Automated Irrigation System Using Robotics and Sensors

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Abstract: ***An automated irrigation system was developed to optimize water use for agricultural crops and also to verify water scarcity in the field. The system has distributed wireless network of soil-moisture and temperature sensors and conductive sensors that are placed in the root zone of the plants. In addition, agate way unit handles sensor information, triggers actuators, and transmits data to android mobile. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. The added future of this project is here we are also monitoring the condition of the crop whether they are affected by insects or not by using an robot. The robot will move within the field and we can monitor the condition of crop in our mobile.***

Keywords: controller, Radio Set, Robot,HC-05, Camera, Cellular Network, Temperature sensor, Conductive sensor, water resource.

1. Introduction

Agriculture uses 85% of available freshwater resources worldwide and this percentage will continue to be dominant in water consumption because of population growth and increased food demand. As there are very few water resources and due to scarcity of water we had upgraded our technology and invented many different techniques for sustainable use of water for agricultural crops. Automatic irrigation scheduling consistently has shown to be valuable in optimizing cotton yields and water use efficiency with respect to manual irrigation based on direct soil water measurements. An alternative parameter to determine crop irrigation needs is estimating plantevapotranspiration (ET). ET is affected by weather parameters, including solar radiation, temperature, relative humidity, wind speed, and crop factors, such as stage of growth, variety and plant density, management elements, soil properties, pest, and disease control. .An electromagnetic sensor to measure soil moisture was the basis for developing an irrigation system at a savings of53% of water compared with irrigation by sprinklers in an area of 1000 m2 of pasture. A reduction in water use under scheduled systems also have been achieved, using soil sensor and an evaporimeter, which allowed for the adjustment of irrigation to the daily fluctuations in weather or volumetric substrate moisture content .A system developed for malting barley cultivations in large areas of land allowed for the optimizing of irrigation through decision support software and its integration with an infield wireless sensor network (WSN) driving an irrigation machine converted to make sprinkler nozzles controllable.

2. Previous Techniques

2.1 Irrigation Techniques

Efficient application of irrigation water is one the most important ways to mitigate any effects that increased biofuels production may have on water resources. There are several irrigation techniques that reduce the amount of water applied per unit of biomass produced, thus improving irrigation efficiency regardless of crop type.For example, subsurface drip irrigation systems minimize the amount of water lost due to evaporation and runoff by being buried directly beneath the crop and applying.

2.2 Advanced Irrigation Scheduling

A system of soil sensors, monitored through a wireless broadband network and powered by solar panels, allows farmers to monitor soil conditions on a daily or hourly basis and to selectively target areas for irrigation. For example, a farmer could hold off watering when it's raining.

2.3 Conservation Tillage

By using a cover crop and leaving plant residue in the field, farmers can modify plant root structure to improve the soil's capacity to hold water and reduce soil temperature, thereby reducing the amount of water lost to evaporation.\

3. Proposed System Architecture

Water directly to the root zone, thus keeping the soil surface dry.Real-time soil moisture and weather monitor—the former through microwave remote sensing—are emerging technologies that can potentially help improve the scheduling of irrigation. Rainfall harvesting, efficient irrigation water transport, and use of reclaimed water can also lead to more efficient agricultural water use. These techniques would be effective for both corn and cellulosic ethanol crops.

Irrigation Side:

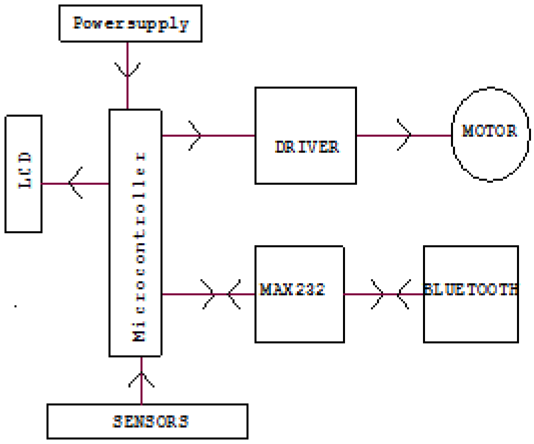

Figure 1: Block diagram at Irrigation end (user end)

Robot Side:

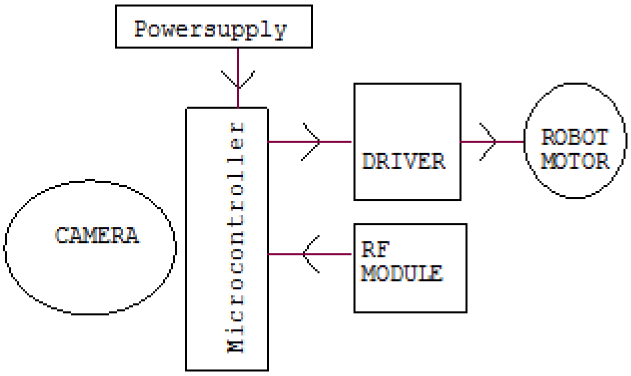

Figure 2: Block diagram at robot end

4. Working

This project includes two parts one part is irrigation part, second part is robot part. The irrigation part incorporates Temperature sensor, Conductive sensors, the microcontroller always monitors the temperature and the water content of the soil and it could send the data to the base station through wireless communication, here we are using Bluetooth radio set to establish the communication. The irrigation part works in two modes. One mode is automatic mode second mode is manual mode. If it is automatic mode the microcontroller automatically controls the irrigation motor based on the water content, if it is manual mode the motor will switch on/off based on the user command which can be sent through the Bluetooth communication. In both modes the irrigation system always gives the soil parameters to the destination. Here we are using Lpc2148 microcontroller to control the irrigation unit, and HC-05 is Bluetooth module which establish wireless network the module operating frequency is 2.4GHZ and operating voltage is 3.3v why we preferred these modules, is that these modules requires less power and the execution speed is also very high comparing with other processors and radio sets. The second part is robot section, the robot section contains camera and wireless module by using wireless module we can controls the robot in the different directions. By using the camera we can monitor and observe the insects of the field.

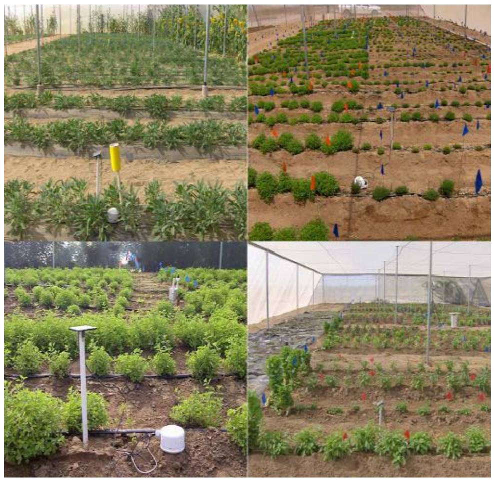

Figure 3: General view of a field

4.1 Irrigation END ARM7 (Lpc2148 Controller):

- ARM7TDMI-S based high-performance 32-bit RISC Microcontroller with Thumb extensions.
- 512KB on-chip Flash ROM with In-System Programming (ISP) and In-Application Programming (IAP), 32KBRAM, Vectored Interrupt Controller,
- Two 10bit ADCs with 14 channels, USB 2.0 Full Speed Device Controller,
- Two UARTs, one with full modem interface.
- Two I2C serial interfaces, Two SPI serial interfaces
- Two 32-bit timers,
- Watchdog Timer,
- General purpose I/O pins.
- CPU clock up to 60 MHz,
- LPC2148 are based on 16/32 bit ARM7TDMI-S CPU.
- It contains 128/512 kilobytes of embedded high speed flash memory.

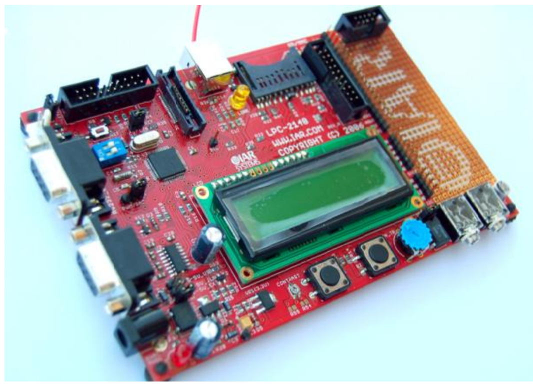

Figure 4: LPC 2148 Processor

4.2 Power Supply

Step down transformer is used to reduce 230v to required voltage levels.

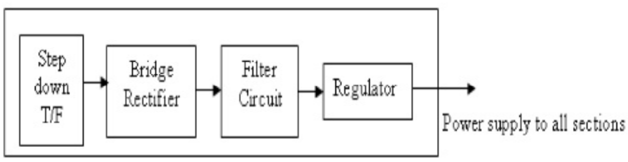

Figure 5: Block diagram of Power Supply

4.3 RADIO SET

The radio set is used to transmit and receive the data from one end to the other end. Here we are using BLUETOOTH module i.e HC-05 at the irrigation end. The operating frequency of HC-05bluetooth module is 2.4GHZ and the operating voltage is 3.3v. The maximum communication distance of the Bluetooth module is 20meters in free space. We are placing a RF-module at the robotic end. The RF module used at the robotic end is A434MHZ.th e operating voltage of RF module is 5V.and the maximum distance of the RF module is 50meters in free space. We can also place ZIGBEE module or Bluetooth module at both the end but as per the requirement we are placing the RF module. In order to make both the devices work at a same time we are using two different modules because by the use of Bluetooth at a time we can operate only one system.

4.4 SENSORS:

In our project we are using two sensors.

A. **Temperature Sensor:** In order to monitor the temperature of the climate we are using LM35 temperature sensor. The capability of LM35 sensor is of 150.c as the maximum temperature of the atmosphere will be around 60.c with in the peak summer we can use this sensor.Temperature sensor is a device which senses variations in temperature across it. LM35 is a basic temperature sensor that can be used for experimental purpose. It give the readings in centigrade(degree Celsius)since its output voltage is linearly proportional to temperature. It uses the fact that as temperature increases, the voltage across diode increases at known rate(actually the drop across base-emitter junction of transistor).
LM35 sensor gives an output of 10mV for every 1 degree centigrade.

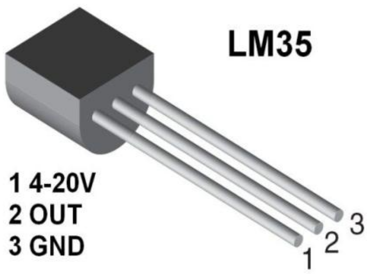

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Fig6: LM 35 Temperature Sensor

B. **Conductive Sensor:** It is also called as moister sensor which is used to measure the water content in the soils which are nothing but two iron rods placed in the soil. To one end we are applying the +ve v/g and the other terminal is used as an output terminal. If the soil contains sufficient amount of water then conduction takes place between the two terminals and the output will be a +ve v/g.

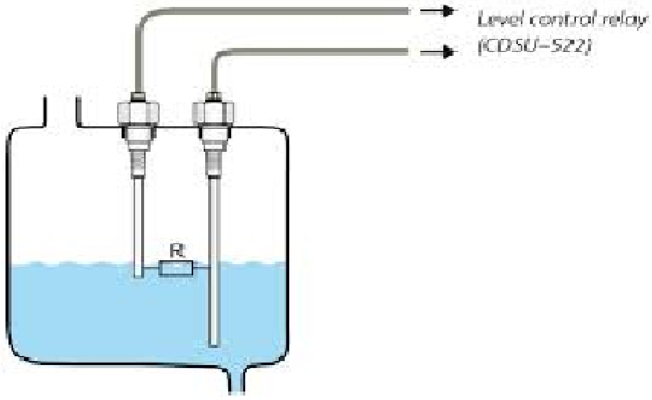


Figure 7: Conductive Sensor

4.5 Motors

We are using two types of motors.

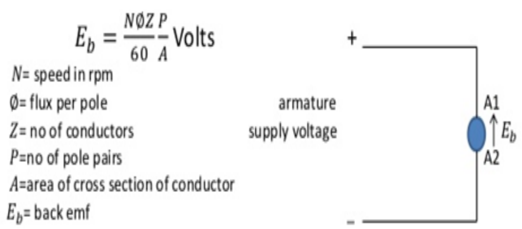
a. AC motor at irrigation end
b. DC motor at robot end

An electrical motor is such an electromechanical device which converts electrical energy into a mechanical energy.

AC MOTOR:
It consists of two parts:
- Stator.
- Rotor.

Working Principle
The stator of the motor consists of overlapping winding offset by an electrical angle of 120°. When the primary winding or the stator is connected to a 3 phase AC source, it establishes a rotating magnetic field which rotates at the synchronous speed.
A rotating magnetic field is set up in the stator when a 3-phase supply is given and the stator will cut the revolving field and due to electromagnetic induction an E.M.F is induced is induced in the rotor.as the rotor conductor is short circuited current flows and generates the magnetic field and start rotating.

DC MOTOR
When current carrying conductor is placed in magnetic field it experiences force.When the armature windings of dc motor is start rotating in the magnetic flux produced by the field windings, it cuts the lines of magnetic flux and indices the E.M.F in the armature windings.According to Lenz's law the induced E.M.F acts in the opposite direction to the armature supply voltage. Hence this E.M.F is called as back E.M.F



5. Robot

The robot is the one we are using to monitor the condition of the crop by placing a camera up on the head of the robot and we can monitor the moment of robot and the condition of the crop in our PC. As the functionality of the robot is only to move around the field and to monitor the condition of the crop and forward the data to the camera which is handled by the user so here we can use a 8051micro-controller. Also we are using s DC motor towards the robotic end. The DC motor works under the principle of electro-magnetic induction.

A fully autonomous robot can:
- Gain information about the environment
- Work for an extended period without human intervention
- Move either all or part of itself throughout its operating environment without human assistance
- Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications

6. Camera

There are two types of cameras
- **Wired.**
- **Wireless.**

By the use of wired cameras we can connect the wire to our PC's to monitor the condition of the crop. The maximum distance that wired cameras will supports is for 20meters.

In real time scenario we can go with wireless cameras as there won't be any kind of interaction between the PC and a camera. The maximum distance that a wireless camera supports is of 10meters.wireless security system acts as a visible deterrent to criminals, allowing you to record events at home and monitor staff at work. Some of our wireless cameras also connect to wireless monitors allowing you monitor and record footage from your security camera to review at a later date. After the exposure, the pixel is read out and the following stages measure the signals S1 and S2. As the length of the light pulse is defined, the distance can be calculated with the formula:

$$D = \frac{1}{2} \cdot c \cdot t_0 \cdot \frac{S2}{S1 + S2}$$

7. Working Algorithm

Initialize the LCD
{
Monitor the temperature from temperature sensor
{
If(temp< set value)
{

Check the water content
{
If(water content <set)
Switch ON the motor and send the info. to smart phone
Else
{
Motor is OFF
}
}
}

8. Applications

This system is an advanced version of the robotics technology where we are using the robot for monitoring the condition of the crop. As in these days we can't go and see the condition of the crop regularly we can verify the condition in our PC by sitting at our house. This kind of systems can also be used in industrial systems for frequent monitoring and also for controlling the system.

9. Conclusion

The system had been successfully designed for monitoring the condition of the crop regularly by using robot as it continuously moves with in the field and we can see the condition of the crop in our PC. The automated irrigation system developed proves that the use of water can be diminished for a given amount of fresh biomass production. Besides the monetary savings in water use, the importance of the preservation of this natural resource justify the use of this kind of irrigation systems

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