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Design of a Microcontroller Based Automated Pyranometer

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Abstract:

An experimental system for measuring the intensity of solar radiation has been developed; it is done based on a microcontroller and can measure eight signals at programmable time intervals. The data are acquired from sensors are placed on a dome to monitor and measure the insolation during the whole day. Thanks to the technology used the system has a large autonomy of use, which allowed us to measure the sunlight with an accuracy of about 0.1%.

Key word*:* Irradiance; microcontroller; photodiode; zigbee

1. Introduction:

Solar radiation data is important for a wide range of applications, e.g. in engineering, agriculture, health sector, and in many fields of the natural sciences. A few examples showing the diversity of applications may include: architecture and building design e.g. air conditioning and cooling systems, solar heating system design and use, solar power generation, weather and climate prediction models, evaporation and irrigation**.** Generally, the sunshine is the time during which the sun shone on an area exceeding the $120W/m^2$ [1-3]. The extent of this irreverent, thereby using the heliograph Campbell stokes, an instrument used in most weather stations. Today, microprocessor devices are used to collect meteorological data and most of them are especially designed for solar energy applications [4]. In this paper, we present a microcontroller-based radiation data-acquisition system was devised in our laboratory. This system, described in the next sections, is able to work alone for one month. The data so recorded are then carried in a non-volatile random access memory (NOVRAM) cartridge and transferred to a personal computer via zigbee wireless terminal. This system is versatile and easily transportable. Preliminary results obtained during such an experiment are presented as well.

2. General presentation

Our system is represented by its block diagram in Fig.1. It consists mainly of three modules: The patient's acquisition and processing board, the medical storage unit in the medical control unit in the PC. The microcontroller receives the sensor signals from the conditioning circuit and stores them temporarily in its EEPROM memory. The data are then transferred to a personal computer via the Bluetooth module [4-5].

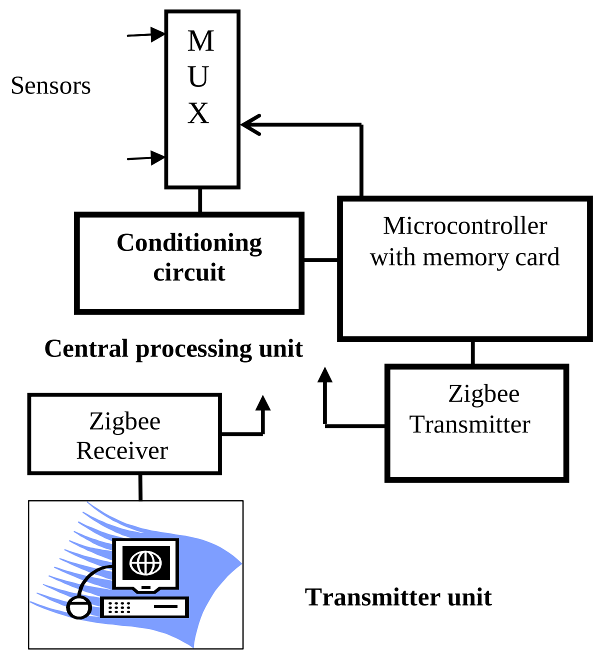

Fig 1. Block diagram of the data acquisition system.

3. Sensor calibration:

The circuit described in Fig.1 is used for conditioning the signal arising from the silicon BPW34 photodiode [5]. Briefly, the signal obtained at the output of the pyranometer is converted to-voltage and amplified by instrumentation amplifier.

Figure 2 shows a typical set of experimental voltage-irradiation curves of a BPW34 photodiode in the radiation range 950-1200 W/m^2. The transparent plastic packaging that allows the device to be sensitive to light from 400 nm to 1100 nm. They make the possibility of using them as solar radiation measurement in meteorological application. The sensor is operated in photovoltaique mode.

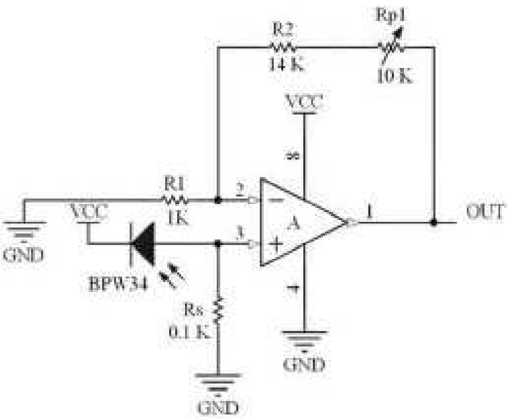

Fig. 1 conditioning circuit for each single photodiode.

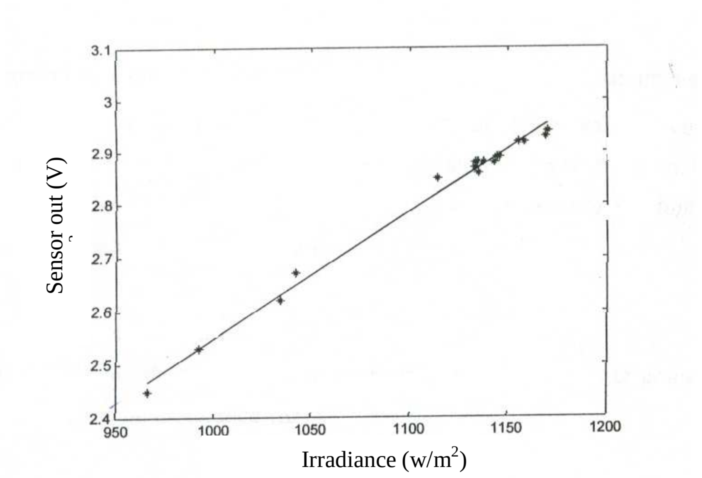

Fig 2: Calibration of the conditioning circuit

As shown in figure 3 eight sensors are placed on a glass dome to monitor and measure the maximum solar radiation. The samples were taken by the Clear Sky, it was also noted that the acquisition time is seven hours and the duration between two successive acquisitions is one minute. Figures 4a-4h represents the responses from eight separate sensors for the day of September 14-2008. The variation nine daily irradiance is shown in fig 5. It is obtained from the eight responses, taking into account only the maximum value.

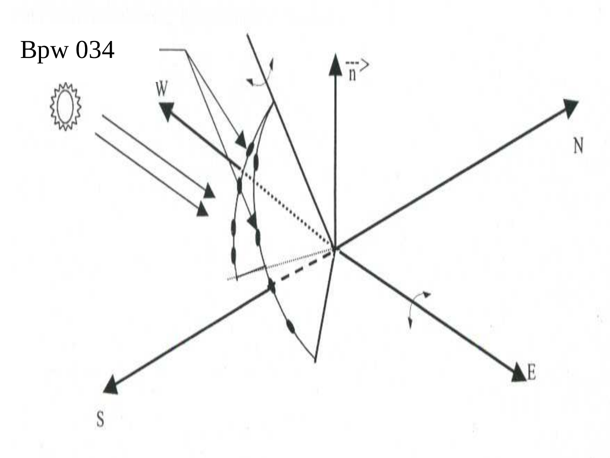

Fig.3. Numbering and Orientation of eight photodiodes

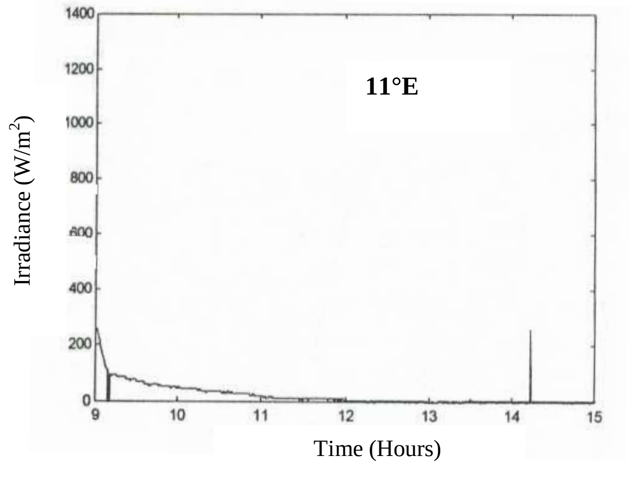

Fig 4.a: 11°E photodiode location

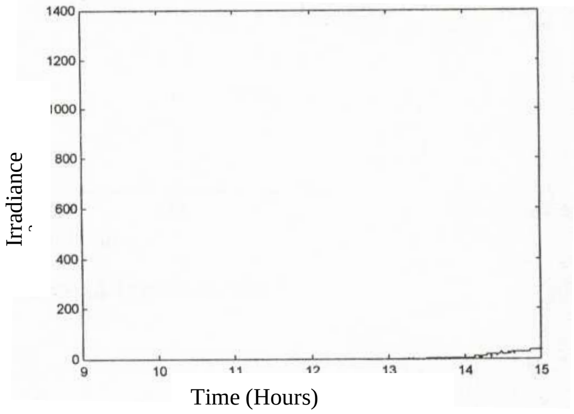

Fig 4.a: 11°W photodiode location

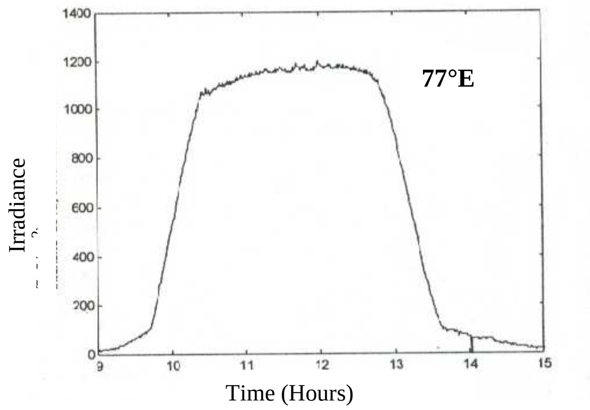

Fig 4.a: 77°E photodiode location

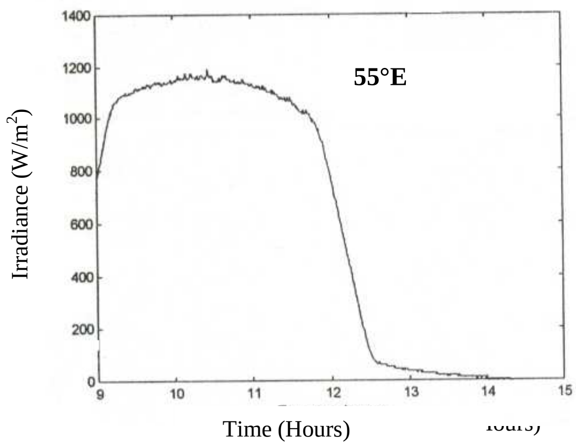

Fig 4.a: 55°E photodiode location

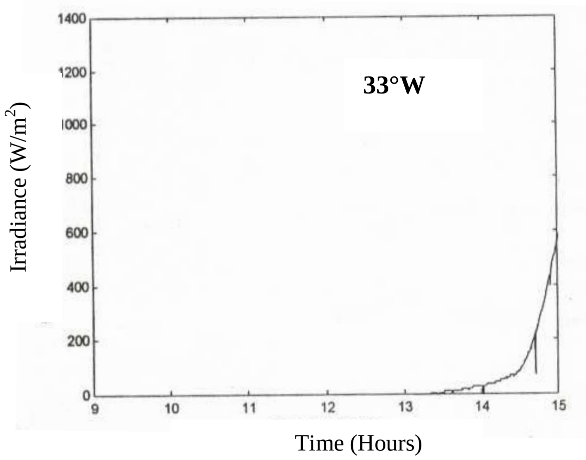

Fig 4.a: 33°W photodiode location

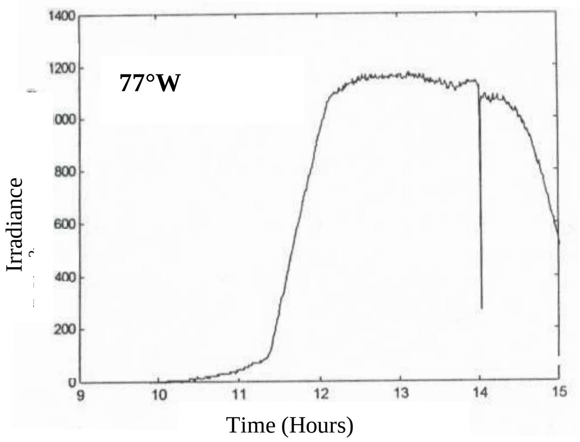

Fig 4.a: 77°W photodiode location

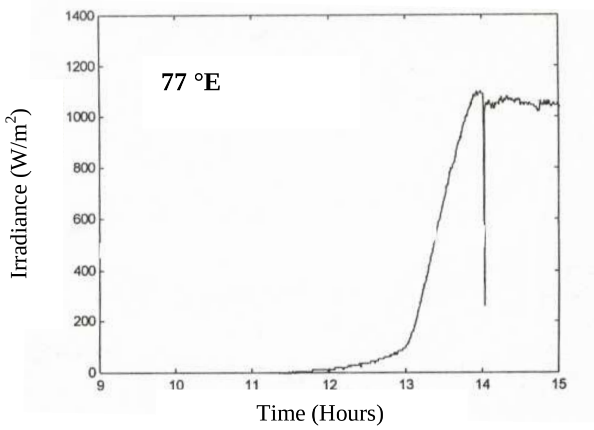

Fig 4.a: 77°E photodiode location

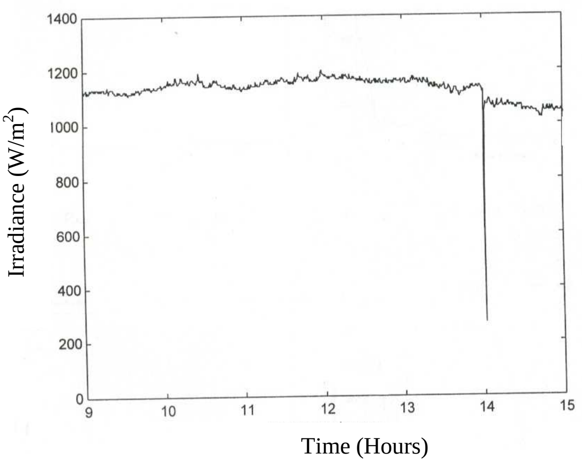

Fig.5 Variation of the irradiance by the Clear Sky

4. Conclusion

A new low-cost solar radiation sensing transducer is proposed to individuate the direction corresponding to maximum insulation and to measure the solar radiation components. The experiment results show that our embedded system has good sensibility is accurate about 0.1%. The system can be adapted for the simultaneous measurement of other meteorological parameters. It constitutes an additional means for calibration of data from meteorological satellites. The duplication of such a device could solve the lack of data on solar radiation in Algeria.

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