Smart Trickle Irrigation System for Green Agriculture

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***Abstract*—Agriculture is the back bone of India. This paper presents a fully automated trickle irrigation system which is controlled and monitored by using ARM11 processor To make the system sustainable, monitoring and control is a necessity. A GSM module is a recent paramount technique of providing the state of the system to the processor. Using various sensors the PH content and the nitrogen content of the soil are frequently monitored. The system informs the user about any abnormal conditions like less moisture content, even concentration of carbon-di-oxide and temperature rise via SMS through the GSM module.**

Keywords—Agriculture, Irrigation, ARM Processor, GSM

I. INTRODUCTION

In many agricultural cropping systems irrigation is necessary. In semi-arid 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 trickle 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 Trickle 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.

There have 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.

II. TYPES OF IRRIGATION

A. CONVENTIONAL Vs MODERN

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 inter 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. 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. ARCHITECTURE OF THE PROPOSED SYSTEM

Automation of the irrigation system is gaining importance as there is need to use water resources efficiently and also to increase the field productivity[7]-[10]. 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. 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.

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.

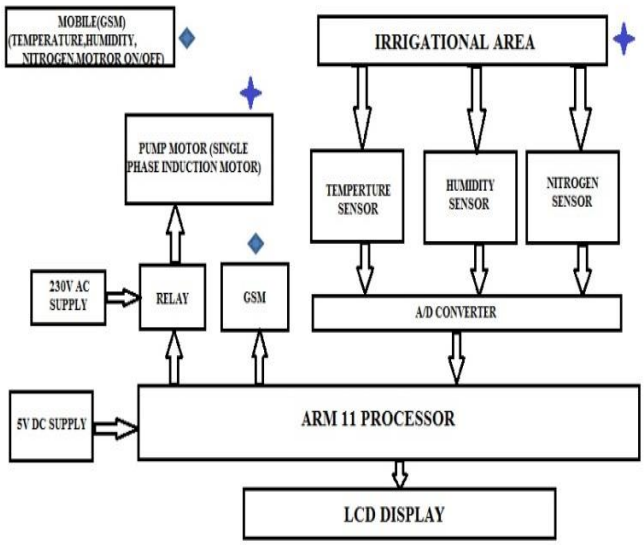

Fig.1.Architecture of Smart Trickle Irrigation System

In the Fig.1 an 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 is controlled through the relay bank. The data is transmitted wirelessly by using Si 4432 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 consists of the 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. fine abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. ARM 11 Processor

The processor ARM1176JZF-S is consists of LCD Controller, camera interface, audio, resistive touch screen, Ethernet 10/100 and high speed USB and SDIO. It has a combination of user interface functionality and high data rate connectivity. The processor operates at 400MHz and multiple 100+ Mbps data rate peripherals. It provides a 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.

Special Features of the ARM 11 Processor

- It consists of 32KBytes Data Cache memory.
- 32Kbytes instruction Cache, MMU Peripherals.
- High Speed Memory Card Hosts are available.
- For communication Four USARTs are available.
- It consist of 8-channel 10-bit ADC
- It consist of 32 bit Five parallel input/output port controller.
- It is also having 160 Programmable I/O Lines multiplexed with up to Two Peripheral I/Os with Schmitt trigger input.

C. Transmitter / Reciever Section

The transmitter section as shown in Fig.2 consists of ARM11, 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 consists of Si4432 ISM transreceiver, 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) equation.

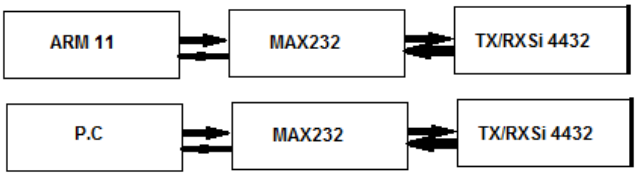

Fig.2 Transmitter/Reciever Section

D. ISM Transciever Section

Silicon Laboratories' Si4432 is a highly-integrated, single chip wireless ISM transceiver and it is part of the EZRadioPRO™ family. The transceiver 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 cost while simplifying overall system design. The low receive sensitivity (–118 dB) when coupled with the Si4432's industry leading +20 dB 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 SK/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. Special Features of the transceiver over the analog based architecture are :

- Frequency Range of 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 chopping capability is available.
- It is provided with on-chip crystal tuning.

E. GSM Module

In this system GSM module is interfaced with the main controller chip. GSM is used for remotely monitoring and controlling the devices via a mobile phone by sending and receiving SMS via GSM network.

Fig.3. Smart Trickle Irrigation System

IV. PC SOFTWARE ALGORITHM

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 monitored data is given below :

Step1. Start
Step 2. Open the main form.
Step 3. Select com port of PC.
Step 4. Open wireless data communication.
Step5. Capture the wireless data.
Step 6. Store the data in database.
Step 7. Show the respective data to user for analysis.
Step 8. End.

V. CONCLUSION

The drip irrigation system using GSM and ARM processor is fully automated as shown in Fig.3. The system provides a real time feedback regarding the soil pH and soil nutrients like nitrogen. It monitors and controls the ON/OFF of all the system valves automatically depending upon the moisture content and helps for healthy plant growth. The data collected by the system can be used for further analysis purpose such as preventing soil erosion and nutrient leaching. Finally, it is concluded that with this simple designed proposed system one can save manpower and water to improve production which ultimately increases the profit.

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