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A Real time implementation of a GSM based Automated Irrigation Control System using Drip Irrigation Methology

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Abstract— The green house based modern agriculture industries are the recent requirement in every part of agriculture in India. In this technology, the humidity and temperature of plants are precisely controlled. Due to the variable atmospheric circumstances these conditions sometimes may vary from place to place in large farmhouse, which makes very difficult to maintain the uniformity at all the places in the farmhouse manually. Therefore we present in this paper, to the best of our knowledge for the first time a GSM based Irrigation Control System, which could give the facilities of maintaining uniform environmental conditions. For this, a software stack called Android is used for mobile devices that include an operating system, middleware and key applications. The Android SDK provides the tools and APIs necessary to begin developing applications on the Android platform using the Java programming language. Mobile phones have almost become an integral part of us serving multiple needs of humans. This application makes use of the GPRS feature of mobile phone as a solution for irrigation control system.

Index Terms— Drip Irrigation, Android, GSM Module, Moisture sensor, Temperature sensor, Precision Agriculture, Solenoid Valve.

1 Introduction

IN the modern drip irrigation systems, 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 at the regular intervals. This process sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. Water deficiency can be detrimental to plants before visible wilting occurs. Slowed growth rate, lighter weight fruit follows slight water deficiency. This problem can be perfectly rectified if we use automatic microcontroller based drip irrigation system in which the irrigation will take place only when there will be intense requirement of water.

2 Block diagram of the irrigation control system

A pipe is connected from water pump and the other opening is kept near the root of the plant, with drip irrigation mechanism attached to it. The flow of the water from the pipe is controlled by a solenoid valve. The opening and closing of solenoid valve is done by microcontroller.

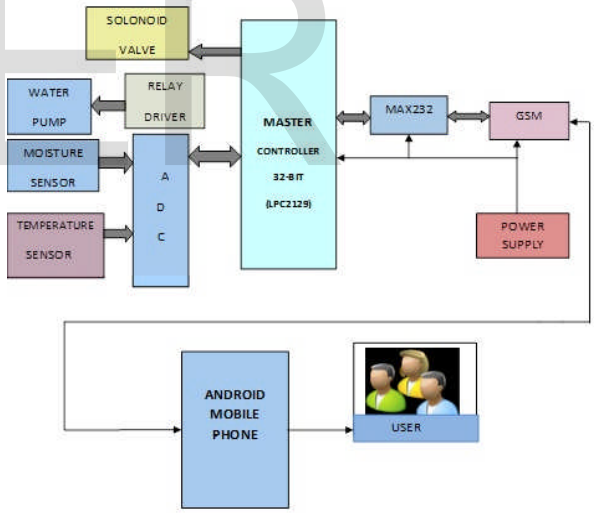

fig1.Block Diagram of the Irrigation Control System

The connections between the two mobiles are done using GSM. The GSM module and microcontroller are connected using MAX232. When the moisture sensor senses that the moisture content of the soil has become low, it gives a signal to the microcontroller. The microcontroller then gives a signal to the called mobile (which is kept in the auto answering mode). The called mobile activates the buzzer.

Therefore when calling mobile calls, that buzzer is heard indicating the valve needs to be open. By pressing the button in the called function, the signal is given back to the microcontroller. The microcontroller gives signal to the valves which causes it to get open. The water is given to the root of the plant drop by drop, and when the moisture content becomes sufficient, the sensor senses this and gives back the signal to

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the microcontroller and the buzzer becomes off. Then by pressing the button in the calling function again, the valve is made off. The power supply needed by the controlling system is +5V.

3 Drip Irrigation Mechanism

A wetted profile developed in the plant's root zone is as shown in Figure 2. Its shape depends on soil characteristics. Drip irrigation saves water because only the plant's root zone receives moisture.

fig2.Drip irrigation Mechanism

Little water is lost to deep percolation if the proper amount is applied. Drip irrigation is popular because it can increase yields and decrease both water requirements and labours. When compared with overhead sprinkler systems, drip irrigation leads to less soil and wind erosion. Drip irrigation can be applied under a wide range of field conditions.

4 Android Architecture

Applications: These are applications written in Java. Some of basic applications include an calendar, email client, SMS program, maps, making phone calls, accessing the Web browser, accessing your contacts list and others.

Application Framework: This is the skeleton or framework which all android developers has to follow. The developers can access all framework APIs an manage phone's basic functions like resource allocation, switching between processes or programs, telephone applications, and keeping track of the phone's physical location.

Libraries: This layer consists of Android libraries written in C, C++, and used by various systems. These libraries tell the device how to handle different kinds of data and are exposed to Android developers via Android Application framework. Some of these libraries includes media, graphics, 3d, SQLite, web browser library etc.

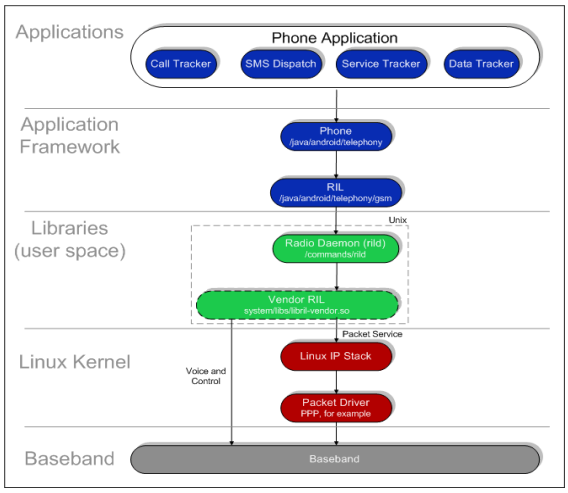

fig3Android architecture

The Android runtime layer which includes set of core java libraries and DVM (Dalvik Virtual Machine) is also located in same layer.

Runtime Android: This layer includes set of base libraries that are required for java libraries. Every Android application gets its own instance of Dalvik virtual machine. Dalvik has been written so that a device can run multiple VMs efficiently and it executes files in executable (Dex) optimized for minimum memory.

Linux-Kernel: This layer includes Android's memory management programs, security settings, power management software and several drivers for hardware, file system access, networking and inter-process-communication. The kernel also acts as an abstraction layer between hardware and the rest of the software stack.

5 Block Diagram of the ANDROID System

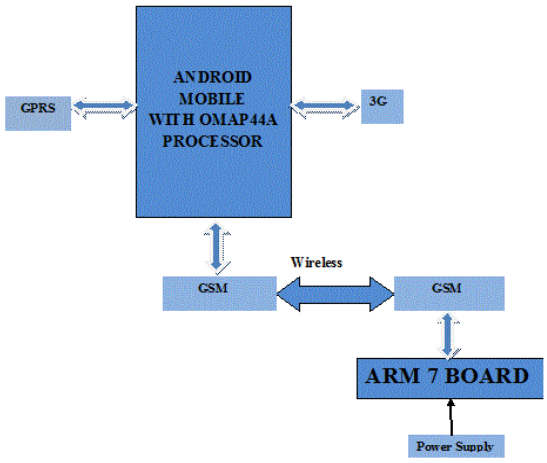

fig4.Block diagram of the Android system

GSM: The Global System for Mobile Communications is a standard set developed by the *European Telecommunications Standards Institute* (ETSI) to describe technologies (2G and 3G).

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GPRS: *General packet radio service (GPRS) is a packet oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications (GSM). GPRS was originally standardized by European Telecommunications Standards Institute (ETSI) in response to the earlier CDPD and i-mode packet-switched cellular technologies. It is now maintained by the 3rd Generation Partnership Project (3GPP).*

ARM7: *ARM7 is a generation of ARM processor designs. This generation introduced the Thumb 16-bit instruction set providing improved code density compared to previous designs. The most widely used ARM7 designs implement the ARMv4T architecture, but some implement ARMv3 or ARMv5TEJ. All these designs use Von Neumann architecture, thus the few versions comprising a cache do not separate data and instruction caches.*

Some ARM7 cores are obsolete. One historically significant model, the ARM7DI is notable for having introduced JTAG based on-chip debugging; the preceding ARM6 cores did not support it. The "D" represented a JTAG TAP for debugging; the "I" denoted an ICE Breaker debug module supporting hardware breakpoints and watch points, and letting the system be stalled for debugging. Subsequent cores included and enhanced this support.

6 General Description of the Master Controller

LPC2129 is an ARM7TDMI-S based high-performance 32-bit RISC Microcontroller with Thumb extensions 256KB on-chip Flash ROM with In-System Programming (ISP) and In-Application Programming (IAP) 16KB RAM. Also there are Vectored Interrupt Controller, Two UARTs, I2C serial interface, 2 SPI serial interfaces Two timers (7 capture/compare channels), PWM unit with up to 6 PWM outputs, 4-channels 10bit ADC, 2 CAN channels. In addition to that there is Real Time Clock, Watchdog Timer and General purpose I/O pins. CPU clock up to 60 MHz, on-chip crystal oscillator and on-chip PLL.

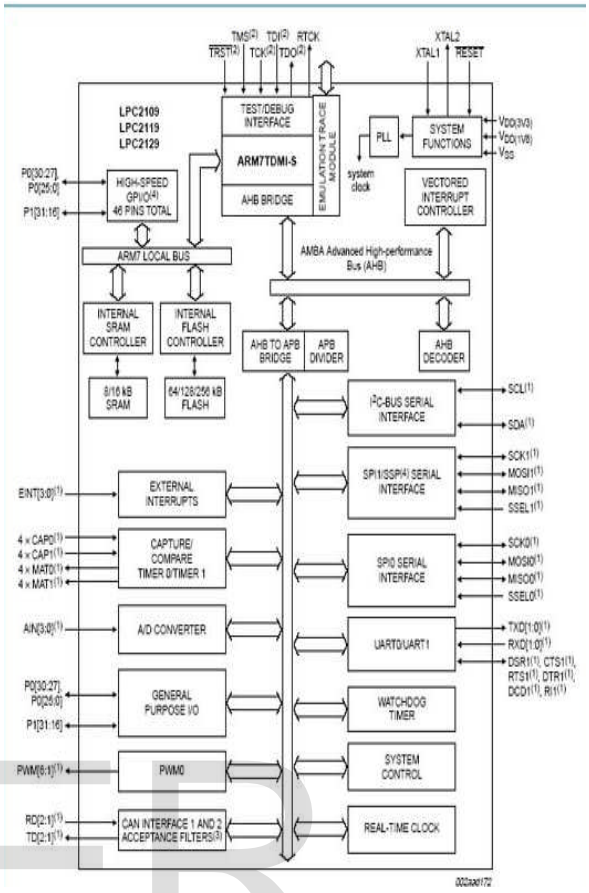

fig5.Internal structure of ARM7 based LPC2129 IC

7 Solenoid Valve

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. Here, in this case a two-port valve is used in which the flow is switched on or off. It basically works as an actuator for the system.

A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically. The signal to open or close the valve is given by the master controller.

This type of valve relies on a differential of pressure between input and output as the pressure at the input must always be greater than the pressure at the output for it to work. If the pressure at the output,
for any reason, rise above that of the input then the valve would open regardless of the state of the solenoid and pilot valve.

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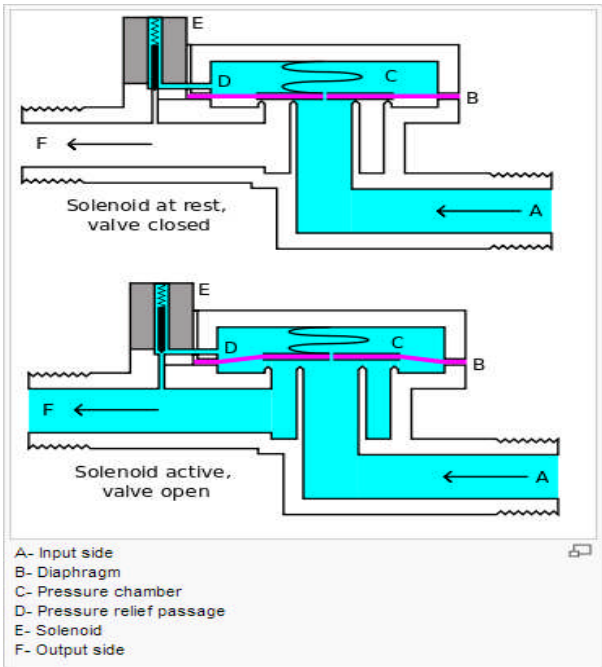

fig6. Solenoid Valve operation

8 GSM MODULE

The GSM (Global System for mobile communication) module (mobile) is used for Remote Control (for example Gate Control, Temperature Control etc.). GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.) for computer.

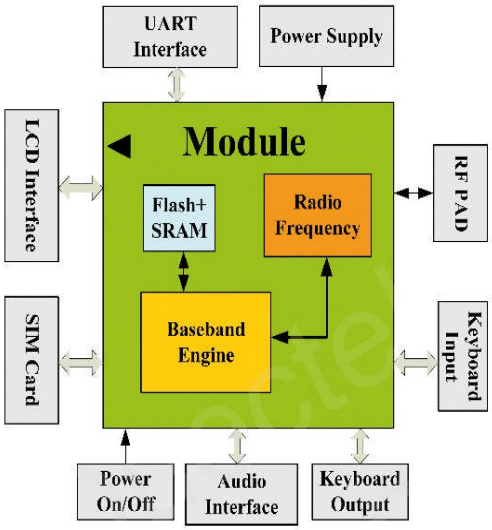

fig7.GSM module structure

The MODEM is the soul of such modules. They generate, transmit or decode data from a cellular network, for establishing communication between the cellular network and the computer. These are manufactured for specific cellular network (GSM/UMTS/CDMA) or specific cellular data standard (GSM/UMTS/GPRS/EDGE/HSDPA) or technology (GPS/SIM). They use serial communication to interface with the user and need Hayes compatible AT commands for communication with the computer (any microprocessor or microcontroller system).

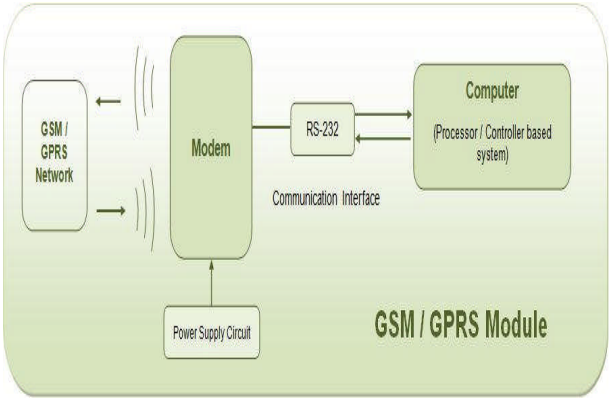

fig8. Module external connections

9 MAX 232 IC

The MAX232 is an integrated circuit, which converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. It's a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals.

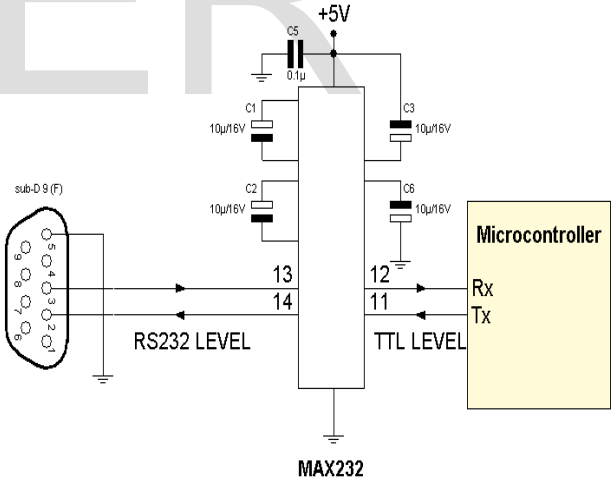

fig9.MAX232 external connections

The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps *and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as* power supply *design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V* TTL *levels. These receivers have a typical threshold of 1.3 V, and a typical* hysteresis *of 0.5 V.*

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When a MAX232 IC receives a TTL level to convert, it changes a TTL Logic 0 to between +3 and +15 V, and changes TTL Logic 1 to between -3 to -15 V, and vice versa for converting from RS232 to TTL.

10 Moisture Sensor

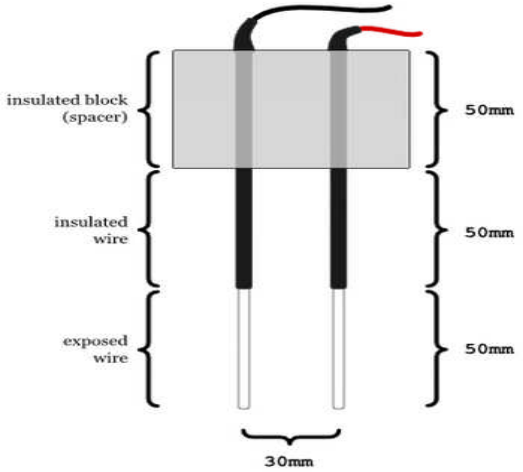

fig10.Moisture sensor diagram

The exposed wire is porous; therefore it allows transmission of water vapors into the sensor. These exposed areas are engineered very thinly. Therefore the sensor responds very rapidly to changes in applied moisture, both when being dried (on process start-up) and when called into action if there is moisture ingress into a process.

Despite this extreme sensitivity to changes in moisture content, the Moisture Sensor can be incredibly rugged due to the nature of its construction. To protect the sensor further against contaminants, it is recommended that the sensor should be housed in a protective sintered stainless steel guard.

11 Software implementations

Android Software development kit

Android software development is the process by which new applications are created for the Android operating system. Applications are usually developed in the Java programming language using the Android Software Development Kit. The Android software development kit (SDK) includes a comprehensive set of development tools. These include a debugger, libraries, a handset emulator based on QEMU, documentation, sample code, and tutorials. The SDK also supports older versions of the Android platform in case developers wish to target their applications at older devices.

Development tools are downloadable components, so after one has downloaded the latest version and platform, older platforms and tools can also be downloaded for compatibility testing. Android applications are packaged in .apk format and stored under /data/app *folder on the Android OS (the folder is accessible only to the root user for security reasons). APK package contains .dex files (compiled byte code files called Dalvik executables), resource files, etc.*

Eclipse (software)

Eclipse is a multi-language software development environment comprising a base workspace and an extensible plug-in system for customizing the environment. It is written mostly in Java. It can be used to develop applications in Java and, by means of various plug-ins, other programming languages including Ada, C, C++, COBOL, Fortran, Haskell, Perl, PHP, Python, R, Ruby (including Ruby on Rails framework), Scala, Clojure, Groovy, Scheme,and Erlang. Developme nt environments include the Eclipse Java development tools (JDT) for Java and Scala, Eclipse CDT for C/C++ and Eclipse PDT for PHP, among others.

The Eclipse software development kit (SDK), which includes the Java development tools, is meant for Java developers. Users can extend its abilities by installing plug-ins written for the Eclipse Platform, such as development toolkits for other programming languages, and can write and contribute their own plug-in modules.

12 Conclusion

Conventional Flood-type methods consume a large amount of water, but the area between crop rows remains dry and receive moisture only from the incidental rainfall, hand pumps or canal waters whereas the drip irrigation technique slowly applies a small amount of water to the plant's root zone.

A few concluding comments:

1. *The system increases the crop productivity and reduces farmer's workload.*
2. *There is efficient usage of water.*
3. *The time consumed is less there by giving more throughputs.*
4. *Controls the growth of weeds, saving the fertilizer.*
5. *Erosion of soil could be stopped totally by using this type of a system.*
6. *Leads to development of a cost effective irrigation control system.*

This system supports aggressive water management for the agricultural land. This architecture is based on the capabilities of current and next-generation microcontrollers and their application requirements. Microcontroller used for the system is promising that it can increase system life by reducing the power consumption resulting from lower power consumption.

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