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Design And Manufacturing of Automated Agricultural Irrigation System

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Abstract— ***This paper demonstrates the application of automatic irrigation system to the plants which helps in saving money and water. The entire system is controlled using micro controller which is programmed as giving the interrupt signal to the sprinkler. Soil moisture sensor, temperature sensor and humidity sensor are connected to internal ports of micro controller via comparator, whenever there is a change in Soil moisture level, temperature and humidity of the surroundings these sensors senses the change in temperature and humidity and gives an interrupt signal to the micro-controller and thus the centrifugal pump, sprinkler, foggier is activated.***

Keywords— Automatic irrigation system,Centrifugal pump,Sprinkler,Micro controller; Soil moisture sensor; Temperature sensor; Humidity sensor, etc

INTRODUCTION

India is an agriculture based economy. Most of the people depend on agriculture for their livings. But per capital income of most of the Indian farmers is very low due to which lots of the farmers commit suicide. It is necessary to avoid the unnecessary or excess application of water, fertilizers etc. in the field so as to make farming more profitable which in turn will help India grow more rapidly and that too from grass root level. The main objective of this work to present irrigation system which periodically monitor and control the various parameters of farming such as soil moisture, temperature, water flow etc., so as to optimize the application of various resources such as water, fertilizers etc. for maximum production. The system presented here makes the irrigation automatic with the use of low cost sensors and the simple circuitry, thereby making it a low cost product, which can be bought even by a poor farmer.A good irrigation control system maximizes irrigation efficiency by applying the exact amount of water needed to replenish the soil moisture to the desired level through the use of proper irrigation scheduling techniques.

NEED OF AUTOMATIC IRRIGATION SYSTEM

Automatic irrigation systems are convenient, especially for those who have continuously out of station. If system installed and programmed properly, automatic irrigation systems can even save you money and helpin water conservation. Dead lawn grass and plants need to be replaced, and that can be expensive. But the savings from automatic irrigation systems can go beyond that. Neither method targets plant roots with any significant degree of precision. Automatic irrigation systems can be programmed to discharge more preciseamounts of water in a targeted area, which promotes water conservation.

LITERATURE REVIEW

The Consumers are demanding food products that are safe to eat and that have been produced in such a way as to minimize the environmental footprint (natural production). This entails effective management of water and agrochemicals. The problem becomes severe especially in arid and semi-arid areas, where water for irrigation is becoming scarce due to recurrent droughts.Improved scientific and practical knowledge on plant responses together with advances in electronic sensors and automated equipment for monitoring and data acquisition areHelping to overcome some of these limitations.

Irrigation methods and techniques

Surface Irrigation System

In surface irrigation systems water moves over and across the land by simple gravity flow in order to wet it and to infiltrate into the soil. Figure 1 Manual irrigation using buckets or watering cansThese systems have low requirements for infrastructure and technical equipment but needhigh labor inputs. Irrigation using watering cans is to be found for example in peri-urbanand rural agriculture areas in most African countries.

Overhead Irrigation System

Water is piped to one or more central locations within the field and distributed by overhead high-pressure sprayers or lower-pressure sprinklers. The sprayers can be hidden below ground level, if esthetics is a concern and pop up in response to increased water pressure. Individual sprayers can be designed to rotate in a full or partial circle.At the high-tech end, computerized, automatically moving wheeled setups may irrigate large areas unattended. At the low end, a person may water each plant individually with a watering can. Much water can be lost because of high winds or evaporation, and irrigating the entire field uniformly can be difficult or tedious.

Figure 1 Surface Irrigation Systems

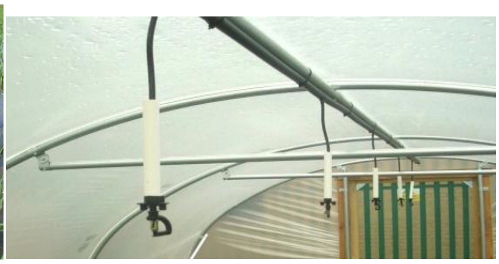

Figure 2Overhead Irrigation Systems

Lateral Move Irrigation System

A series of pipes, each with a wheel of about 1.5m diameter permanently affixed to its midpoint and sprinklers along its length, are coupled together at one edge of a field. Water is supplied at one end using a large hose. After sufficient water has been applied, the hose is removed and the remaining assembly rotated either by hand or with a purpose built mechanism, so that the sprinklers move 10m across the field. The hose is reconnected. The process is repeated until the opposite edge of the field is reached. This system is less expensive to install than center pivot and is most often used for small or oddly-shaped fields, such as those found in hilly or mountainous regions.

Centre Pivot Irrigation System

The centre pivot system is propelled by electric motors or hydraulic motors located on each wheel of the drive system. Centre pivot irrigation is a form of sprinkler irrigation consisting of several segments of pipe (usually galvanized steel or aluminum) joined and supported by trusses, mounted on wheeled towers with sprinklers positioned along its length. The system movement can be circular or lateral. The system is fed with water from the pivot point at the center of the arc. Most center pivot systems now have drops hanging from a u-shaped pipe called a gooseneck attached at the top of the pipe with sprinkler heads that are positioned a few meters (at most) above the crop, thus limiting evaporative losses.

Figure 3 Lateral Move Irrigation Systems

Figure 4Centre Pivot IrrigationSystems

Micro-Sprinkler Irrigation System

Here water is applied as to the soil surface as spray droplets or tiny streams through miniature spray heads placed along a water delivery line called a lateral or feeder line. The typical wetted diameter is 0.6 to 2.2 m with discharge rates less than 4.5 liters per hour.

Drip Irrigation System

In drip irrigation, water is delivered drop by drop through an emitter to or near the root zone of plants. If managed properly, this method can be the most water-efficient method of irrigation, resulting in minimized evaporation and runoff. In modern agriculture, drip irrigation is often combined with plastic mulch to further reduce evaporation, and can also be a means of delivering fertilizer and agrochemicals. The process is known as fertigation. Drip irrigation methods range from very high-tech and computerized to low-tech and relatively labor-intensive. In some instances the irrigation tape can be buried at depth range of 10.2 to 12.7 cm below the surface.


Figure 5Micro-Sprinkler IrrigationSystems Figure 6 Drip IrrigationSystems

Many models have been developed to predict maximize production rate from agriculture. These models have some disadvantages and limitation such as Investment Cost, Water Supply and System Capacity, Management Time, Limited Drip, line Lengths, Installation, Inflexible Design, Emitter Clogging, Rodents, Soil Salinity, Drip line Alignment, Legal Issues. Main requirement of many applications are minimum water consumption with maximum capital income.

Problem formulation

Roses are one of the most important cash-crop flowers in greenhouse. These crops are typically grown under drip irrigation systems in greenhouses, where optimal conditions can be achieved for maximum production and optimization time of harvest in order to satisfy specific market needs**.** The current irrigation control systems in greenhouses use measurements of soil water content or use weather data to calculate evapotranspiration rates or establish irrigation thresholds for irrigation management. The major problems associated with these control systems are that they are not accurate and may lead to over or under-irrigation, especially when the plant demand increases or declines temporarily under changing environmental conditions. In addition, the current control systems do not respond rapidly enough to meet the demand of the plant. Automated irrigation control systems require the use of soil, crop, or environmental sensors to determine the need for irrigation and then either a controller or a computer to control the irrigation sequence. The common problem with existing irrigation controllers is that they are typically factory set with a designated group of features that may not be modified.

AUTOMATED AGRICULTURAL IRRIGATION SYSTEM

The conventional irrigation methods like flood type feeding systems usually wet the lower leaves and stem of the plants. The entire soil surface is saturated and often stays wet long after irrigation is completed. Such condition promotes infections by leaf mold fungi. The flood type methods consume large amount of water and the area between crop rows remains dry and receives moisture only from incidental rainfall. A higher degree of water control is attainable. Plants can be supplied with more precise amounts of water. Disease and insect damage is reduced because plant foliage stays dry. Operating cost is usually reduced. Field operations may continue during the irrigation process because rows between plants remain dry. Fertilizers can be applied through this type of system. This can result in a reduction of fertilizer and fertilizer costs.

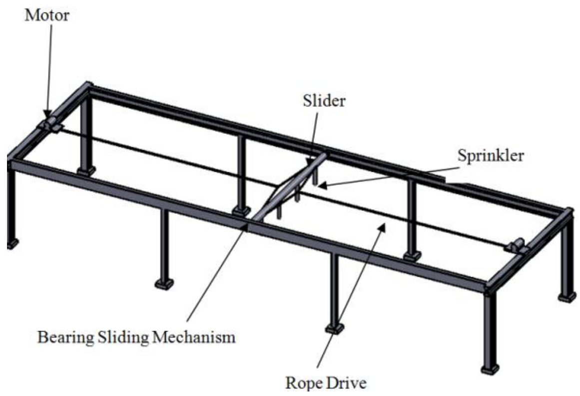

Figure 7 Water Distributions System

Water distribution mechanisms: Water distribution mechanisms consist of sliding boom, torque motor, rope drive, micro sprinkler and valve figure shows details of water distribution mechanisms. The main function of this mechanism is to distribute uniform water and support to sliding mechanism. Microcontroller Unit (PIC16F631690):The entire automation is done using micro controller. The microcontroller unit is now explained in detail: -The automated control system consists of moisture sensors, temperature sensors, Signal conditioning circuit, Digital to analog converter, LCD Module, Relay driver, etc.The important parameters to be measured for automation of irrigation system are soil moisture and temperature. LM35 can be used as a temperature sensor while Soil moisture sensor can be used as the moisture sensor to detect moisture contents of soil. These sensors are buried in the ground at required depth. Once the soil has reached desired moisture level the sensors send a signal to the microcontroller to turn off the relays, which control the forward and reverse direction.[1] Soil moisture sensor- A short electric pulse is send into an isolated probe. If the surrounding material is air or dry soil the shape of the reflected pulse will be different from when the soil is wet. Analyzing the pulse gives the volumetric soil moisture percentage. [2] Flow meters: sea water flow sensor(YF-S201) It is very important that a flow meter be part of the irrigation system. Knowing the flow rate is necessary for determining the amount of water being supplied, which, in turn, is critical to efficient irrigation and scheduling.

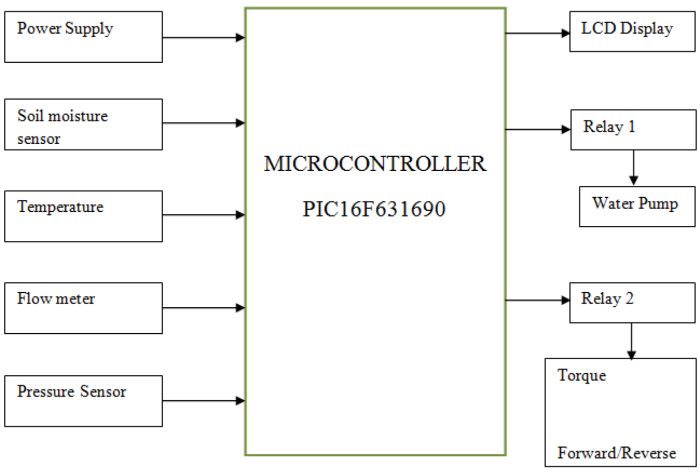

Figure 8 Block Diagram of Microcontroller

Micro sprinklers:Advantages of micro sprinklers compared to drip systems include a larger wetted area, often a higher application rate, less susceptibility to particulate clogging since the orifices are larger, and easier visual inspections for clogging problems. While wetting a larger area may be a benefit for tree growth, it is a disadvantage due to increased weed growth. Another disadvantage of micro sprinklers is a problem with insects entering or laying eggs in the micro sprinkler orifice and causing them to clog.

Temperature sensor IC LM135:LM35 IC senses instantaneous temperature, and converts it into voltage. This voltage is then amplified and given to ADC. Step down transformer converts 230V from AC mains into 15V AC have used a center tap transformer having -15V, 0V, 15V and 0.5 ampere. Transformer selection is based on the fact that regulator ICs require around 14v as input considering dropout voltage (around 2v), in order to obtain 12v power supply. And current demand of ICs 741, ADC, microcontroller, comparator etc is satisfied using 500mA transformer. Transformer steps down ac voltage from 230v ac to15v ac. It is then given to bridge rectifier. Bridge rectifier converts ac voltage into pulsating dc. It is then given to regulator ICs which output constant dc voltage. These voltages are givento other ICs as VCC or reference. Outputs of ICs 7805, 7812 &7912 are +5v, +12v &-12v respectively.

Working of Automated Irrigation System

In automated agricultural irrigation system consist water distribution mechanism(main line ,micro-sprinkler, sliding boom, bearing),moisture sensors, temperature sensors, microcontroller ,Signal conditioning circuit, Digital to analog converter, LCD Module, Relay driver etc The important parameters to be measured for automation of irrigation system are soil moisture and temperature. LM35 can be used as a temperature sensor while Soil moisture sensor can be used as the moisture sensor to detect moisture contents of soil. These sensors are buried in the ground at required depth. Once the soil has reached desired moisture level the sensors send a signal to the microcontroller to turn off the relays, which control the forward and reverse direction.The signal send by the sensor is boosted up to the required level by corresponding amplifier stages. LCD module can be used in the system to monitor current readings of all the sensors and the current status of respective valves. The forward and reverse direction are controlled by microcontroller though relays. A flow meter is attached for analysis of total water consumed. The required readings can be transferred to display on microcontroller unit

DESIGN PHASE

While designing any irrigation system the general procedure is:

1. Select the site: First of all select the farm or site for which the system is to designed. Decide the area or if it is a farm measure its area.
2. Crop: The crop consideration must be the next step. Its important to consider crop because the amount of water needed for irrigation depends on the crop. The total amount of water will give us the total discharge required.
3. Select sprinkler: Depending upon the total flow rate required and the area to be irrigated select proper sprinkler. Decide the height on which the sprinkler is to mounted and its wetted area, also number of sprinklers required.
4. Select pump: According to total discharge required, head and pressure; select proper pump. Generally centrifugal pump is used for irrigation purpose.
5. Pipng system: The diameter of pipe should be considered so it will give the required flow rate and will also sustain the system pressure.
6. Drive mechanism: Choose proper drive mechanism for sliding of sprinkler arrangement called as slider.
7. Select motor: Consider torque that will come on motor while selecting the motor. The speed of motor should be sufficiently low so the irrigation will be proper and the torque capacity should be high.

Design of structural frame:

1. Calculate load: Calculate all the loads that willcome on the frame. It includes both live and dead loads. The weight of pulley or drum, motor, wire ropeetc are considered as dead load and the weight of piping system, sprinklers and slider mechanism are live loads.
2. Select material: Select proper mterialfor beam and columns of the frame and also for the slider.
3. Diamensions: Calculate the diamensions of those beams and columns, their crossections so that it willsustain the load coming on it.
4. Check for bending and buckling.

Design of Sprinkler System:

1. Area Selection: The area selected is 5ft×15ft. We have selected these area because the flowers are taken in these at collage and the gardening department of collage like toinstalled our newlly desiged system there for their use. So we finallize that area of 90sq.ft.
2. Crop Selection: The flowers are the main crops taken at these place which we have selected.

   Problem statement using practical constraint:

   Water Requirement:

   For the area selected i.e. 5ft×15ft and crops of flowers or vegetables we found out the total water requirement.

   Water required for wetting 1sq.ft. areaupto 1inch depth = 0.6 gph

   Therefore, Water required for wetting 75sq.ft. areaupto 1inch depth = 0.6×75 = 45.0 gph

   For proper irrigation and survival of plants 10inch depth of soil must be wetted with water once in a week.

   Hence, we need to calculate water required for irrigating the 75 sqft area and 10inch depth.

   Water required for wetting 75sq.ft area upto 10inch depth = 0.6×75×10 = 450 gph

CONCLUSION

The system provides with several benefits and can operate with less manpower. The system supplies water only when the moisture content in the soil goes below the reference. Designed control system was found to be working satisfactorily. The automated irrigation system was developed and successfully implemented along with soil moisture sensor, flow sensor, temperature sensor and controller. Salient features of the system are: Closed loop automatic irrigation system water usage monitoring. User can easily preset the levels of the moisture and is regularly updated about current value of all parameters on LCD display.

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