



Fuzzy Irrigation Controller Using Solar Energy

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ABSTRACT: In this study, an automatic fuzzy logic irrigation controller with two sensors, water pump, Brushless DC Motors (BLDC) has been designed and implemented in Khartoum Sudan. The motor was used for driving deep well pump which has been used for irrigation process. Optimum solar panels were selected according to calculated maximum power consumption of motors. The need of energy of BLDC Motors has been provided from solar panels and batteries. A DC-DC buck converter has been developed to feed motor and charge the batteries safely. The controller inputs come from soil moisture sensors and temperature sensor the output of the controller is on off signal to control dc motor and solenoid valves according to the plant needed.

KEYWORDS: Fuzzy controller, irrigation, soil moisture sensor, solar energy

I. INTRODUCTION

Sudan is a country located in northeastern of Africa, with high solar radiation, according to Abdeen, (1997), the average sunlight hours in the capital– Khartoum - range between 8.7 hours per day in July and 10.5 hours per day in February, this gives a yearly average of sunlight hours 9.92 per day, and around 3600 hours/year [4].The solar energy is quite simply is the energy produce directly by the sun and collected elsewhere, normally the earth. The sun generate its energy through thermonuclear reaction which convert about 650, 00,000ton of hydrogen to helium every second .the process of thermonuclear reaction produce heat and electromagnetic radiation the heat remain into the Sun and the electromagnetic radiation stream out into the space in all directions [11] .The proposed fuzzy irrigation controller system is designed based on the solar energy technology. Using sensor to collects the soil temperature and moisture information, and transmits the data to the fuzzy logic controller. The fuzzy controller can monitor the soil parameters and control the irrigation according to the specific needs of plants. The sensor is low power consumption and uses a lead-acid battery charged by the solar cell panel.

II. LITERATURE SURVEY

Many papers published in the field of irrigation control using solar energy. A water-saving irrigation system is designed based on the wireless communication and solar energy technology. The administrator can monitor the soil parameters and control the irrigation on the remote computer according to the specific needs of plants as in paper [12].Study solar radiation amount and develop solar grid which estimate Kw per hour and can be collected for each top roof in study area to be used by house hold in Lamb Nassir city in Shegera administration unit, Khartoum State as in paper [1].Cost effective solar power can be the answer for all our energy needs. Solar powered smart irrigation systems are the answer to the Indian farmer. This system consists of solar powered water pump along with an automatic water flow control using a moisture sensor as in paper [2].An automatic drip irrigation of dwarf cherry trees system with solar powered Brushless DC Motors (BLDC) has been designed and implemented in Zile District of Tokat Province of Turkeyas in paper [3],[7].Instability of electricity supply in Sudan is an increasing problem, especially in the capital and other larger cities. Commercial users such as hotels are looking for alternative solutions in order to be able to deliver adequate standards to their guests. In this study we investigate and optimize combined PV/Diesel system as a main electricity source for a hotel as in paper [4].For several years we have field tested many different types of solar powered water pumping systems. In this paper, several steps are given to select a solar-PV water pumping system as in

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paper [5],[10].Photovoltaic powered pump drive scheme comprising a separately excited DC motor and DC/DC converter as in paper [8],[9].

III. METHODOLOGY

In this proposed system we utilize the solar energy from solar panels to automatically pump water from bore well directly into a ground level, and storage the water into a tank. While conventional methods include pumping of water from tank onto field using another pump, our system uses only a single stage energy consumption wherein the water is pumped into a ground level tank from which a simple valve mechanism controls the flow of water into the field. This saves substantial amount of energy and efficient use of renewable energy. A valve is controlled using fuzzy logic controller in which it regulates the flow of water into the field depending upon the moisture requirement of the plant. In this system we use temperature sensor and soil moisture sensor that detects the amount of moisture present in the soil and depending upon the requirement of level of moisture content required.

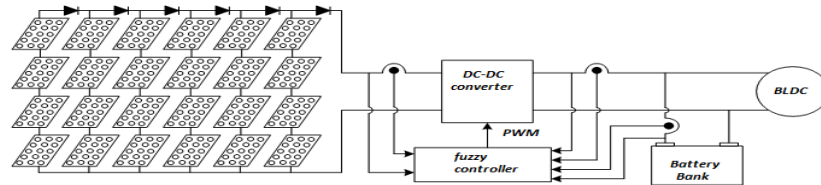


Figure 1. block diagram for the solar powered fuzzy logic controller

A.PHOTOVOLATICS

Photovoltaic cells are able to turn the energy in solar radiation into electricity due to an energy transfer that occurs at the sub-atomic level. Solar energy comes in small packages called photons. These photons hit the outer level electrons in the photovoltaic cells like the flappers hit the metal ball in the pin ball machine. The dislocated electrons form the electrical current

B.CONVERTER AND BATTERY SPECIFICATION

An inverter is designed with a DC input of 230V D.C which is generated from 12V D.C using a boost converter. Sine PWM technique is applied to generate 230V A.C. The inverter circuit fabricated is shown in figure 1. As far as battery is concerned we are using a battery with 12V, 100Ah capacity for a 2HP pump.

C. SOFTWARE IMPLEMENTATION

The proposed system implemented BASCOM BASIC development tools for the ATMEGA microcontroller family support every level of developer from the Professional applications, engineer to the student just learning about embedded software development .The industry standard BASCOM compilers, Macro assemblers, Debuggers, Real time kernels, and single board computers support ATMEGA32 compatible derivatives and help you to get your projects completed on schedule. With the BASCOM tools, we can generate embedded applications for virtually every BASCOM derivative, The BASCOM AVR software development tools are designed for the professional; software developer; any level of programmer can use them to get the most out of the ATMEGA32 microcontroller architecture .BASCOM AVR help provide the variation simulation output. The programming step started by the problem statement, algorithm, flow chart, program code, debugging and testing for the program. Universal programmer used to down load program which save in hexadecimal file from computer into microcontroller ATMEGA32.

IV. DISCUSSION

The fuzzy logic controller and solar powered system as in the figure.1,the flowchart of the fuzzy controller represented as in figure .2 designed using MATLAB Simulink 2013 , the simulation result ware given in figure .3 fuzzy logic membership , figure .4 fuzzy logic rule viewer and figure .5 fuzzy logic controller surface viewer , the programmer designed with two input sensors humidity and temperature sensors with feedback control signal as in figure.6 ,the controller input humidity and temperature signal and output of fuzzy controller the signal that controller the irrigation process represented as in figure .7.

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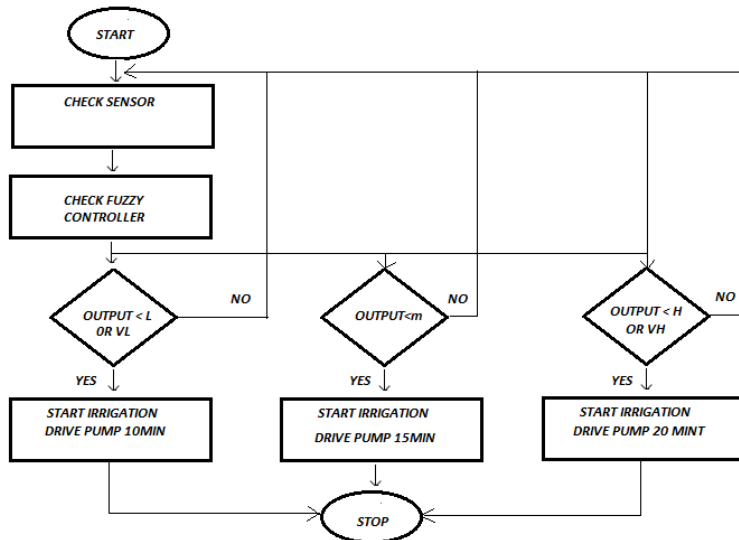


Figure 2. Flow chart of fuzzy logic controller for irrigation control

Flow chart of fuzzy logic controller for irrigation control, the irrigation process depending up on the running time of DC motor, for low or very low the irrigation process take 10 minutes, 15 minutes for medium and 20 minutes for high and very high (in the fuzzy controller each 4 minutes represented as one units of time. Eg: (5 in motor speed indicate the 20 minutes).

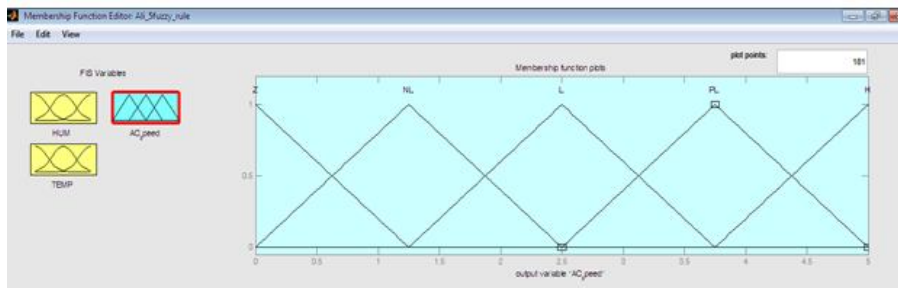


Figure 3. Membership function for five memberships

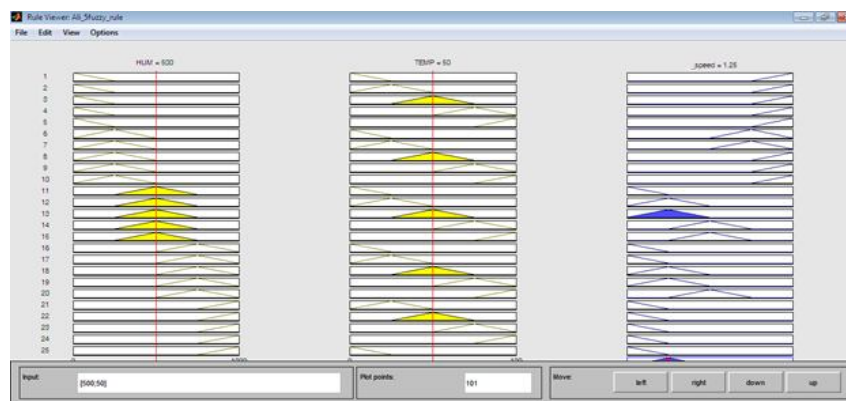


Figure 4. Rule viewer for five membership which produce (25 rules). The yellow color for temperature and humidity and the blue color for output

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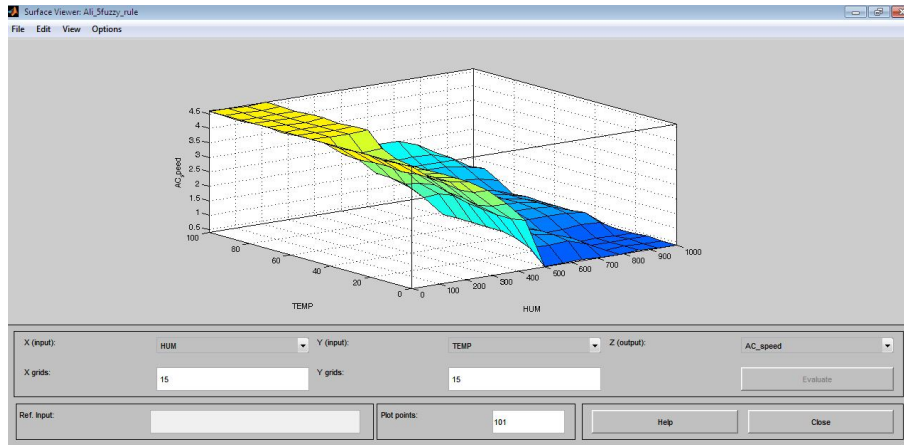


Figure 5. Surface viewer for five membership (25 Rules) represent the relationship between inputs temperature and humidity and the one out put motor speed

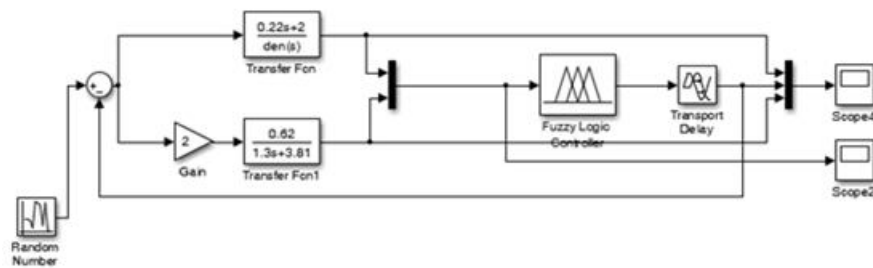


Figure 6. Fuzzy controllers with two inputs temp and humidity , the input signal taken as random number connected to feedback signal with summing point, temp signal interred through transfer function and humidity through gain 2 and followed via transfer functions1.

Mamdani fuzzy controller with two input(Temp and Hum) with feedback

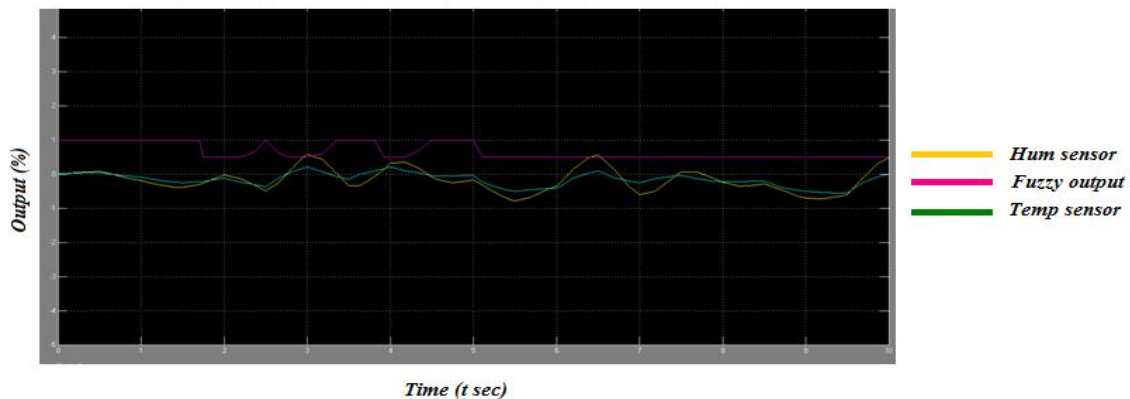


Figure 7. Fuzzy controller with two input(yellow and green) and one output, the controller with feedback signal Mamadni type



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V.CONCLUSIONS

Solar-PV fuzzy irrigation control systems are used in Khartoum Sudan for power irrigation systems because of larger area of land with a good solar resource. The solar-PV modules can be decreased significantly and/or efficiency of Solar-PV modules can be improved significantly. However if worldwide production increases for the high voltage modules, these modules would be better due to better motor/pump efficiency with higher voltage. For a diaphragm pumps, using a fuzzy controller is nearly always the best option instead of directly connecting PV array to pump motor. MTLAB SIMULINK, Protus and BASCOM AVR are the programs that used for design Fuzzy controller.

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REFERENCES

- [1] Badr-EldinTaha Osman, "National Solar database and Potential Solar Energy Mapping in Lamab Nassir Khartoum State," University of Khartoum, Faculty of Geographical and Environmental Sciences, Dept. of GIS-Master Student Projects Presented at the Occasional GIS Symposia OCGISS/ I- May 2014
- [2] S.Harishankar, "Solar Powered Smart Irrigation System," Advance in Electronic and Electric Engineering. India. ISSN 2231-1297, Volume 4, Number 4 (2014), pp. 341-346.
- [3] Mahir DURSUN, "Application of Solar Powered Automatic Water Pumping in Turkey," International Journal of Computer and Electrical Engineering, Vol.4, No.2, April 2012
- [4] Asim M. Widadalla., "Designing a Photovoltaic Solar Energy System for a Commercial Building Case Study: Rosa Park Hotel in Khartoum-Sudan," world renewable energy Sweden 8-13 may2011.
- [5] Khan, M.T, Ahmed, A.U., "The feasibility study of solar irrigation: Economical comparison between diesel and photovoltaic water pumping systems for different crops," IEE, Electrical Information and Communication Technology (EICT), 2013 International Conference on13-15 Feb. 2014
- [6] Khan, M.T.A. "Design and performance analysis of water pumping using solar PV," IEEE ,Developments in Renewable Energy Technology (ICDRET), 2012 2nd International Conference 2012
- [7] Hariharan, S., "Design of a DC — DC converter for a PV array," IEEE., Industrial Electronics, Control & Robotics (IECR), 2010 International Conference, Page (s):79 - 84, 27-29 Dec. 2010
- [8] Shokrolla, S.S., "A photovoltaic powered separately excited DC motor drive for rural/desert pump irrigation," IEEE, Electrical Machines and Drives, 1993. Sixth International Conference on (Conf. Publ. No. 376) 1993
- [9] Li Wenyan."Design of Wireless Water-Saving Irrigation System Based on Solar Energy," IEEE, Control, Automation and Systems Engineering (CASE), 2011 International Conference, Page(s):1 - 4 ,30-31 July 2011