International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.003 ISSN: 2581-4621

AN OPEN SOURCE SCADA FOR SOLAR WATER PUMPING SYSTEM

[1]Ms. T. Anuradha, [2]B. Mounika, [3]M. Neeraja, [4]T. Nikhil, [5]V. Naveen Kumar
Associate Professor, Student, Department of ECE, AITS, Tirupati

ABSTRACT
This paper is about an open source SCADA system which is used to monitor different parameters of a solar water pumping system. A prototype built in lab for the overall system is also discussed in this paper. The parameters monitored are Environmental parameters which include temperature, humidity, and Hydro parameters include water level in the water tank and Electrical parameters include Photovoltaic Panel voltage, battery voltage, load current. These parameters are collected by Arduino UNO which acts as a hub for the sensors and then a string of data with information about different parameters measured using sensors is sent through a serial communication Open Source SCADA ThingSpeak is installed. The ThingSpeak identify the parameters sent to it, perform logging and display the data in dashboards. The dashboard has live parameters displayed over it and displays historically logged data of parameters monitored.
Keywords: ThingSpeak, Arduino UNO, Photovoltaic Panel.

I. INTRODUCTION

India is a country which is highly dependent upon agriculture, not only to feed its ever increasing population but also it is an important component of country's economy which contributes around 22.8% to the country's Gross domestic product (GDP) [1]. To keep up with the increase in demand for agriculture and a need to irrigate remote lands to increase the overall productivity, there has been an increase in acceptance of solar water pumping systems.

To control a solar water pumping system which is especially located in a remote area, keeping a person for 24/7 is not only difficult but costly as well. So to control a solar water pumping system, incorporation of a Supervisory Control and Data Acquisition (SCADA) technology play a very vital part. Supervisory Control and Data Acquisition (SCADA) is a technology which involves reflection of data on an HMI (Human Machine Interface) which is taken from different sensors which are deployed on different locations; they help to get information regarding different parameters of the site, that data is then stored in a cloud or some local storage which can range from a small SD card to a server depending upon the data size and then it can be viewed at an HMI [2]. This technology has many applications which range from business to personal use. This paper involves capturing and reflection of parameters like solar panel voltage, battery voltage, load current, water level of the tank and environmental parameters like humidity, temperature and solar insolation.

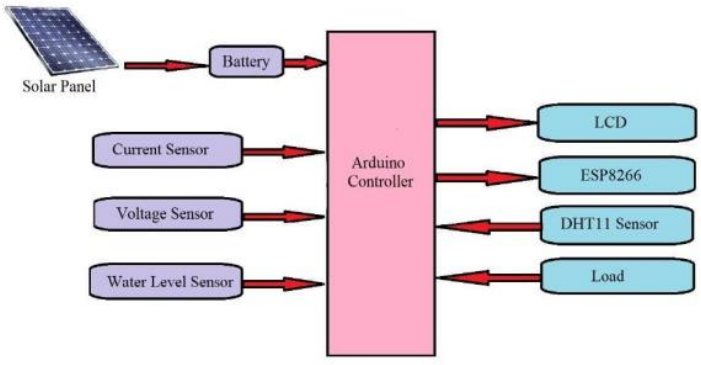

Figure1: Proposed SCADA System

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.003 ISSN: 2581-4621

II. LITERATURE REVIEW

As per author [4] an economical SCADA system is proposed for a solar water pumping system in which Node-Red is used as an HMI and voltage, current and solar irradiance data is extracted using respective sensors which were integrated with Arduino Uno, which again is connected with Raspberry Pi zero which has a camera module connected with it.

In this paper [5], the writer implemented a SCADA system for a Portuguese irrigation canal network which supported in remote monitoring of parameters such as water flow, water levels etc. and for remote control of different gates. PV Panel Voltage Sensor Battery Voltage Sensor Load Current Sensor Water Flow Sensor Water Level Sensor Arduino Mega 2560 Raspberry Pi Model B Human Machine Interface (HMI).

The writer in the paper [6] presents an idea of using Xbee and GSM module to monitor and control a solar drying and water pumping system.

In the paper [7], a 2.4KW solar water pumping system is monitored and controlled using influxDB and Grafana which are an open source storage database and HMI (Human Machine Interface), in this data is acquired with the help of an RS486 bus using ModBus-RTU protocol which communicates with hardware having sensors.

In paper [8] a SCADA system is developed using LABVIEW which has a PLC connected with it takes values of different parameters for solar powered irrigation system and reflect them on SCADA easing the overall monitoring of the system.

Discussed by author [9] is a general SCADA system which help to monitor different parameters and optimise operation as per a rule based approach which is Water system operator.

III. COMPONENTS

A. ARDUINO UNO

The Arduino UNO is a microcontroller based board with 14 digital input/output pins, 6 analog pins. It is the one which acts as a hub in this overall SCADA system and all the sensors are connected to it via wires. It will gather the data from sensors. The board will typically be powered via USB or an external power supply which in turn allows it to power other hardware and sensors.

B. SOLAR PANEL

The photovoltaic array converts the solar energy into electricity, which is used for running the motor pump set. The pumping system draws water from the open well, bore well, stream, pond, canal etc. The system requires a shadow-free area for installation of the Solar panel.

C. BATTERY

A battery is a device that can add to the solar power system to store the excess electricity generated by the solar panels. Then use that stored energy to power the water pumping system at times when the solar panels don't generate enough electricity, including nights, cloudy days, and during power outages.

D. CURRENT SENSOR AND VOLTAGE SENSOR

One current sensor module(ACS712) and voltage sensor module 25V used in the overall network. This current sensor can measure current up to 30A of current. It is used to measure the load current. voltage sensor is used to measure the voltage of an electrical circuit or system. These current and voltage readings are fed into Arduino and eventually logged into ThingSpeak. Log file and is reflected on ThingSpeak dashboard.

E. WATER LEVEL SENSOR AND WATER FLOW SENSOR

The water level sensor is a device that measures the liquid level in a fixed container. which converts the height of the liquid level into an electrical signal for output. Water flow sensors are installed at the water source or pipes to measure the rate of flow of water and calculate the amount of water flowed through the pipe. Rate of flow of water is measured as liters per hour or cubic meters.

F. DHT11 SENSOR

The temperature and humidity sensor (DHT-11) is used to measure the temperature and humidity of the surrounding environment where solar water pumping system is installed. It can measure

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.003 ISSN: 2581-4621

temperature from -40 to 80°C with great accuracy. The sensor is connected with Arduino UNO which takes the readings and it is eventually logged into ThingSpeak to reflect on ThingSpeak dashboard.

G. ESP8266

The ESP8266 Wi-Fi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

IV. METHADOLOGY

A. ThingSpeak

The platform used as SCADA for the solar water pumping system in this paper is ThingSpeak. It is a powerful open source tool which is installed as a local host in our scenario. It is used to reflect the environmental, hydro and electrical parameters of the solar water pumping system. Their logs are maintained in ThingSpeak.log. It logs data after every 30 seconds.

B. Proposed ThingSpeak Based SCADA System for Solar Water Pumping System

The proposed local host based open source ThingSpeak SCADA system for the solar water pumping system. It can be seen in figure location of different sensors in actual scenario which are in turn connected with Arduino UNO which piles up all the data and sends a string of parameters to data in a certain format compatible with ThingSpeak.

C. Prototype of ThingSpeak based SCADA System for solar water pumping system

A prototype for the ThingSpeak based SCADA system can be seen in figure. It can be seen in the prototype clearly the sensors namely water level sensor, then humidity and temperature sensor can be seen in the figure, a lamp was used to simulate the sun and was directed on photo resistor to vary the light intensity and verify the working. Then two potential divider can be seen, one on the left was used to measure PV Panel voltage and one on the right was used to measure battery voltage, a bulb of 12V was used as a load which simulates a solar water pump and in series with it a current sensor was connected as can be seen in the figure which helps to measure load current.

V. EXPERIMENTAL RESULTS

The different parameters sent to it, perform logging and display data in the dashboard. The dashboard has live parameters displayed over it, and displays historically logged data of different parameters monitored.

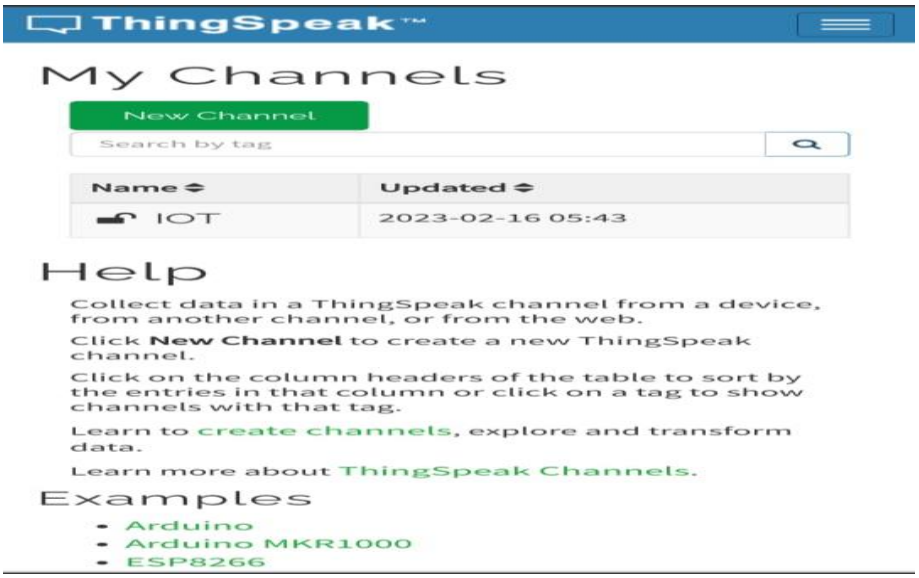

Figure 2: Channels in ThingSpeak

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.003 ISSN: 2581-4621

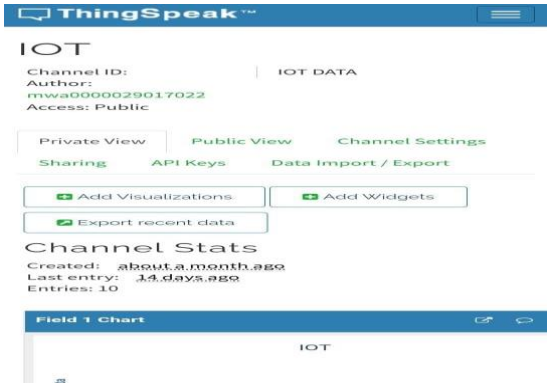

Figure 3: ThingSpeak Dashboard

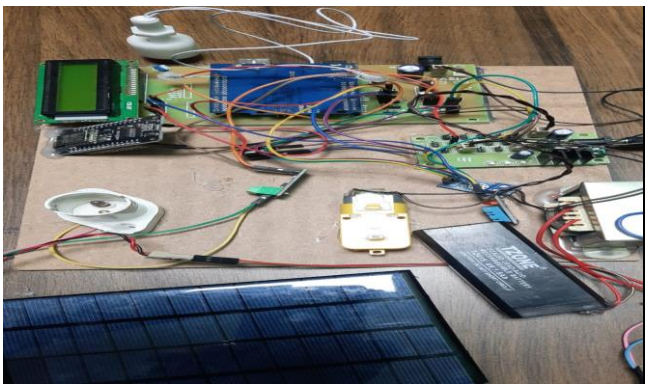

Figure 4: Prototype of An Open Source SCADA for Solar Water Pumping System

Figure 5: Inputs, Temperature and Current values before applying Load

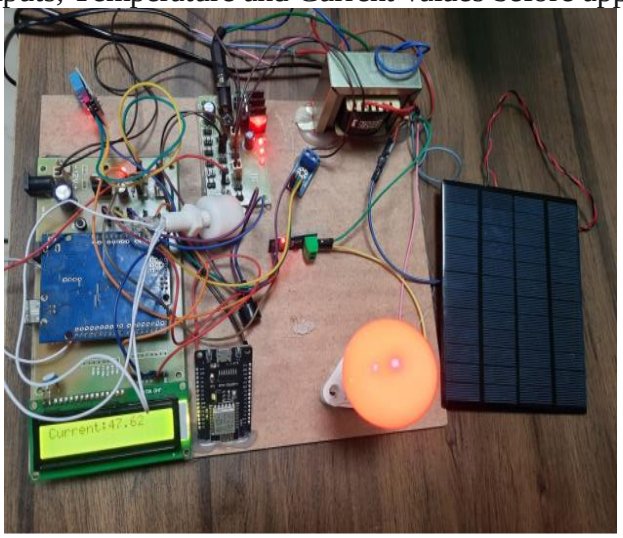

Figure 6: Current values after applying Load

DOI:10.46647/ijetms.2023.v07si01.003 ISSN: 2581-4621

V. CONCLUSIONS

An open source SCADA system known as was adapted for a solar water pumping system. Process from taking data from sensors and pushing it to Arduino UNO and from Arduino in form of a data string to NodeMCU through serial communication was explored. Different parameters for a solar water pumping systems were explored which included temperature, humidity, water level in the storage water, PV panel voltage, Battery voltage and load current on ThingSpeak and were exhibited in dashboards ranging from live to historic data for convenient monitoring was explored.

REFERENCES

[1] M. Adnan et al., "Variability and Predictability of Summer Monsoon Rainfall over Pakistan," Asia-Pac. J. Atmospheric Sci., Jan. 2020, doi: 10.1007/s13143-020-00178-2.
[2] D. Upadhyay and S. Sampalli, "SCADA (Supervisory Control and Data Acquisition) systems: Vulnerability assessment and security recommendations," Comput. Secur., vol. 89, p. 101666, Feb. 2020, doi: 10.1016/j.cose.2019.101666.
[3] J. Marcuse, B. Menz, and J. Payne, "Servers in SCADA applications," in IAS '95. Conference Record of the 1995 IEEE Industry Applications Conference Thirtieth IAS Annual Meeting, Oct. 1995, vol. 3, pp. 2124– 2129 vol.3, doi: 10.1109/IAS.1995.530573.
[4] M. Zamanlou and M. T. Iqbal, "Development of an Economical SCADA System for Solar Water Pumping in Iran," in 2020 IEEE International IOT, Electronics and Mechatronics Conference (IEMTRONICS), Sep. 2020, pp. 1–4, doi: 10.1109/IEMTRONICS51293.2020.9216408.
[5] M. Rijo, "Design, implementation and tuning of an irrigation canal system SCADA," Agric. Eng. Int. CIGR J., vol. 19, no. 2, Art. no. 2, Aug. 2017.
[6] J. G. Natividad and T. D. Palaoag, "IoT based model for monitoring and controlling water distribution," IOP Conf. Ser. Mater. Sci. Eng., vol. 482, p. 012045, Mar. 2019, doi: 10.1088/1757-899X/482/1/012045.
[7] F. J. Gimeno-Sales et al., "PV Monitoring System for a Water Pumping Scheme with a Lithium-Ion Battery Using Free Open-Source Software and IoT Technologies," Sustainability, vol. 12, no. 24, Art. no. 24, Jan. 2020, doi: 10.3390/su122410651.
[8] A. I. Abdelkerim, M. M. R. S. Eusuf, M. J. E. Salami, A. Aibinu, and M. A. Eusuf, "Development of Solar Powered Irrigation System," IOP Conf. Ser. Mater. Sci. Eng., vol. 53, p. 012005, Dec. 2013, doi: 10.1088/1757- 899X/53/1/012005.
[9] R. Amaral Lopes, R. Grønborg Junker, J. Martins, J. Murta-Pina, G. Reynders, and H. Madsen, "Characterisation and use of energy flexibility in water pumping and storage systems," Appl. Energy, vol. 277, p. 115587, Nov. 2020, doi: 10.1016/j.apenergy.2020.115587.
[10] T. R. P. Foundation, "Buy a Raspberry Pi 4 Model B," Raspberry Pi. https://www.raspberrypi.org/products/raspberry-pi-4-model-b/ (accessed Dec. 27, 2020).
[11] "Arduino Mega 2560 Rev3 | Arduino Official Store." https://store.arduino.cc/usa/mega-2560-r3 (accessed Dec. 27, 2020).
[12] "ACS712 Current Sensor Module (30A Max)," Canada Robotix. https://www.canadarobotix.com/products/1925 (accessed Dec. 28, 2020).
[13] "YF-S201 Hall Effect Water Flow Meter / Sensor |." https://www.hobbytronics.co.uk/yf-s201-water-flow-meter (accessed Dec. 28, 2020).
[14] A. Industries, "DHT22 temperature-humidity sensor + extras." https://www.adafruit.com/product/385 (accessed Dec. 28, 2020).
[15] "Emoncms - site home." https://emoncms.org/ (accessed Dec. 28, 2020).