Measuring temperature and the weather station engineering

Contents

5. Introduction

Weather station is the station that usage to mensurate / detect the conditions status and the clime. Normally the conditions station will mensurate temperature, humidness, wind way, wind velocity, and others [13] . To mensurate weave velocity and way of velocity, it need a air current wind gauge to mensurate the velocity and a air current vane to bespeak the way.

There have two type of air current wind gauge which is speed type and force per unit area type. For speed type, it consist of cup, windmill, hot-wire, laser Doppler, sonic and ping-pong type wind gauge. While for the force per unit area type, it consist plate and tube wind gauge. The simplest wind gauge was cup type. The first was invented by Dr. John Thomas Romney Robinson in 1846. It have 4 cup which saddle horses in equal angle to each other cup and fixed on a shaft. When the air current blow the cup, the cup will revolve relative to the air current. By numbering the figure of rotary motion over the clip period, it can easy establish the mean velocity of the air current. [14]

Normally to mensurate weave velocity and way, they both will use two different set of detector to mensurate, eventhough both are fixed in a box. So in this undertaking, it will merely necessitate individual set of detector but can mensurate both velocity and way of air current. The chief advantage of this individual detector is it will do the building simpler than those metre that

used two different detectors to mensurate. It besides can cut down tear and wear for the mechanical portion. [14]

In air current wind gauge, it can use detectors like optical detector, reed switch or hall detector. In this undertaking, it will use hall detector because it consume less power and non bring forth any noise like reed switch. [14]

For way metre, it can utilize potentiometer or optical grey encoder. But with hall detector, it can merely utilize a individual air current vane with the air current velocity metre and left the mechanical building more simple and easy to construct. [14]

5. 1 Aim

Construct a circuit that has the ability to mensurate the air current velocity and the way of the velocity.

The device has to be easy to utilize.

Able to expose the consequence in digital signifier.

To larn more about the detector and microcontroller

6. 0 Undertaking BACKGROUND

Hall-effect detector

Hall consequence detector was a device that will trip when it detect the nowadays of magnetic field. This detector will observe the denseness of magnetic flux around it. When the denseness of magnetic flux around the detector was exceed certain degree, this will do the detector on and bring forth an end product electromotive force called Hall electromotive force, VH.

The end product electromotive force, VH are direct relative to the strength of magnetic field.

Figure 1: Diagram of how the hall-effect detector operate. [4]

It was made by a thin rectangular p-type semiconducting material stuff like Ga arsenide (GaAs) , indium antimonide (InSb) or indium arsenide (InAs) and have uninterrupted current flow on it. When there have the presence of magnetic field, the magnetic flux will exercise force on the stuff and debar the stuff ‘ s the charge, negatrons and holes to one of the side of the semiconducting material slab. Potential difference are produce between two sides of semiconducting material by charge bearers. The motion of negatrons through the semiconducting material besides will be affect by the presence of magnetic field. For bring forthing possible difference across the semiconducting material, the magnetic flux lines must be 90A° perpendicular to flux of current. Normally the hall-effect detector are in off manner when no presence of magnetic field and in on manner when exist of magnetic field.

Normally a hall-effect detector are build with a DC amplifier, logic shift and electromotive force regulator to better the end product electromotive force, detectors sensitiveness and hysteresis. It besides let the detectors can run over a scope of power supply and magnetic field conditions.

The hall-effect detector have two type of end product which is additive or digital. For additive end product, the end product signal will taken straight from the end product of op-amp with the end product electromotive force, VH are straight relative to the magnetic field go throughing the device. It

was produce uninterrupted end product electromotive force and will impact by the strength of the magnetic field. The end product electromotive force can be increase to a saturate degree which are the value of power supply. Further addition of the strength of magnetic field will non increase the end product electromotive force but it will stay in saturate degree. For digital end product, when the magnetic flux passing through the detector exceed a certain value, it will alter the province of detector from OFF to ON. The oscillation of end product signal ‘ s job that produce when the detectors move in & A ; out of the magnetic field are solved by the detector ‘ s hysteresis. So, the end product for a digital are merely in two provinces which is ON or OFF. The hall-effect detector besides can distinguish by bipolar or unipolar.

In this undertaking, the detector that will be used are unipolar type and the end product of the detector are parallel. It need analog end product because it need uninterrupted electromotive force to mensurate the alterations of mean value and the frequence to mensurate the air current way and the velocity. The method of sensing in this undertaking will be crabwise sensing. The magnet are move sideways across the surface of the detector.

Operational amplifier

Operational amplifier (op-amp) are a device that have about all the demand to be ideal DC elaboration. It had been used widely to filtrate signal, mathematical operation (amount, subtract, distinction, integrating) or signal conditioning. It will hold 3 terminus which is inverting input, non-inverting input and end product. Normally an ideal op-amp must hold the feature of

High electromotive force addition,

High input opposition,

Low end product opposition,

No current flow at input,

The input electromotive force must be with end product electromotive force

An ideal of an op-amp was been labelled as a electromotive force controlled electromotive force beginning. The undermentioned diagram was the construction of an ideal op-amp. The end product electromotive force can be found by the addition, A multiple by the input electromotive force, Vout = A X Vin. Input electromotive force, Vin was the difference of V2, non- inverting electromotive force and V1, inverting electromotive force while the addition, A was the elaboration addition of the circuit.

Figure 2: Structure of ideal op-amp [5]

A op-amp can be used in few different ways such as non-inverting amplifier, inverting amplifier, summing amplifier, differential amplifier, planimeter and others. For this undertaking, the inverting amplifier was been use. It has negative electromotive force addition. It mean that if the input electromotive force is addition, the end product electromotive force will diminish, or frailty versa harmonizing to the electromotive force addition value. In the circuit of inverting amplifier, the input is connect to a resistance, Rin before connect to the op-amp and a feedback resistance, Rf is connect between the end product and the input. Non-inverting input are non be use in this type

amplifier and merely link to land. The undermentioned diagram was shown the circuit of inverting amplifier.

Figure 3: Circuit of Inverting Amplifier [5]

As an ideal op-amp have a really high addition. But in world, the really high addition will do the amplifier unstable and hard to command. So, a feedback resistance, Rf are used to command the addition of the amplifier and do the system stable. This method is know as negative feedback. Negative feedback will direct some of the end product signal back to the inverting input. This feedback will do the electromotive force different between inverting input and the end product become about zero and formed a closed cringle circuit. This closed cringle circuit will alter the addition of the amplifier to closed loop addition. This addition so will utilize the negative feedback control the overall addition accurately and the bandwidth besides will be reduced. This closed cringle circuit besides make the electromotive force at the inverting input about same with the non-inverting input although the non-inverting input was connected to land.

When the negative feedback connect to the inverting input, it will blend with the input electromotive force and organize a summing point. This will do the op-amp hard to place which is the feedback or input signal. To work out this job, a resistance, Rin are used to divide the signal.

Programmer

In this undertaking, I been used MPLAB v8 to compose and prove the codification. This plan was created by Microchip, a company that produce microcontroller and was free to user. MPLAB was a integrated development

environment plan and incorporate toolset for the development of embedded application on microcontroller.

Figure 4: Block diagram of plan a microcontroller

In MPLAB, it contains text editor, MPASM assembly program, PICSTART Plus package and some other maps. For the text editor, it look like a notepad but was a topographic point that can compose the codification. After finish composing the codification, it will salvage the file in “ filename. asm ” file extension.

After save the codification, the codification have to be look into whether it have any job. The assembly program in this plan is called MPASM. It can either bring forth absolute codification or relocatable codification. Relocatable codification is the codification that can unite with another assembled codification by utilizing MPLINK linker. Absolute codification is the concluding codification that can executed straight by a microcontroller. In this design, it merely used absolute codification. The assembly program foremost will roll up and look into the assembly codification for mistake. If the codification was free from mistake, so the assembly program will construct a file in “ filename. hex ” file extension.

To direct the jinx file to microcontroller, a coder is needed. The coder used in this undertaking is called USB ICSP PIC Programmer, UIC00B. It is a low cost and easy to utilize coder. It been design to back up most of the PIC theoretical account like 8bit, 16bit and 32bit mirocontroller. It have ICSP (In Circuit Serial Programming) connection to lade plan, UART tool and Logic tool. It can lade the plan on board or UIC-S socket board. No external power

was required since it use USB to link with computing machine. It aslo can provide 5V electromotive force to the circuit if plan on-board. I was used the coder with UIC-S socket board because it is more easy to link if compare to on-board scheduling. The UIC-S socket board non merely merely can back up 28 pins microcontroller, but it besides can back up 18 pins and 40 pins.

This type of coder was come with his ain package called PICKIT 2 Programming package. It will necessitate the file that created antecedently by MPLAB in hex extension file to plan the microcontroller. Beside it can plan microcontroller, it besides can read or wipe out the codification in the microcontroller.

7. 0 Design

When the air current blown the air current vane, the vane will revolve harmonizing to the way of the air current blown. So, by puting two hall-effect detectors in 90A° to each others, it was possible to mensurate the way of the air current by mention point of angle to the air current way. Each detectors will be supply with a sinewave electromotive force.

At the beginning, it need mensurate the mean value of each detector for a few bend of the vane. When the air current way have somewhat alterations, it besides will alter the mean value of the detector. By compare the alterations of mean value to a angle mention tabular array, the microcontroller can find the way of air current in term of grade.

The air current velocity can be determine by the frequence of the detector ' s sinewave electromotive force. When the air current velocity addition, it

besides will increase the frequence. So, the air current velocity is straight relative to the frequence.

Figure 5: Block Diagram of step wind velocity and way

In this design ‘ s block diagram, there will be hold two detectors install in 90A° to each others. Each of them will link to a operational amplifier which will move as amplifier to change over the signal from parallel to digital type. Then, the digital signal will direct to a microcontroller to procedure. It besides have a clipper that act as bound the sum of input been gaining control to be send to microcontroller. After the microcontroller done the computation, it will direct the information to LCD and the LCD will demo the consequence.

8. Construction AND Testing

8. 1 Circuit Analysis

In this design, the chief constituent was the microcontroller, PIC16F876, IC1. The two input are used 10-bit Analog to Digital convertor and a capture/compare faculty with one input are used to mensurate the mention signal.

Two hall-effect detectors, Q2 & A ; Q3 will be connect to a dual operational amplifier. The quartz crystal, X1, 16 MHz clock frequence, both side will link to a little value capacitance 15 pf, C1 & A ; C2 before connect to microcontroller. The operational amplifier ‘ s signal are adjust to optimal so that the microcontroller can back up. To set the signal, a CRO has been used.

The end product have to be in scope of 0. 5V to 4. 5V and the signal have to be without any deformation.

For LCD, the port like R/W, Enable and RS are connect to PIC to drive the LCD. It used 4 datalines (DB0, DB1, DB2 & A ; DB3) instead than 8 datalines because it was operated in 4-bit manner.

The chief supply electromotive force in this design was 9V battery. Since this design merely necessitate 5V-DC supply electromotive force, so it besides include a regulator in this circuit to step down the electromotive force from 9V to 5V. A regulator bit, 7805 and three capacitance were used to step down the electromotive force.

8. 2 Circuit Diagram

Figure 6: Circuit of the Design

8. 3 Bill of Material

No

Material

Measure

1

Resistor 5. 6ka„¦

2

2

Resistor 10ka„¦

5

3

Resistor 1ka„¦

1

4

50ka„¦ Turn-finger adjust potentiometer

2

5

5ka„¦ Turn-finger adjust potentiometer

2

6

Ceramic capacitance 15 pF

2

7

Ceramic capacitance 100 nF

2

8

Capacitor 100 uF

1

9

Capacitor 10 uF

1

10

Capacitor 1 uF

1

11

Diode, 1N4148

1

12

NPN Transistor, BC547

1

13

Low power double operational amplifier, LM358AN

1

14

Microcontroller, PIC16F876

1

15

Regulator IC, 7805

1

16

Hall-effect detector, A1301EUA

2

17

Crystal, 16 Megahertz

1

18

LCD, 16X2

1

8. 5 To plan the microcontroler

After the the design been set up on the board, it still got few thing have to make. First, the microcontroller demand to be plan. To plan the movie, foremost the movie was placed to a coder (figure 7) . The coder was came with it package called PICKIT2 (figure 8) which is really simple to utilize. The movie so are plan with the codification shown below in appendix.

Figure 7: Programmer

Figure 8: PICKIT 2 package

8. 6 Adjust the amplifier

After the microcontroller been programmed and put in to the board, there is 4 potentiometer (VR1- VR4) in the circuit demand to be adjust. The potentiometer for VR1 and VR2 was for elaboration while VR3 and VR4 was for beginning. All of the potentiometer demand to be adjust so that the end product electromotive force for amplifier was between the scope of 0. 5 to 4. 5V. This can been done with a aid of oscillator. First, the circuit demand to be switch on and allow the air current vane tally. Then get down adjust the potentiometer and detect the signal green goods by pin 1 and pin 7. The end product electromotive force should be in sinewave signal and no cutting.

8. 7 Callibration

Wind velocity standardization

First the air current velocity metre will mensurate the period for a revolution and the velocity can be calculate by velocity = K / Period. The K is the changeless, speed factor. The invariable was base on the comparing of the

step velocity and the existent velocity. It can be find by the undermentioned expression, Speed factor = Y + 256X where the Y is existent velocity and ten is measured velocity.

Wind way standardization

Each of the detector are linked to a 72 value tabular array with 5 degree increase. This have to be done because there is difference of force in the magnet. This standardization need a package called tuning package and the circuit demand connected to a computing machine while make this standardization. First, this plan are set 8 points for each curve of the detector. Each of the points will hold 45 grade to each other. Then it need turn the air current vane by manus until it reach 45 grade and salvage the information by the package. This procedure demand to be continue until all the 8 points been set. The circuit will be ready to mensurate after all the informations been set.

9. 0 Decisions

The chief job in this undertaking was the air current vane. The air current vane was need some mechanical accomplishment to construct. So, I merely stick the magnet on the rod and it was without the air current vane. This lone can proving the circuit.

The chief disadvantage of this design was it ca n’t demo the precisely value of the air current way. It merely can expose the consequence in value of multiply of 5. So if the measured way value was non precisely 5 degree interval, it will round the consequence to the nearest. ex. 6 grade, it will shown 5 grade. So it was somewhat less accurate. This can be solve if it set

more values for the mention curve but this will besides increase the clip from step to expose the consequence.

Overall the constituents that need in this design was less therefore it was inexpensive to construct. The use of the hall consequence detector besides cut down the mechanical portion and it was free of mechanical job.

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