"Real-time controlling and monitoring of Solar drying and Water pumping system using IoT"

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ABSTRACT
A solar-powered pump is a pump running on electricity generated by photovoltaic panels as opposed to grid electricity or on the diesel engine. Excess amount of heat generated at the backside of the solar panel due to which the efficiency of solar panel decreases; to avoid this solar panel is air-cooled and heat recovered utilized for another agricultural application called dryer. This paper presents a remote monitoring and controlling system for solar drying and water pumping using Xbee and GSM module. Xbee sends system real-time data from sensors wirelessly to a central server after every 20 seconds, which collects the data, stores it, and transfers to the cloud through the GSM module. The real-time monitoring and controlling are also possible at the client-side through customized Mobile app.

Keywords: IoT, Xbee, GSM module, Hybrid solar drying, and water pumping system.

1. INTRODUCTION
Photovoltaic (PV) panels are often used for converting solar energy to electrical energy, especially in remote areas or where the use of an alternative energy source desired. In particular, they have been demonstrated repeatedly to reliably produce sufficient electricity directly from solar radiation (sunlight) to power livestock and irrigation watering systems. A benefit of using solar energy to power agricultural water pump systems is that increased water requirements for livestock and irrigation tend to coincide with the seasonal increase of incoming solar energy. When properly designed, these PV systems can also result in significant long-term cost savings and a smaller environmental footprint compared to conventional power systems. The volume of water pumped by a solar-powered system in a given interval depends on the total amount of solar energy available in that period. Specifically, the flow rate of the water pumped is determined by both the intensity of the solar energy available and the size of the PV array used to convert that solar energy into direct current (DC) electricity. The efficiency of the solar panel gets decreased as the operating temperature varies from 25^0 C. For increasing output of the PV panel it is air-cooled from the backside and subsequently that air is used for agricultural product drying. For continuous monitoring and controlling of the system Internet of Things (IoT) is used which proved a helpful tool in system performance.

2. EXPERIMENTAL SETUP
Figure 1 shows the experimental setup of forced convection indirect solar dryer and water pumping system. It consists of 320 W solar panel works as a solar absorber fitted in the enclosure of size 2*1*0.2 m, and energy developed by this panel is used for driving a 0.5 hp PMDC motor water pump. A 30 W capacity DC blower is used for blowing fresh ambient air over the back surface of the absorber. Two 4 W exhaust fans are fitted at the outlet of the enclosure to accelerate the airflow to a cabinet where products to be dried are kept in trays.

For remote monitoring and controlling of the system, the IoT platform is used. One special purpose custom made data transmitter is used. All the sensors like temperature, irradiation, humidity, water flow, voltage, and current are connected to this transmitter. Transmitter receives the data from sensors processes it and transfer it to the receiver for sending it to the cloud. The receiver is equipped with Xbee and ATMega 16.

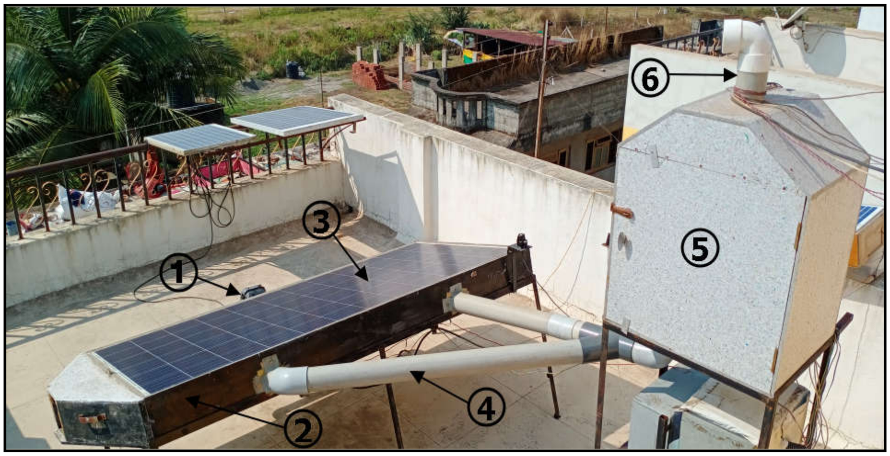
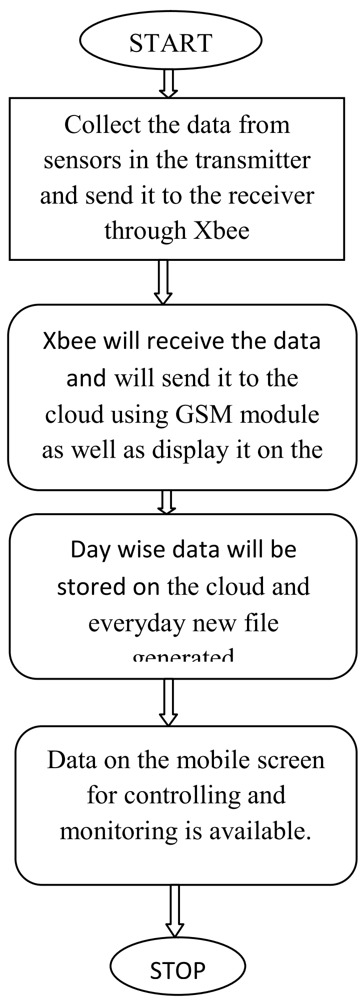


Fig 1 Experimental setup 1) 30W DC Blower 2) Enclosure 3) PV Panel as absorber 4) PVC pipe for carrying hot air 5) Drying cabinet 6) Chimney.

3. IOT SYSTEM FLOW CHART



4. SYSTEM ARCHITECTURE AND MOBILE APP

The system architecture of the transmitter and receiver is shown in Fig 3 A and B. All the sensors are connected to a transmitter through wires it receives the real-time data and sends it to the receiver through Xbee. The receiver accepts this data and helps visualization through the LCD. The receiver is equipped with the GSM module which helps to transfer the data to the cloud where it is stored.

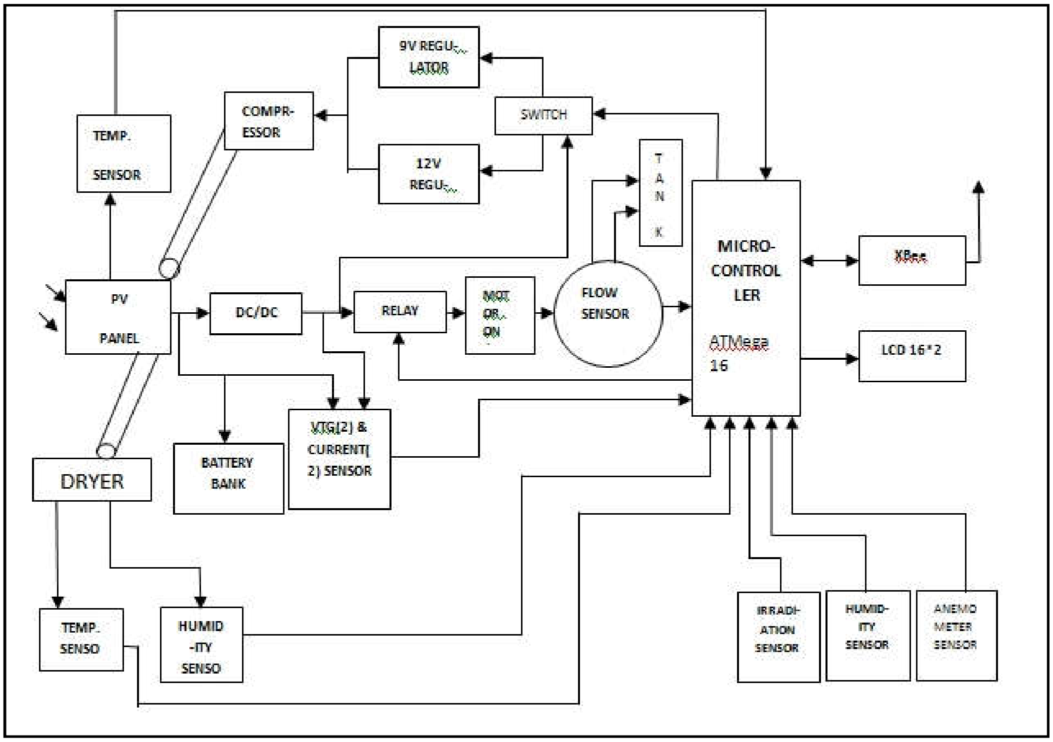


Fig 2 (a) Transmitter System Architecture.

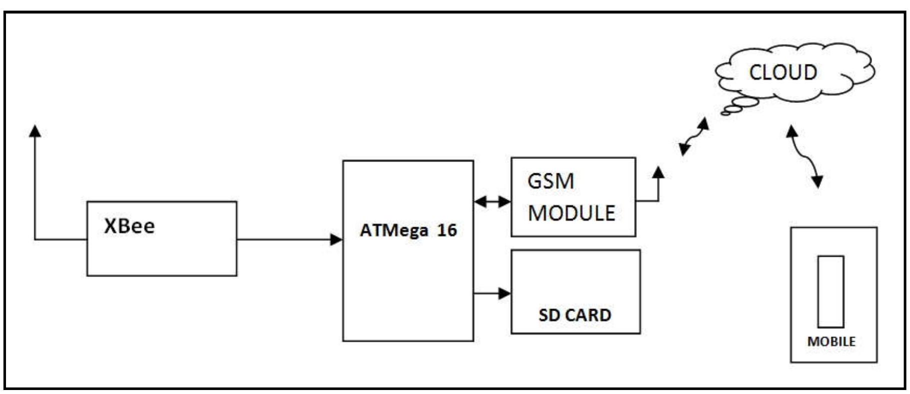


Fig 2 (b) Receiver System Architecture.

The user can access the data with the custom made the mobile app as shown in Fig 3. By using this app monitoring and controlling the system is possible. Through the mobile app sensors information like different temperatures in dryers, in and out air humidity, the weight of drying product, airflow, water flow, voltage, and current can be checked quickly. In the case of the drying of agricultural products, it is necessary to stop dehydrating the product after achieving the required moisture content beyond which quality may get spoiled. This facilitated with the help of app as there is a provision to change airflow and starting and stopping of the blower as per operators will. Hence spoiling of the product avoided and good quality of product maintained from a remote place. Cloud data is available as and when necessary as it is going to store over there.

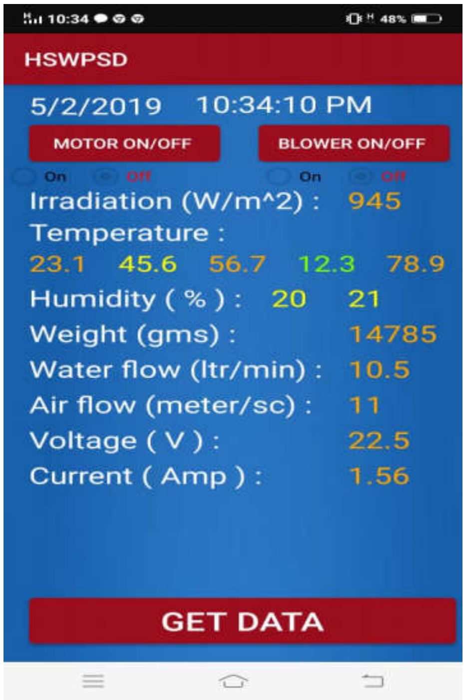


Fig 3 Mobile app screen appearance.

5. CONCLUSION

Real-time conditioning monitoring and controlling through the IoT proved a better solution for system monitoring. The number of sensors data like different temperatures in dryers, in and out air humidity, the weight of drying products, airflow, water flow, voltage, and current for every 20 second time was accessible easily from any remote place which reduced manual attention every time. Controlling the blower on-off for over reducing the moisture content proved good results and good quality of the product was maintained. As all data is stored at cloud storage system performance on a particular period can be checked whenever required.

6. REFERENCES

[1] J G Natividad, D Palaoag, “IoT based model for monitoring and controlling water distribution”, International Conference on Information Technology and Digital Applications. Materials Science and Engg. 482, (2019). DOI:10.1088/1757-899X/482/1/012045

[2] L. Belli, S. Cirani, A. Gorrieri, M. Picone, "A novel smart object-driven UI generation approach for mobile devices in the Internet of Things", Journal of electrical and electronics, (2017).

[3] Pratidnya Desai.Rohini Dhanavade, Rahul Nitturkar, Vikas Mane,” Monitoring of Solar Water Pumping System ”, IRJET Journal, (2017).

[4] C.A. Calderon, Miguel Cueva, NilvarCanla, AlexixHonores, Danny Guaman “Monitoring and automation of the water pumping & storage process applied to water treatment plant”. 13th Liberian conference on information system & technology monitoring, (2018.

[5] S. Duquennoy, G. Grimaud, J.-J.Vandewalle, "The Web of Things: Interconnecting devices with high usability and performance", Proc. Int. Conf. Embedded Software. 323-330, (2009).

[6] Ahmad Agus Setiawan, Didik Hari Purwantoa, Didit Setyo Pamujia, Nurul Huda "Development of solar water pumping system". Science Direct, Energy procedia, (2013)

[7] Pranita Kulkarni, Mrs. M. S. Joshi, "An IOT based Water Supply Monitoring and Controlling System with Theft Identification", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 9, (2016).

[8] S S Kusuma, G N Anil, "An IOT based Water Supply Monitoring and Controlling System", International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 02, (2018).

[9] Graham Nasby, Matthew Phillips, "SCADA Standardization, Modernization of a Municipal Waterworks with SCADA Standardization: Past, Present, and Planning for the Future", The 6th Annual ISA Water & Wastewater and Automatic Controls Symposium, Missouri, USA, (2011).

[10] Verma and Sundaresan "R 2015 Towards an IoT based water management system for a campus Smart Cities" Conf. (ISC2) IEEE First Int. pp 1-6, (2015)

[11] Ebere E V and Francisca O "Microcontroller based automatic water level control system", Int. Journal of Innovative Research in Computer and Communication Eng. vol 1 no 6, (2013).

[12] Prima E C, Munifaha SS, Salam R, Aziz M H, and Suryani A T 2016 Automatic water tank filling system controlled using Arduino based sensor for home application Engineering, Physics Int. Conf. 2016 vol 170 pp 373-377, (2016).