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Design and Application of Internet Based Solar Pump and Monitoring System

M. Dursun and E.N. Yılmaz
Department of Electrical Education, Faculty of Technical Education, Gazi University,
Mahir Dursun, 06500, Teknikokullar/Ankara, Turkey

Abstract: In this study, a solar pump system has been designed and setup. This system controlled by using software which JAVA programming language has been carrying over the internet. This software provides more flexibility over the system and data, such as transmitting data from the panel to the host computer, data follow data acquisition and monitoring, intervention in necessary situations. It is built around a WEB server with dynamic HTML and JAVA that include direct access to digital I/O, analog I/O, parallel ports, USB ports and serial ports, as well as databases.

Key words: Solar energy observing, internet control, solar pumping, data follow, data acquisition and monitoring

INTRODUCTION

All over the world, the peak demand load is increasing and the load factor of utility is decreasing year-by-year (Rahman *et al*., 2004). As, the fossil fuel is considered insufficient, solar energy becomes more important. By the help of the improvements concerning photovoltaic system technology, the implementations to telecommunication, space studies, middle grade energy manufacturing plants and operating irrigation pumps at rural area without electricity (Mori, 2000). Nowadays, the utilization of solar cells, which are used to supply electrical energy, has more and more investment and branch of business (Argul *et al*., 2002). Solar-powered pumps are available in a wide variety of configurations. If the water source is a dugout, floating pumps are available. If the water source is a well, submersible centrifugal pumps are often used. For dugouts, streams and shallow wells, self-priming surface centrifugal or positive-displacement pumps can be used. Whatever kind of pump is used, it is especially important in low-voltage applications like solar energy that care is taken to ensure that the pump is matched to head and discharge requirements of the application. Furthermore, there are many advantages like mobility, silence, longevity and lightness (Setaka *et al*., 2000).

Not only installation of a system but also monitoring and controlling of that system are important. However, charging at least one of the operators for this monitoring increase the costs alongside with the errors. The costs are very important for small-scale applications. Generally, simple calculations and installed monitoring-following systems are neglected for small-scale applications in the designed systems (Rosenthal *et al*., 1997).

Through the widespread usage of internet has removed the distances and has generalized the usage of e-technology on many applications. In consideration of its having own network structure and accordingly having an advantage on communication area, it has began to highlight internet based control systems.

In this study, the target is to monitor and control a developed solar pump system by using the available internet foundation. In this system, java-programming language has been used. The main reason to choose this language is:

- Because of its structure, it will be acceptable at many platforms without any extra recovery
- It can be operated at long distant connections without any extra software and hardware
- It can be connected during off-hours
- Its maintenance and reparation will be easy due to its limited number of elements

Especially during installation stage, there will be no need to form a communication line for data transfer so there will be no time waste and it will be employment economy.

SUN TRACKING AND SOLAR PUMP SYSTEM

Tracking of solar collectors is an effective method to increase energy yield (Teolan, 2008). For concentrated collectors (especially in desert conditions), two-axes

Corresponding Author: Mahir Dursun, Department of Electrical Education, Faculty of Technical Education, Gazi University, Mahir Dursun, 06500, Teknikokullar/Ankara, Turkey Tel: +90(312)2028526 Fax: +90(312) 212 00 59

Table 1: Average sunbath time in application area.

	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Daily average of sun hours	2.6	4.0	5.6	6.4	8.6	10.4	11.4	10.9	9.4	6.6	4.4	2.4
Monthly average of sun hours	80.6	112.0	173.6	192.0	266.6	312.0	353.4	337.9	282.0	204.6	132.0	74.4
Average number of sun days	29.5	17.8	20.8	17.4	18.6	20.7	27.0	27.7	26.3	23.7	21.0	19.9

tracking systems are used effectively, as they are most productive and relative cost of their drive is not so high compared with the concentrator (Abdallah and Badran, 2008). For the region that the system was built, the total average sunbath time where shown in Table 1 (Turkish Government Meteorology, 2008) per year which is 2520 h (totally 6, 9 h day^{-1}) and the average total radiation strength which is 1311 kWh m^{-2} year^{-1} (totally 3, 6 k Wh m^{-2} day^{-1}) are detected.

On the basis of the data in the table, a prototype solar pump tracking system has been developed and installed at the experimental site and connected to a control station, placed near well. In this developed pump tracking system, 2 items of 24 V Direct Current (DC) motor has been used and these motors which are fed by the energy produced by PV Panels has also been used for the movements of these panels. PIC16F877 microcontroller whose effect to system cost is negligible has been used for controller. Besides, PIC16F877 microcontroller has again been fed by the energy stored at PV panels. Four items of LDR components have been separated into 2 groups and have been located in order to sense the light through East-West, North-South direction. The error signal has been produced through the voltage difference of these components and the position error of the panels has been detected. By means of the control method, the panels have gathered the sunlight vertically. Therefore, independent from the geographical coordinates of the system, it senses the sun light automatically and it can follow the sun continuously in the view of the world's cycle. The system can follow the sun at vertical and horizontal axis. Figure 1 shows the photograph of the movement mechanism of the sun tracking system at the horizontal axis. The designed sun tracking system can track to sun it at both vertical and horizontal axis during the day.

In order to tracking in the direction of East-West, an endless round screw has been located to the bottom of the system. The voltage of LDR components is set to be equal when the panel gathers the sunlight vertically. In case of the panels did not gather the sunlight vertically, the voltage on LDR whose resistances changes according to the sunlight. This voltage difference detected by the analog inputs of PIC circuit is used to get information about the direction and the reference speed for the motor by undergoing it fuzzy logic controller, however, subject of this study is not position control with fuzzy logic. On

Fig. 1: Movement mechanism

Fig. 2: General view of solar monitoring pump system

the output of fuzzy logic a direction, PIC micro controller transfers speed and cycle signal. These signals collected from the power circuit have been used for running the motor and turning the endless screw. By speeding down between the endless screw and gear with the rate of 1:100 step differences, the torque has been increased and the vibrations while the panel is getting to its reference location have been reduced by the slow motion of the system. A dead zone in PIC microcontroller has been defined for preventing the continuous running and energy consumption of the motor, which turns the panels. Therefore, the panels could monitor the sun light with maximum error margin of 1%.

System stops automatically when a cloud comes in front of the sun or it gets darks and keeps that position until the sun light arises again. As the sun rises, the system finds it in a 5 min period and starts running. Figure 2 shows the photograph of solar pump system.

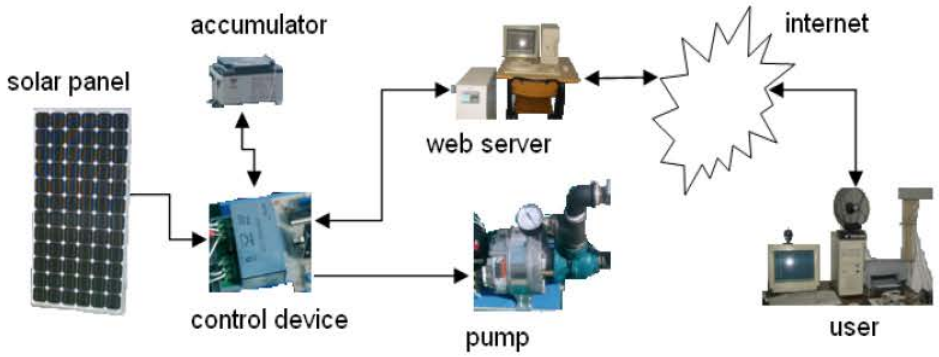

Fig. 3: The general structure of the sun monitoring system

INTERNET BASED MONITORING SYSTEM

In order to make an internet based monitoring system, the application area has chosen to be a pump in an open use area with two solar panels. The basic structure of the system can be seen in Fig. 3 and control system can be shown in Fig. 4.

In order to observe and control the system while working, one computer has been used and already present LAN line has connected it to the internet. All the data observed and control functions have been performed from monitor.

It has been aimed the study to be observe through internet at will and the communication and control functions to be done by the help of computer ports. This developed solar pump monitoring system was designed by using Java Program. Many sub programs have been used to improve the functionality and the clarity of the program. The start point of the system is a file called sun.class.

Knowledge is the most valuable thing for foundations. In the foundations defined with not only the employees but also customers, business partners and part owners, it has a strategic importance to create the good faith related to the knowledge conservation and confidence. Fast growing technology and communication facilities present new potentialities for committing crimes in electronic form while they bring along the solutions for knowledge conservation (Filibeli *et al*., 2007). A probable security problem in electronically form can prejudice the foundations by financial loss, strategic knowledge loss, confidence loss and image loss. In order not to have such losses, a firewall must be installed into the system.

Together with being essential, control through internet is a risky process in the security and illegal people field. The units that will be under control must be carefully observed. Concerning system security and business principles, in real-time connections, it is not acceptable everyone to freely enter and check variables.

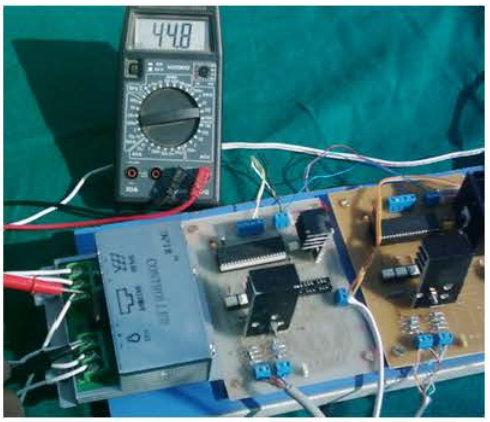

Fig. 4: Control card view of solar monitoring system

Fig. 5: Password page for control and monitoring functions

As shown in Fig. 5 password page for real-time images, graphs and controls which can be opened only by authorized people have been designed. The user password and name are required for that page.

Password pages have been designed sufficiently protected against unauthorized accesses. Hence, in order program passwords not to be cracked, an interface has been improved and masking has done for saving the opened page. The developed interface casually mixes the user name and password and sends it to the main program. The help of the analyzer located in the main

program forms the right logic order. Therefore, passwords are hidden and the protection against unauthorized accesses is provided. Considering the sensitivities of the system, authorization is done only from the main computer, not through the internet.

Solar panels do not hold line voltage at the output. The voltage obtained from them should be made suitable for system voltage. For this reason, an inverter circuit should assist the system. The inverter control form in Fig. 6 appears after the authorization passwords was entered and inverter control part located in the main form of real time functions is selected.

The system can be start and stopped by use of the serial port of the computer. The control authorizations that will bring the system into critical levels or damage the system are principally avoided. The authorization of running or stopping the system is used in case of a problem.

In order to put the real time controls in the practice, one of the ports of serial, parallel or USB can be selected. The control circuit would be as shown in Fig. 7 for USB port. At the application, one optocoupler integrated has been used for each output signal. Thanks to this, the port has been protected against backward and excessive current.

A simple camera mechanism has been installed in order the system to run or to be observed. This installed mechanism is also moved into the internet area. The view of that form is shown in Fig. 8.

As database and the past time oriented analyses is the principle for Solar pump monitoring systems, past time-oriented camera reviewing is sometimes required for security control. Under that circumstance, an assistant program copies the view.

Some of the important properties of solar pump monitoring system is the view or data save and

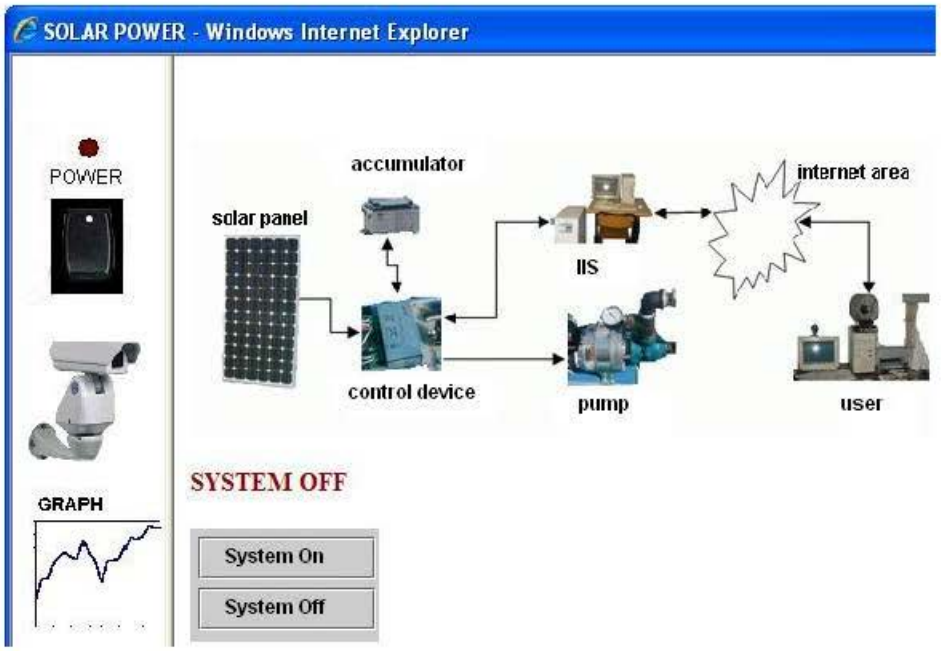

Fig. 6: The inverter control form

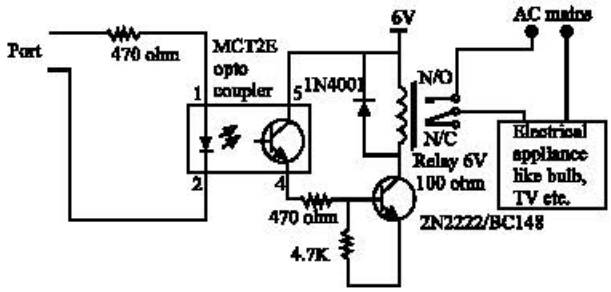

Fig. 7: Simplified port circuit for real-time controls

Fig. 8: The view of real-time camera monitoring form

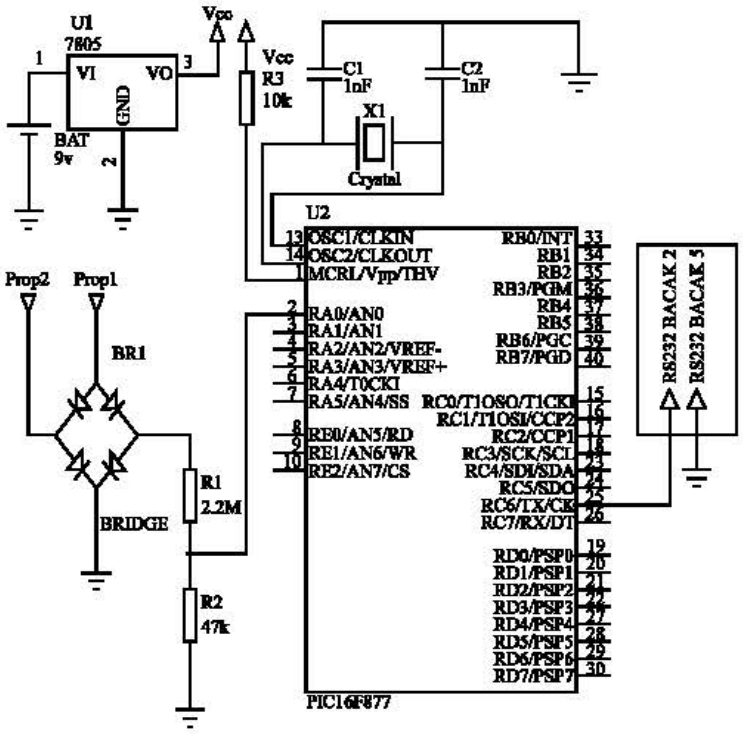

Fig. 9: Serial port data reader circuit

monitoring punit. By means of the communication system, it continuously deals with the programmable electronic units, which are located in control units. In this way, it presents an opportunity of high level of control and observation for the operators. These features can be titled as real time data collection, failure state record, long-term data save, state display of the control system and remote control.

In solar pump monitoring system, all data such as alarm limits and warning notices are used to form data base parameters as a part of the configurations. While, all the environmental units are physically keep up with solar pump monitoring system by means of external device inter unit, the dynamic data required for automatic control and monitoring the system are controlled and updated.

In the study, in order to save data into the data base file, the analog signals must be instructed. Using Data Acquisition Card for instructing only one analog signal increases the cost of the application. Using PIC16F877 microcontroller and the serials ports of the existing computer instead, have reduced the cost and made it practical. Figure 9 shows the circuit diagram used for instructing an analog signal.

This circuit that was built for reading the numerical data from system uses a com port by means of its ability to read a data easily. The R resistances used here are to limit the voltage. Therefore, the port be protected in case any possible corruption.

For the graphic program installed into the web browser, an inquiry from the database is carried out by means of a java program located in the server. After the

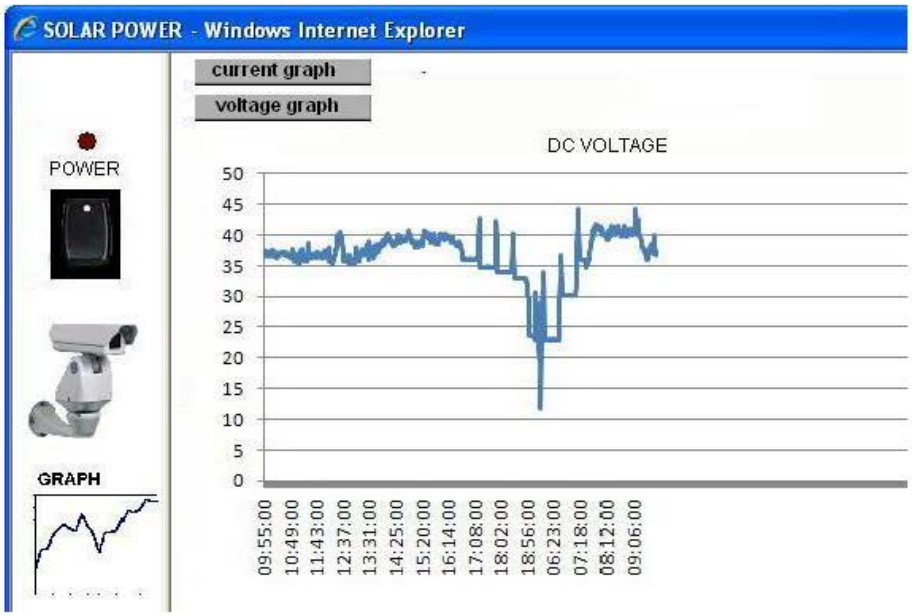

Fig. 10: The last 24 h inverter output voltage graph

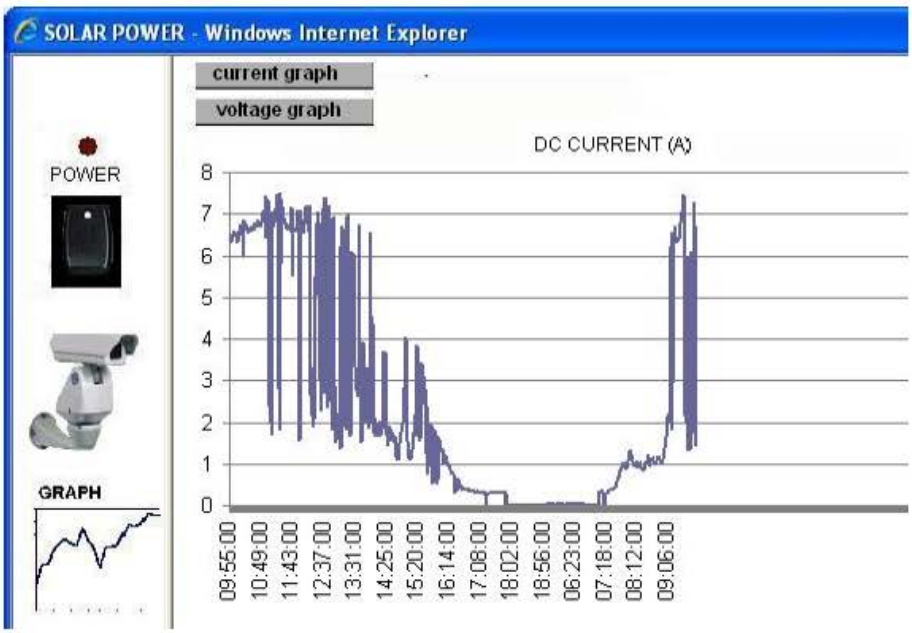

Fig. 11: The last 24 h inverter output current graph

java program completed that inquiry, it transfers the results from the database to the graphic program with a two-second of delay. The graphic program draws the desired graphs on the display screen. The data interrogated by the java program from the database and then transferred in to the graph, contains the coordinate information of the graphs that will be drawn. By means of the graphical opportunities provided by the java programming language, the coordinates are drawn in the web browser. Figure 10 shows the 24 h voltage graph. Here, the real time connection to the database, where the measured values by serial port data reader is written on, is provided and thanks to this, the changes can be monitored.

While, studying on solar pump monitoring system, it is much more important to save and monitor different data for the system efficiency. Monitoring only the voltage or only the current is not sufficient to reach the real results. Therefore, monitoring different data becomes important during data monitoring process. For these reasons, system monitors both the voltage and the current and presents them to the customer as graphical form. Figure 11 shows the 24 h past time and immediate current graphs.

CONCLUSION

In this study, the implementation of an internet based solar pump monitoring system has been performed. Especially for solar panels which are used with an increasing personal usage and the help of internet sub structure has performed the control and monitoring of electrical manufacturing. For any information (current, voltage, frequency etc.) availability and efficiency of internet media and local network have been examined.

In internet based solar pump monitoring control system, in addition to the information purposefully for quality, cost, efficiency and maintenance, by means of the operator control, the system control and the statistical information, these results below are achieved:

- Not handling the communication line especially on the installation stage has provided employee and system economization.
- Maintenance and reparation have become much easier by means of the utilization of the internet sub structure through communication and connections.
- Control on the production has increased by means of illimitable and wherever suitable monitoring.
- Effective treating to the failures has reduced the time for maintenance.
- As it is possible to reach the retrospective data, it is easier to maintain the units which may possibly cause trouble by data examination method.
- It has been possible to increase the system efficiency.
- Because of the structure of the Java program, it is accepted on many platforms without any editing. Therefore, there is no need to select a platform for the connection.
- In long-range connections, it has been operated with the present structure without any extra hardware and software needed.
- The connection has also been enabled at off-hours.

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