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A PATH FOR HORIZING YOUR INNOVATIVE WORK

IMPROVING PRODUCTION IN AGRICULTURE USING SENSOR BASED TECHNIQUES AND GREEN HOUSE CONCEPT

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Abstract

Green houses are climate controlled house. They have a variety of applications which includes off-season growing of vegetables, floriculture, planting material acclimatization, fruit crop growing for export market and plant breeding and varietals improvement. In conventional agriculture practices, the crops are being grown / cultivated in the open field under natural conditions where the crops are more susceptible to sudden changes in climate i.e. temperature, humidity, light intensity, photo period and other conditions due to which the quality, yield of a particular crop can get affected and may be decreased. The purpose of this paper is to propose a real time system for monitoring the various environmental parameters. These parameters include temperature, rainfall, humidity level etc. and take the appropriate action like roofing & watering the plants, humidity maintaining when one or more parameters violate the favorable conditions.

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Introduction

A greenhouse is a structure with a glass or plastic roof and frequently glass or plastic walls; it heats up because incoming solar radiation from the sun warms plants, soil, and other things inside the building. Air warmed by the heat from hot interior surfaces is retained in the building by the roof and wall. These structures range in size from small sheds to very large buildings. Greenhouses can be divided into glass greenhouses and plastic greenhouses. Plastics mostly used are PEfilm and multiwall sheet in PC or PMMA. Commercial glass greenhouses are often high tech production facilities for vegetables or flowers. The glass greenhouses are filled with equipment like screening installations, heating, cooling, and lighting and may be automatically controlled by a computer.

The glass used for a greenhouse works as a selective transmission medium for different spectral frequencies, and its effect is to trap energy within the greenhouse, which heats both the plants and the ground inside it. This warms the air near the ground, and this air is prevented from rising and flowing away. This can be demonstrated by opening a small window near the roof of a greenhouse: the temperature drops considerably. This principle is the basis of the autovent automatic cooling system. Greenhouses thus work by trapping electromagnetic radiation and preventing convection. A miniature

II. Real Time System for Agriculture

A real time system changes its state as a function of physical time, e.g. a chemical reaction continues to change its state event after its controlling computer system has stopped. It is reasonable to decompose a real time system into a set of subsystems called clusters.

1) Controlled Cluster -Controlled Object
2) Computational Cluster–Real time computer or Microcontroller
3) Operator Cluster – Human Operator

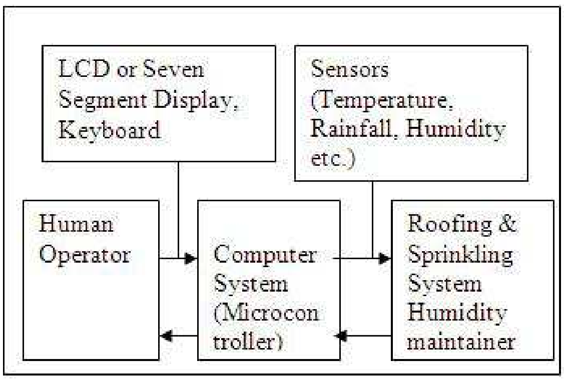

Figure 1 : A Real Time system Model for Irrigation

The above system shows that the controlled object are roofing mechanism, watering mechanism and humidity maintainer. The various sensors will read the intensity of various parameters. The intensity values read by sensors are in analog (voltage) form, hence, it is necessary to covert these values into digital format. An analog-to-digital converter is used to convert the analog values sent by sensors into digital values. After the digitization process, the digital values are given to the computer. The computer will read the values and check whether the particular parameter value is exceeding its threshold value. If so, then particular mechanism is activated by computer to protect the plant from adverse effect. For example, if temperature increases to or above the set threshold value then roofing action will be taken. The roofing action may be incremental or complete depending upon the situation. As temperature decreases to the threshold value, un-roofing will be performed.

III. Sensors

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. For example, a mercury thermometer converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. A thermocouple converts temperature to an output voltage which can be read by a voltmeter. For accuracy, all sensors need to be calibrated against known standards. Sensors are used in everyday objects such as touch-sensitive elevator buttons and lamps which dim or brighten by touching the base. There are also innumerable applications for sensors of which most people are never aware. Applications include cars, machines, aerospace, medicine, manufacturing and robotics. A sensor's sensitivity indicates how much the sensor's output changes when the measured quantity changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C. Sensors that measure very small changes must have very high sensitivities. A good sensor obeys the following rules:

1. the sensor should be sensitive to the measured property
2. the sensor should be insensitive to any other property
3. the sensor should not influence the measured property

Ideal sensors are designed to be linear. The output signal of such a sensor is linearly proportional to the value of the measured property. The sensitivity is then defined as the ratio between output signal and measured property. For example, if a sensor measures temperature and has a voltage output, the sensitivity is a constant with the unit [V/K]; this sensor is linear because the ratio is constant at all points of measurement.

IV. Sensors for Agriculture

A. Sensor Resistance temperature detector (RTD) Resistance Temperature Detectors or RTDs for short, are wire wound and thin film devices that measure temperature because of the physical principle of the positive temperature coefficient of electrical resistance of metals. The hotter they become, the larger or higher the value of their electrical resistance. They, in the case of Platinum known variously as PRTs and PRT100s, are the most popular RTD type, nearly linear over a wide range of temperatures and some small enough to have response times of a fraction of a second. They are among the most precise temperature sensors available with resolution and measurement uncertainties or ±0.1 °C or better possible in special designs. Usually they are provided encapsulated in probes for temperature sensing and measurement with an external indicator, controller or transmitter, or enclosed inside other devices where they measure temperature as a part of the device's function, such as a temperature controller or precision thermostat.

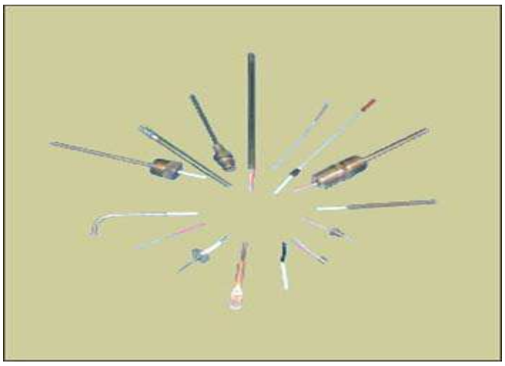

Figure 2: Resistance Temperature Device

The advantages of RTDs include stable output for long period of time, ease of recalibration and accurate readings over relatively narrow temperature spans. Their disadvantages, compared to the thermocouples, are: smaller overall temperature range, higher initial cost and less rugged in high vibration environments. They are active devices requiring an

B. Rainfall Sensors

A rain sensor or rain switch is a switching device actuated by rainfall. There are two main types of rain sensors. The first is a water conservation device connected to an automatic irrigation system that causes the system to shut down in the event of rainfall. The second is a device used to protect the interior of an automobile from rain and to support the automatic mode of wipers. A rain sensor is an irrigation shut-off device that prevents an automatic sprinkler system from operating during and after a rainfall. Rain sensors are available in several designs and are usually connected into the automatic irrigation system's wiring. The device overrides a scheduled irrigation after a specific amount of rainfall has occurred. When the collected rainwater has evaporated from the device, scheduled irrigations resume. Rain sensors are simple, economical and useful tools for preventing irrigation that would be wasteful. Rain sensors for irrigation systems are available in both wireless and hard-wired versions, most employing hygroscopic disks that swell in the presence of rain and shrink back down again as they dry out - an electrical switch is in turn depressed or released by the hygroscopic disk stack has been sensed. Some irrigation rain sensors also contain a freeze sensor to keep the system from operating in freezing temperatures (typically freeze sensors are employed in regions where irrigation systems are not "blown-out" for the winter, yet there is sometimes a chance of overnight frost).

C. Soil Moisture Sensor

Electromagnetic techniques include methods that depend upon the effect of moisture on the electrical properties of soil. Soil resistively depends on moisture content; hence it can serve as the basis for a sensor. It is possible either to measure the resistively between electrodes in a soil or to measure the resistively of a material in equilibrium with the soil. The difficulty with resistive sensors is that the absolute value of soil resistively depends on ion concentration as well as on moisture concentration. Therefore, careful calibration is required for these techniques. Measured Parameter: Soil water potential aided by electrical resistance measurements Response Time: Instantaneous Disadvantages: Calibration not stable with time and affected by ionic concentration Cost of equipment to generate signal and readout system is high but could decrease with new solid-state technology Advantages: Theoretically, can provide absolute soil water content Can determine water content at any depth Sensor configuration can vary in size so sphere of influence or measurement is adjustable Relatively high level of precision when ionic concentration of the soil does not change Can be read by remote methods

V. Implementation of the System

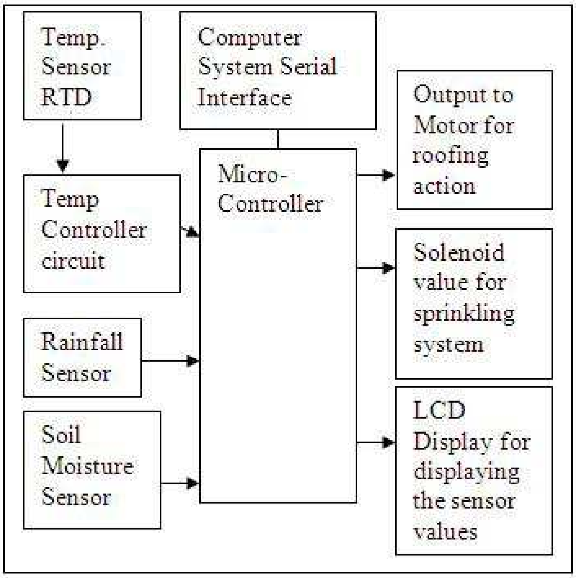

Figure 3: Block Diagram for Irrigation System

The above block diagram shows the soil resistance to obtain a soil moisture level reading. As the moisture level decreases the resistance should increase. They could be placed at different depths to give a better overall indication of soil conditions.

Using a 3 pin temperature sensor unit (possibly an NS ICLM35) to convert the current temperature to an appropriate voltage level. The three pins are ground, 5 volts and signal (1 – 4V). The signal would be sent to an ADC (Analogue to

Digital Converter) which would send its output to the computers input port.

Using a 3 pin humidity sensor component (possibly a HIH3605A) to convert current humidity to an appropriate voltage level. The three pins are ground, 5 volts and signal (1 – 4V). The signal would be sent to an ADC (Analogue to

Digital Converter) which would send its output to the microcontrollers input port.

Using a tipping bucket method of rainfall level reading. This involves having a small container on one side of a balance and a counterweight on the other side. The counterweight, in its starting position, would interrupt light between the two parts of an opt coupler (the emitter and the receiver). When it rained, the container would fill up, and at a certain point (most likely to be calibrated to be when 1 mm of rain had fallen) the container would reach its lowest point and the counterweight would reach its highest point, allowing light to pass through the opt coupler. Just after this, the container would tip over and empty its contents. The output of the opt coupler would be received by the computer which would increment a rain counter on every transition of signal state.

VI. Sprinkling System

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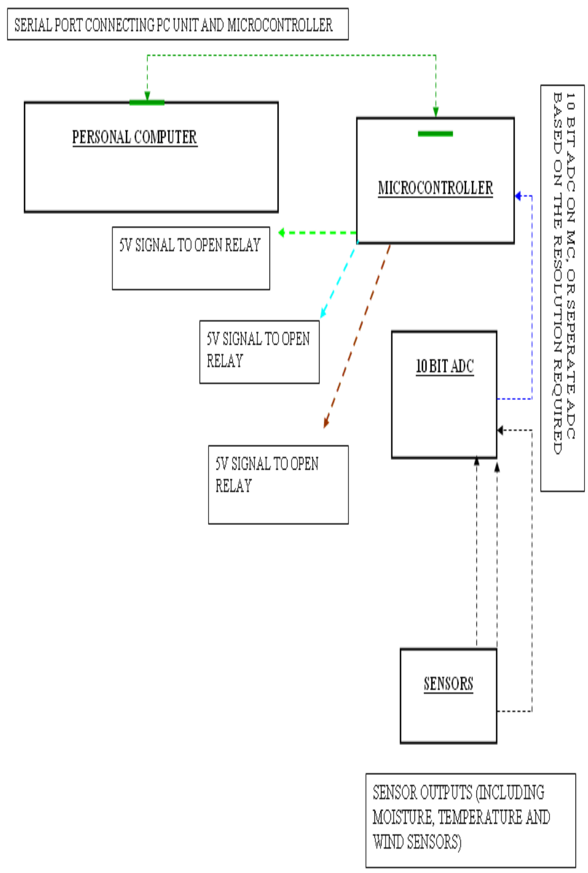

Figure 4: Block diagram of the Smart Sprinkler System

The major components of the Smart Sprinkler System are a computer, a microcontroller, analog-to-digital converters, sensors, and the circuitry to open and close the solenoid sprinkler valves. It is desirable to utilize 120 VAC/60

Hz household standard powers available to run the Smart Sprinkler System. The solenoid valves require 24 VAC/60 Hz to properly open and close. We will incorporate a step-down transformer to convert the 120V to the required 24V Relays requiring 5V to open will be used to control the valves. Once the valves open, the system becomes primarily mechanical. The sprinkler heads will open due to the water pressure in the pipes. At that stage, sensing circuitry will determine how long to irrigate to reach the desired moisture level in the ground. Due to environmental situations, the desired moisture level might not always be reached. Hence, algorithms will be in place to account for these occurrences to ensure that irrigation is still effective

VII. Automatic Agriculture System

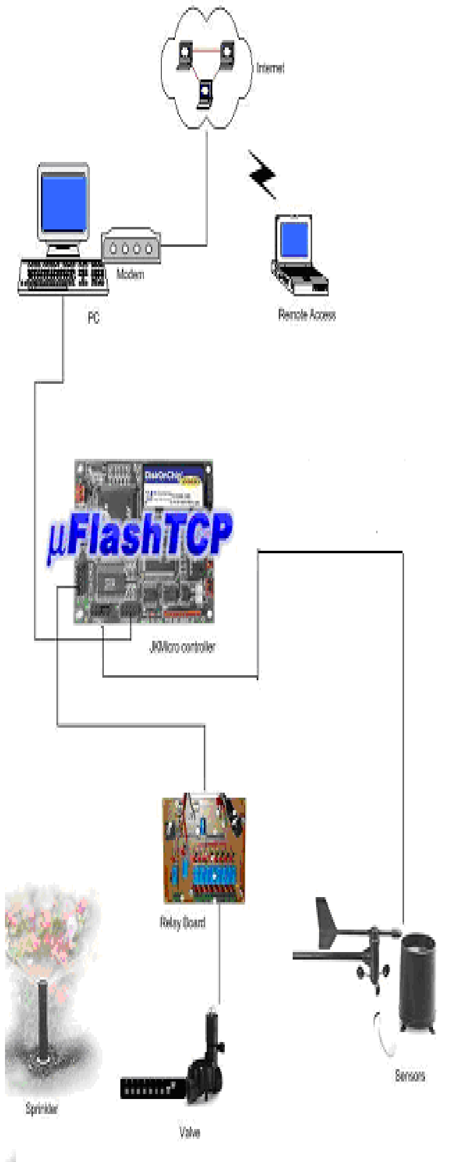

Figure 5 : Basic connectivity for Automatic Irrigation System

Here sensor values are read by microcontroller and processed by it. Relay board is used for operating motors or valves in case of starting of roofing or starting of sprinkling system. If rainfall is detected, the sprinkling system is stopped. As the soil moisture level decreases, the electrical receptivity increases. At some point, threshold value of receptivity, the valve of sprinkling system is opened to operate the sprinkling system.

VIII. Flow Diagram of the System

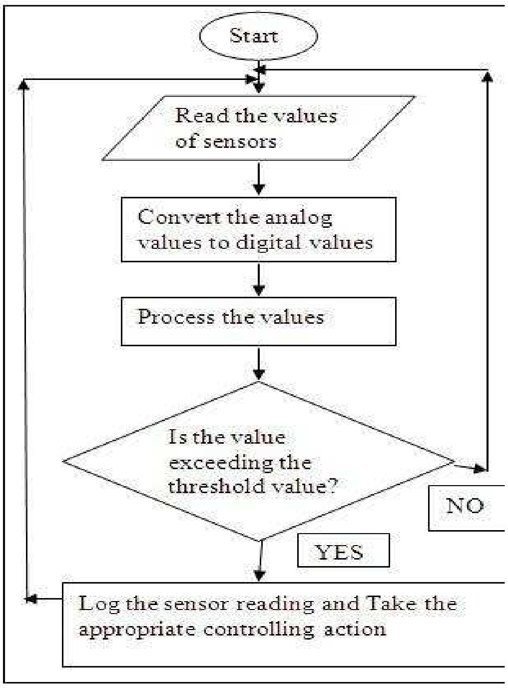

Figure 6 : Flow diagram of the system

In above flow diagram, we have used the polling method for reading the values of sensors continuously. Instead of continuously checking the status of sensors, after the particular time intervals, values of sensors can also be checked. We can also use interrupt driven system. In interrupt driven system, when the particular set values are violated, then only signals are given to the processing so that appropriate action can be taken. The appropriate action can be the roofing of the area when temperature increases or rainfall is detected, starting the watering system automatically when the low humidity is detected. For roofing purpose, the D.C. motor with delay can be used or stepper motor can be used for stepwise roofing.

IX. Conclusion

Several international studies, as well as recent surveys in France, have shown that the performance of irrigation practices and equipment, especially in the uniformity of water application, is still too low. This is due to farmers lacking the management skills to manage their irrigation systems properly. Consequences include reductions in crop yields and a waste of water resources. To improve irrigation performance, it is necessary not only to promote the implementation of irrigation scheduling methods, but concurrently to improve system design and make some automotive techniques to increase the production. Various advanced irrigation methods have been developed in recent years like irrigation controlling based on computer or computer through sensors, remote messaging. The advanced controlling techniques automated roofing, sprinkling system etc.

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