

Detection of Crop Disease Using Segmentation and Monitoring Irrigation Control

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Abstract

The practical problems in the present irrigation methods are overcome by sensing the local soil water level. If the water level is low, the system sprinkles water by using pump motor by means of relay. The soil fertilizer level, humidity and temperature of the field are also checked by using the corresponding sensors. The current status is always displayed in the Liquid Crystal Display (LCD). If any abnormality occurs, then the message is sent to the owner by means of Global System for Mobile (GSM). Disease monitoring of the crops is done by segmentation. Irrigation control can reduce water consumption.

Keywords: Irrigation, fertilizer and segmentation.

1. Introduction

Our country economy depends mainly on agriculture. Since diseases in plants are natural, the plant disease detection is an important in agriculture. Proper care should be taken care of. Otherwise, plant quality and quantity will get affected.

Water scarcity is the main problem in most of the parts of our country. So we should concentrate on reducing the water usage and should save our ground water reservoirs.

The water consumption must be reduced. The main aim of the irrigation system should be to maintain good plant health. To maintain the plant healthy, correct quantity of water should be supplied to plants periodically. Pouring little amount of water causes the plant to become brown and die. Current irrigation will over irrigate the plants for their safety. But, this also causes some problems. Excess water stagnating on the surface of land will get evaporated and runoff to undesired places. Excess water will also cause the root rot. Thus the plant dies.

Excess water causes erosion of soil. The chemical fertilizer leaks beyond the root and mixes with ground water.

Sprinkling water system is a new method of watering the plants slowly to avoid wastage of water and runoff. Irrigation controller controls irrigation by considering water consumed on that particular day in the way of evaporation and plants which consume water for transpiration. It also considers the weather data. But this controller supplies same quantity of water to all plants. The factors such as the type of soil, physical characteristics of the land and sunlight are not yet considered. If these points are also taken into account, then the water quantity required will be supplied to the various locations for irrigation.

Current irrigation system is such that the valve is actuating many sprinklers. This system also does not provide the required water supply since the sprinklers operated by the same valve will supply water for the same duration of time.

To accomplish the minimization, the fluid movement across the soil and through to the soil should be known. The currently used models measure the existing pressure between soil and water flowing through porous soil media. These models give accurate measurement. But, slow water flow measurement and small amount of water absorption computation are possible and not sufficient for irrigation control. The processing is tedious and time consuming.

An alternate method of including the data related to the predefined water flow with the irrigation system was developed.

This system was provided with an input of weather details and hydrological details taken from satellite images. So an optimized system was created. But, size and discontinuity of land lead the outcome of the system to be unpredicted.

Lumped component system was also taken for irrigation control. In that case, complex problem was split into smaller and simple sub components. Previously, fluid jets prototype was developed using the above method and

analyzed. The system was also used to measure aortic blood flow in human beings from their arterial pressure. This system was lacking accuracy but the processing time was lessened.

The challenges found in the previous methods were overcome by adopting little changes in the prevailing irrigation system. A sprinkler node is developed to sense soil moisture, to communicate the same message through wireless system and to activate the sprinkler allocated to it. Later, the system is used to calculate moisture content from water runoff, absorption and diffusion. A valve is scheduled to control sprinkler node. The drawbacks of the existing system are: 1.They cannot be operated automatically. 2. Less operation can be performed using robot. 3. They are not user friendly.

2. Proposed System

The irrigation control system blocks are shown in Figure 1.

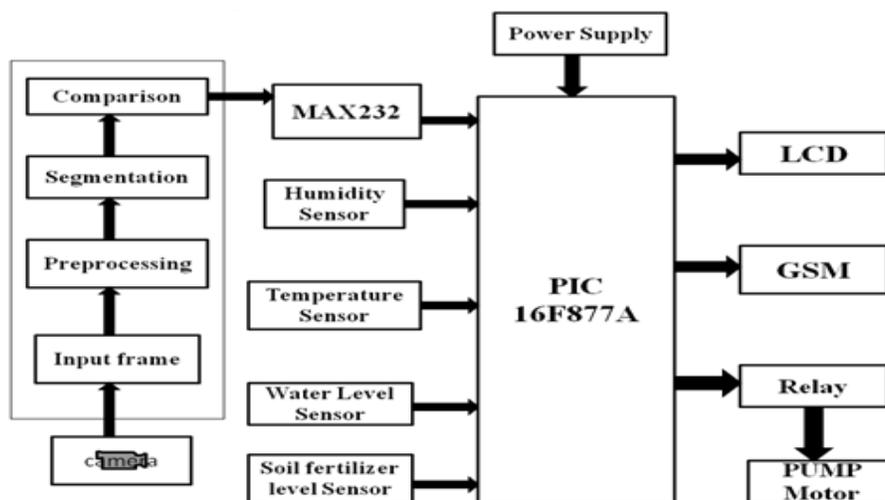


Figure 1: Irrigation control system block diagram

Web Camera

Video and audio images can be transmitted by video cameras. Wireless web camera consists of monitors and digital video recorder also.

Video images are transmitted to monitor by using frequency of 2.4 GHz. Due to this high frequency, camera is able to transmit through greater walls and big obstacles. Each video camera operates with a different frequency. The locations have different operating frequency range.

Camera captures the input to recognize and monitor the field.

Preprocessing

Captured image is preprocessed by bringing the image to the fixed 256x256 pixel size. Median filtering is applied on the image to remove the noise if present [13].

Segmentation

The preprocessed image is sent for the region based segmentation.

Segmentation is the process of dividing the images to highlight the difference in the specific part of the image. There are two types namely, supervised and unsupervised method of segmentations. The supervised method needs

prior knowledge and unsupervised method does not need any prior knowledge. K Means clustering segmentation is an unsupervised method.

The leaf image is used as input to K Means algorithm. The number of clusters is predefined. This segmentation is suitable for round structures. K denoted the number of cluster. The algorithm is n iterative [11]. The clusters should not overlap. Each and every element of a cluster is nearest or closer to its cluster center [12]. The objective function for the K Means algorithm is to be minimized to get the convergence of algorithm. The number of clusters used is equal to five. The pixel grouped in one group must not belong to another cluster.

Then, the picture is compared with the photographs available in the data base.

MAX232

It consists of two drivers and two receivers. It plays dual role as driver and receiver. MAX232 consists of pump capacitive supplier of voltage. Five volts is an input and it converts to RS 232 volt. Then MAX232 receiver converts RS232 volt to five volts TTL/CMOS level. It is again converted into EIA232 by MAX232 driver.

TX P3_1 and RXP3_0 pins present in microcontroller are connected to T2IN and T2OUT pins of MAX232 driver. TX and RX are directly connected to Global System for Mobile (GSM) or personal computer. T2IN pin converts five volt TTL level to RS232 level. T2OUT pin is connected to RX pin of nine pin D type serial connector. Serial connector is connected to personal computer.

Personal computer supplies transmit data to R2IN pin of MAX232 through serial connector. R2OUT pin is connected to RX pin of microcontroller. R2IN pin converts RS232 level into five volt TTL/CMOS level.

T2OUT and T1OUT pins give RS232 line data output to remote RS22. Similarly, R2IN and R1IN pins give line data input from remote RS232.

Humidity Sensor

It is also known as hygrometer. After rain moisture will be suspended in air. So air gets moist. Moisture in the air results in humidity. There are three types such as capacitive, resistive and thermal.

In capacitive sensors, thin strip of metal oxide/non conductive polymer film is placed between two electrodes or two metal plates. The film identifies moisture present in air. Electrical property of metal oxide in between the two plates changes with humidity of atmosphere. The changes are viewed as digital readings. It directly gives the value of moisture level.

In resistive sensors, sensors use ions in salts for the measurement of resistance of atoms. The electrodes are

placed on either side of salt medium. The resistance between the electrodes changes with respect to the change in humidity. Gold and ruthenium oxide are used as electrode. The electrode is covered with a polymeric film. When the ions move towards the electrodes, the film senses humidity.

In thermal case, two sensors conduct electricity based on humidity of air. One sensor is enclosed in dry nitrogen. Other sensor measures humidity in air. The difference gives the humidity.

Temperature Sensor

The LM35 is an integrated circuit temperature sensor. It can be used to measure temperature. The voltage or current output is proportional to variation in temperature in centigrade.

The temperature sensor measures temperature accurately when compared to thermistor. The temperature sensor gives an output of higher voltage than thermocouple. The output voltage will not be amplified.

Water Level Sensor

After the detection of water content level, a pump motor will be actuated for the low level. Pump is activated by sending a control signal.

There are two types of measurement namely, the continuous level sensing and point level sensing. The continuous level sensors sense the liquids or solids contained in a container. The point level sensors sense whether the level of the content is above or below the predefined value.

Soil Fertilizer Sensor (NPK Sensor)

Nutrition sensor is used to identify the nutrition level in the soil.

Macronutrients are Nitrate NO₃, Ammonium NH₄, Potassium K and Phosphate PO₄. Nitrogen is used for the growth of leaves. Phosphorus is used for root growth. Potassium is used for flowering and fruiting. The amount of nutrients present in soil is compensated by applying the fertilizer. The quantity should be carefully chosen as per the need of the plants. If the nutrients are insufficient, then the plant growth will be affected. If the fertilizer quantity is more, the environment will get affected. The unused fertilizers will be dissolved in water and further it will pollute the ground water. So the correct amount of nutrients is needed. The soil fertilizer sensor measures the quantity of each substance separately.

A small quantity of the sample soil is mixed with the concerned liquid. The water is filtered and used for testing. This mixing device is combined with the irrigation system.

Nutrient values are determined by their movement or conductivity. The ions are separated by the application of an electric field. The ions move with their own velocity towards the detection unit. The samples are measured with their reach.

With moisture measurement and weather data, the required amount of fertilizer will be known.

Power supply

Figure 2 shows the power supply.

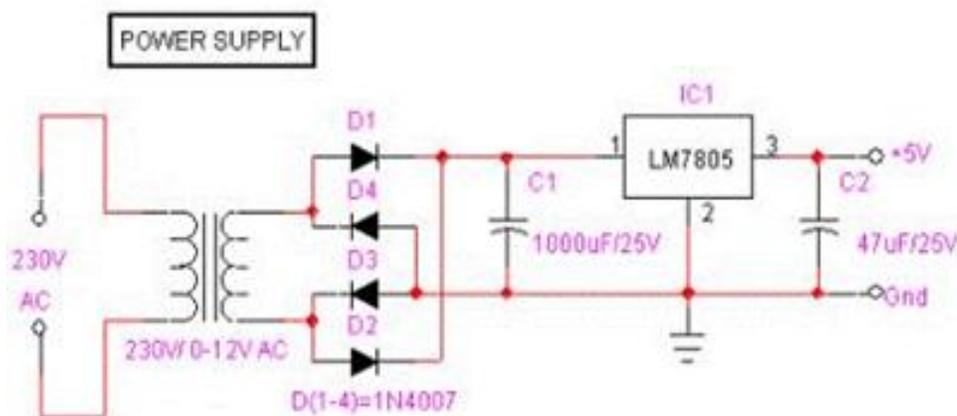


Figure2: Power supply

The transformer primary is connected to 230 volt AC. It is a step down transformer. So the output at secondary is 12 volt AC. A diode bridge rectifier circuit converts AC voltage to DC voltage. Capacitor is used as filter. LM7805 is used to give regulated five volts output.

LCD

Controller status is displayed in LCD.

Liquid Crystal Display (LCD) screen is an electronic display module. A 16x2 LCD display is a commonly used in various devices and circuits.

LCD consumes less power compared to cathode ray tube and light emitting diodes. The display also uses only microwatts whereas light emitting diodes use milliwatts for their display. LCD is an inexpensive and they provide good contrast. LCD is thin and light.

LCD requires additional light sources. Operational temperature range is limited. It is not reliable. Less speed and they need AC drive.

GSM

SIM80 is a GSM module. It meets almost all the space requirements in the applications. It does not consume power. It is used for all data transfer applications.

Relay

A relay is an electro-mechanical switch. It can be remotely actuated and or controlled. A relay contains two parts: a switch controlling the power and a digital (remote) control part.

Pump Motor

A DC motor runs from DC power. There are two examples of DC motors namely, Michael Faraday's homo polar motor and the ball bearing motor.

DC motors are categorized as the brushed and brushless types. Brushed type uses internal commutation. Brushless type uses external commutation. They create an oscillating AC current from the DC source.

DC motor is a rotating machine. It converts DC power into mechanical power. During its rotation forces developed in the by magnetic fields. DC motors are electromechanical system. They change the direction of current flow in the motor.

The proposed system uses PIC16F877A controller to monitor the field. The whole process is controlled by PIC microcontroller. Sensors are connected to the PIC controller.

Figure 3 shows the overall work flow.

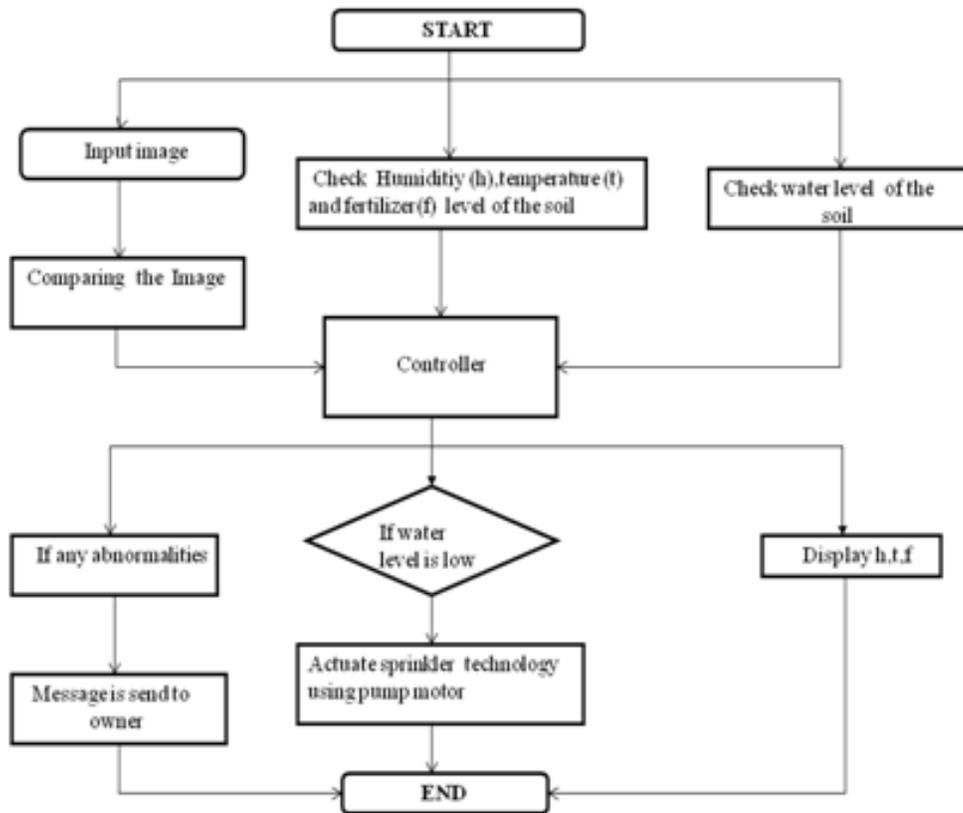


Figure 3: Work Flow

3. Results and Discussion

Figure 4 shows the input normal leaf image.



Figure 4: Input normal leaf image

Figure 5 shows the output normal leaf image after segmentation.



Figure 5: Output normal leaf image after segmentation

Figure 6 shows the input affected leaf image.



Figure 6: Input affected leaf image

Figure 7 shows the output affected leaf image after segmentation.

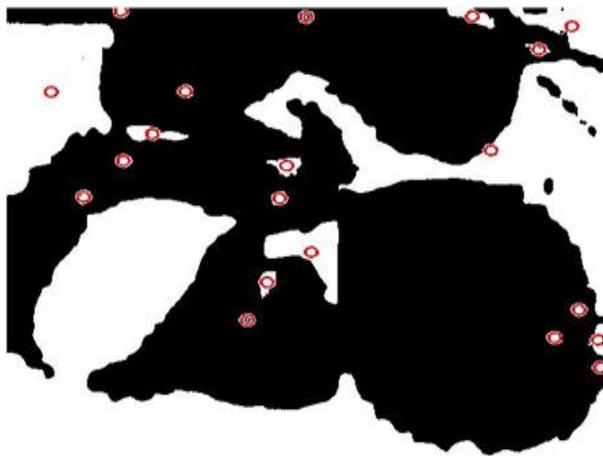


Figure 7: Output affected leaf image after segmentation

The digital signal a '0' sent to the controller denotes normal and a '1' denotes affected. The signal '1' is also sent to the controller so that the same is sent as message to the owner of the field.

Sensors:

1. If Temperature value exceeds 50 is abnormal
2. If soil fertilizer level(NPK) exceeds 50 is abnormal
3. Humidity value is constant
4. Water level if the value is less than 30 it is low level

Digital values:

- 0 for low level
- 1 for medium level

2 for high level

If water level sensor output is 0 the controller turns ON the pump motor

4. Conclusion

In this paper, the crop condition is checked whether it is affected or not. Water level, humidity, temperature of the soil checked and fertilizer level of the soil are monitored with the corresponding sensors. If any abnormalities occur, controller sends the message using GSM. Current status is displayed in LCD. The leaf condition is sent in SMS to the owner of the field.

5. Future Enhancement

The water level will be checked and the water will be pumped out based on the weather forecast. Sprinkler node will be placed all over the field instead at a particular node. Instead of taking single image of crop multiple images for a single plant will be taken and calibrated.

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