COMPUTER SUPPORTED WIND SPEED AND DIRECTION MONITORING AND LOGGING SYSTEM

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ABSTRACT

Before an investment in wind turbines takes place a feasibility study should be carried out, which gives information to potential investors about costs and economical aspects of a planned wind energy project. The wind potential of a site actually-mainly determines whether the site is feasible or not

To determine the wind potential of a site, first of all, wind speed information of the site is required. This work is related with the measurement of wind speed and wind data logging to determine the wind potential of a site In the work, wind speed and direction data are converted to electrical signals by a designed-constructed anemometer and a wind direction pointer. These converted wind and direction data are sent to a PC by an interface circuit. A software is written in VB5 and the data gathered is stored and processed in a sensible form for further analysis.

The designed prototype system, with the added properties, will be very helpful in preparing detailed wind map and to wind industry, which are still not mature in our country[1].

1. INTRODUCTION

As time passes world is running out his invaluable fuel sources which were constituted in time as old as world's age. So it seems impossible to construct these sources back with natural ways [2]. The question "so what to do?" is frequently asked by humans especially by the scientists dealing with energy. The only way to fulfil the growing future energy needs seems to start using renewable energy sources more actively.

Wind is one of those major free, clean and inexhaustible renewable energy sources. Actually, for ages, according to historical records since 10^{th} century [3] wind has served mankind well to sail ships, drive windmills to grind grain and pump water and even generating small amounts of electricity. In a period in the past, the discovery of oil, the invention of steam and internal combustion engines and the subsequent large-scale development of power plants caused a rapid decline in the use of wind as a power source [4]. But with progressing technology wind energy showed a steep rise.
Thus the economics of wind energy and other renewable energy sources look extremely encouraging.

Before an investment in wind turbines takes place a feasibility study should be carried out, which gives information to potential investors about costs and economical aspects of a planned wind energy project [5]. Accurate, properly designed measurements are extremely valuable. A lot of money is wasted when decisions have to be made without such measurements.

It is evident that as in many industries we are undeveloped in the energy industry. In this industry many devices are easily imported from foreign countries. In this study a prototype, computer supported wind speed and direction monitoring and logging system which can be easily produced in our country was constructed. The system can be used to draw a wind map of a specific site as well as to determine the wind potential of the whole country with some extras and additions[1].

2. WIND SPEED DETERMINATION

Wind direction and velocity can be measured and recorded accurately by means of instruments or they may be obtained through estimation from certain observations. The means that are used naturally depend on the equipment available and the purpose for which the observations are taken.

Usually wind speed can be determined quite accurately by means of anemometer. There are two common types of anemometers, those employing freely rotating cup wheels and those operating by virtue of the air pressure produced by the wind on a restrained system. Pressure tube anemometer is example of the latter type. Additionally there exist so called "hot wire" and "doppler" anemometers and studies on these are still continuing.

The common-type anemometers consist essentially of three or more hemispherical cups extending on horizontal arms from a vertical shaft or spindle. The higher the wind velocity the faster will the cups rotate the moveable spindle. In former examples of these devices, by means of magneto generator arrangements, or a gear system with proper electrical contacts, this spinning motion is translated to show the wind speed on remote instruments. This equipment may indicate the instantaneous velocity or it may record instantaneous or average velocities [5,6]

2. SYSTEM

First of all it must be stated clearly that such a study was decided due to the high need for wind speed and direction measurement and logging systems in Turkey.

The main objective of the system is to get the digital speed and direction data directly from the hardware designed and process, store and display these data on the monitor in a sensible form. The data gathered in this way may be used to prepare statistical calculations about the wind speed and direction in a required period. The overall system is a combination of mechanical parts, electronics hardware and a PC as shown in Figure 1

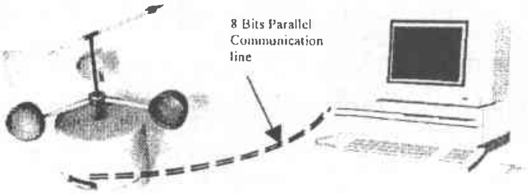

Figure 1 The Overall System

The speed unit consists of a suitably designed PCB and an incrementally coded disk. The coded disk can be seen in the Figure 2. It is rotated by the movement of the wind and with the help of hemispherical cups. This rotation excites an optical sensor on the PCB and owing to this excitation a signal whose frequency changes with changing wind speed is produced. This means that if the disk rotates at a high speed, the frequency of the signal produced will be high and vice-versa. The obtained signal whose frequency changes with the changing wind speed is converted into analog form using a frequency to voltage converter. Thus obtained speed signal is converted into digital form using an 8 bits analog digital converter (A/D).

The direction data is directly taken from a Gray coded disk with the help of photo sensors. Direction data is 4 bits that is why a whole direction scale (360°) is divided into 2^4=16 parts. So the direction resolution is 22.5°. A 5 segments absolute coded disk is used as shown in Figure 2. The 5th (outmost) segment is used to measure the speed and to make the design simpler all codes are located on the same disk [7,8,9].

Speed and direction data are transferred to the PC using a parallel interface. Because the received data on the PC side is still raw it must be calibrated in order to make it approach to the real values. Calibration is performed as it will be explained later.
Because there are two different data sets (speed and direction) to be input to the PC and there exists only one parallel port in the PC, the correct data set selection is done with a command from the PC. This is achieved using a data out line of the PC. This data out line of the parallel port is connected to two separate 3-state buffers but one of them is inverted. So by this way when one is selected the other will be idle.

Figure 2 Coded Disk

The received data are logged into the PC, processed and displayed on an active window. In this active window wind speed and direction information is monitored continuously for that specific site using VB5.0 and some extra toolboxes.

The software of this system has been performed in Visual Basic 5.0. There exist two different screens of the software. The first one (the main) is used for the real time wind data presentation. It includes a compass to show the direction and a speedometer for showing the speed as shown in Figure 3. A strip chart is also included to show the lately recorded data in the past 30 seconds (changeable) as a graph versus time passed. The second one is used to show the back wind data as a graph. At the beginning it covers the whole year. The end user has the ability to zoom in and out to where he wants. He can zoom in up to 15 minutes periods. He can reset to the whole data or go back to one up level zoom as well.

Data is recorded for each minute passes. But the real time wind changes can be viewed through the strip chart section of real time reception vs. period of 30 seconds. After each 1-minute period of this action it is recorded to a database. If it were selected to record the data with a shorter period the database would have been uselessly inflated. That is why such systems mostly use a recording period of 5 minutes (changeable up to 1 hour depending on the purpose) .
other wind readings from the system.

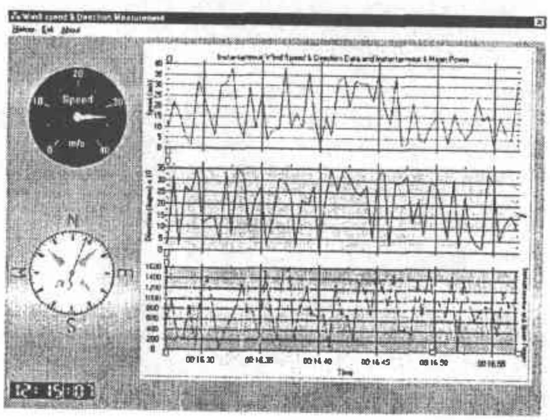

Figure 3 Main Screen of the Software

4. CALIBRATION OF THE SYSTEM

In order to calibrate the system to show the real wind values, a commercially available analog and a digital anemometer with the courtesy of the Head of the Meteorological Affairs office Gaziantep Branch and Akmaks Refrigeration company respectively and a wind tunnel supplied by Mechanical Engineering Department of University of Gaziantep were used. Commercially available anemometers and the constructed system were put in front of a constant wind source such us a ventilator or an air conditioner at same angles to produce the same wind effect on all devices. All readings from anemometers and the constructed system were recorded. And by dividing the value from the system to the value from the anemometers gave us a coefficient, which *will* be used to calculate the
A graphic to show the interrelation of those two data obtained from the device and anemometers respectively after the coefficient was found and the resulting data were drawn as in Figure 4. Additionally, an error indication after the calibration was drawn on the same graph. As seen from the Figure 4 it can easily be said that at almost all speeds, the constructed device shows linearity. It shows a little deflection from the linearity at speed around 4 m/s. But this was due to the high friction force for the low speeds and after a point friction force reduces and stays constant for the further speeds. Due to this, the error is reduced at higher speeds.

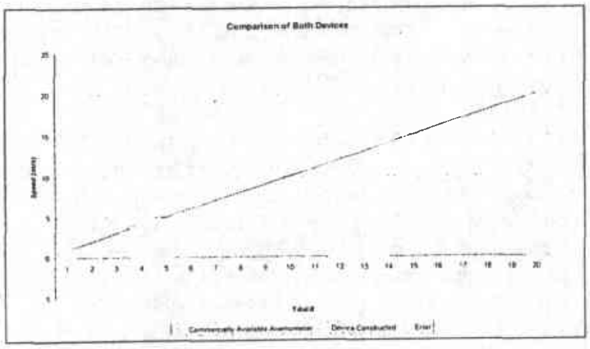

Figure 4 Calibration Results

5. CONCLUSION

Actually there are many commercially available similar systems imported from foreign countries. But they are quite expensive and they increase the dependency of Turkey to foreign countries and cause the waste of money.

The system has some mechanical construction problems. They are caused by mainly from the friction forces exerted by bearings which are not precise and two not very precisely aligned concentric sticks belonging to both speed and direction detection mechanics and imprecise handwork on those sticks. Due to the design depending mainly on handwork these problems were not cleared away.

It is believed that if suitable parts (bearings, nuts, screws, sticks) and machinery had been available these troubles can be minimised.

Tens or hundreds of the radio frequency or telephony supported similar systems can be connected to a central PC. By this way it is believed that a wind map of Turkiye for which formerly a foreigner company was selected can easily be drawn. In any case, investments to be done on this subject will encourage wind industry and help investors on their decisions and support our country for the expected later energy crisis to overcome the problem.

6. REFERENCES

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