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ES 106-2021- Team 1022

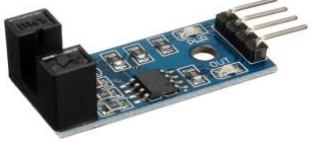
SPIROMETER

ABSTRACT

A spirometer is used to measure the functioning of a human lung. With the pandemic, the need and usage of spirometers have significantly increased. This motivates the current project, wherein we have designed and assembled a spirometer that can give an indirect measurement of lung capacity.

ELECTRONIC DEVICES NEEDED FOR THE PROJECT

LM 393 - speed measuring sensor



ESP 8266 - Node MCU

1. INTRODUCTION

Currently, the whole world is facing such a pandemic condition. In this current situation, our lung capacity should be improvised, and the measurement of lung capacity is fundamental. So here we have introduced a spirometer. A spirometer is a device through which we can indirectly measure our lung capacity. Just we have to blow in the pipe, and the spirometer will give us a measurement of the lung capacity of how much air we can blow in one breath, and from that, we can conclude whether our lungs are capable of storing enough air or not.

en.wikipedia.org

2. DESIGN

Describe Spirometer has a measurement of 110 mm X 65 mm X 45 mm. It contains a base plate at the bottom for support. The housing case of the spirometer is designed like a lego that one gets fixed into another. There is a small hole to the side housing plate through which the blowpipe is inserted. An impeller is fitted inside the housing case. Impeller contains fan blades that rotate after we blow air through the pipe. The impeller and slotted disk are connected through the shaft, and due to bearings, the slotted disk rotates when the impeller gets rotated.

3. MATERIALS AND METHODS

Materials -

a) Housing plates - Acrylic sheets (5mm width)
b) Base plate- MDF sheet(5mm width)
c) Slotted disk - MDF sheet(3mm width)
d) Impeller - plastic

Acrylic sheets

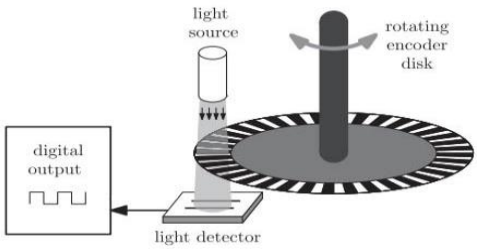
MDF sheets

Manufacturing Method -

a) Housing plates, slotted disk - Laser cutting
b) Impeller - 3D printing

4. ALGORITHMS

When we blow air through a pipe, the impeller rotates. As the impeller is connected to the slotted disk through the shaft, the slotted disk also starts to spin. A slotted disk has small circular holes at the periphery. LM393 speed measuring sensor is placed at the bottom of the slotted disk. This sensor has a gap between transmitter and receiver, through which the slotted disk rotates. The infrared light sensor can sense the gap in the holes of the slotted disk. Each gap in the slotted disk triggers the IR sensor when passing through the gap; a comparator is then used to convert these triggers into a voltage signal. The comparator uses ON Semiconductor's LM393 IC.



Teachmicro.com

The LM393 module has three pins, two of which are used to power the module, and one output pin is used to count the number of triggers. So the output pin is connected to the ESP 8286 input node, and the output node of ESP 8286 is connected to the laptop, which converts signals into values by implementing the following code.

Code:

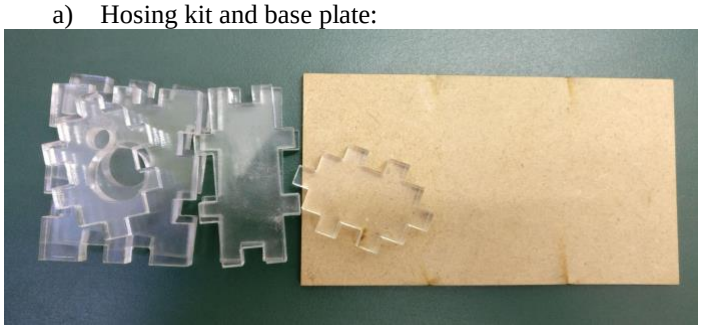
```
#define x D4
unsigned long start_time = 0;
unsigned long end_time = 0;
int steps=0;
float steps_old=0;
float temp=0;
float rpm=0;

void setup()
{
  Serial.begin(9600);
  pinMode(x,INPUT_PULLUP);
}
void loop()
{
 start_time=millis();
 end_time=start_time+1000;
 while(millis()<end_time)
 {
   if(digitalRead(x))
   {
    steps=steps+1;
    while(digitalRead(x));
   }
 }
    temp=steps-steps_old;
    steps_old=steps;
    rpm=((temp*3));
    Serial.println(rpm);
}
```

RESULTS AND DISCUSSION

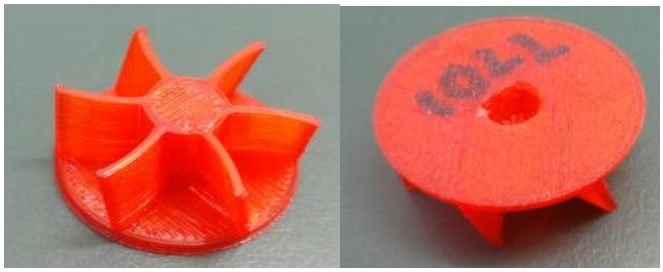
After running code, when we blow air, we get readings of rpm of the slotted disk. From that, we can measure our lung capacity. On our strength of blowing, the rpm value increases.

5. Manufactured Components

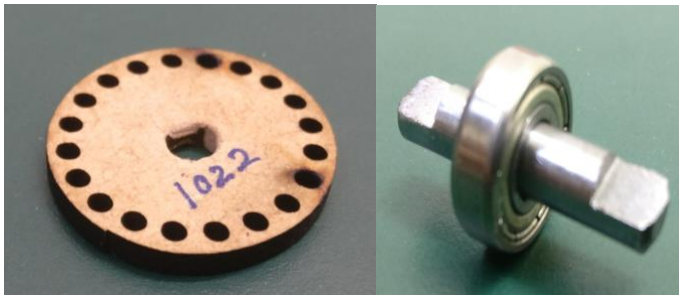
a) Hosing kit and base plate:



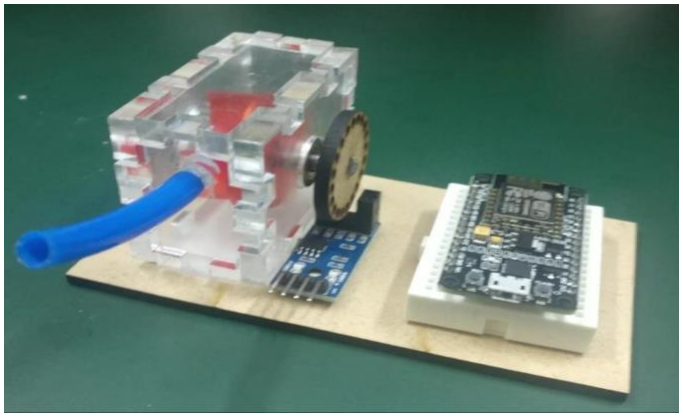
b) Impeller:

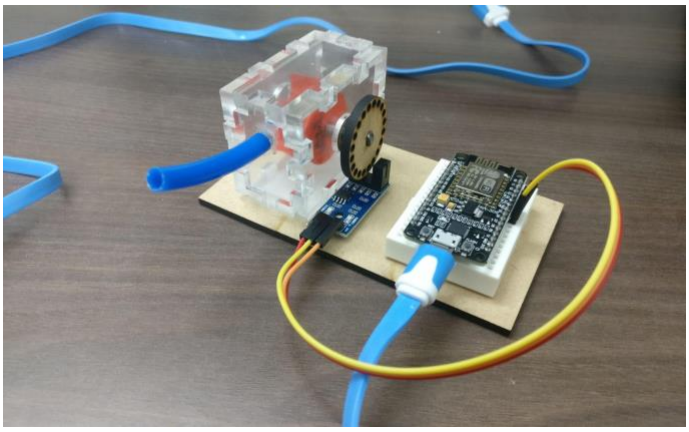


c) Slotted disk and Ball-bearing shaft:



6. FINAL ASSEMBLY





7. CHALLENGES AND FAILURES

Challenges:

a) The dimensioning of all components was the main challenge. All parts had to be assembled via a friction fit. So we have to consider all minute details.
b) Another challenge was designing the shape of the blades of the impeller such that it will rotate easily when we blow air without any disturbance.

Failures:

a) After manufacturing the housing kit, There was a problem with a friction fit. Parts did not fit properly, so we removed some material.
b) The holes of the slotted disk and impeller where the shaft was supposed to be placed, became small so we increased hole size.

8. RECOMMENDATIONS AND IMPROVEMENTS

a) We can also see the output readings of the spirometer on a smartphone by connecting Sensor to wi-fi with the help of a specific app.
b) We can use better design and material for the impeller and ball-bearing shaft to rotate smoothly and effectively.

9. CONCLUSIONS

We got the knowledge of various steps that are generally requires in the process of manufacturing a tool. We have learned the basic drawings of components on Autodesk fusion360. Along with it, we have got experience with laser cutting, 3D printing. This project will help many patients and people in such a drastic situation of a corona pandemic.

ACKNOWLEDGEMENTS

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REFERENCES

1) www.wikipedia.org
2) https://www.electronicshub.org/interfacing-lm393-speed-sensor-with-arduino/#A_Brief_Note_on_LM393_Speed_Sensor_Module

CONTRIBUTIONS

1) Donge Gajanan Sanjay (20110061) -

   Dimensioned all parts, created their sketch in Autodesk software, and created .dxf and .stl files of all components.

2) Aman Chaudhary (20110012) -

   Collected all manufactured components and assembled them. Created demonstration video showing whole assembly , functioning process.