THE USE OF LOW COST MICROCOMPUTERS IN SOLAR AND WIND ENERGY DATA MANAGEMENT

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ABSTRACT

Site-specific, assessment of solar and wind energy and data analysis can be a tedious and costly task. However, the recent advent of low cost "home" computers can provide solutions to both tedium and high cost. This paper describes a low cost data acquisition and processing system presently being assembled around a small, inexpensive "home" computer.

INTRODUCTION

Growing interest in alternative energy usage has resulted in an increase in the number of locations worldwide at which solar radiation intensity, wind speed and related parameters are measured. The major requirements of a suitable recording system are accuracy and reliability and especially in the case of developing countries, low cost.

Many types of data recording instruments are currently on the market and these may be placed into two broad categories - those which store data as recorded and those which process data before storing. The former type requires that the data be fed into a computer for analysis. The latter type also requires another instruments to access the data (Wyatt 1983).

Huge quantities of data accumulate in a relatively short time (Munroe, 1978), making it necessary to exercise some degree of control over what data are actually stored. The advent in recent years of relatively inexpensive "home" computers has opened up possibilities for completely computerised data collection and reduction systems with efficient data storage capabilities and at a low cost.

This paper describes the organisation of a small data acquisition and processing system built around a low-cost "home" computer. It illustrates how an important research tool can be assembled at relatively low cost.

DATA ACQUISITION AND PROCESSING SYSTEM

System organisation

The organisation of a typical data acquisition and processing system is illustrated in Figure 1. The system consists of three major sub-systems:

1. Instrument sub system
2. Data management sub-system
3. Power sub-system

Instrument sub-system

The World Meteorological Association (1971) has comprehensively reviewed the types and accuracy of the various instruments available for measuring solar

radiation and wind energy parameters. This will not be repeated here. However, as would be expected, all instruments would need to have a computer compatible output. The Kipp and Zonen or Licor range of pyranometers would thus be quite suitable for solar radiation intensity measurement. Similarly, for wind speed measurement, a suitable instrument would give as output either a voltage or a train of pulses proportional to wind speed. For the wind direction indicator, the sensor should give a voltage output which is proportional to wind direction.

Data management sub-system

The microcomputer

The microcomputer is the most important component in the data management sub-system. Of the several microcomputers available at prices below £150, the Sinclair ZX Spectrum was the one chosen. Reasons for choosing the Spectrum included:

1. Low cost - around £130

2. Excellent software support-programs for statistical analysis, linear regression etc. are readily available commercially.

3. Excellent hardware support - peripherals which are readily available include floppy disc drives for mass storage of data, analog-to-digital interfaces, real-time clock, etc.

4. Good literature support - several books are available on the Sinclair range of computers, for programs, hints and tips, etc.

5. Good "technical" support - there are books and at least one magazine devoted to projects for the Sinclair computers. Those handy in electronics can build and calibrate their own wind speed and direction indicators etc.

6. Data storage capability - the computer can store data alone, without having to store the entire program. This increases the storage efficiency of any storage medium chosen.

7. Can be operated from a single voltage source - unlike some others which require three separate voltage sources. The computer can thus be efficiently operated from a single 12-volt battery.

The ZX Spectrum is an 8-bit microcomputer designed around the Z80A, 8-bit microprocessor. The unexpanded machine with 16 kilobytes (16K) of memory would be quite adequate for this application. However, a 48K machine is currently being used, to allow extra space for program development. The computer is reasonably easy to program and simple programs are required for control of instruments, data channel selection and data capture, analysis and reduction. In operation, the computer reads all the channels every five minutes and processes the data in the time interval between successive readings. Storage of the summary of the results takes place once each hour.

Analog-to-digital converter/multiplexer

The analog-to-digital converter (A/D converter) converts the voltage output of the sensors to a form which is acceptable to the computer. This is available as an off-the-shelf item for the Spectrum, but may be assembled from scratch using any of several designs available. The system should have facilities for channel selection or multiplexing, so that only one A/D converter is required for all the channels used. One channel is required for each sensor and the multiplexer switches the A/D converter to any channel selected for measurement. The unit plugs into the computer and is powered from the computer's power supply.

Data processing and storage

Data storage can be on an ordinary cassette tape recorder. However, problems can arise when trying to run the computer and the tape recorder from the same set of batteries. A better solution would be to use floppy discs for storage. While this can cost from four to ten times as much as a tape recorder, it offers the following advantages:

1. It can be plugged into the expansion port of the computer and receive power from the computer.

2. Information stored on the disc can be accessed in a random manner, rather than only the serial or first-in, first-out basis of the cassette.

3. The system is very fast and a large amount of data may be read (or stored) in seconds, as compared to minutes on the cassette recorder. If the cassette recorder is used, then some additional circuitry would be required to start and stop the recorder by computer, so that the system can be completely automatic.

To cut down on the amount of storage required per channel, some control should be exercised over what information is stored. If information is required hourly, then the following data is stored each hour for each data channel.

1. Maximum value

2. Minimum value

3. Mean value

4. Standard deviation

5. Total (if applicable)

6. Cumulative frequency distribution (ie what percentage is greater or less than a given value).

7. Hour of the day

This procedure would drastically reduce the amount of information to be stored. Values for any given day may be synthesised from the hourly values. The computer is quite suitable for this task and would perform the required calculations rapidly and accurately though only within the limits of accuracy of the original data.

Real-time clock

The real-time clock can be read and set by the computer. If measurements are to be made every five minutes, then the computer will take its time from the clock which it frequently reads. Data is then processed once each hour on the hour and stored.

The clock would have its own rechargeable nickel-cadmium battery and once set, would continue running independent of the rest of the sytem.

Visual display unit

An ordinary television set is adequate for this purpose. This does not need to be operating continuously when the system is fully operational but is necessary for monitoring any communication with the computer.

Power sub-system

The power sub-system is quite straight forward, and consists of a 12-volt battery and a battery charger connected to the mains supply. In operation, the mains charges the batteries as well as supplying power to the computer. In the event of a power failure, the batteries take over automatically and system operation continues unaffected, since the power sub-system constitutes an uninterruptible power supply. The size of the battery determines how long the system can continue operating after a prolonged mains failure.

Sealed nickel cadmium or lead-acid rechargeable batteries are ideal for this application, since they require virtually no maintenance, eg topping up with distilled water, etc.

SYSTEM PERFORMANCE

It is not possible to give a report on the performance of the system as it is not yet finished. It has undergone some design modifications which are still to be acquired. For example, when the system was first conceived in 1983, there was no floppy disc drive compatible with the Spectrum. Now there are several to choose from.

Sensors for solar radiation monitoring have been acquired and will shortly be mounted. Sensors for wind speed and direction are being designed and built locally. They are to be calibrated against a meteorological intrument which is expected to be located at the University in the very near future. It is hoped that a report on system performance, cost and component availability can be given soon after the system is completed.

CONCLUSION

The system described here demonstrates that an inexpensive "home" computer can be converted at relatively low cost to a data management system for solar and wind energy studies.

REFERENCES

Munroe M M (1978) A data logging and processing system for solar energy studies. Thesis: (Ph.D.) University of Bradford, UK.

World Meteorological Organisation (1971) Guide to meteorological instrumentation and observing practices

Wyatt J H A (1983) Anemometers and microcomputers in wind energy data collection and analysis. Training Workshop on Meteorological Data for Solar and Wind Energy Applications, 20-25 June, Maha, Seychelles.

Figure 1: Organisation of the data acquisition system