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Solar Powered Smart Irrigation System

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ABSTRACT

In the field of agriculture, a proper method of irrigation is of utmost importance because of two main reasons: lack of rains & scarcity of land reservoir water. Continuous extraction of water from the earth has been reducing the groundwater levels due to which many of the agricultural lands have been pushed slowly into the zones of un-irrigated lands. Another very important reason of this is the uncalculated use of water due to which a significant amount of water goes wasted. To overcome this problem, an automatic irrigation system can be used which derives power from solar energy through photovoltaic cells and by which, the dependency on erratic commercial power can be reduced. In this proposed system, solar energy is used to operate an irrigation pump. An automatic pump control using a moisture sensor and a microcontroller is implemented. Sensor are placed on the agricultural field and it continuously sense the water level in them and based on the information given by the sensors, the microcontroller controls the water flow to the field by making Pump on/off. Further, this project can be extended by interfacing it with a IOT, so that the farmer can be aware of the soil moisture level and by that, can control the switching operation of the water pump from a remote area.

Keywords : Zener diode, solar energy, Arduino, DC Motor, Soil Moisture sensor

I. INTRODUCTION

Farmers have always played a significant role in our society as they provide the world's population with food. In fields we are supplying water but we are not updated in serving the water to the field. For this we are trying to design a pump by using micro controllers. With this the machine will supply water automatically to the field at an exact time and it stops supplying water when the sensor reading is more than the controller's value. Although soil water status can be determined by direct(soil sampling) and indirect (soil moisture sensing) methods, direct methods of monitoring soil moisture are not commonly used for irrigation scheduling because they are intrusive and labor intensive and cannot provide immediate feedback. Soil moisture probes can be permanently installed at representative points in an agricultural field to provide repeated moisture readings over time that can be used for irrigation management. Special care is needed when using soil moisture devices in coarse soils since most devices require close contact with the soil matrix that is sometimes difficult to achieve in these soils.

II. DISCRIPTION

In agricultural fields, farmers usually control the electric motors observing the soil, crop and weather conditions by visiting the sites. These manually controlled irrigation systems cannot ensure a proper level of water in the site. Due to mismanagement in the manually controlling systems, sometimes their fields become dry and sometimes flooded with excess water. These unplanned and manually controlled irrigation systems may cause a significant amount of water waste. Now-a-days; every system is automated in order to face new challenges. Automated systems

that have less manual operation are flexible, reliable and accurate. Due to these demands every field prefer automated control systems especially in the field of electronics where automated systems are giving good result. Microcontroller is one of the major devices in the field of electronics. While using microcontroller has become very much popular for its wide application field and user adaptability, microcontroller is used in many major areas. So using a microcontroller this automated irrigation system is designed to avoid wastage of water. Another major problem for farmers is electricity. The agricultural fields should be watered regularly and to water their plants farmer needs electricity. In rural areas, the power outages are huge and the farmers do not know when the power will be restored. To avoid this problem, the proposed irrigation system is supplied power using solar panels. The micro controller has an input signal from moisture sensor. When the moisture level in agricultural field is low then the moisture sensor will send a signal to micro controller which makes the pump switch on and then water flow to the field.

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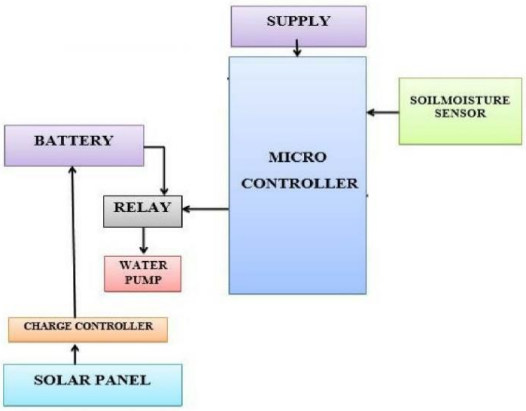
A.BLOCK DIAGRAM:



The main components used are

a. **Micro controller(NodeMcu)**
b. **Soil moisture sensor**
c. **LM317 Charge controller**
d. **Solar panel**
e. **Lead acid battery**
f. **Relay board**
g. **Water pump**

a. Microcontroller NodeMcu _v1.0:

Fig 1. **Micro controller NodeMcu**

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMcu devkit to our laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

Specification:

- Voltage: 3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Current consumption:10uA~170mA.
- Flash memory attachable: 16MB max (512Knormal).
- Integrated TCP/IP protocolstack.
- Processor: Tensilica L10632-bit.
- Processor speed:80~160MHz.
- RAM: 32K +80K.
- GPIOs: 17 (multiplexed with other functions).
- Analog to Digital: 1 input with 1024 stepresolution.
- 802.11 support:b/g/n.
- Maximum concurrent TCP connections:5.

b. Soil Moisture sensors:

These sensors are used to measure moisture level in the soil. The two large exposed pads function as probes for the sensor, together acting as a variable resistor. The more water that is in the soil means the better the conductivity between

the pads will be and will result in a lower resistance.

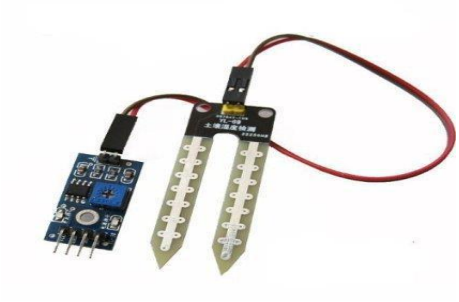


Fig.2 **Soil moisture sensor**

Features:

Adjustable range with POT.

Logic output 1 or 0.

The working of this sensor has two metallic probes of sensor are inserted into the ground. The two large exposed pads function as probes for the sensor, together acting as a variable resistor. The more water that is in the soil mean The more water that is n the soil means the better the conductivity between the pads will be and will result in a lower resistance .The sensor module has an analog output pin and a digital output pin. Depending upon the application any pin can be used. It uses a LM393 comparator which compares the sensor output with the threshold value set by the user. The threshold value is to be changed depending on the type of land and crop.

c. IC LM317 charge controller:

A solar charge controller regulates the voltage and current coming from your solar panels which is placed between a solar panel and a battery .It is used to maintain the proper charging voltage on the batteries. As the input voltage from the solar panel rises, the charge controller regulates the charge to the batteries preventing any overcharging. The most basic charge controller (ON/OFF type) simply monitors the battery voltage and opens the circuit, stopping the charging, when the battery voltage rises to a certain level.It is the basic utilization of solar energy. This is the important way that we can change sunlight into power specifically and step by step there is improvement. Solar panels are essentially solar cells arranged together in parallel to get an accurate voltage and p-n intersection semiconductor with silicon wafer doped with "n"

Specifications:

Operating voltage: + 5v D.C.

Module Output is high when the moisture in soil is low and module output is low when the moisture in soil is high.

On-board LM393 comparator.

Pin Specification:

VCC: 3.3V-5V.

GND: Ground.

DO: digital output interface (0 and 1).

AO: analog output interface.

sort phosphorous on the top and "p" sort boron on the base. These electrons are pulled in to the positive charge in the n-sort silicon and repulsed by the negative charge in the p-sort silicon. Associating wires over the intersection will have a current in them. We depicts to make a solar based charger circuit utilizing IC LM317 which is adjustable voltage regulator to charge lead acid battery.

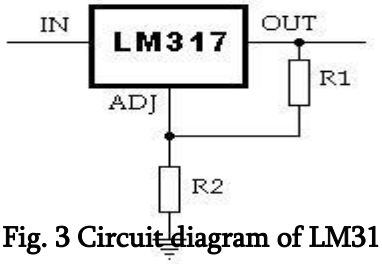


Fig. 3 Circuit diagram of LM31

It is a flexible voltage controller IC which implies it gives Line Regulation (independent of the adjustments in the info voltage, the yield voltage stays consistent) and Load Regulation (regardless of the adjustments in burden the yield voltage is altered). We can modify the yield voltage by differentiating the resistance over the change pin. This is needed an altered voltage over the battery (to constrain the current and charge it at steady voltage). Straightforwardly associating the sun powered board to the battery might even blast it because of the shifting yield from it. The voltage crosswise over R1 is kept up to be 1.25 V utilizing an inward circuit. The Vout is likewise then gotten to be steady and given by: Vout = VR1*(1+R2/R1) +Iadj*R2. This Iadj is of the request of micro so can be fail to have a controlled yield voltage. This circuit is intended for a 12V 14Ah battery. This implies a 14A current will charge the battery in 1hour. Lead corrosive batteries are not the best

accessible alternatives in rechargeable batteries (not at all like compact and simple to utilize Li-particle batteries). In any case, for little applications such as our sunlight based light, they are adequate. Care must be taken while taking care of corrosive batteries.

Diodes (1N5812): These are essentially blocking diodes which guarantee that the present streams just in restrictedso that the battery doesn't release when the yield from sun powered board is low.

Zener Diode (1N4736) and the Transistor (BC548): This piece of circuit guarantees that once the charging cutoff voltage is come to by the battery, the charging stops. The Zener is evaluated at 6.8V as breakdown. This permits all the voltage to drop over the Zener and the transistor changes on because of biasing of the Base-Emitter intersection. The transistor demonstrations like a switch and once the battery is charged, it draws all the present accordingly securing the battery.

Produced by the solar panel is given to charge a battery by means of charge controller.

z Solar Panel -> PWM Charge Controller -> Battery Bank

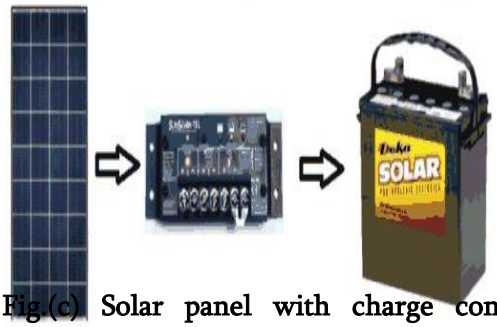


Fig.(c) Solar panel with charge controller and battery

Advantages:

- Solar power is pollution free and causes no greenhouse gases to be emitted after installation
- Reduced dependence on foreign oil and fossil fuels
- Renewable clean power that is available every day of the year, even cloudy days produce some power
- Return on investment unlike paying for utility bills

Disadvantages:

High initial costs for material and installation and long ROI

Needs lots of space as efficiency is not 100% yet

No solar power at night so there is a need for a large battery bank

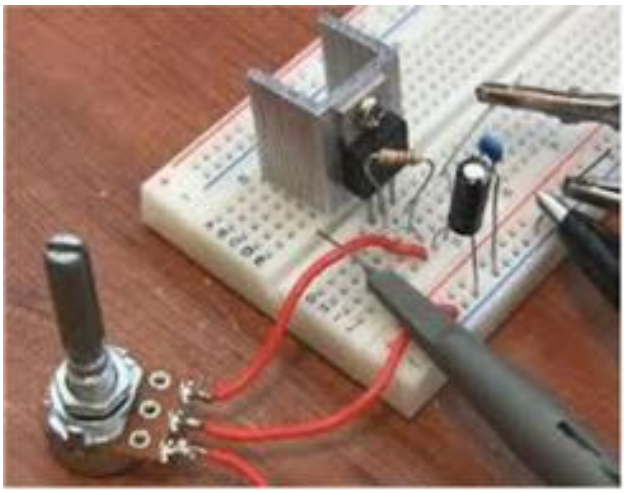


Fig. 4 Hardware of adjustable voltage regulator

d. Solar panel:

The photovoltaic (PV) module is a packaged; connect assembly of typically 6×10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 watts. The electrical energy

Some people think they are ugly (I am definitely not one of those)

e. Lead-Acid Battery:

The availability of solar energy is constrained, not continues throughout the day. But we require instant energy to run the water pump based on the moisture content in the irrigation field. To avoid the ambiguity in availability of solar energy we need a storage device. For that we need to choose reliable, efficient and most economically affordable device. Here we use lead acid batteries to meet above requirements. The specifications of lead acid battery is

- Nominal cell voltage : 2.1 V
- Charge and Discharge efficiency : 50-95%
- Charge temperature : Min -35 ^{0}C, max 45 ^{0}C
- Energy density : 60-110 Wh/L
- Self-discharge rate : 3-20%/month
- Specific energy : 33-42 Wh/kg
- Specific power : 180 W/kg

f. Relay Board:

The term Relay generally refers to a device that provides an electrical connection between two or more points in response to the

application of a control signal. The most common and widely used type of electrical relay is the electromechanical relay or EMR

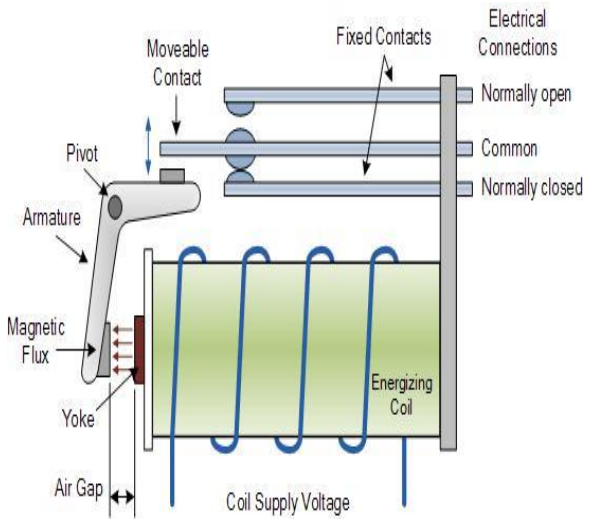


Fig.5 Electro mechanical relay

One pair of contacts is classed as Normally Open, (NO) or make contacts and another set which are classed as Normally Closed, (NC) or break contacts. In the normally open position, the contacts are closed only when the field current is "ON" and the switch contacts are pulled towards the inductive coil.

In the normally closed position, the contacts are permanently closed when the field current is "OFF" and the switch contacts return to their normal position. These terms Normally Open, Normally Closed or Make and Break Contacts refer to the state of the electrical contacts when the relay coil is "de-energized", i.e., no supply voltage connected to the relay coil.

- Trigger Voltage (Voltage across coil) : 5V DC
- Trigger Current (Nominal current) : 70mA
- Maximum AC load current: 10A @ 250/125V AC
- Maximum DC load current: 10A @ 30/28V DC
- Compact 5-pin configuration with plastic moulding
- Operating time: 10msec Release time: 5msec
- Maximum switching: 300 operating/minute (mechanically

g.Water Pump:

Device to lift, transfer, or increase the pressure of a fluid (gas or liquid) or to create a vacuum in an enclosedspace by the removal of a gas (see vacuum pumps under vacuum). The centrifugal pump, the most common kind, consistsbasically of a rotating device, called an impeller, inside a casing. The fluid to be pumped enters the casing near the shaft ofthe impeller. Vanes attached to the spinning impeller give the fluid a high velocity so that it can move through an outlet. Thereciprocating pump moves a fluid by using a piston that travels back and forth in a cylinder with valves to help control the flowdirection. Examples are the lift pump and the force pump. In a lift pump the piston and cylinder are positioned vertically.When the piston moves upward, atmospheric pressure pushes water into the cylinder to fill the empty space beneath thepiston. On the downward stroke, the water in the cylinder is forced to flow above the piston. Reversing direction, the pistonmoves up, allowing more water to come up under it into the cylinder and lifting the water held above it to an outlet pipe wherethe water flows out of the pump. Since atmospheric pressure will support a column of water no higher than about 33 ft (10m), a lift pump can raise water no farther than this distance. The rotary pump is like the reciprocating pump in that it allows afluid to fill a space that then decreases in volume, forcing the fluid out of the space. However, unlike a reciprocating pump, ithas no valves and uses one or more rotating components in place of a piston. The jet pump has no moving parts; it uses aswiftly moving fluid to induce motion in another fluid. For example an atomizer, a type of jet pump, uses a high speed stream of air to pump a liquid, such as a perfume

A pump is placed at the irrigation field and it is used to pump or stop water flow to irrigation field. The microcontroller controls the operation of pump depending on the output of moisture sensor. When the moisture level in soil is less, then microcontroller sends a control signal and makes the pump switched on which results in water flow to the field. When the moisture level in soil is sufficient then microcontroller sends a control

signal and switched off the motor to stop the water flow to field.

III.WORKING MODEL OF THIS PROJECT

In this automated system we use moisture sensors to find moisture level in the soil. This sensor senses the decrement or increment of soil moisture level and the sensor output is continuously read by the microcontroller. When the moisture level in soil decreases the sensor output will become high and the microcontroller will send a control signal to the pump to switch on it. As the pump switched on water starts to flow to the irrigation field. When the moisture level in soil increases and reaches the required level then the sensor output will be low. Then the microcontroller again sends a control signal to the pump to switch off it, so the water flow to the field stopped.

The entire system uses solar energy to operate which is stored in the battery. This unit contains solar panel, charge controller and a battery. The solar panel converts solar energy to electrical energy by using photo voltaic effect and the charge controller maintain proper charging voltages to the battery. The battery stores electrical energy which can be utilized by components in the system.

Fig.6 operating condition

Fig.7 off condition

V.RESULTS

In this project we designed a solar powered smart irrigation system to conservate water and energy for the future generations. While using microcontroller has become very much popular for its wide application field and user adaptability, microcontroller is used in many major areas. So using a microcontroller this automated irrigation system is designed to avoid wastage of water.

Another major problem for farmers is electricity. The agricultural fields should be watered regularly and to water their plants farmer needs electricity. In rural areas, the power outages are huge and the farmers do not know when the power will be restored. To avoid this problem, the proposed irrigation system is supplied power using solar panels.

VI.CONCLUSION

Automatic solar irrigation system offers an effective way to reduce the wastage of water and conserve electrical energy using solar energy. Since the design is completely automated, it is not necessary for the farmer to stay in the field. Moisture sensors are placed on the irrigation fields and are used to identify an increment or decrement in the soil

moisture level. A pump is used to allow or block the flow of water to the irrigation field and this pump operation depends upon the sensor output.. The system is controlled by using NodeMcu microcontroller. Now a day's automatic system occupies each and every sector of applications as it is reliable and accurate.

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