Design of a Wind Vane System with Anemometer Using Pic Microcontroller

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***Abstract*— Importance of wind speed and direction is significant feature for weather forecasting and air navigation in army and other aspects of science. In this paper, a microcontroller based wind speed measurement and wind direction monitoring system has been designed as well as enhanced. An IR sensor is used to convert the wind speed into electrical pulses in cup anemometer. Microcontroller counts the input pulse from IR sensor and display the wind velocity in particular unit according to program installed into the microcontroller. An IR sensor is used to sense exact direction by taking one horizon as base in accuracy of single degree. In addition, LCD display board is used to visualize the real time wind speed and direction actively. Finally the alert message will be sent to the people through GSM when wind speed crosses the threshold speed.**

Keywords*— Microcontroller, IR sensor, Anemometer, Wind Vane, LCD & GSM

I. INTRODUCTION

Wind is the natural motion of the air which is parallel to the surface of the Earth. It is caused by the unequal heating and cooling of the Earth and atmosphere by the sun, which produces differences in air pressure. As the atmosphere shifts air flow to equalize these differences wind is obtained, tending to flow from areas of high pressure to areas of low pressure. Some of the factors also come into play that can impact the wind speed and direction, such as Earth's rotation, the condensation of water vapor, the formation of clouds, friction over land and water, and others. As per the statistics on March 2011, only 29% of the total gross potential for wind power development was installed in India of which 32% alone is technically usable. Since the government targets for to enhance the wind power production to 60GW by 2022, it's clear that India is more focused to produce electricity using renewable sources towards clean energy technology. The study therefore presents a design which could possibly provide a potential to be used in wind resource assessments. Wind is commonly measured and analyzed with its scalar components separately; wind speed with anemometer and wind direction with wind vane or weather vane. The annual nature of the system of air circulation in the troposphere, affects both the wind speed and direction at a location. Due to their linearity and accuracy, rotational anemometers of cup type is commonly used for wind speed measurements. Though the measurements taken are usually of mean wind data, instantaneous wind measurement is also important. Instantaneous wind speed and direction data assist in analyzing the build of the turbine and tower whereas the mean wind speed data predicts wind power generation . Minor differences in the wind speed measurement affects the power generation greatly. The air flow tracks as well as speed monitoring are major part in modern trends of technological advancement in the agricultural farmland, battle field, wind power harvesting and mainly on weather forecasting. According to the conditions of application system, different tools are applied to measure the wind speed and direction. In this paper, a simple electronic circuit is designed to determine real time wind speed as well as direction.

II .HARDWARE DESCRIPTION

A. PIC Microcontroller 16F877A

The term PIC or Peripheral Interface Controller has been coined by Microchip Technology Incorporated. PIC use the Harvard Architecture, it use both Data memory (RAM) and Program Memory (ROM). In PIC 16F877A, it has 40 pin package,8kB of flash program memory with 3 internal hardware timers, built- in USART for serial communication and 5 digital I/0 ports. All instructions in 16F877A are single instruction. They take two machine cycles to complete an instruction. PIC 16F877A finds its applications in a huge number of devices. It consists of two 8 bit and one 16 bit timer. Capture and compare ports, serial ports, parallel ports and five input/output ports are also present. It is used in remote sensors, security and safety devices, home automation and in many industrial instruments. The PIC microcontroller PIC16F877A is one of the most renowned microcontrollers in the industry. This controller is very convenient to use, the coding or programming of this PIC microcontroller is also easier than other controllers. One of the main advantages is that it can be easily write-erase as many times as possible because it use FLASH memory technology.

The cost of this controller is low and its handling is also easy. The PIC 16F877A was shown in Fig.1 as below.

Figure 1 PIC 167877A

B. IR Sensor

An InfraRed sensor is an electronic device , that emits in order to sense some facets of the surroundings which is invisible to eye. Sensors are important components in many applications,not only in the industries for control but also in the day to day life for human's safety and security monitoring,traffic flow measuring,weather condition

monitoring system. An IR sensor can measure the heat of an object as well as detects the motion. IR light is detected by photodiode. The resistance and that output voltages,change in propotion to the magnitude of the IR light received. IR sensor can be classified into different types depending on the applications. The speed sensor is used for synchronizing the speed of multiple motors. The IR sensor is shown in Fig. 2 for reference.

Figure 2 IR Sensor

C. Anemometer and Wind Vane

Anemometer is an instrument used to determine the speed of the wind. It is derived from Greek word 'anemos'. A number of mechanical technique have already employed to attain real time statistics of speed of the air flow, for example cup anemometer consists of three or four semicircular cups are installed at dead end of the three or four arms are mounted on top of the tower by means of bearing to rotate in less mechanical friction. Air put the pressure on cups while blowing in vertical direction and turns the arms proportionally to wind speed. The weather vane that comes attached with the anemometer is flexible and has quick response to align itself pointing to the direction in which the wind blows. The vane's direction corresponding voltage is recognized and direction is displayed accordingly on the LCD. The Anemometer setup and wind vane setup is displayed in Fig. 3 and Fig. 4 for reference.

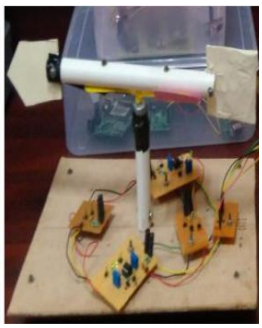

Figure 3 Anemometer Setup Figure 4 Wind Vane Setup

D. LCD

LCD (Liquid Crystal Display) monitor is an electronic display module. A 16x2 LCD display is very simple module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. A 16x2 LCD incomes it can display 16 characters per. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers namely command and data. The data is the ASCII value of the character to display on the LCD ranging from 0 to 255. It is used in various electronic gadgets and devices like Television, Computers, Laptops, and Watches. The 16x2 LCD is displayed in Fig. 5 for reference.

Figure 5 LCD Display

E. GSM

GSM (Global System for Mobile communications) is a typical developed standard by European Telecommunications Standards Institute (ETSI) to describe the protocols for second generation (2G) digital cellular networks utilized by mobile phones, first deployed in Finland in July 1991. It is an open source system allows access to code. It operates based on 900 MHz, 1800 MHz and 1900 MHz. It uses Time Division Multiple Access (TDMA) technology as their air interface standard. It has 3 layers.GSM uses voice coders/decoders. It has improved spectrum efficiency with high quality speech and mainly it supports for news services.GSM SIM 300 provides serial TTL interface for easy and direct interface to microcontrollers and
with power supply. Onboard 3V Lithium Battery holder with suitable circuitry for providing backup for the modules internal RTC. It can be used for GSM based Voice communications, Data/Fax, SMS, GPRS and TCP/IP stack and it can be controlled through standard AT commands. The GSM SIM 300 module is displayed below in Fig.6 for reference.

Figure 6 GSM SIM 300

III. SOFTWARE DESCRIPTION

A. MPLAB

Mansfield Public Library Advisory Board is an Integrated Development Environment for the development of embedded applications on PIC microcontroller. MPLAB X is the first version of the IDE to include cross-platform support for Mac OSX and Linux operating systems, in addition to Microsoft Windows. MPLAB 8.X is the last version of the legacy MPLAB IDE Technology, custom built by Microchip Technology in Microsoft Visual C++. It is a free, integrated toolset for the development environment or IDE, because it provides a single integrated environment to develop code for embedded microcontrollers. It runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. These simulators use the PC to simulate the instructions and some peripheral functions of the PIC micro MCU and PIC DSC devices.

MPLAB uses many compilers to run the code. But in this paper HI –TECH C compiler is used. HI-TECH C Compiler for PIC10/12/16 MCUs a whole program compilation technology to provide denser code and better performance on PIC MCUs. This ANSI C compiler assimilates into Microchips MPLAB(R) IDE and is compatible with Microchip debuggers and emulators.

IV. WORK FLOW

The Block diagram for the device is shown in Fig.7. It shows the simple circuit to calculate the speed and direction of wind using IR sensors and PIC 16F877A. The software was implemented using MPLAB . The mechanical setup of Wind vane IR sensor and 3 cup anemometer is used to measure the direction and speed of the wind.

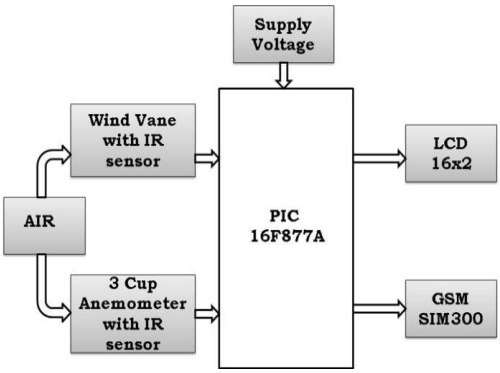

Figure 7 Block Diagram

Output of the IR sensor used to calculate wind speed is connected to PIC counter. Here one timer act as a timer and other timer act as a counter. First, the wind was sensed by the 3 cup anemometer sensor due to the sudden force of the wind the cup tend to rotate and the rotation was calculated by the counter and timer. The counter generates one clock pulse for one rotation and the timer resets for every 6 seconds. Both the output from counter and timer is used to calculate the speed of the wind in addition with the product of the circumference of cup anemometer and RPM value the speed value was generated in kmph. The formula for the speed calculation is given below. Speed=RPM x Circumference of the cup anemometer.

On the other hand the wind was sensed by the wind vane sensor. Each direction was having a separate sensor and it was connected to the input pins of the PIC microcontroller. The corresponding digital output from the wind direction is obtained.

According to the HI TECH-C program dumped into the PIC microcontroller, the corresponding RPM, speed and direction was displayed in the 16x2 LCD. Each time the speed of the wind is compared with the threshold value in the code. If the wind speed is slow then count pulse rate was also low and the corresponding value of the speed was only displayed on the LCD. If it was high then the count pulse rate was also high and the corresponding value of the speed was displayed on the LCD. In addition it gives the alert message to the public using GSM about the RPM, Speed and Direction. When the speed is equal or greater then threshold speed value.

The design methodology is shown in the Fig.8 for reference.

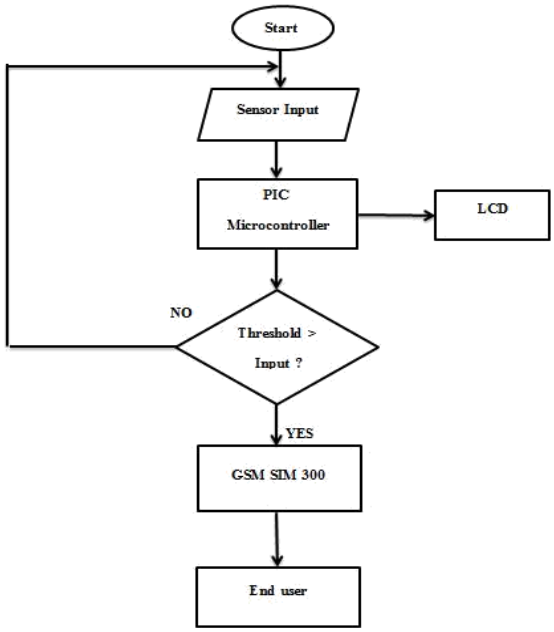

Figure 8 Methodology

At first the IR sensor senses the wind and it was given to the counter and timer. Here generated pulse rate is given to input pin of PIC Microcontroller. The code was implemented by using MPLAB software. According to our application the code was written and installed in the PIC microcontroller. There exists some threshold value which is higher speed of the wind. If the wind speed is below that threshold value then it will go back to the previous stage to sense the wind value. For each sense of the wind RPM, Speed and Direction of the wind was displayed in the LCD device. If the wind speed is exceed above that threshold value then the GSM will set to be active. Then the message will be sent to the higher official about the speed of the wind and the direction of the wind which cause some damage to the public and things in the coastal area. The output of the LCD display is shown in Fig.9 for reference.

Figure 9 Output of LCD

V. CONCLUSION

The system developed using PIC 16F877A microcontroller where measures the real-time wind speed using anemometer and the direction of the wind can be measure by using wind vane system. This system developed using low cost and our proposed method gives warning to the public near the coastal areas. This method can also be used in the Navy, Defense and for Sailor.

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