[2020]

7th International Conference on Green Energy & Environmental Engineering (GEEE)

PET Proceedings
Vol. 63
ISSN : 1737-9934

7th International Conference on Green Energy & Environmental Engineering (GEEE)
Proceedings of Engineering & Technology – PET -
Vol.63, pp. 35-41

Conference International Committees

Honorary General Chairs

Dato' Mohamed Yussof Ghazali (MAL)

Ille Gebeshuber (AUS)

General Chairs

Ahmed Rhif (TUN)

Ridvan Kizilkaya (TUR)

Güleda Engin (TUR)

Georges Descombes (FR)

Publication Committee

Ahmad Tahar Azar (EGP)

Sundarapandian Vaidyanathan (IND)

Steering Committee

Brahim Berbaoui (ALG)

Djamila Rekioua (ALG)

Leila Bendifallah (ALG)

Mimi Belatel (ALG)

Mustapha Hatti (ALG)

Mohamed Gherbi (ALG)

Nachida K. Merzouk (ALG)

Salma El Aimani (MOR)

Saoussen Hammami (TUN)

Sara Zatir (ALG)

Advisory Committee

Ali Haddi (MOR)

Abdelfettah Barhdadi (MOR)

Abdelhamid Kheiri (FR)

Houria Siguerdidjane (FR)

Sophie Simonet (FR)

Technical Committee

Abdellah El Fadar (MOR)

Abdellah Mechaqrane (MOR)

Arouna Darga (FR)

Chahboun A. Adil (MOR)

Driss Youssfi (MOR)

Entissar AL Suhaibani (KSA)

Fawaz Massouh (FR)

Hassane Mahmoudi (MOR)

Irina Mitrofanova (UKR)

Ivana Maksimovic (SER)

Ivanka Milosevic (SER)

Kamal Reklaoui (MOR)

Karkaz M. Thalij (IRA)

Khenfer Nabil (ALG)

Maria Esposito (ITA)

Mohamed Benbouzid (FR)

Mohammed Hamouni (ALG)

Rahmani Lazhar (ALG)

Rehab Abd El Baky (EGY)

Sallam Mebrouk (ALG)

Tounzi Abdelmounaïm (FR)

Vesna Bjegovic-Mikanovic (SER)

Yao Azoumah (BUR)

Youssef Errami (MOR)

Zohra Ameur (ALG)

ISSN: 1737-9334

7th International Conference on Green Energy & Environmental Engineering (GEEE)
Proceedings of Engineering & Technology – PET -
Vol.63, pp. 35-41

Solar energy in irrigation system

W. Difallah[1,2*], S. Nour [1,3], A. Maamar [2], K. Benahmed [4], B.Draoui [2]

[1]*Departement of Exact Sciences, Normal Higher School of Bechar ,Algeria*
Bechar, Algeria

[2] *Laboratory of Energetic in arid zones, Tahri Mohammed University*
Bechar, Algeria

[3] *Laboratory of Semiconductor Devices and Physics (LPDS), Tahri Mohammed University*
Bechar, Algeria

[4] *Department of mathematics and computer science*
Bechar, Algeria

***e-mail: wafadif@gmail.com**

***Abstract*— Water resource covers 70% of the earth, and it seems to be the most abundant resource in our planet. However, freshwater represent only 1% of the world's water, and the remaining 99% are unavailable for human use. Moreover, because irrigation is the largest consumer of this vital resource, it will be the first affected by water scarcity. In fact, water is not the unique problem facing irrigation; there is also the energy crisis that many countries suffer from.**

Solar power is one of the most promising solution to energy consumption; it became clear that there was a need to invest from this resource, especially in developing countries. Recently, there is a growing interest in solar-powered irrigation systems around the world. In this paper, a typical solar powered irrigation system will be discussed. The proposed system having two working systems: solar pumping system and smart irrigation system.

***Keywords*— Water, solar energy, irrigation, WSN.**

I. INTRODUCTION

Solar energy has a vital role to play in meeting the world's energy needs [1]. Irrigation system applications is one of the fields that is widely benefits from this renewable resource. The exploitation of solar energy in this field is strongly contributed in the optimization of water and energy consumption.

The aim of this article is to explain how to integrate solar power in an irrigation management system. Firstly, as an energy resource for smart irrigation system devices, and secondly, to pump water from the source to the storage tank by using photovoltaic panels that produce direct current (DC) electricity when exposed to light. After this introduction, a selection of relation works is presented, followed by section 3 that explain how to build a solar powered irrigation system based on wireless sensor network and solar energy, and a conclusion.

II. RELATED WORKS

Solar powered smart irrigation systems is a promising application to optimize water and energy consumption. Many studies have been done in this field, to mention but a few; a wireless data acquisition network was implemented to control drip irrigation of dwarf cherry trees in [2]. To realize a remote on-line monitoring and controlling water-saving irrigation system wireless sensor network was combined with fuzzy control system in [3]. An intelligent drip irrigation system for tomato crops was implemented in [4]. In [5], a low-cost remote monitoring system was implemented and validated. In [6] and [7], solar powered irrigation systems were developed to optimize power consumption of wireless sensor network devices. For the same purpose, a solar powered soil moisture sensor was used in [8] to determine plant water needs. Other implementations of these technologies were done in [9], [10] and [11] for the same objective. An automatic soil moisture sensing water irrigation system with water level indicator was proposed in [12], solar panels are used to process the system.

III. SOLAR POWERED SMART IRRIGATION SYSTEM

The system is worked in two levels:

A. Solar water pumping system

Solar energy is the easiest way for farmers to produce energy, especially in Off-grid Zones. The use of solar water pumps in agriculture is becoming increasingly popular [13].

Several PV (photovoltaic) panels are used to produce direct current (DC) when exposed to sunlight. An inverter is used to convert this DC current into alternating current (AC) to run the pump that pumps water whenever the sun shines and the excess water could be stored in a storage tank for later usage [14].

Fig. 1 Working principle of solar water pump.

ISSN: 1737-9334

Advantages and disadvantages of solar water pump:

1) Advantages:

- Solar water pump is powered by a free energy resource. With the panel, all the needed energy comes from the sun. This is a major advantage over fossil fuel pumps that require to constantly buy fuel.
- Solar pumps require less labor and maintenance compared to fossil fuel pumps.
- It present a clean, simple and energy-efficient alternative to traditional electric and fuel-driven pump.
- It is an environmentally friendly approach in agriculture.
- It can be used in every region (developed or poor).

2) Disadvantage :

- The costs of solar water pump are relatively high (water pump, panels …), however, the real efficiency of solar systems is seen in their use over the years [15].

B. Smart irrigation system

From related work section, it can be said that wireless sensor network is the backbone of a smart irrigation system. A wireless sensor network consists of distributed autonomous devices equipped with sensors to measure physical or environmental constants (temperature, soil moisture, pressure, vibrations, ….) [16,17]. Each sensor node is composed of four units as is illustrated in figure 2 below.

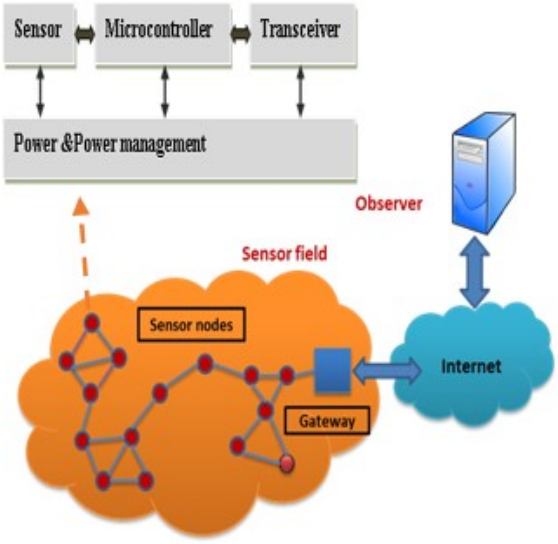

Fig. 2 Wireless sensor network architecture.

The big challenge facing WSN application is the energy constraint, knowing that sensors are equipped with limited energy source. In this proposal solar powered sensors can be integrated in the network to resolve this problem (see figures 3,4,5).

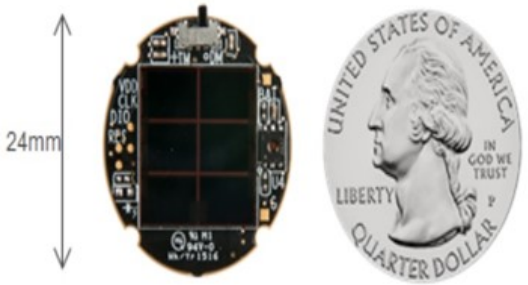

Fig. 3 Tiny Solar BLE temperature and humidity sensor [18].

Fig. 4 Edyn soil moisture sensor [19].

Fig. 5 Heliomote solar harvesting sensor node [20]

The irrigation system is composed of four parts:

Sensor nodes: to collect climatic parameters and feed the system database. The most used sensors in the irrigation field are presented in table 1.

TABLE I
MOST USED SENSORS

Sensor	Soil moisture	Soil temperature	Temperature	Relative humidity
10SH	✓	-	-	-
EC-5	✓	-	-	-
SHT11	-	-	✓	✓
TDR-3A	✓	✓	-	-
DS18B20	-	-	✓	-
On9558	-	-	-	-

ISSN: 1737-9334

VH400	✓	-	-	-
DS1822	-	-	✓	-
SHT75	-	-	✓	✓
LM35	-	-	✓	-
HS220	-	-	-	✓
DHT22	-	-	✓	✓
Watermark 200ss	✓	-	-	-

Sink node: it is a powerful node, links between the wireless network and the terminal monitoring.

Transmission networks: according to the number of sensors, the price range, the available power system and the wide of the study area, transmission network can be: Bluetooth (small networks of maximum 7 nodes, to send small amount of data over short distances), WIFI (a network of 32 nodes or more, to send large amount of data over long distances)

Zigbee (to send small amount of data - environmental data- over long distances and with the minimal possible power consumption)…etc. Because of its properties, Zigbee transmission protocol is the most appropriate solution for irrigation network systems.

Terminal monitoring: (server, microcontroller), it is the part of the system in which the collected data are checked to decide ever to switch on or off the irrigation system (figure 6). Different types of microcontrollers can be used (PIC16F877A, MSP430F1612, PIC24FJ64GB004, AT mega 1281, Amega382P, 8051 microcontroller,…etc.).

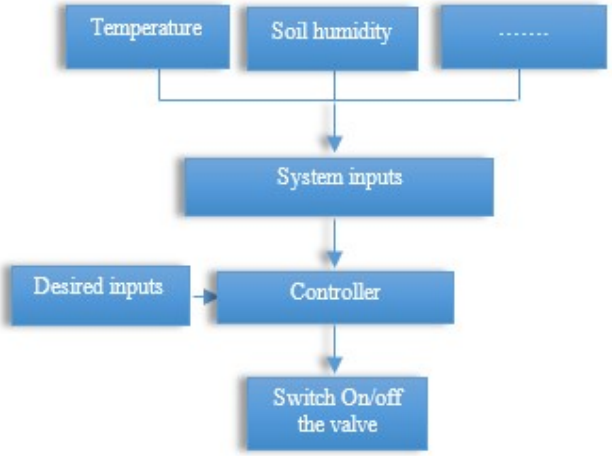

Fig. 6 Block diagram of the irrigation controller.

IV. Conclusions

Irrigation strategies are changing continuously; integration of new technologies and renewable energy resources has strongly improved this vital sector. Solar energy is one of the most important energy resources; it is widely used in the irrigation field.

A solar powered smart irrigation system is mainly composed of two basic subsystems: smart irrigation system or monitoring system and solar water pumping system. Photovoltaic panels are used to provide solar energy. It's produce direct-current (DC) electricity from absorbed sunlight

The benefits of this system application are numerous. It is easily installed, and based on sustainable, clean and secure energy, moreover, the system is autonomous in making irrigation decisions based on real time information from the monitoring system.

References

[1] K.H. Solangi et al., "A review on global solar energy policy, " *Renewable and Sustainable Energy Reviews,* vol. 15, pp. 2149-2163, 2011.

[2] M. Dursun, and S. Ozden, "A wireless application of drip irrigation automation supported by soil moisture sensors," *Scientific Research and Essays*, vol. 6, pp. 1573-1582, April 2011.

[3] L. Gao, et al., "An Intelligent Irrigation System Based on Wireless Sensor Network and Fuzzy Control, " *JOURNAL OF NETWORKS*, vol. 8, 2013.

[4] F.S. Mohammad, et al., "Adoption of an intelligent irrigation scheduling technique and its effect on water use efficiency for tomato crops in arid regions, " *Australian Journal of Crop Science, AJCS*, vol. 7, pp. 305-313, 2013.

[5] J.P. Kumar, et al., "Implementing Intelligent Monitoring Techniques in Agriculture Using Wireless Sensor Networks, "*International Journal of Computer Science and Information Technologies*, vol.5, pp. 5797-5800, 2014.

[6] J. Gutiérrez et al., "Automated Irrigation System Using a Wireless Sensor Network and GPRS Module, " *IEEE transactions on instrumentation and measurement*, vol. 63, pp. 166-176, Jan.2014.

[7] P. Alagupandi et al., " Smart Irrigation System for Outdoor Environment using Tiny OS, *International Conference On Computation Of Power, Energy, Information And Communication ICCPEIC. IEEE,* (Chennai, India, 16-17 April 2014).

[8] M.H. Ariff, and M.Z. Ibrahim, "Solar Powered Soil Moisture Detector. " Latest trends on communications and information technology, pp.79-83.

[9] G.S. Sharath Patil et al., "Solar Powered Irrigation System with Automatic Control of Pump and SMS Alert," *International Journal of Engineering Technology & Management Research*, vol. 3, pp. 90-94, Feb. 2015.

[10] A. Gangadharan, et al., " Solar Powered Smart Irrigation System, " *International Journal of Computer Science and Information Technology & Security*, vol.6, pp. 102-106, Mar-April 2016.

[11] W.Difallah et al., "Design of solar powered smart irrigation system (SPSIS)," *International Conference on Software Engineering and Information Management ICSIM2018. ACM*, (Casablanca, Morocco, January 4–6, 2018).

[12] B. Ecija Edmond et al., "Automatic soil moisture sensing water irrigation system with water level indicator, "*LPU-Laguna Journal of Engineering and Computer Studies*, vol. 3, September 2015.

[13] (2020) Solar Water Pumps: Things To Know and Tips For Use [2020] website. [Online]. Available: https://solarmagazine.com/solar-water-pumps/

[14] W.Difallah et al., "Water optimization using solar powered smart irrigation system, " *7th International Conference on Software Engineering and New Technologies ICSENT2018. ACM, (*Hammamet, Tunisia 26 - 28 December 2018).

[15] (2020) F. Herman, website. [Online]. Available: https://futurepump.com/advantages-and-disadvantages-of-solar-water-pumps/

[16] J. Kenyeres *et al*., "Indoor experiment with WSN application," *MIPRO, IEEE*. (Opatija, Croatia, 2010).

[17] W. Difallah, et al., " Implementing wireless sensor networks for smart irrigation, " *Taiwan Water Conservancy*, vol. 65, pp. 44-54, 2017.

[18] Tiny Solar BLE temperature and humidity sensor. website. [Online]. Available: http://www.mouser.com/ds/2/100/CYALKIT-E03_Kit_Guide-968035.pdf

ISSN: 1737-9334

[19] Edyn soil moisture sensor. website. [Online]. Available: https://www.gardeners.com/buy/edyn-garden-soil-moisture-sensor-wifi-solar-powered/8592711.html
[20] K. Lin et al., " Demo Abstract: Heliomote: Enabling Long-Lived Sensor Networks Through Solar Energy Harvesting, " ACM, 2015.

ISSN: 1737-9334