National Taiwan University of Science and Technology

Department of Mechanical Engineering

Low Cost Flow Meter

NAME

Zhe Min (Desmond) Du (B9803036),

Tai-Jung (Debbie) Chang (B10103102),

Yuan-Wei(Flora) Pi (B10103201)

Person in charge

Prof. Dr. George Lee

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ABSTRACT

Objective

The objective of the project is to use the impeller and other IC device to construct a digital flowmeter. The purpose of this device is to measure, collect, and transmit the data of domestic water consumption per faucet that we need and then display them on a smart phone. The fundamental principle underlying this design is to use less money to produce the flowmeter which is available to common.

Keywords:

Flow meter, tap water consumption, wireless data transmission, android app enabled,

1 INTRODUCTION

Our goal is to make a low cost flowmeter. Together with a student group from the MUAS in Munich we develop a flow measurement for a water tap. This project is divided into mechanical and electronic parts. MUAS students are responsible for the mechanical part in which they have to design the mechanism of the flow meter including the impeller and the casing. We are responsible for the designs of the electronic and all IC devices.

2 MATERIALS AND METHODS

2.1 Methods and Principles

The principle of the project is using the impeller and other IC device to measure, collect, and transmit the data we need and then display said data on a smart phone. To get the flow rate, we attach the magnets on the tip part of the blades of the impeller. Then, we use reed switch as a sensor. The purpose of this is every time when the impeller rotates, the magnet will cause the reed switch to receive a magnetic signal, which the reed switch will pick up the rotating motion and the speed of its rotation. Then, we can measure the frequency of the signals to calculate the speed of flow. At last, we use Bluetooth 2.0 to transmit our data onto a smart phone. The software displaying the data is available in Android devices.

We design the electronic and all IC devices in both the reed switch as well as the Bluetooth transmitter; the former transfers the data collected at the impeller point, whereas the latter transmits the data to smartphone device. Also, we have to design how to house our components. In addition to these electronic hardware designs, we are also responsible for designing the App that will translate the hard data onto Smartphone display.

The reed switch will transmit signals while the impeller rotates. Then Attiny85, the controller, will receive the signals and calculate the data, then transfers the data to the smartphone through Bluetooth 2.0—the maximum distance of transmission is within 10 meter. The lithium battery supplies power to the Bluetooth HC-05, Attiny85 and reed switch. The circuitry of each one of them is parallel, therefore they receive the exact power 3.7V.

2.2 Materials

List of components specifications:

- Attiny 85 (dimension, power)
- Bluetooth HC-05
- Lithium Battery(GSP402246 330 mAh 3.7V)
- Reed Switch MK06_E

2.2.1 The circuit of electrical components

Given this project involved specific division of labor between NTUST and MUAS, this section will only present the materials and designs used by NTUST team. Our main electronic components are Bluetooth HC-05, Attiny85 controller, reed switch and lithium battery. The circuit is showed as Figure 1.

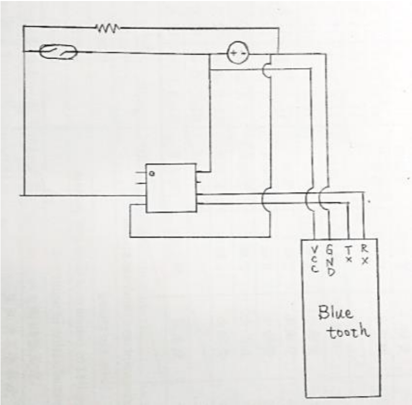

Figure 1

In order to reduce the flow meter to as small as possible, we have to choose electronic components that will satisfy our technical needs and be of the right size. For this reason, out of … different CPUs we reviewed, Attiny85 is the one that provides the right size and for the right job. The advantage of Attiny 85 is that we can easily use C language to program it to process the data that we need to collect. As for the choice of using Bluetooth HC-05, it requires the same power input as the Attiny85—3.7V—therefore we can use one single power resource for the entire device. A lithium battery (GSP402246 330 mAh 3.7V) is the power backbone of the flowmeter. In case of short circuit, we place a 1 K resistance parallel to the reed switch. The finished electrical components is showed as Figure 2.

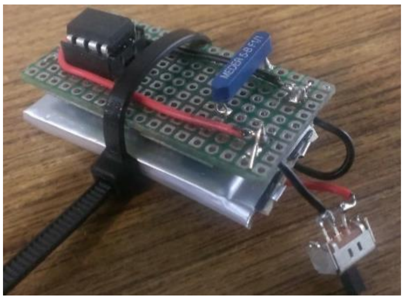

Figure 2

2.2.2 Components layout

To place our electronic components in their precise positions, we use double side circuit board to weld our components and use M1 screws (the size is same as the holes of the circuit board) to attach the electronic components on the mechanical parts.

To maximize the space within the housing unit efficiently, we place our electronic components in three close layers. First layer is the circuit board, second layer is the Bluetooth and third layer is the battery. We also place the on/off switch in the second layer. The position is showed as Figure 3.

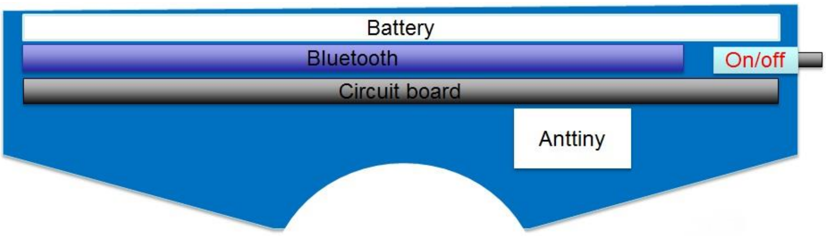

Figure 3

The MUAS counterparts are responsible for mechanical components as well as the casing of the device. To reduce the electrical interference, we use plastic to build our flow meter. The shape design is showed as Figure 4.

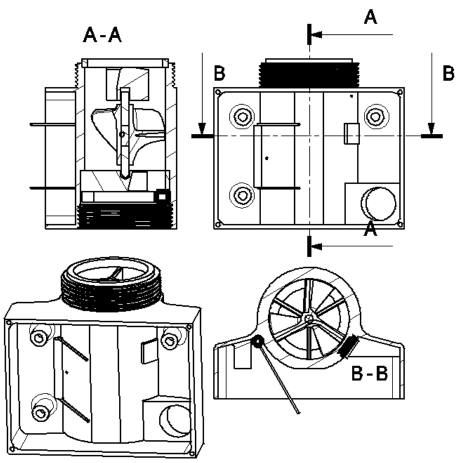

Figure 4

2.2.3 The programming

The method of burning program into the Attiny 85 is using Arduino uno to work it. The connection is showed as Figure 5. In the Attiny 85 programming, we only transferred the impulses data to Bluetooth, you can see as Figure 6. Then the Bluetooth transmitted the impulses data to app which is written by App Inventor. All the calculation worked in app. The formula as Figure 7 to find out the accurate flowrate is based on K-factor. Before doing the experiments about the function the k-factor has to be defined. The k-factor is a linear coherence between the flow rate and the impeller speed. The result of the tests from MUAS team is k=145.254 (signals/liter). By the calculation of impulses in a period with the function below, we can find the flow rate.

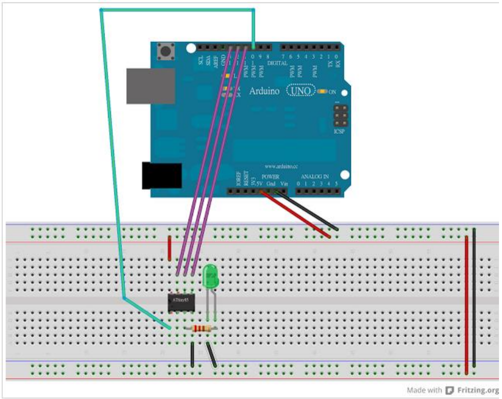

Figure 5

```
int LED = 3;
unsigned long startTime;// 按鈕被按下的起始時間
unsigned long duration; //    週期（毫秒）
unsigned long flowrate;
unsigned long impulse;
unsigned long impulse_par;
unsigned long liter_par=10;
unsigned long cycle;//  週期（分）
unsigned long frequency;//  頻率(每次幾分鐘)
void setup() {
  Serial.begin(9600); //Arduino起始鮑率9600
  BT.begin(9600); //藍牙鮑率57600
  //(注意！此鮑率每個藍牙晶片不一定相同，請先確認完再填寫進去)
  pinMode(buttonPin, INPUT);
  pinMode(LED, OUTPUT);

}

void loop() {

  digitalWrite(LED, LOW);
  if (analogRead(buttonPin) <512){    //    接觸到磁鐵
    startTime = millis();                    //   開始計時
    while (analogRead(buttonPin) <512){   //      接觸磁鐵，
    digitalWrite(LED, HIGH);
    }
    while (analogRead(buttonPin)>512){    //    離開磁鐵
      digitalWrite(LED, LOW);
    }
    digitalWrite(LED, HIGH); //    完全離開磁鐵
    duration = millis() - startTime;     // 計算按鈕被按了多久(半圈)
    if(duration<99999 && duration>0){
      duration=duration+100000;
    BT.print(duration);
    }



  }
}
```

Figure 6

$$\frac{n}{Q} = \mathrm{K}\frac{\mathrm{n}}{\mathrm{v}};\ Q = \frac{f*60}{K}\,l/min$$

- n = rotational speed
- Q = flow rate
- K = number of signals per volume unit
- v = kinematic viscosity
- f = frequency

Figure 7

2.3 RESULTS

2.3.1 The final prototype

The finished mechanical part was sent from Germany which is showed as Figure 8. Then we combined it with our electrical part as Figure 9 together and adjusted to the right position.

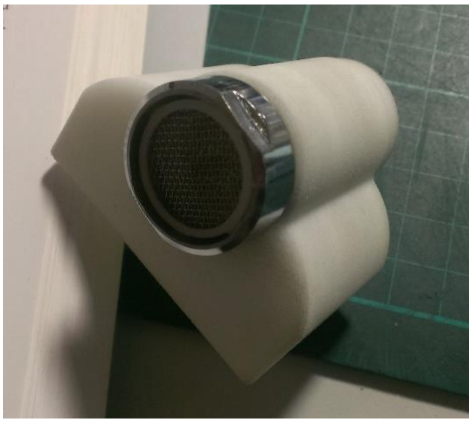

Figure 8

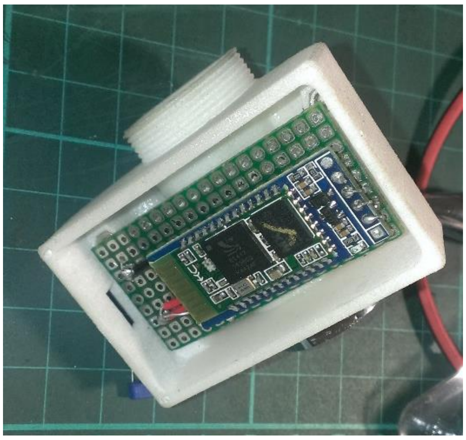

Figure 9

2.3.2 Testing

Let a constant flow go through the impeller. Then, we can get the data of the impulses. After calculation of the data. The app will show flow rate, consumption liter, time, impulses and the figure of time to flowrate. The interface on phone is showed as Figure 10.

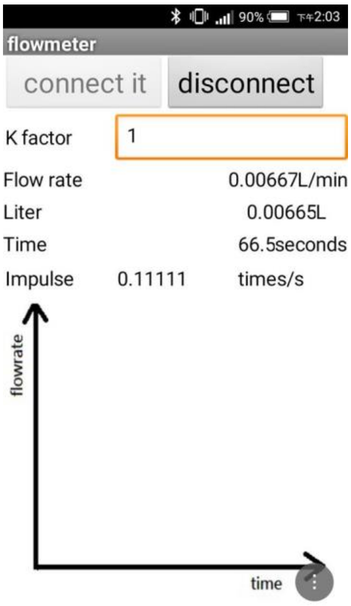

Figure 10

3 DISCUSSION

This device is only for tap now. In the future, we are interested in other application such as rain water measuring device for roofs of buildings and swim distance measurement device. With the idea of low cost of flowmeter, the expensive products above can reduce its price and more available to common people.

4 CONCLUSIONS

The project is based on teamwork between NTUST and MUAS. The students from Munich has done the mechanical part. At the beginning, it was hard to express and exchange our idea and thoughts through the small screen with Skype. But after a while, we can get each other idea and clarified the tasks before next meeting.

The developed flow measurement for a water tap is measuring the flow rate and is showing the results on a display. The mechanical part of the prototype is developed from MUAS students. We are responsible to the electrical part that get the data and display. As the flow go through the measurement device the impeller start to rotate. We attach the magnets on the tip part of the blades of the impeller. The magnet will cause the reed switch to receive a magnetic signal, which the reed switch will pick up the rotating motion and the speed of its rotation. Then the electronic convert the signals and shows the results on a display with an Android app on cell phone.

Although there were some difficulty during the project, by the support of teachers and our great partners from MUAS in Munich, we overcome the corner. Furthermore, we have to appreciate to Prof. Lee and Prof. Schiebener. Thank for providing the cooperating chance with the people from other side of earth and the support all the time.

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