Automated Irrigation System By Using ARM Processor

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ABSTRACT

The continuously increasing population in India demands for the rapid improvement in food production technology. Indian, economy is mainly based on agriculture. Water is the main resource for agriculture. Hence efficient water management of fresh water resources has a crucial importance. To save the water and to increase the yield of crop proper method of irrigation must be used. It is well known that irrigation by drip is very economical and efficient. The conventional drip irrigation system is fully controlled and monitored by the farmer. This paper presents a fully automated drip irrigation system which is controlled and monitored by using ARM9 processor. Sensors are used to monitor the moisture content of the soil and depending on that the valves of the system are turned ON or OFF automatically for different interval of time. pH of the soil is also important factor to be considered as it affects the nutrient availability in the soil. Sensor to detect the pH of the soil is used and depending on the value of the pH, suggestions are given to the farmer to maintain the proper pH. Nitrogen is one of the important macronutrient in the soil. It is a vital nutrient compound for plant growth. Sensor to detect the soil nitrogen content is used and depending upon the available nitrogen content suggestions are given to the farmer to maintain nitrogen level as per requirement.

Keywords – ARM9, Automation, LCD, Si4432 ISM Transceiver.

I. INTRODUCTION

In many agricultural cropping systems irrigation is necessary. In semiarid and arid areas, efficient water applications and management are of major concerns [1]. The continuous extraction of water from earth is reducing the water level due to which lot of land is coming slowly in the zones of un-irrigated land. Large amount of water goes waste due to improper planning of water usage. The demand for new water saving techniques in irrigation is increasing rapidly right now [2]. The aim of farmer is to produce "more crop per drop", hence there is need to find the irrigation techniques which consumes less fresh water. These techniques are helpful in the regions where there is a scarcity of fresh water.

In the modern drip irrigation systems, the most significant advantage is that water is supplied near the root zone of the plants drip by drip due to which a large quantity of water is saved. At the present era, the farmers have been using irrigation technique in India through the manual control in which the farmers irrigate the land from time to time. This process sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. Water deficiency can be hazardous to plants before wilting becomes visible. This problem can be perfectly solved if automatic controller based drip irrigation system is used in which irrigation will take place only when there is intense requirement of water. Irrigation system uses valves to turn ON or OFF automatically. Automatic Drip Irrigation is a valuable tool for accurate soil moisture control in highly specialized greenhouse vegetable production and it is a simple, precise method for irrigation. It also helps in time saving, removal of human error in adjusting available soil moisture levels and to maximize their net profits. Along with water the other important resources to the crop are the nutrients. If the nutrients are available in the right amount for the growth of crops then the yield of the crops also increases. Thus the productivity can be raised with the proper management of water resources and nutrients.

II. IRRIGATION

There has been technological advancements in agriculture sector from the last decades and growth of the irrigated areas. But the traditional irrigation methods are still predominant when it comes to try and correct the natural rain distribution [3]. The artificial application of water to the soil for growing crops is called as irrigation. Irrigation is mainly used in dry areas and in periods of rainfall shortfalls to increase crop production. The detail

analysis of the conditions must be done while providing irrigation to the land.

- Types of irrigation

1. Surface Irrigation(conventional irrigation)
2. Drip Irrigation
3. Sprinkler Irrigation

The conventional methods of irrigation like sprinklers of overhead type, flood type irrigation systems wets the lower leaves and stem of the plants. When irrigation is done by using such methods the soil surface is often saturated and stays wet for long time after irrigation is completed. These conditions leads to infections by leaf mould fungi. The flood type methods consume large amount of water and the intermediate area between crop rows remains dry and receives water only from incidental rainfall. In order to solve this problem the drip or trickle irrigation is used which is a type of modern irrigation technique that slowly applies small amounts of water to part of plant root zone [4]. Water is supplied frequently, often daily to maintain favorable soil moisture condition and prevent moisture stress in the plant with proper use of water resources.

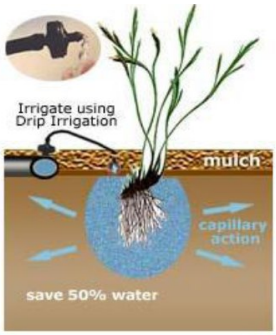


Fig. 1.Drip Irrigation at Root Zone

Drip irrigation at plant's root zone is shown in Fig. 1. Its shape depends on soil characteristics. Drip irrigation system saves water because only the plant's root zone receives moisture and helps to conserve water resources. Small amount of water is lost through deep percolation if the proper amount is applied.

III. SYSTEM ARCHITECTURE

Automation of the irrigation system is gaining importance as there is need to use water resources efficiently and also to increase the field productivity. The system is used to turn the valves ON or OFF automatically as per the water requirement of the plants. The system is used for sensing, monitoring, controlling and for communication purpose. The system block diagram is shown in Fig. 2.

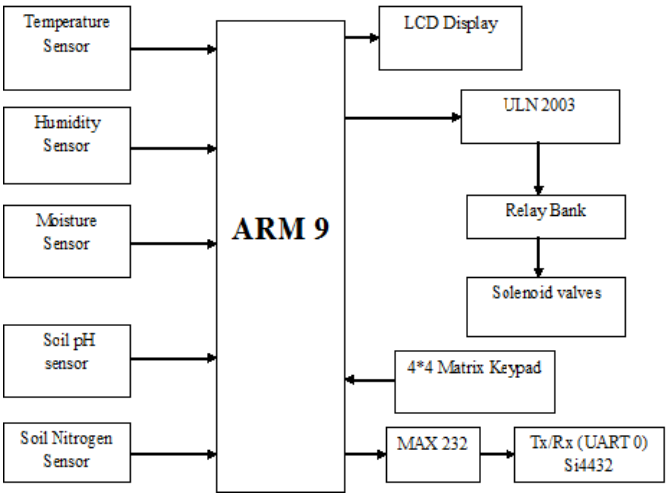


Fig. 2.System Block Diagram

Different sensors are used to detect the different parameters of the soil like moisture, temperature, humidity, pH of soil and nitrogen content of the soil. Depending upon the sensors output the ARM9 processor will take the necessary action. The moisture sensor output will help to determine whether to irrigate the land or not depending upon the moisture content. Along with moisture sensor the temperature sensor output can also be taken into consideration while irrigating the land. If the moisture content of soil is very low and the temperature is very high then there is need of irrigation for plants, but the time for which irrigation will be provided is different for different temperature range. Because if the temperature is very high then the evaporation rate is also very high and hence we have to provide water for more time in order to attain the proper moisture level in the soil. Hence for different temperature range and moisture content level in the soil the land will be irrigated for different time interval. Soil pH is also detected and measured. pH of the soil is also important factor which will affect the plant growth. Acidic or basic nature of the soil will affect the nutrient availability in the soil.

Soil nutrients i.e. macronutrients or micronutrients are helpful for plant growth and there availability depends on the pH of the soil [6]. Hence there is need to measure soil pH. Depending upon the measured pH of the soil, suggestions can be given to the farmer to add various chemicals in order to achieve the desired pH of the soil for good plant growth. Nitrogen is one of the important macronutrient which is required for plant

growth. In the system the nitrogen content of the soil is also detected. According to the available nitrogen content in the soil suggestions can be given to the farmer to add the fertilizers containing nitrogen for healthy plant growth.

In the system LCD display is used to display various measured parameter of the soil and also the required suggestions. Solenoid valves are used in the system which are controlled through the relay bank. The data is transmitted wirelessly by using Si4432 ISM transceiver and the data is fetched by using PC and which will be used for analyzing purpose. The keypad is used to choose the soil type in which the system will work and accordingly we can set the threshold points. Keypad is also used for manual operation. Thus the system will help to monitor, control and communicate.

The system consist of following blocks:

A. Sensors:

Sensors are the device which converts the physical parameter into the electric signal. The system consists of temperature, humidity, moisture, soil pH and soil nitrogen sensor. The output of sensor is analog signal; the signal is converted into digital signal and then fed to the processor. The temperature sensor is used to measure the temperature of the soil. Here LM35 temperature sensor is used. The output voltage of sensor is linearly proportional to the Celsius (Centigrade) temperature. The humidity sensor is used to measure the environment humidity. SY-HS-220 is used as a humidity sensor module. The relative humidity is converted to the output voltage which is the required output. The moisture sensor is used to measure the moisture content of the soil. Copper electrodes are used to sense the moisture content of soil. The conductivity between the electrodes helps to measure the moisture content level. The pH sensor helps to determine the pH of the soil. Electrode is used to measure the pH. The nitrogen sensor is used to measure the nitrogen content of the soil.

B. ARM9 Processor:

Here ARM9 processor AT91SAM9G45 is used. The ARM926EJ-S based AT91SAM9G45 consist of the combination of user interface functionality and high data rate connectivity. It also consists of LCD Controller, camera interface, audio, resistive touchscreen, Ethernet 10/100 and high speed USB and SDIO. The processor is running at 400MHz and multiple 100+ Mbps data rate peripherals, it has the has the performance and bandwidth to the network or local storage media to provide an adequate user experience. It supports the latest generation of DDR2 and NAND Flash memory interfaces for program and data storage. It consists of 133 MHz multi-layer bus architecture associated with 37 DMA channels internally, and also a dual external bus interface and distributed memory including a 64- KByte SRAM which can be configured as a tightly coupled memory (TCM) sustains the high bandwidth required by the processor and the high speed peripherals. The I/Os support 1.8V or 3.3V operation, and they are independently configurable for the memory interface and peripheral I/Os. The power management controller features efficient clock gating and a battery backup section which minimizes power consumption in active and standby modes.

Features:

1. It consists of 32KBytes Data Cache, 32KBytes Instruction Cache, MMU

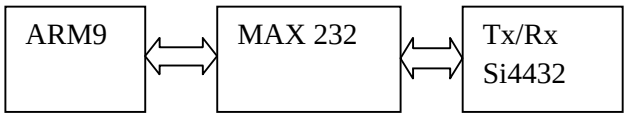
2. Peripherals

- 2 High Speed Memory Card Hosts are available
- For communication Four USARTs are available
- It consist of 8-channel 10-bit ADC with 4-wire Touch Sreen support

3. I/O

- It consist of five 32-bit Parallel Input/Output Controllers
- It is also having 160 Programmable I/O Lines Multiplexed with up to Two Peripheral I/Os with Schmitt trigger input

C. Transmitter/Receiver Section:



Fig, 3.Transmitter Section

The transmitter section is shown in Fig. 3. It consists of ARM9, MAX 232 and Si4432 ISM transceiver. The soil parameters are sensed by the different sensors in the system. The value of the parameter sensed is stored in the ARM9 processor. The data stored is transmitted further for analyzing purpose. The Si4432 ISM transceiver is used for communication. The receiver section is shown in Fig. 4. It consists of Si4432 ISM transceiver, MAX 232 and PC. The data send by the system is fetched by using PC. The data fetched can be displayed and analyzed by using VB software. Visual

Basic i.e VB is used to prepare the graphical user interface(GUI).

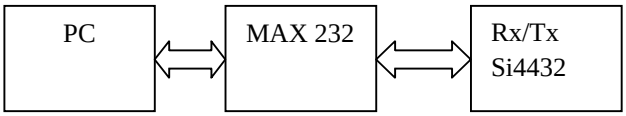


Fig. 4.Receiver Section

Si4432 ISM Transceiver

Silicon Laboratories' Si4432 is a highly-integrated, single chip wireless ISM transceiver and it is part of the EZRadioPRO™ family. The EZRadioPRO family includes a complete line of transmitters, receivers, and transceivers which allows the RF system designer to choose the optimal wireless part for their application. It provides advanced radio features. It provides continuous frequency coverage from 240–930 MHz and adjustable output power of up to +20 dBm with the Si4432. The Si4432 provides high level of integration which reduces BOM cost while simplifying overall system design. The low receive sensitivity (–118 dBm) when coupled with the Si4432's industry-leading +20 dBm output power ensures extended range and improved link performance. The range can be extended by using built-in antenna diversity and through frequency hopping; it also helps to enhance performance. The system link budget is improved by 8-10 dB as antenna diversity is completely integrated into the Si443x which results in substantial increase of range under adverse environmental conditions.

The Si4432 receiver uses a single-conversion architecture to convert the 2-level FSK/GFSK/OOK modulated receive signal to a low IF frequency. Following a programmable gain amplifier (PGA) the signal is converted to the digital domain by a high performance delta-sigma ADC allowing filtering, demodulation, slicing, error correction, and packet handling to be performed in the built-in DSP, increasing the receiver's performance and flexibility versus analog based architectures.

Features:

- Frequency Range = 240–930 MHz (Si4432/31)
- FSK, GFSK, and OOK modulation
- It is having maximum output power of +20 dBm (Si4432)
- Low Power Consumption-18.5 mA receive
  transmit -27mA@ +11 dBm
- It supports data rate from 1 to 128 kbps
- It requires power supply of 1.8 to 3.6 V
- It consist of ultra low power shutdown mode
- It is having Auto-frequency calibration (AFC) feature
- It supports TX and RX of 64 byte with FIFOs
- It comprises of temperature sensor and 8-bit ADC
- Frequency hopping capability is available
- It is provided with on-chip crystal tuning

IV. SOFTWARE

➢ KEIL µ VISION (IDE)

Keil an ARM company makes C compilers, macro assemblers, real-time kernels, debuggers, simulators, integrated environments, evaluation boards, and emulators for ARM7/ARM9/Cortex-M3, XC16x/C16x/ST10, 251 and 8051 MCU families. When starting a new project simply select the microcontroller you use from the Device Database and the µVision IDE sets all compiler, assembler, linker, and memory options. The Keil ARM tool kit includes three main tools, assembler, compiler and linker. An assembler is used to assemble the ARM assembly program. A compiler is used to compile the C source code into an object file. A linker is used to create an absolute object module suitable for in-circuit emulator.

Here visual basic software is used on the PC. The data send by the system is fetched by PC which is used for analysis purpose. The algorithm to view the data is given below.

Algorithm:

1. Start
2. Open the main form.
3. Select com port of PC.
4. Open wireless data communication.
5. Capture the wireless data.
6. Store the data in database.
7. Show the respective data to user for analysis.
8. End.

V. ADVANTAGES

- Relatively simple to design and install.

- It is safest system and no manpower is required. The system helps to farmer or gardener to work when irrigation is taking place, as only the area between the plants are wet.
- Reduce soil erosion and nutrient leaching.
- The system need smaller water sources, as it consumes less than half of the water needed for a sprinkler system.
- Fertilizers can also be provided by using the system
- pH and nitrogen content of the soil is maintained through the suggestions which helps for healthy plant growth

VI. CONCLUSION

The main objective of this paper is to design a fully automated drip irrigation system. The system provides a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently. The system valves are turn ON or OFF automatically depending upon the moisture content. The system also provides the efficient information regarding the soil pH and soil nutrients like nitrogen along with the proper suggestions. The system also provides the communication interface. The data collected by the system can be send further for analysis purpose. Thus the system monitor, control and communicate. Using this system, one can save manpower, water to improve production and ultimately increase profit.

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