AUTOMATIC IRRIGATION SYSTEM USING SOLAR ENERGY

Original Research Article

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ABSTRACT

The smart irrigation system is developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a GSM module is provided which sends the values of parameters through message. An algorithm is developed with values of temperature and soil moisture that is programmed into microcontroller-based gateway to control water quantity. The system is powered by solar panels and has a duplex communication link based on a cellular-Internet interface that allowed for data inspection and irrigation scheduling to be programmed through a web page.

Key Words:

Cellular networks Internet,
Irrigation,
measurement,
water resources,
wireless sensor networks (WSNs),
GSM,
Microcontroller, zigbee.

I. INTRODUCTION

Indian agriculture is dependent on the monsoons which is not sufficient sources of water. The automatic irrigation system can provide water to farms according to their moisture and soil types. Suitable water supply is required because of most of the farms are depends upon the monsoon.

In conventional system, the farmer has followed a schedule for watering, which is different for different crops. Too much watering causes diseases to plants and even they die out. To provide uniform and required level of water for both plain and sloppy areas and avoids the water overflow at the sloppy areas and considering the current labor shortage situation, the automated sensing system will be most appropriate. The primary source of water in agricultural production in most parts of the world is rainfall. The three main factors that characterize rainfall are amount, frequency and intensity, the values of which vary spatially and temporally. When the weather does not provide enough rainfall to feed agricultural needs, farmers should supplement water available through rainfall by some type of irrigation to manage the soil moisture and nutrient concentration to create the optimum-growing environment. With limited availability of freshwater and increasing costs of energy and manpower, irrigation, which can contribute substantially to crop production should be planned and managed in such a way that no drop will be wasted.

Due to complexities in the precise knowledge of the rainfall's main characteristics, the irrigation scheduling cannot be planned neither on the minimum values of the average precipitation during the growing season nor on the maximum. The former may lead to an over-irrigation causing crop diseases and waste of water, fertilizer, and energy. Also, and besides running off and evaporating, the excess water will percolate deep to soil layers below the root zone with all nitrates and other pesticides it contains polluting the ground water. The latter on the other hand, leads to an under-irrigation causing a highly reduction in both crops quantity and quality. Therefore, deciding when to turn on the irrigation system and how much water to apply is a complex decision-making process. With increasing population pressure throughout the nation and need for increased agricultural production there is need for management of nation agricultural resources. The real time values of soil moisture, air humidity, temperature and water level in the soil are wirelessly transmitted using wireless technology and protection from insect attack to the crop for better production.

1.1 Objective

The objective of this project is to save water and reduce human intervention in the agriculture field.

Continuously monitoring the status of sensors and provide signal for taking necessary action.

To get the output of soil water sensor & provide water to crop accordingly.

To observe other parameters for better yield.

II. RELATED WORK

There were many works on the application of WSN for monitoring system such as in where Zigbee is used to monitor the condition of long span bridge after considering disadvantages of the currently used wire and cable for data communications such as high installation cost of communication and power supply for the sensors, difficulty in the installation of steel pipeline for protecting the cables, sensor data distortions due to temperature changes on cables, noise affecting cables and sensors etc. The zigbee is used for the short distance communication whereas CDMA (Code Division Multiple Access) infrastructure was used for long distance communication between sensors and the server system. Recent advances in microelectronics and wireless technologies created low-cost and low-power components, which are important issues especially for such systems such as WSN Power management has been addressed in both hardware and software with new electronic designs and operation techniques. The selection of a microprocessor becomes important in power aware design.

III. SYSTEM HARDWARE DESIGN

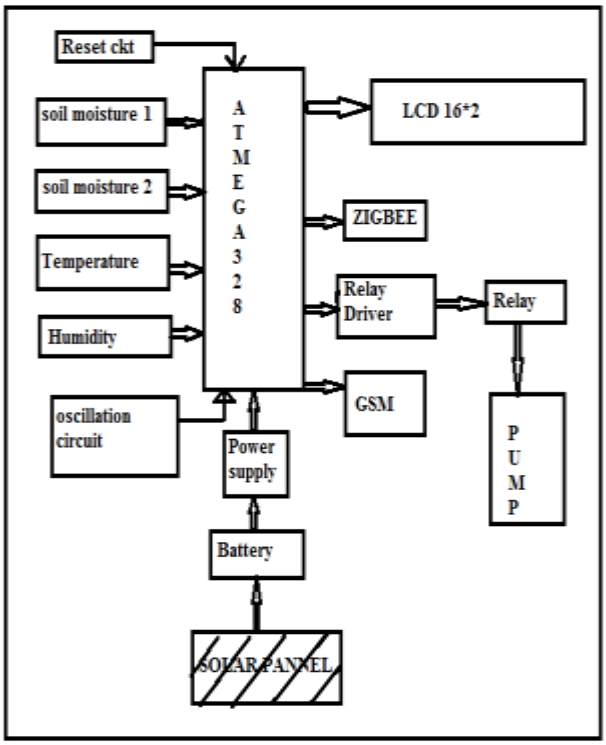

Figure 1. Transmitter

The block diagram of the system consists of two sections: transmitter and receiver section which effectively measures parameters by using different sensors like temperature sensor, humidity sensor, soil moisture sensor and the system also consist of microcontroller 328P, GSM module, LCD, and zigbee module.

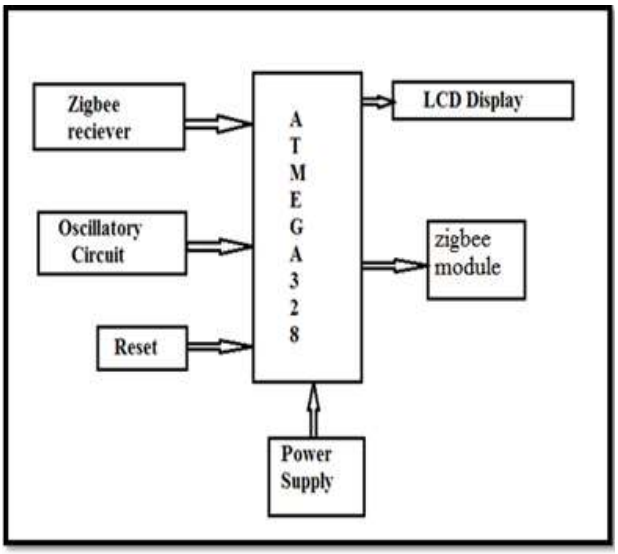

Figure 2. Receiver

3.1 Sensors

As shown in the transmitter block there are three sensors used in the system, which are mainly as follows:

a. Temperature
b. Soil moisture
c. Humidity

The LM35 precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.LM35 is temperature sensor is used to sensing the temperature. It is integrated circuit that can be used to measure temperature with electrical output It is more accurate and its operating temperature range is from -55 to 150 degree C.

A humidity sensor senses relative humidity. This means that it measures both air temperature and moisture. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature. HS1100 is used for sensing humidity. Humidity is measure in percentage of vapour in the air. HS1100 gives the output in terms of frequency range 5khz to10khz.

Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors. One common type of soil moisture sensors in commercial use is a Frequency domain sensor such as a capacitance sensor. Another sensor, the neutron moisture gauge, utilize the moderator properties of water for neutrons. In This sensor We are using 2 Probes to be dipped into the soil. As per moisture we will get Analog Output variations from 0.60volts - 12volts. Input Voltage 12 VDC.

3.2 Microcontroller used

The ATmega328P is a low-power CMOS circuit with 8-bit microcontroller, and is depended on the AVR with enhanced RISC architecture. By executing high power instructions in a single clock frequency, the ATmega328P gets a result of throughputs approaching 1 MIPS per MHz which allows the system designer to find optimize power consumption versus processing speed.

3.3 Data Transmission

GSM Module

The SIM900 can be used embedded in many of the applications as it is complete Quad-band GSM/GPRS solution in a SMT module. Feature for an industry-standard interface, the SIM900has the capability of delivering GSM/GPRS 850/900/1800/1900MHz performance for voice, Data, SMS, and small form factor Fax and requires low power consumption. GSM900 has an small configuration of 24mm x 24mm x 3 mm, and can be fit in nearly all the space requirement in M2M application, as there is slim and compact demand of design. SIM900 is designed with a highly powerful with single-chip processor and integrated AMR926EJ-S core, Quad - band GSM/GPRS module having a size of 24mmx24mmx3mm, SMT type suit for many application, An embedded of highly Powerful TCP/IP protocol stack, depends on mature and field-proven platform, and is backed up by a support service provided, from definition to production and design.

Figure3. GSM 900

Zigbee module.:

Zigbee 802.15.4 RF modules are of zigbee family, looking for excellent wireless performance, it is the premiere choice for OEMs and a small form factor solution and also cost-effective. Every zigbee module comes in a two range that can be regular or long-range. Pin-for-pin compatibility is found in all Zigbee modules with the exception of a few varying I/O features, a standard footprint for OEMs is provided to different applications. zigbee Series 1 is depended on Zigbee 802.15.4 silicon from free scale. It is ideal for the topologies such as point-to-multipoint, point-to-point and peer-to-peer because of 802.15.4 firmware feature. The zigbee Series 1 gives the user maximum control over minimum latency and network nodes. zigbee Series 2 is referred from Zigbee/802.15.4 silicon which is from Ember. For creating ad-hoc mesh networks is based from features of Zigbee firmware. Automatic route discoveries are performed by the zigbee Series 2 which can create a self-healing network for the routers which are fully function and also for low-power end devices. Whereas zigbee Series 1 and Series 2 modules do not communicate with each other. It is basically known for ease of use, the zigbee modules are ready in form and can be operated out of the box and an API for advanced, user-settable configurations, it also offer simple AT commands.

Figure 4. Zigbee module

For effective wireless data communication without a license, 2.4 GHz ISM band, zigbee modules are known worldwide. Zigbee modules are basically a part of Dig's full line of Drop-in Networking products. With the connection of Port X gateways and zigbee device adapters, extenders and modules, this provides end-to-end wireless connection to commercial-grade electronic devices which is in locations where proper infrastructure exists or where customer needs are satisfied.

IV. PROGRAMABLE LOGIC

4.1 flowchart

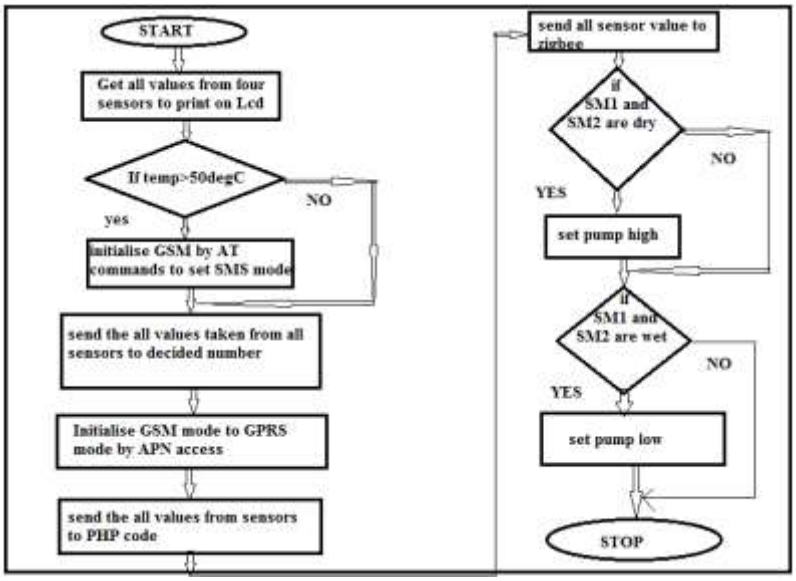

Figure 5 Transmitter flowchart

The smart irrigation system uses temperature, soil moisture and humidity Sensor to measure the relative parameter in order to give the water to crops. Since the outputs of the sensors measured are analog in nature and microcontroller will handle solely digital signals, the system makes use of ADC which is inbuilt in microcontroller. The outputs of sensors are directly given to ADC, which converts the analog signals into the corresponding digital signals. These digital signals at microcontroller 328P then uses Zigbee module for communication that is to send data at the receiver and GSM module at the receiver side interfaced with microcontroller 328P for communication at a particular level. Microcontroller sends the measured values to wireless communication zigbee module and further uses GSM module to send message to the farmer. Since it's a real time system thus microcontroller sends the measured values of different parameter and according that water is given to the crops. Microcontroller also displays the values of the parameter on the LCD. The power supply is given by the charging the battery by the solar panels and the appropriate voltage is given to all the components.

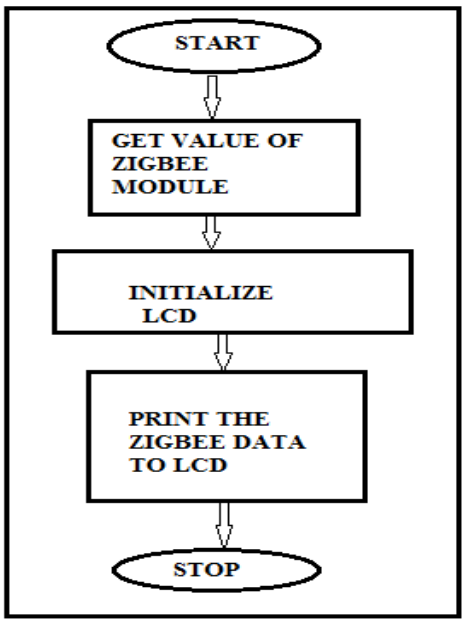

figure 6. Receiver flowchart

V. RESULTS AND DISCUSSION

Below is the transmitter and receiver part of the project, we used the software Proteus 7.6 SP0 v2.0.1 for simulation purpose. The most exciting and important feature of Proteus is its ability to simulate the interaction between software running on a microcontroller and any analogue or digital electronics connected to it. It simulates the execution of your object code (machine code), just like a real chip. If the program code writes to a port, the logic levels in circuit change accordingly, and if the circuit changes the state of the processor's pins, this will be seen by your program code, just as in real life. It is anything but a simple software simulator since the interaction of all these peripherals with the external circuit is fully modeled down to waveform level and the entire system is therefore simulated.

transmitter

Figure 7. Practical model

Above figure 5 shows practical connection done on PCB with a well programmed ATMEGA 328P interfaced with Sensor and other modules. The Resistance of 10k is used as a fixed resistance with sensor network. LCD displays the data in digital form output obtain from microcontroller. Sensed output in voltage form is given to microcontroller. This microcontroller then convert data into digital form as ATMEGA 328P have inbuilt 10 BIT ADC.

Below are the results of different values obtain from the sensors connected.

Temperature

Following result shows the variations of temperature values for different timings in the day and night. Here T1,T2,T3 and T4 are different temperature values of sensors taken in the morning, afternoon, evening and night time. As temperature increases the moisture content in the soil decreases which makes soil dry.

When the temperature exceeds the limit and goes above 50 deg C then SMS is sent on given number and irrigation starts automatically.

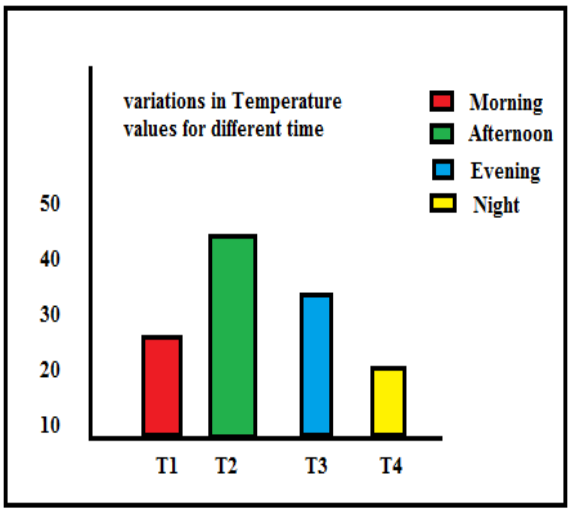

Figure 8.Temperature values

Soil moisture

Below result shows the water content present in the soil. Four different values of soil moisture sensor are taken. Following result shows the different values of soil moisture sensor taken at different time. Here content of water is measured in the form of percentage. When both the sensors show values to the 0% it means that there is no water content present in the soil or it is completely dry which leads to automatic starting of irrigation. When both the sensors show values of soil moisture to 100% it means that soil is wet and there is no need of watering to plant.

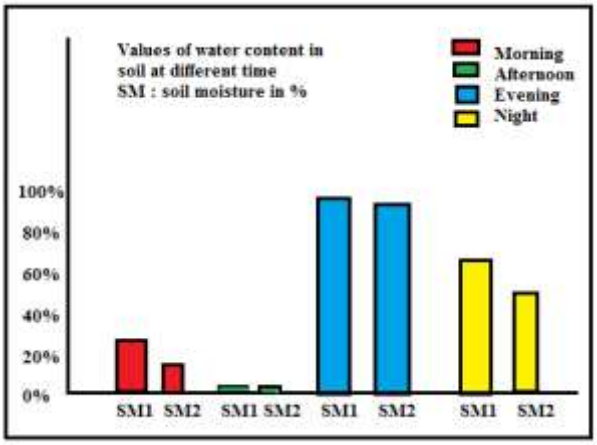

Figure 9.Soil moisture values

SMS Part

The following result shows when the temperature exceed its limit SMS is sent to the decided number and irrigation starts automatically.

Figure 8. SMS values

Above three results show the different values of temperature, soil moisture sensors(SM1,SM2),and humidity sensor .All the three sensors senses the information about parameters and send it via SMS. As in first two results soil moisture values are zero it means that soil is dry and irrigation started automatically. In the case of third soil is wet means moisture is present in the soil so irrigation stopped automatically.

VI. CONCLUSION AND FUTURE SCOPE

The smart irrigation system implemented is feasible and cost effective for optimizing water resources for agricultural production. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability. The smart irrigation system developed proves that the use of water can be diminished for a given amount of fresh biomass production. The use of solar power in this irrigation system is pertinent and significantly important for organic crops and other agricultural products that are geographically isolated, where the investment

in electric power supply would be expensive. Real time system for irrigation is based on GSM and zigbee module. The system is incredibly versatile and economical. It doesn't need individuals on duty it is so easy and reliable.

6.1 Future scope

To provide protection from insect attack for better yield.
Focused on the prevention of crops from insect attack which damages the crop leaves and root so it automatically affects the crop yield.

To observe other parameters for better yield.
Climatic conditions also affect the growth of crops, like temperature increases the water requirement also increases so it can also be monitored.

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