

Automatic Solar Powered Water Pumping Using Zigbee Technology

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Abstract- There has been a vast improvement and change in agriculture technologies used for irrigation purpose. Farm machineries, farm buildings and production facilities have been improved to a large extent. It has been found that PV system is the best solution for remote agriculture and for needs such as water pumping for crops or river life stock. Zigbee technology is renewable and is still a new concept. A Zigbee based water pumping system comprises of various components like, PV panels, pumps and Zigbee modules. In this Zigbee technology is used for wireless transmission and for enhancing the security of the system. In our system we have tried to automate the water pumping system to pump the water whenever the water level is increased beyond the prescribed level during rain or flood.

I. INTRODUCTION

Solar photovoltaicity is being widely used in different applications. Despite of various limitations of several energy sources, one of the most appropriate and simplest use of photovoltaicity is water pumping[2]. Solar powered water pumping system is widely used in crop irrigation now days. The major advantage of this water pumping system is storing water when sun is shining thus eliminating the need of batteries. It enhances the simplicity and reduce the overall cost of the system. There are two types of solar power water pumping system[6]. They are battery coupled and direct coupled. Battery coupled water pumping system shown in fig 1(a) consists of PV panels, charge control regulator, batteries, pump controllers, pressure switch, tank and DC water pump. The PV panels charges the batteries, which provide supply to the pump whenever water is needed [3]. In direct coupled pumping system which is shown in fig 1(b), electricity from PV modules is directly sent to the pump which in turn pumps water whenever it is needed. This is designed to pump the water only during day time while battery coupled can pump the water both during day and night[7]. Since in direct coupled water pumping system the amount of pumping is directly dependent on the sunlight hitting the PV panels and the type of the pump, thus due to change in intensity of sunlight during the day the amount of water pumped by the system also changes.

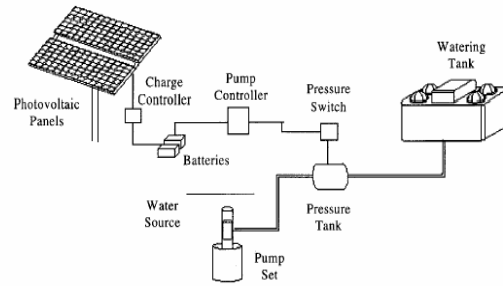


Fig1(a) . Battery coupled solar water pumping system

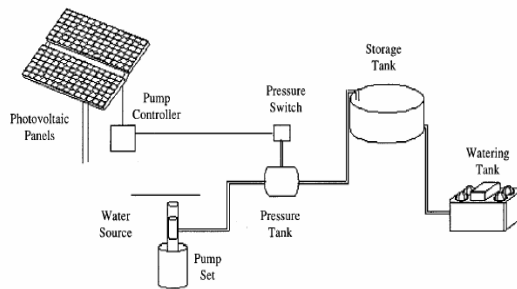


Fig1(b) . Direct coupled solar water pumping system

In this paper automatic controlling of the solar pump using solar panel and Zigbee module is done. Zigbee technology provides security and wireless transmission of data from transmitter (control board) to receiver (water pump). The major challenge with this solar powered water pumping system is its monitoring and control. In addition these systems are installed in open ambient, which poses a challenge for the appointed personnel to monitor its operation. It would be convenient if it could be operated from remote control room. Zigbee technology provides one such easiest way for the operation of solar powered water pumping system [5].

II. TECHNOLOGY USED

The control of solar powered water pumping system has been done through Zigbee technology. Zigbee technology is a wireless communication technology to connect local wireless nodes. Due to data communication with low power, it provides high stability and high transfer rate.

It is possible to perform wide range of data transfer by grouping study method. Data is transferred depending on the node signal strength in Zigbee node and the suggested algorithm, which can be analyzed through simulation. The Zigbee standard has been proposed to interconnect simple, low rate and battery powered wireless device based on IEEE 802.15.4. Low Rate Wireless Personal Area Network (LR-WPAN) standard[1]. Numerous applications such as home appliances network, home healthcare, medical monitoring and environmental sensors are expected to be facilitated by deployment of Zigbee network. For Zigbee mesh networks effective routing scheme is more important for which it uses NS-2. In Zigbee application layer, different data services is suitable for routing and for Zigbee mesh network best routing strategy are proposed. Physical layer wireless standard, applications support services operating on the top of the IEEE 802.15 Medium Access Control(MAC) and network security are provided by Zigbee standard[14].

A group of technologies are employed to enable scalable, self organising, self healing networks that can manage various data traffic patterns. It has the advantage of low cost, low power and has wireless mesh networking standard. It has wide application in wireless control and monitoring application. Due to its low cost, the low power usage allows longer life with smaller batteries and mesh networking which promises high reliability and larger range.

Zigbee has been developed to meet the growing demands for capable wireless networking between numerous low power devices which promises high reliability and larger range. Aim of using Zigbee technology is to reduce the energy consumption and latency by enhancing routing algorithm. In a traditional three routing, when a node wants to transmit a packet to the destination like a child/parent relationship, packet has to follow and go along tree topology, even if the destination is lying at nearby source. An enhanced tree routing algorithm is introduced using Zigbee network in order to solve this problem. By computing the routine cost for all routers, this algorithm can find out the shortest path by routing. The shortest path by routing caused of all to router that's stored in neighbour table and transmit the packet to the neighbour router which reduces the hop count of transmission. More stability and better efficiency can be achieved by enhancing tree routing algorithm.

Zigbee has many features like, Dual PHY (2.4GHz and 868/915 MHz) , Data rates of 250 kbps (@2.4 GHz), 40 kbps (@ 915 MHz), and 20 kbps (@868 MHz) [15], Optimized for low duty-cycle applications (<0.1%), CSMA-CA channel access, Yields high throughput and low latency for low duty cycle devices like sensors and controls, Optional guaranteed time slot for applications requiring low latency, Fully handshaked protocol for transfer reliability, Range: 50m typical (5-500m based on environment), Low power (battery life multi-month to years), Multiple topologies: star, peer-to-peer, mesh.

Comparison of key features of complementary protocols:

Feature(s)	IEEE 802.11b	Bluetooth	Zigbee
Power profile	Hours	Days	years
Complexity	Very complex	complex	simple
Nodes /master	32	7	64000
Latency	Enumeration upto 3 seconds	Enumeration upto 10 seconds	Enumeration upto 30 milli seconds
Range	100 m	10 m	70 m-300 m
Extendibility	Roaming possible	No	yes
Data rate	11 Mbps	1 Mbps	250 Kbps
Security	Authentication service set ID (SSID)	64 bit, 128 bit	128 bit AES & application layer user defined

Bluetooth is a cable replacement for items like Phones, Laptop, Computers, Headsets and expects regular charging whereas ZigBee is better for devices, where the battery is 'rarely' replaced. Zigbee transfers smaller packets over large networks and these networks are mainly static while Bluetooth transfers large packets over small networks using ad-hoc network. Zigbee used in toys, remote controls, home automation etc and Bluetooth used in mobiles, screen graphics, pictures, hands free audio, headsets, PDAs, etc.

The advantages of Zigbee are low power consumption, simply implemented, Bluetooth has many different modes and states depending upon your latency and power requirements such as sniff, park, hold, active etc whereas, ZIGBEE/IEEE 802.15.4 has active (transmit/receive) or sleep, mains powered equipments needs to be conscious of energy, low cost (device, installation, maintenance), high density of nodes per network, security etc.

III. METHODOLOGY

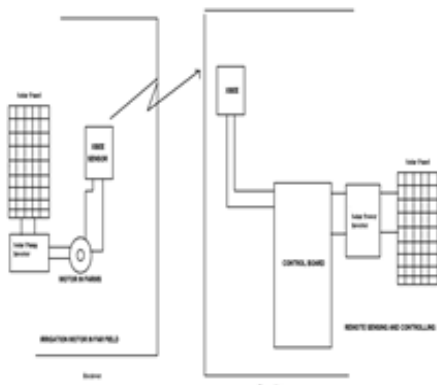


Fig 2.1. Block diagram of Zigbee based water pump controlling

Different components used in the system are[11]:

- a) *Solar Panel:* solar panel is a electrically connected PV modules attached on a supporting structure. The solar panel is used for generate and transmit electricity in different areas from solar energy. The DC output power is the rating of each module under STC (standard test condition) ranging between 100 to 320 watt. Solar panel is most costlier than the others components in this experiment. It comprises 80% of the setup cost. 16% efficient module consist half of the area of 8% on 230 watt module. A limited amount of power can be produced by a single solar module. The size of the solar panel is directly dependent on the size of the pump, the amount of water that is required (m³/d) and the solar energy available[4].
- b) *Sensor:* The purpose of the Sensor is used for sensing the level of water on operating condition, if there is any deviation from normal level of the water takes place then the system will be turned off. Due to this wastage of water minimises and efficiency will increase[10].

- c) *Solar Pumping Motor:* Solar pump motors can be used on AC (alternating current) or DC (direct current) voltage. Direct current motors are in range of about 3 kW ,and used for small to medium applications e.g. garden fountains, landscaping, drinking water for livestock, or small irrigation projects. Since DC pumps have higher overall efficiency than AC pumps of same size, cost will be reduced with the use of smaller solar panel[9].
- d) *Inverter:* An inverter is used for converting the alternating current output of AC solar pump in direct current. The power range of inverters can be extends from 0.15 to 55 kW for larger irrigation systems. However, the panel and inverters will be used according to the requirement.
- e) *Zigbee Module:* ZIGBEE is a specification for a suite of high level communication protocol used to create personal area networks built from small, low power digital radios. ZIGBEE is a low cost low power wireless mesh network standard. The low cost allows the technology to be widely deployed in wireless control. Low power uses allows longer life with smaller batteries.

Circuit diagrams of transmitter and receiver are shown in fig. 2.2 & fig. 2.3.

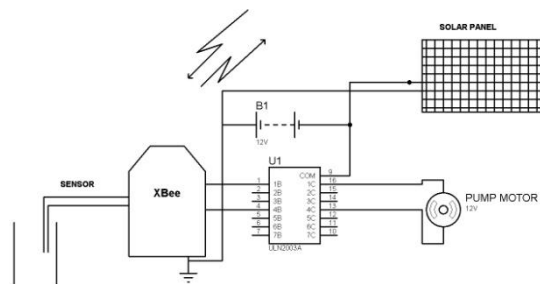


Fig. 2.2 Circuit diagram of transmitter

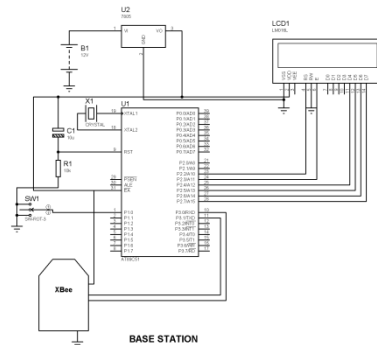


Fig. 2.3 Circuit diagram of receiver

As shown in the fig. 2.1, the operation of solar power water pumping system has been presented in the following manner:

- Start solar water pump.
- Now motor is running on its normal operating condition.
- Controller or sensor matches the desired water level.
- If water level is sufficient for the use then motor will run normally.
- otherwise abnormal condition signal will be transmitted from zigbee module situated at farm to zigbee module situated at control board.
- Then controlling signal will be sends back to the receiver side zigbee module to switch OFF the motor.
- Motor will be turned OFF.

A farmer simply sends a command from control board for switching ON/OFF the water pump for preventing the excess flow of water and the command signal uses Zigbee technology for transmitting the signal to water pump connected in the farm for irrigation purpose. This zigbee technology uses Zigbee modules connected in transmitting side (control board) and receiving side (water pump). On the time of wastage of water, Zigbee module sends a signal of excess water flow to control board from which farmer can monitor and control the water pump. And power for operating pump and controlling board are provided by solar panel. Zigbee also have an advantage of security, embedded C programming provides controlling of the pump[8] can possible by that farmer which is authenticate for this So this project uses a new technology with the use of solar energy without making any pollution and farmers doesn't need to go to switch OFF or ON the pump, hence controlling of water pump becomes easier and secure[12].

IV. BENEFITS/COST

Assume, If the pumping is done for 4 hours a day then electrical energy consumption is 2 units a day and if the cost of each unit INR 4.5 then cost of pumping water from a normal pump *INR 9 a day. Then monthly cost of pumping from a normal pump will be INR 270, whereas monthly cost of pumping water from solar powered pump INR 0. If the cost of labour is INR 100 per day so monthly charge for the labour INR 3000, whereas cost of pumping water from solar powered pumping with ZIGBEE technology INR 0.

*INR- INDIAN RUPEES

V. CONCLUSION

At present, labour-saving and water-saving technology is a key issue in irrigation. A wireless solution for intelligent field irrigation system dedicated to planting, based on Zigbee technology instead of conventional wired connection, the wireless design made the system easy installation and maintenance. The hardware architecture and software algorithm of wireless sensor/actuator node and portable controller are acting as the end device by coordinator in Zigbee wireless sensor network respectively. So that the controlling of water pump for farmers makes so easy and providing security make it secure. Overall, the proposed implementation of high power Zigbee based automatic water pump controlling system offering low power consumption with high reliability is presented. Another important fact of this system is the easy installation of the system where the base station can be placed at the local residence close to the farm and the monitoring task can be done by only that person who has authenticated for it[13]. And the main advantage of solar system is, when the prices of fossil fuels rise and the economic advantages of mass production reduce the peak watt cost of the photovoltaic cell[9], photovoltaic power will become more cost-competitive and more common. The cost of power and labour will be zero.

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International Journal of Emerging Technology and Advanced Engineering

Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 4, April 2014)

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