}V_0\mathbf{(1-}e^{\mathbf{-(t-t1)/RC)}}\mathbf{.}$$

During discharging voltage varies as

$$\mathbf{V(t)=}V_0e^{\mathbf{-(t-t1)/RC}}\mathbf{.}$$

OBSERVATION:

I got this graph of charging and discharging of capacitor in EXCEL which is closer to the actual graph of charging and discharging according to relation of voltage with time.



RESULT:

This way very easily we can collect data through Arduino where observation of data at each milli seconds is important. This reduces error in observing data as we directly get data from Arduino to excel and observation becomes easy.

This type of analysis is useful when more than one circuit components are connected and we have to observe individual components.