Solar Driven Auto Irrigation System

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***Abstract*—Our paper "Solar Driven Auto Irrigation System" includes the design and construction of an Arduino based irrigation system which is powered by solar system. Auto irrigation system helps to save the water and power, which helps to save the cost of farmers. As the technology on every field is immensely changing, our project will help to modernize the irrigation system by replacing the traditional one. The tracking system has the ability to always point the solar array toward the sun. The voltage thus obtained from solar power is stored in the battery. The surveillance camera installed on our project helps to ensure the security of the surrounding. By using this system, there is no need of manual control.**

Keywords—Auto irrigation, Arduino, Surveillance, Security

I. Introduction

The continuous increasing demand of the food requires the rapid improvement in food production technology. In a country like Nepal, where the economy is mainly based on agriculture and the climatic conditions are isotropic, still we are not able to make full use of agricultural resources. The main reason is the lack of rains & scarcity of land reservoir water. The continuous extraction of water from earth is reducing the water level due to which lot of land is coming slowly in the zones of un-irrigated land. Another very important reason of this is due to unplanned use of water due to which a significant amount of water goes waste.

In the modern drip irrigation systems, the most significant advantage is that water is supplied near the root zone of the plants as per requirement to which a large quantity of water is saved. At the present era, the farmers have been using irrigation technique in Nepal through the manual control in which the farmers irrigate the land at the regular intervals. This process sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. Water deficiency can be detrimental to plants before visible wilting occurs. Slowed growth rate, lighter weight fruit follows slight water deficiency. This problem can be perfectly rectified if we use automatic micro controller based drip irrigation system in which the irrigation will take place only when there will be intense requirement of water.

The different types of irrigation techniques used are surface irrigation, localized irrigation, sprinkler irrigation and Drip Irrigation system.

a. Surface Irrigation

In this system, water is applied and distributed over the soil surface by gravity. It is most common and has been practiced in many areas virtually unchanged for thousands of years.

b. Localized Irrigation

Micro irrigation, also called localized irrigation, low volume irrigation, low flow irrigation or trickle irrigation is an irrigation method with lower pressure and flow than a traditional sprinkler system. Low volume irrigation is used in agriculture for row crops, orchards, vineyards, wholesale nurseries etc.

c. Sprinkler Irrigation

An irrigation sprinkler device is used to irrigate agricultural crops, lawns, landscapes, golf courses and other areas. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground.

d. Drip Irrigation

It is a type of micro-irrigation that has the potential to save water and nutrients by allowing water to drip slowly to the roots of the plants, either from above the soil surface or buried below the surface.

II. Objective

To develop solar driven auto irrigation system with integrated security feature

III. Problem Statement

Irrigation of plants is usually a very time- consuming activity, to be done in a reasonable amount of time, it requires a large amount of human resources. Traditionally all the steps were executed by humans. Nowadays some technology is used to reduce the number or workers or the time required to water the plants. With such systems, the control is very limited, and many resources are still wasted. Water is one of these resources that are used excessively. Irrigation is one method used to water the plant. This method represents massive losses since the amount of water given is in excess of the plant’s need. The excess water is evacuated by the holes of the pots in greenhouses, or it percolates through the soil in the fields. The contemporary perception of water is that of a free renewable resource that can be used in abundance. It is therefore reasonable to assume that it will soon become a very expensive resource everywhere. In addition to the excess cost of water, manpower cost is becoming more and more expensive. As a result, if no effort is invested in optimizing these resources, there will be more money involved in the same process. Technology is probably a solution to reduce costs and prevent loss of resource; this project paper can be a strong way to tackle such a situation.

IV. SCOPE

i. The project can be extended to greenhouses where manual supervision is far and few in between.

ii. The principle can be extended to create fully automated gardens and farmlands.

iii. In agricultural lands with shortage of rainfall, this model can be successfully applied to achieve great results with most types of soil.

V. LITERATURE REVIEW

A microprocessor based solar tracking controller was designed and fabricated and the controller was capable acquiring photovoltaic and metrological data from a photovoltaic system and controlling battery / load [1]. These features were extremely useful in autonomous PV system installed in remote areas for system control and monitoring.

This system had a novel design of a dual-axis solar tracking PV system which utilizes the feedback control theory along with a four-quadrant light dependent resistor (LDR) sensor and simple electronic circuits to provide robust system performance [2]. The system used a unique dual-axis AC motor and a stand-alone PV inverter to accomplish solar tracking.

The system was controlled by two relays as a DC-geared motor driver and a microcontroller as a main processor. This project was covered for a single axis and is designed for low power and residential usage applications [3]. From the hardware testing, the system was able to track and follow the Sunlight intensity in order to get maximum solar power at the output regardless motor speed.

The system which used microcontroller 89C52 from Atmel, automatically tracked the sun’s position and accordingly change the direction of the solar plate to get the maximum output [4]. They made a solar tracking system which automatically tracked the sun’s position to growing the efficiency of solar system.

This prototype focused at saving time and avoiding problems like constant vigilance in farmland [5]. It also helps in water conservation by automatically providing water to the plants/gardens depending on their water requirements, risks and making work simpler. Embedded and micro controller systems provide solutions for many problems. This application precisely controls water system for gardens by using a sensor micro controller system. It is achieved by installing sensors in the field to monitor the soil temperature and soil moisture which transmits the data to the microcontroller for estimation of water demands of plants.

This paper discussed the prototype design of microcontroller based Intelligent irrigation system which allowed irrigation to take place in zones where watering is required, while bypassing zones where adequate soil moisture is indicated [6]. Other feature of this prototype was pesticide sprinkling system where the mixture is prepared in required proportion deserved by the plants automatically (required ratio is preloaded), there-by preventing the human mistakes to maximum extent.

This project was sensor based automated irrigation system to reduce water requirement and to increase the productivity of orange orchard in Vidarbha region [7]. This system was best suited for places where water is scarce and has to be used in limited quantity. Also, third world countries can afford this simple and low cost solution for irrigation and obtain good yield on crops

This paper describes the design and implementation of a low-cost system monitoring based on Raspberry Pi, a single board computer which follows Motion Detection algorithm written in Python as a default programming environment [8]. In addition, the system uses the motion detection algorithm to significantly decrease storage usage and save investment costs. The algorithm for motion detection is being implemented on Raspberry Pi, which enables live streaming camera along with detection of motion.

VI. METHODOLOGY

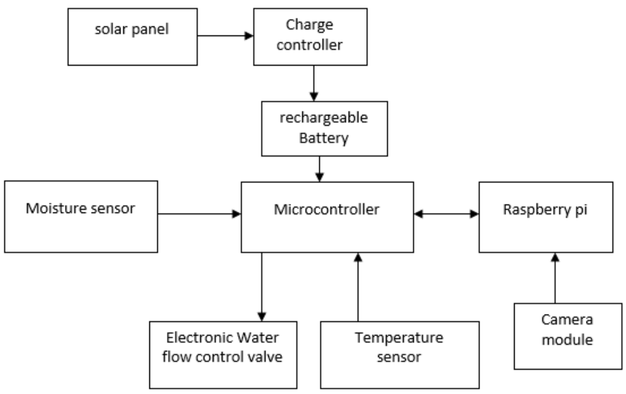

Figure 1: Block diagram of the system

As shown in figure, the brain of the system is microcontroller. It is interfaced with different sensors and different information’s are achieved through the respective sensor. Moisture sensor calculates the moisture content in the soil. If the content of moisture is less than the predefined threshold value, the valve of the water pipe gets opened and the soil gets required amount of water.

The system has the security feature. A camera is used for the surveillance of farm land. The Raspberry pi camera module is interfaced with the raspberry pi module. The video is streamed over the internet and this can be viewed by the owner from their house. The owner constantly monitors the activities in the field.

For supply of the power to each module, solar energy is used. For the use of most amount of solar energy, automatic solar tracking system is implemented. For the detection of intensity of sunlight, Light dependent resistors (LDR) are used. LDRs are light dependent devices whose resistance is decreased when light falls on them and that is increased in the dark. When a light dependent resistor (LDR) is kept in dark, its resistance is very high. This resistance is called as dark resistance. It can be as high as 1012 Ω and if the device is allowed to absorb light its resistance will be decreased drastically. If a constant voltage is applied to it and intensity of light is increased the current starts increasing. Depending upon the values of resistance from LDR, servo motors are operated which rotates the solar panel.

Soar tracking Algorithm:

Step 1: Initialize angles of servos = 90

Step 2: Read analog values lt, rt, ld, rd

// lt=top left ldr; rt=top right ldr; ld= down left ldr; rd= down right ldr

Step 3: if (lt < 40 && rt < 40 && ld < 40 && rd < 40)

avt = (lt+rt)/2

avd = (ld+rd)/2

avr = (rt+rd)/2

avl = (lt+ld)/2

//taking averages of the ldr values

Step 4: tol = analogRead(5)/2; //for tolerance

dtime = analogRead(4); //for speed

Step 5: dvert = avt-avd //difference of average value of the top and down ldrs

dhoriz = avl-avr //difference of average value of the left and right ldrs

Step 6: if (-1*tol > dvert | | tol<dvert)

vertical.write(servov)

if (-1*tol > dhoriz | | tol<dhoriz)

horizontal.write(servoh)

// comparing tolerance value with the difference of the averages value of the ldrs to move either the vertical or horizontal servos

Step 7: delay (dtime) // for the smoothness of the servo movement

Step 10: go to 1

1) Soil moisture sensing and water valve control:

2) Step 1: Start

3) Step 2: If soil moisture content is less than desired amount, then go to step 3

4) else go to step 4

5) Step 3: Open the valve of pipe.

6) step 4: check the moisture content

Solar Charge Controller working Principle

Circuit must have adjustable voltage regulator, so Variable voltage regulator LM317 is selected. Here LM317 can produce a voltage from 1.25 to 37 volts maximum and maximum current of 1.5 Amps. Adjustable Voltage regulator has typical voltage drop of 2 V-2.5V. So Solar panel is selected such that it has more voltage than the load. Here we are selecting 18v/5w solar panel.

Li-ion battery which is used here has specification of 12v/1.6Ah. In order to charge this battery following are required. Schottky diode is used to protect the LM317 and panel from reverse voltage generated by the battery when it is not charging. Any 3A diode can be used here.

Charging a 12V Battery

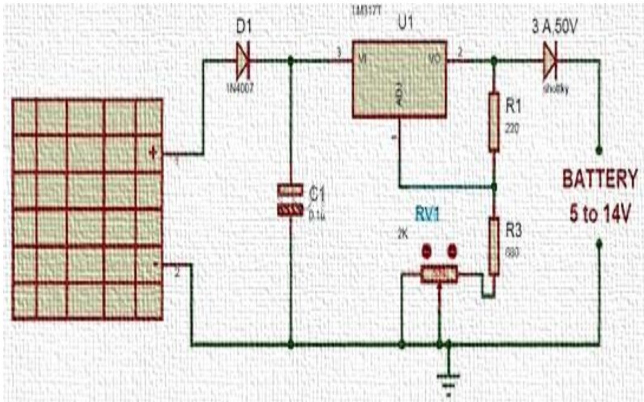

Figure 2: Circuit diagram of solar charge controller

Charging current = Solar panel wattage/Solar Panel Voltage = 5 / 18 = 0.27A.

Here LM317 can provide current up to 1.5A. So, it is recommended to use high wattage panels if more current is required for your application. (But here our battery requires initial current less than 0.39Amps. This initial current is also mentioned on the battery).

If the battery requires initial current more than 1.5A, it is not recommended to use LM317.

Time taken for charging = 1.6Ah/0.277A = 5.77hours

In the circuit diagram, capacitor C1 protects from the static discharge. Diode D1 protects from the reverse polarity. And voltage regulator IC provides voltage and current regulation.

VII. Result Analysis and Discussion

This project presents a smart dual- axis solar tracker. The Arduino mega is used to develop a smart solar tracking model with automatic LED light. We compared the output voltage drawn by the solar panel with and without the tracking system.

Table 1: Voltage with and without tracking system

Time	Voltage without tracking system	Voltage with tracking system
10AM	19.94	21.03
11AM	18.63	21.41
12PM	14.19	22.06
1 PM	12.54	21.55
2 PM	12.07	21.1
3 PM	11.83	20.06
4 PM	11.67	19.78
5 PM	11.47	18.60

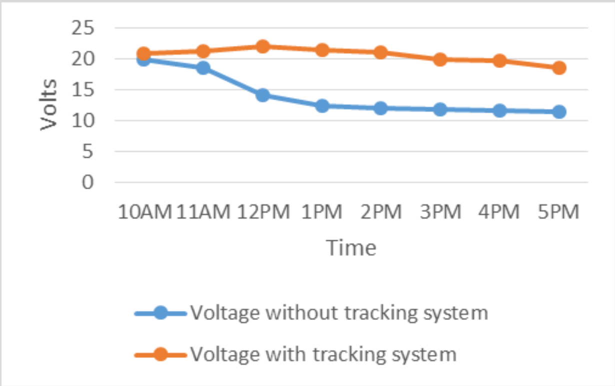

Figure 3: Graph of Voltage generated by solar panel

From the results obtained, it was observed that the system with a tracking system will have a greater efficiency as the maximum voltage is using a tracker is about 25% to 30% greater as compared with a traditional fixed PV system. And the generated power is also increased about 30% which is much better than fixed PV panel system. From these data it was seen that the period between 11 am - 4 pm was a high time to generate maximum output from the solar panel.

The moisture sensor used to sense the sensitivity of the soil measured the moisture of the soil. We used two moisture sensors to measure the sensitivity of the soil. The first sensor was kept on a muddy soil /wet soil and one was kept on a dry soil. From the serial monitor we found out the two different values that helped us to keep the threshold of our sensor.

The Solar panel gave the fluctuated voltage to the battery which may damage the battery. So, the solar panel is directly connected to the solar charge controller to avoid from fluctuated voltage. The solar charge controller is then connected to the battery to charge the battery.

The power to the Arduino Mega and Raspberry pi is given from Lead acid battery. But it cannot be directly connected to the module because it gives more current and voltage than required. Thus, to maintain the required voltage, buck regulator is used.

Now, the moisture sensor, water pump, servomotors etc. are connected to the Arduino. When there is less amount of water than required, then the water-pump pumps the water to the soil and when the threshold is obtained, it stops pumping the water. The Pi-camera is used for the surveillance of the garden for the security feature.

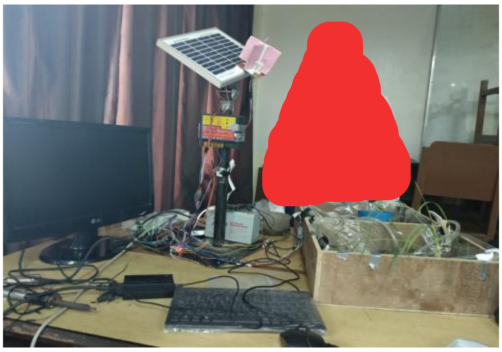
Figure 4: Finalized project

VIII. Conclusion

Hence our project sensed the moisture content of the soil added water to the soil if the moisture content is low. Voltage obtained from solar power charged the lead acid battery and that battery gave the power to the different modules used in our project. Hence the project was automatic.

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