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Design and Implementation of Real Time Irrigation System Using ARM Powered Microcontroller

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Abstract: **This project probes into the design of the automated irrigation system based on ARM micro controller. There are many embedded platform based irrigation control systems are available, but the major drawback of such systems are their inability to handle multiple tasks. The reliability and processing capability of the systems are greatly improved by adding the Real Time Operating System (RTOS). That provides realtime multi-tasking capabilities to the system. This paper proposes an embedded platform based on µC/OS-II RTOS and ARM microcontroller, using this system the condition of field can be sensed with help of sensors the related information is displayed on LCD and transmitted to farmer/user. The purpose of this paper to measuring the moisture of agriculture soils by real time method and to minimize this manual involvement by the farmer.**

Keywords: **RTOS, ARMLPC2148, Irrigation System, Multi-Tasking, Sensor Modules.**

I. INTRODUCTION

Indian economy is basically depends on agriculture. The purpose of a real-time operating system (RTOS) is to schedule tasks in order to guarantee that inputs are acquired and outputs are produced according to timing constraints. Modern agriculture offers a range of benefits, including greater production and higher incomes for farmers including small producers in both developed and developing countries.

Technical advances also have sharply reduced environmental impacts, enabling reduced pesticide, herbicide and fertilizer use, less tillage, and less land and water use per unit of output all decreasing pressure on fragile global ecosystems. It is clear that we have a productivity gap going forward, a gap that we must begin now to close. If we are to double agricultural output by 2050 and do so with basically the same amount of land and water as we have today while also reducing the environmental footprint then clearly we must become more productive than we have been in the past.

The aim of farmer in agriculture is to produce "more crop per drop", hence there is need to find the irrigation techniques which consumes less fresh water. In high end applications, sometimes devices may malfunction or totally fail due to long duration of usage or any technical problem which give fatal results. An embedded monitoring system is necessary for continuously collecting data from onsite and later analysing that and eventually taking proper measures to solve the problem. The systems that are in use today use non real time operating systems based on mono-task mechanism that hardly satisfies the current requirements. This paper will focus on porting of µC/OS II in ARM7 controller that performs multitasking. The µC/OS II features and its porting to ARM7 are discussed. Finally it provides an overview for design of embedded monitoring system using µC/OS II as application software that helps in building the total application. An algorithm was developed with threshold values of temperature, rain, leaf wetness and water level that was programmed into a microcontroller based gateway to control water quantity.

II. IRRIGATION

In some of the irrigation system irrigation scheduling is achieved by monitoring soil, water status with tension meter under drip irrigation by the automation controller system in sandy soil. It is very important for the farmer to maintain the content in the field. In this the design of a Microcontroller based real time irrigation mechanism is proposed. This is a real time feedback control system for monitoring and controlling all the activities of irrigation system more efficiently. Irrigation system controls values by using automated controller allows the farmer to apply the right amount of water at the right time, regardless of the availability of the labor to turn values. Some irrigation systems are used to implement efficient irrigation scheme for the field having different crops. The green house based modern agriculture industries are the recent requirement I every part of agriculture In India. In this technology, the humidity and temperature of plants are precisely controlled. Due to the variable atmospheric conditions sometimes may vary from place to place in large farmhouse. This makes very difficult to maintain the uniformity at all the places in the farmhouse manually. For this ZIGBEE is used to report the detailed about irrigation. The report the ZIGBEE is send to through the PC. The software and hard ware combined together provide a very advanced control over the currently implemented manual system.

Drip irrigation requires about partially of the water needed by sprinkler or surface irrigation. Lower operating pressures and flow rates result in reduced energy costs. A higher degree of water control is possible. Plants can be supplied with more specific amounts of water. Disease and insect damage is reduced because plant undergrowth stays dry Drip irrigation is popular because it can increase yields and decrease both water requirements and manual labor. 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. 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 rain fall short falls 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. Sprinkler Irrigation
3. Drip Irrigation

III. SYSTEM ARCHITECTURE

The heart of the system is a real-time kernel that uses pre-emptive scheduling to achieve multitasking on hardware platform. The previous sections deals with µC/OS-II porting to the application desired. This section deals with the implementation of hardware and software.

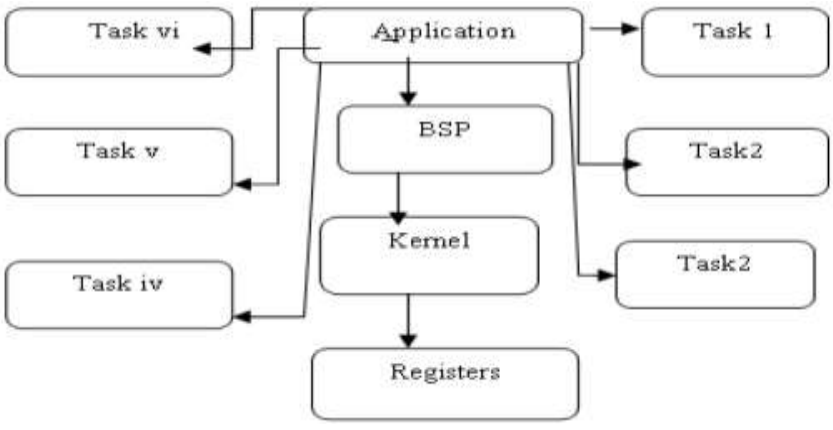

Figure 1: Block diagram multi-tasking

In Micro C/OS-II maximum number of tasks is 64. In the figure shown above the application has six tasks. Depending on the required application the number of tasks may vary.

To perform a sample experiment to understand the porting of µC/OS-II we can perform simple tasks like Temperature sensor (i.e., ADC), Graphical LCD (i.e., degree to graphical Fahrenheit), UART (i.e., digital data displaying), LED toggle (ie. 8-bit data flow control) Buzzer (i.e., alarm device). The ARM runs the Real time operating system to collect information from the external world.

Here RTOS is used to achieve real time data acquisitions. Micro C/OS-II kernel is ported in ARM powered microcontroller for the implementation of multitasking and time scheduling as shown in previous sections. Keil IDE is used for implementation. Keil IDE is a windows operating system software program that runs on a PC to develop applications for ARM microcontroller and digital signal controller. It is also called Integrated Development Environment or IDE because it provides a single integrated environment to develop code for embedded microcontroller.

IV. IMPLEMENTATION OF SYSTEM HARDWARE & SOFTWARE

The real –time irrigation system in agriculture is shown below with several types of sensors. Also the system employs an easy deployment of wireless monitoring system in an agricultural land for efficient accumulation of data about its needs from the multiple locations. Temperature, Leaf, Water Level, Rain sensors. In case of soil moisture, we will check Temperature value is increase or decrease around of plants. If it is increased (dry) means, this condition is very harmful to plants. So immediately release the water into the soil and make it decrease (wet). For this we will use the level sensor which is very useful.

LPC2148 Microcontroller:

Here LPC2148 microcontrollers are basically based on a 32-bit ARM7TDMI-S CPU core hat have real-time emulation as well as embedded trace facility that incorporates microcontroller with that of embedded high speed flash memory up to 512kB. Also 128-bit wide memory interface and unique accelerator architecture will provide 32-bit code execution at the maximum clock rate. Finally for critical code size functionalities, the other possibility 16-bit Thumb mode reduces code almost by 30 % with minimal performance penalty. Temperature and humidity are generally employed in the case of monitoring the weather conditions. Here we are using the one dc motors, among them is for the purpose of bringing the water into the storage from ground. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8kB up to 40kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power.

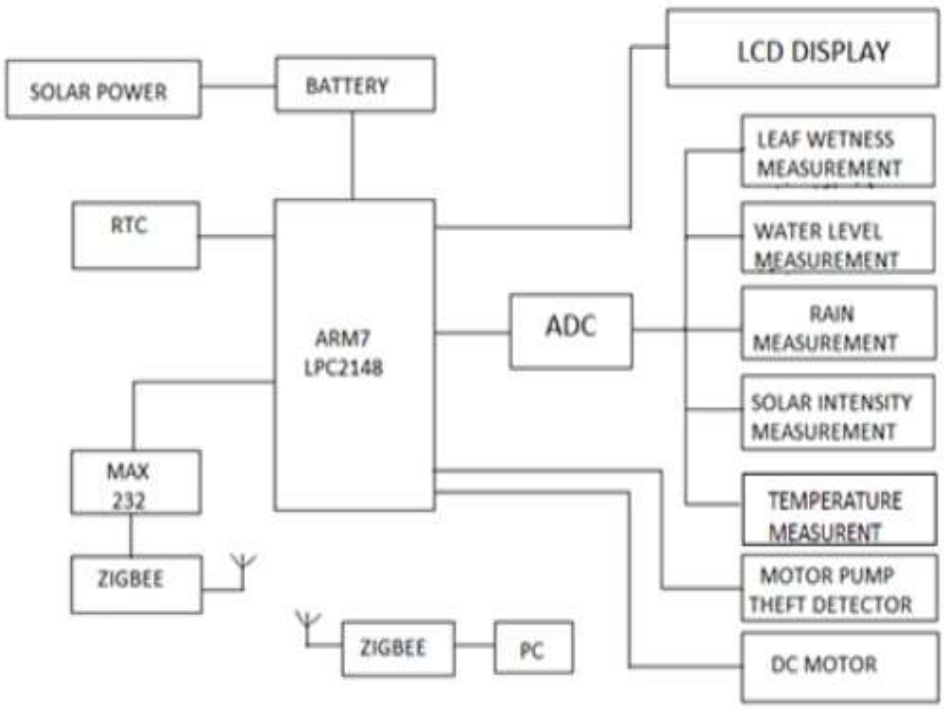

Fig2: Block diagram of real time irrigation system

Hardware Design:

ZIGBEE:

ZIGBEE is a device that is based on IEEE 802.15.4 standard. It has 4 layers based on ISO model. They are physical layer, media access control layer, network layer and application layer. ZIGBEE contains three nodes and they are sink node, routing node, terminating node. Sink node is initialized first and during this network and equipment parameters are configured. After configuration it selects the channel for connection to the network. It is fully controllable node. Routing node can be join or rejoin the network and also scans channel for new connection.

Sensors for Precision Agriculture Leaf Wetness Sensor (LWS):

As we are facing situations like fungal and bacterial diseases that affect plants only when moisture is present on a leaf surface. So now leaf wetness finds the presence and duration of canopy wetness that lets users to forecast disease and protect the plant canopy at initial stages. So therefore if the sensor is totally wet, as in a heavy rain, the signal can range up to around 1400 counts that Leads to small amounts of water on the surface of the sensor cause a sensor output proportional to the amount of water on the sensor's surface.

Water Level Sensor:

This sensor detects the level of substances that flow including liquids, slurries, granular materials and powders. Fluids and fluidized solids flow to become essentially level in their containers (or other physical boundaries) because of gravity whereas most bulk solids pile at an angle of repose to a peak.

Rain sensor:

A Rain sensor for your water irrigation system is a great saver of time, money and embarrassment. Nothing looks more foolish, or is more wasteful, than timer-controlled sprinklers away in a driving rain system. You will not always be at home to manually shut off sprinklers every time it rains.

Solar Light Intensity sensor:

A light sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called “light”, and which ranges in frequency from “infra-red” to “visible “up to “ultraviolet” light spectrum.

Temperature Sensor:

It is a measure of temperature at different levels of the Earth's atmosphere. It is governed by many factors, including incoming solar radiation, humidity and altitude. This variable should be defined as a continuous signal (normally as a sine wave which simulated the day and night temperature changes) [2]. An analog temperature sensor that is LM35 is a chip that tells us what the ambient temperature is. These sensors use a solid-state technique to determine the temperature.

Motor pump theft detector:

This sensor checks the presence of the motor and if motor is absent then ARM activates the buzzer alarm and sends information to the farmer’s.

Solar panel:

Newly added feature for my project is ―Solar Panel‖. As we were facing problem for regularly discharge of 12v battery used at filed. We finally decided to go for solar panel renewable energy source. It converts light energy from the sun in to 12VoltDC electricity. Slowly charges our 12V battery. It also helps to maintain a charge and extend battery's life. It protects battery through long storage periods. This solar panel charger has no moving parts that could wear out over time.

IV. SOFTWARE DESIGN

In this proposed system, as we used LPC2148 we need to use following software tools to program for it.The Keil U Vision is an IDE for Embedded C language. In this IDE, we need to import the utilities and libraries according to the controller we are using. This IDE is very simpler and in user friendly manner to use. It includes all the C/C++ compilers, assemblers, and debuggers in it. It simplifies the process of embedded simulation and testing along with Hex file generation. The flash magicis a programming utility. The C/C++ program written in IDE will be processed into Hex file i.e. in .hex format. It is necessary to dump the hex file on to the microcontroller.

V. RESULT

All Sensors will determine the water level, leaf wetness, Temperature, Rain fall at the root zone. Micro controller should get sensor data per minute.

VI. CONCLUSION

Zigbee based agriculture monitoring system serves as a reliable and efficient system for efficiently monitor the irrigation parameters. With the use of this technique we can reduced water consumption.

VII. FUTURE SCOPE

The project is thus carried out using ARM7TDMI core with the help of WIFI technologies. The project scope involves ARM controller with a video capturing and sending it to user as MMS about the total crop position or to know the total crop condition. We can connect to the nearer weather station to know the upcoming weather changes.

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