www.ijiarec.com

ISSN:2348-2079

Volume-6 Issue-2

International Journal of Intellectual Advancements and Research in Engineering Computations

Design and development of solar hydroponics system

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ABSTRACT

Hydroponics is a subset of hydro culture, the method of growing plants without soil, using mineral nutrient solutions in a water solvent. Terrestrial plants may be grown with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as perlite or gravel. The nutrients in hydroponics can come from an array of different sources; these can include but are not limited to waste from fish waste, duck manure, or normal nutrients. Hydroponic approach to growing plants has many benefits over conventional approach, such as: plants grow faster on smaller area and require less water. Hydroponic system usage in industry is quite well established, however, these systems are usually very specialized and complex. Home users can therefore mostly choose between oversimplified suboptimal or overly demanding hydroponic systems. As a solution to this problem a hydroponic system was designed which has all the capabilities of the complex systems but is simple for managing since it comes with integrated logic that takes over most of the managing tasks

Keywords: Water, Fodder, Temperature, Humidity, Arduino controller, Plant growing

INTRODUCTION

Green fodder is one of the important inputs and plays major role in feed of milk animals. Green fodder provides required nutrients/mineral for milk production and health of the dairy animals or livestock. Control of feed cost in dairy animals impacts the profits and result in successful dairy farming. Generally, in most of Indian states, the feed cost is about 70 to 75% of total milk cost where in green fodder contributes 30 to 35% of total input feed [1-3]. In India, rapid urbanization and mining areas has caused shrinkage of grazing areas and availability of lands that produces green fodder. This situation caused the dairy owners to look for alternative and sustainable method of quality green fodder production. Using hydroponic technology to produce the quality green fodder would be a revolutionary step in country's green fodder production. Having limited irrigation facility is also forces to implement the hydroponic technology in production of green fodder. Greenhouse / Poly house would be the right choice for implementing the hydroponic technology. Many states in India are providing subsidies on building poly house and greenhouses. One can avail these subsidies on greenhouse or poly house to implement the hydroponic technology in production of quality green fodder. Hydroponically grown fodder can be fed to sheep, goat, cattle and other livestock animals.

Need of Hydroponic Technology in Green Fodder Production:- Hydroponics technology is required to overcome the following constraints for the production of quality green fodder in India especially in dairy farmers.

- In case of small land holdings.
- In case of non-availability of fertile lands for green fodder cultivation.
- When the irrigation/water facility, fencing, land preparations resources /labor are limited.

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- In mining and coastal belt areas where it has limited area for growing green fodder dairy industry.

Hydroponic Technology

Well, hydroponics is a scientific way of growing plants/crops in water without any soil in controlled environment. In hydroponic technology, water is enriched with well-balanced nutrients which are essential for plants growth and better yield. When it comes to green fodder production, hydroponic technology takes the pressure off the land to grow green fodder for the livestock / animals. Generally, water, nutrients and sunlight are major inputs to the hydroponic system. Using, hydroponic system, fodder crops like, Barley, Oats, Maize, and Sorghum can be cultivated for producing high quality of nutritious green fodder for livestock/ dairy animals [4-6]. Hydroponic green fodder results in good health of dairy animals apart from high dairy yield. Apart from this, hydroponics system can be used for growing wheat grass, paddy sap lings in 7 to 10 days of time for optimum growth of the crop. Green fodder obtained from hydroponics consists of grass with grains, roots, stem and leaves. Whereas conventionally grown fodder consists of stem and

The hydroponic system allows growing green fodder at wider temperature in the range of 15-33 and humidity range at 70-80 % without fungal growth.

- Hydroponic technology is environmental friendly.
- Hydroponically grown green fodder saves water and labor cost.
- Hydroponically grown fodder is highly nutritious.
- The green fodder from hydroponic system improves animal/livestock health and reproductive efficiency.
- Feeding highly nutritious fodder will result in higher milk yield in dairy animals.
- Cost control can be achieved by growing green fodder in hydroponic system which leads to profitable and successful dairy

Previous work

Greenhouse agriculture has the potential for improving yield and vegetable quality in sub-optimal environments (Paulitz and Belanger, 2001).

Greenhouse agriculture needs to be optimized for efficiency and economic viability (Paulitz and Belanger, 2001; Floros et al., 2010).

Fruit and vegetables are important sources of antioxidants (Ehret et al., 2013), which are important in preventing chronic disease (Mayne, 1996; Omaye and Zhang, 1996; Dubick and Omaye, 2001; Giovannucci, 2002; Dorais et al., 2008; Dorais et al., 2007).

Local agriculture provides employment and access to fresh, healthy fruits and vegetables. Simple, repeatable, quality mixes of organic fertilizers allow the potential for recycling nutrients and locally producing fertilizers (Feri et al., 2002; Monje et al., 2003). Hydroponic systems can be manipulated to investigate the influence of aqueous media on vegetable production.

Proposed System

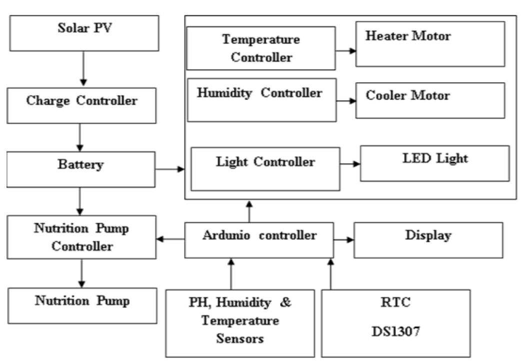

Fig.1 Block Diagram

The block diagram of proposed solar based hydroponics system shown in Fig. Solar PV blocks consists of 20W solar panel associated with charge controller block. Charge controller blocks used to prevent battery from overcharge. Battery block consist with 12V,7.5 AH battery to store electrical energy. Nutrition pump block having 12V high pressure DC motor to spray nutrition solution. Nutrient pump is controlled by nutrient pump controller block. Cooler motor, LED Light and Heater motor blocks are providing LED light, Heat and cooling to maintain humidity in hydroponics system, These blocks are controlled by Light controller, Temperature controller and humidity controller blocks respectively. The display block is interfaced to the arduino controller to display real time parameters in the proposed system. Humidity and temperature sensor block is used to sense humidity and temperature in the hydroponics system.RTC block is used to get the real time and date. All the blocks are interfaced with arduino controller block.Arduino controller block get the data from sensors and control the proposed system.

Arduino controller

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:

1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.

- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

PHYSICAL CHARACTERISTICS

The maximum length and width of the Uno PCB are Fig.2 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"),not an even multiple of the 100 mil spacing of the other pins

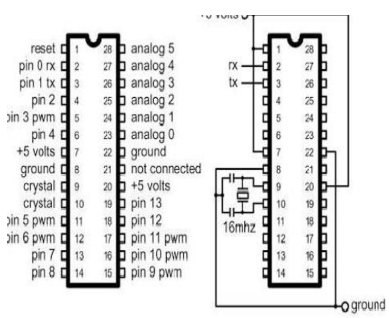

Fig.2 Pin Diagram

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Sensors and Interfacing Circuits

Sensors are mainly used to detect the status of the physical quantity. Here we are using sensors for measuring irrigation area temperature, Humidity, Soil moisture and flow of water.DHT11 temperature cum humidity sensor is used to measure irrigation field temperature and humidity, Soil moisture sensors are used to measure soil moisture and Water flow sensor is used to measure water flow in motor output. Electromagnetic relays are used to interface Motor and solenoid valves.

DHT11 SENSOR INTERFACE WITH ARDUINO

DHT11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any microcontroller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low cost humidity and temperature sensor which provides high reliability and long term stability. In this project, we will build a small circuit to interface Arduino with DHT11 Temperature and Humidity Sensor. One of the main applications of connecting DTH11 sensor with Arduino is weather monitoring in agriculture field.

Soil Moisture Sensor

When you hear the word Smart Garden, one of the things that pop up to your mind is the automatic measurement of the moisture content of the soil. If you're building a Smart Garden that waters plants automatically and give you the readings of the wetness of the soil, then you will definitely need a Soil Moisture Sensor.

A typical Soil Moisture Sensor consist of two components. A two legged Lead, that goes into the soil or anywhere else where water content has to be measured. This has two header pins which connect to an Amplifier/ A-D circuit which is in turn connected to the Arduino.

The Amplifier has a Vin, Gnd, Analog and Digital Data Pins. This means that you can get the values in both Analog and Digital forms.

Most soil moisture sensors are designed to estimate soil volumetric water content based on the dielectric constant (soil bulk permittivity) of the soil. The dielectric constant can be thought of as the soil's ability to transmit electricity. The dielectric constant of soil increases as the water content of the soil increases. This response is due to the fact that the dielectric constant of water is much larger than the other soil components, including air. Thus, measurement of the dielectric constant gives a predictable estimation of water content

Water Flow Sensor

The water flow sensor consists of a plastic valve body, a water rotor and a hall-effect sensor. When the water flows through the rotor, rotor rolls and the speed of it changes with a different rate of flow. The hall-effect sensor outputs the corresponding pulse signal.

This type of sensor can be found on different diameters, water pressure (MPa) and flow rate (L/m) ranges. Make sure to select one that will cover your needs. The sensor that I have it has 20mm diameter, <1.75Mpa water pressure and ~30 L/m flow rate range.

CIRCUIT DIAGRAM

The circuit diagram of proposed solar based hydroponics system shown in Fig. 20W polycrystalline Solar PV is used extract required electrical power from solar system. Diode based charge controller is used to prevent battery overcharging and reverse current flow. 12V,7.5 AH lead acid battery is used to electrical energy. 12V high pressure pump is used to spray nutrient solution. Its controlled through electromagnetic relay.12V peltier based heater system is used to provide heat energy , 12V cooling fan is used to maintain humidity level and 12V LED lighting system is used to provide required light for hydroponics plant photosynthesis. Nutrient pump, Heater, Cooler and LED lights are controlled through electromagnetic relay by arduino controller.16*2 LCD display is connected with arduino controller for displaying real time parameters in developed system.DHT11 temperature cum humidity controller is used to sense temperature and humidity of the system. Its connected with arduino controller. DS1307 Real time clock is provided real time date and time.

Electrical Conductivity/Total Dissolved Solids (EC/TDS) sensor is used to sense nutrient level and nutrient concentration. Arduino controller is connected with all associated components to control proposed system. Arduino controller having inbuild analog to digital converter to convert analog data.Power supply circuits is convert 12V to 5V to provide power supply to associated connected components. Arduino program is developed using arduino IDE and stored into arduino controller through ISP programming for control entire system.

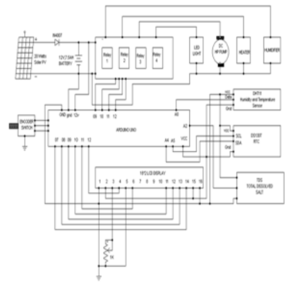

Fig .3 Circuit Diagram

RESULT AND OUTPUT

Nutrient Level

By using for RO water the Nutrient water level is zero of as shown in figure 3. If there is no nutrient content in this water.

Fig 4 (a) Nutrient Level by using RO water

In a modulation of this project to increase in Nutrient level in water content by using NPK (Nitrogen Potassium Phosphorus)power. Plants need nitrogen for leaf growth, Phosphorus for roof formation, Stem growth, and fruiting, and Potassium for flowing and plant immunity. Increasing Nutrient value in water 62% are show in figure 4.

Fig 5 (b) Nutrient Level After using NPK nutrient powers

CONCLUSIONS

A prototype of automation for hydroponics system with smart solar panel unit is proposed. In this prototype, the system ran accordance the prototype design. The communication module work as designed. The data that send from the prototype can be received in the Arduino which showed the information in to display monitor. Currently, the prototype is being improved to control pH nutrient mineral and nutrient solution automatically.

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