



GSM AND WIRELESS SENSOR NETWORKS BASED IRRIGATION CONTROL AND MONITORING SYSTEM

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Abstract:

The motivation for this project came from the countries where economy is depends on agriculture and the climatic conditions lead to lack of rains. The farmers working in the farm lands are dependent on the rains and bore wells. Even if the farm land has a water-pump, manual involvement by farmers is required to turn the pump on/off when on earth needed. The purpose of this paper to measuring the moisture of agricultural soils by real time method and to minimize this manual involvement by the farmer, which is why we are using a micro-controller RF module. The sensor senses the amount of moisture present in the soil and presents an output in the form of analog voltage ranging between (fully saturated condition) (completely dried condition) respectively. In the irrigation area automatic system, high- performance embedded micro-controller and low-power technology is used to design the water wireless sensor network. The sensor node gathers the hydrographic information such as water-level, gate position and rainfall. The sink node receives the real-time data; the information center stores and processes those data which are transmitted from the sink node through the GSM network. The system replaces the wired transmission with the wireless transmission, which reduces the costs in installment and maintenance, and improves the system's reliability and extension. It has better application prospect.

Index Terms: Automation, cellular networks, GSM, irrigation, measurement, water resources, wireless sensor networks (WSNs).

1. INTRODUCTION:

Wireless sensor network is an intelligent private network made by a large number of sensor nodes which have specific function. They transmit the information mutually, and collaboratively complete the specific function through self-organization's wireless communication. It synthesizes the sensor technology, the embedded technology, the modern network and wireless communication technology, the distributional information processing technology and so on. Then it is transmitted to the terminal user. The traditional irrigation area automatic system mostly uses the wire to connect the water-level, rainfall and gate position sensors and the data acquisition to transmit the hydrographic information. It brings the complex wiring, and the line is easily damaged, and the cost in installment and maintenance is high. At the same time, when the survey parameter is needed to be increased, the hardware and software of the data acquisition are often needed to be revised. The system's extension is not good, so it is not convenient. The wireless sensor network is applied in the irrigation area automatic system, and the wired transmission is replaced by the wireless transmission. The irrigation system is use only when there is not sufficient moisture in the soil and the microcontroller decides when should the pump be turned on/off, saves a lot time and water for the farmers. As there is no unanticipated usage of water, a lot of water is saved from creature wasted. The constant increasing command of the food provisions

requires a rapid improvement in food production technology. In a lot of countries like India where agriculture and the climatic conditions are isotropic, at a standstill we are not able to make full use of agricultural possessions. The main reasons is the not have of rains & insufficiency of land lake water. The continuous removal of water at normal intervals from earth is dropping the water level as a result of which the zones of un-irrigated land are frequently increasing. Also, the unexpected use of water accidentally results in wastage of water. This also gives much wanted rest to the farmers, as they don't have to go and revolve the pump on/off automatically. It may real-time monitor, sense, gather and process the information of environment. The farmers working in the farm lands are dependent on the rains and bore wells. Even if the farm land has a water-pump, manual involvement by farmers is required to turn the pump on/off when on earth needed. The irrigation system is used to measuring the moisture of agricultural soils by real time method and to minimize this manual involvement by the farmer. The traditional irrigation area automatic system mostly uses the wire to connect the water-level, rainfall and gate position sensors and the data acquisition to transmit the hydrographic information.

2. SYSTEM ARCHITECTURE AND OPERATIONAL FRAMEWORK:

The aim of this paper, the development of the automated irrigation system based on microcontrollers and wireless communication at experimental scale within rural areas is presented. The aim of the implementation was to demonstrate that the automatic irrigation can be used to reduce water use. A microcontroller for data acquisition, and transceiver; the sensor measurements are transmitted to a microcontroller based receiver. This gateway permits the automated activation of irrigation when the threshold values of soil moisture and temperature is reached. Communication between the sensor nodes and the data receiver is via the Zigbee. This receiver unit also has a duplex communication link based on a cellular Internet interface, using General Packet Radio Service (GPRS) protocol, which is a packet oriented mobile data service cellular global system for mobile communications (GSM).The Internet connection allows the data inspection in real time on a website, where the soil-moisture and temperature levels are graphically displayed through an application interface and stored in a database server. This access also enables direct programming of scheduled irrigation schemes and trigger values in the receiver according the crop growth and season management. Because of its energy autonomy and low cost, the system has potential use for organic crops, which are mainly located in geographically isolated areas where the energy grid is far away.

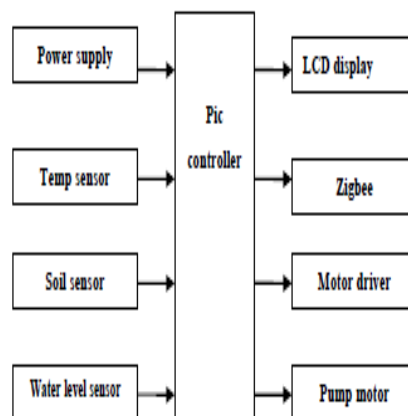


Figure (1): Block Diagram of Irrigation System – Transmitter Section

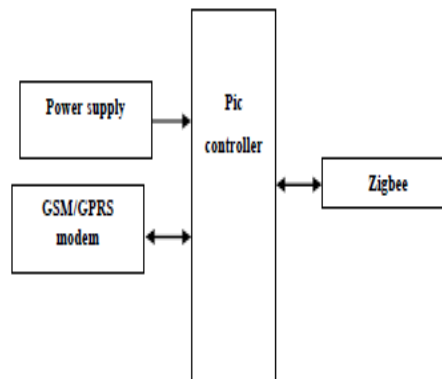


Figure (2): Block diagram of Irrigation System – Receiver section

The block diagram classified as two sections, such that transmitter section and receiver section. In the transmitter section includes a water level sensor, temperature sensor, soil moisture sensor, PIC microcontroller, zigbee module. On the other hand the receiver section includes GSM module and zigbee receiver module. This module is connected to the pic microcontroller. The analog input received is converted to digital values by the inbuilt ADC (Analog to digital converter) of the microcontroller. The temperature sensor senses the temperature level of the land. The soil moisture sensor senses the quality of the soil and given a result of what are the minerals are present in the soil. The water level sensor senses the water level of the land. The microcontroller sets the threshold value, when the temperature reaches the threshold value the motor automatically ON. Otherwise the water level sensor indicates the water level is low or high. if the water level is low the motor automatically ON depends on their soil temperature level.

When the temperature level is increased or decreased the threshold value the microcontroller is allow transmitting the message to the land owner through via GSM module. In this proto type module uses the zigbee module for transmitting purpose. The motor drivers drive the pump motor automatically without human help. The microcontroller PIC16F877A has been used for the measurement of oil reservoirs environment conditions and transmission of data to the receiver. It has 40-Pin packages. It has a 10-bit A/D converter. The microcontroller uses 20MHz clock. Those measured parameters will be displayed in an LCD display. Block diagram of the overall system is shown in above fig. Receiver section consists of a zigbee unit which is interfaced to laptop or desktop computer or mobile. Software collects the data coming from different monitoring devices and presents them in a user interface map. Data is also saved for further analysis

A. Transmitter Section:

PIC Microcontroller: A PIC controller integrates all type of advanced interfacing ports and memory modules. These controllers are more advanced than normal microcontroller like INTEL 8051. The PIC chip also combines a microprocessor unit called CPU and is integrated with various types of memory modules (RAM, ROM, EEPROM, etc), I/O ports, timers/counters, communication ports, etc. The microcontroller is the heart of the whole system. Analog and digital sensors are input of the Microcontroller. Displays unit is an output of the microcontroller. It receives Analog and digital signals equivalent to the quantity of the weather variable to be measured; from sensors connected to it and conversion and processing through pre- programmed instructions written in C language to ensure that corresponding measurement made by

these sensors are available in forms that are meaningful and useful for human analysis, interpretation and record. The microcontroller PIC16F877A has been used for the measurement of oil reservoirs environment conditions and transmission of data to the receiver. It has 40-Pin packages. It has a 10-bit A/D converter. The microcontroller uses 20MHz clock

Sensor Unit:

1. Temperature Sensor:

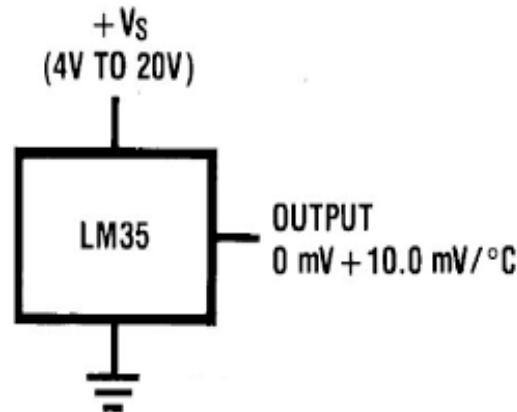


Figure (3): Schematic diagram of LM35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. There are two transistors in the center of the circuit. One has ten times the emitter areas of the other. This mean it has one tenth of the current density since the same current is going through both transistors. This cause a voltage across the resistors R1 that is proportional to the absolute temperature. And is almost linear across the range we care about. The almost part is taken car of by a special circuit that straightens out the slightly curved graph of voltage versus temperature.

2. Humidity sensor: The Microcontroller receives voltage input corresponding to the pressure of the environment from the **Humidity Sensor**. It already has an inbuilt signal condition circuit, which makes the correct voltage available for analog to digital conversion. The Microcontroller converts the analog signal to the corresponding digital equivalent and manipulates the data based on pre-programmed code to displays useful result equivalent of Pressure (KPa) on LCD.

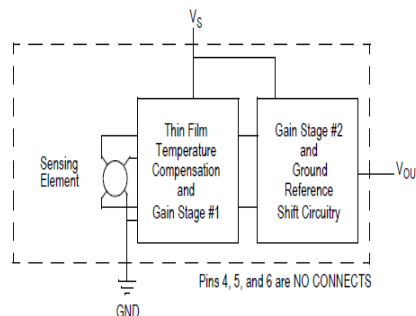


Figure (4): Schematic diagram of humidity sensor

B. Receiver Section:

The receiver Section consist of a PC interfaced with Zigbee through PC serial port the measured values are transmitted to the receiver section through Zigbee. ZigBee is a low power, low cost, low data rate wireless standard for WPAN featured with security, reliability, large network capacity, easily deployed, short delay, long transmission range.

Then the received values are stored in PC using .net process. Web Server runs in the system, being responsible for receiving all the acquisition terminal (regional) data, and according to the area code, sets all data in the database. Then it provides a WEB server functions. System adopts B/S structure .PC terminals service program can be used for access servers, obtains a latest data of each district at anytime and anywhere, and master WSN dynamic data as soon as possible. Liquid Crystal Display (LCD): The 16 x 2 LCD display is capable of displaying different characters and symbols. It is used to display the measured parameters such as pressure, temperature, relative humidity and dew point temperature. Liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

C. Zigbee Technology:

ZigBee is the global Wireless Technology connecting dramatically various devices to work together and enhance everyday life. ZigBee was introduced by IEEE and the ZigBee Alliance provides the standards for various applications. ZigBee is a low power, low cost, low data rate wireless standard for WPAN featured with security, reliability, large network capacity, easily deployed, short delay, long transmission range.

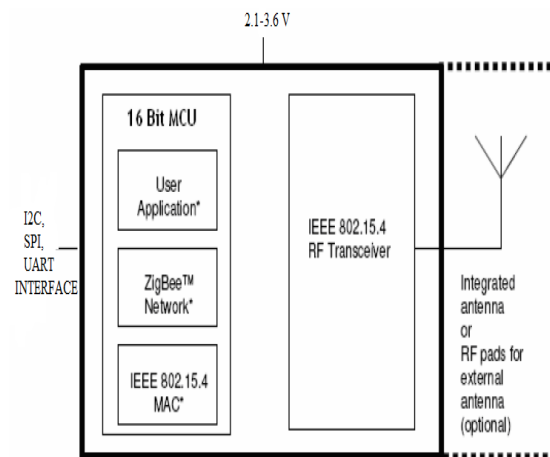


Figure (5): block diagram of ZIGBEE module

There are three categories of nodes in a ZigBee system. They are Coordinator which is responsible for initiating the network and selecting the network parameters, Router which act as intermediate nodes, relaying data from other devices. End Devices can be low-power or battery powered devices. ZigBee coordinator node is completely responsible for the initialization, control and maintaining the network. Network may be extended by using ZigBee routers. This reduced functionality allows the device to reduce their cost. Star, Mesh & Tree are the three topologies which support the ZigBee network. Zigbee protocol stack defines four layer namely PHY layer, MAC layer, Network layer, Application layer. ZigBee defines Application & Network layer whereas PHY & MAC layer are defined by IEEE 802.15.4. Based on data processing capabilities, two types of devices are provided in IEEE 802.15.4: Full Function Device and Reduced Function Device .Full Function Device support complete protocol function and can act as Coordinator, Router and End Device. RFD designed for simple protocol function and can only be used as end device in a network

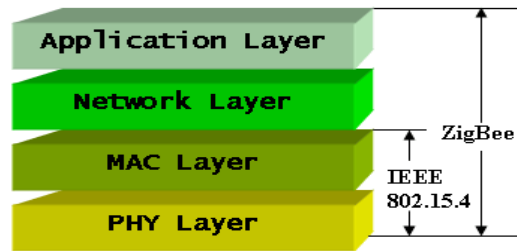


Figure (6): ZIGBEE Protocol Stack

D. Power Supply Unit:

Regulated power supply is very much essential for several electronics devices due to the semiconductor material employed in them have a fixed rate of current as well as voltage. The device may get damaged if there is any deviation from the fixed rate. The AC power supply gets converted into constant DC; unregulated output will be fixed to a constant voltage. The circuit consists of linear voltage regulator 7805 along with capacitors and resistors with bridge rectifier made up from diodes. A rectifier is an electrical device converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification. When four diodes are connected as, shown in figure.

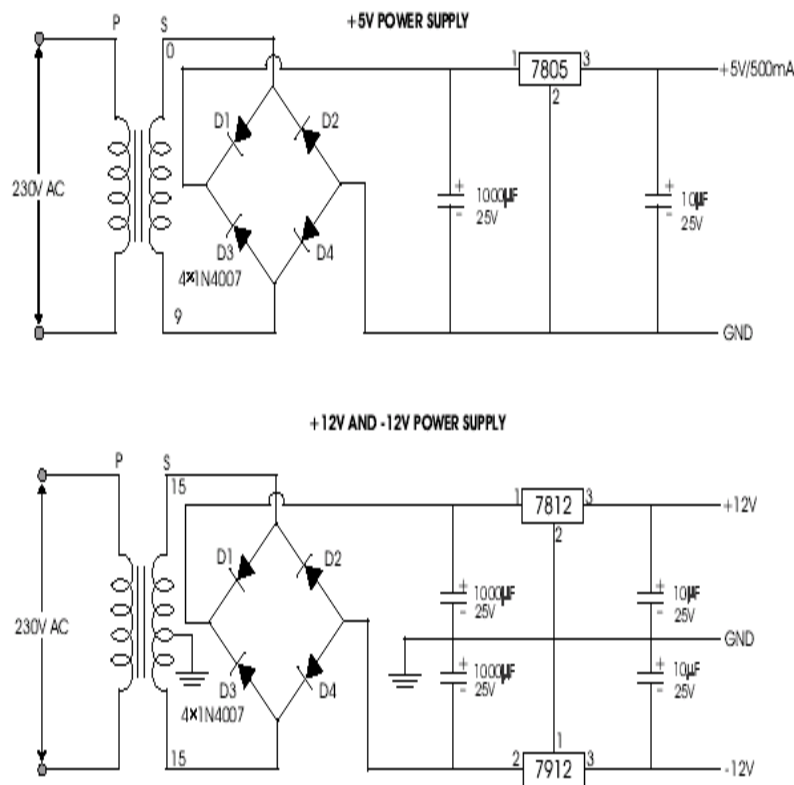


Figure (7): Regulated Power Supply

the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4. The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block



The system can be used to monitor various parameters like Temperature, Soil moisture, water level. Irrigation system using a wireless sensor network based on Zigbee/IEEE802.15.4 standard is utilized as a weather Station network sending weather information. This system focuses on developing devices and tools to Manage, display and alerts the irrigation field's warnings using the advantages of a wireless sensor network system. Zigbee is new wireless technology guided by IEEE 802.15.4 Personal Area Network standard. It is primarily designed for the wide range controlling

Applications and to replace the existing non-standard technologies. It consists of microcontroller based measuring units which collect the value of the temperature, water level and moistures include the irrigation field. The sensor node inside the irrigation field contains the temperature, water level, humidity. The microcontroller is the heart of the whole system. Analog and digital sensors are input of the Microcontroller. Displays unit is an output of the microcontroller. It receives Analog and digital signals equivalent to the quantity of the weather variable to be measured; from sensors connected to it and conversion and processing through pre- programmed instructions written in C language to ensure that corresponding measurement made by these sensors are available in forms that are meaningful and useful for human analysis, interpretation and record.

The microcontroller PIC16F877A has been used for the measurement of irrigation field conditions and transmission of data to the receiver. It has 40-Pin packages. It has a 10-bit A/D converter. The microcontroller uses 20MHz clock PIC 16F877 is 40/44 pin device and is one of the popular microcontroller used in complex applications. The device offers 8K X 14 word of Flash program memory, 368 bytes of RAM, 256 bytes of nonvolatile EEPROM memory, 33 input/output pins, 8 multiplexed A/D converters with 10 bits of resolution, PWM generator. The **LM35** is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in deg Celsius).LM35 temperature sensor can measure more accurately than using a thermistor. It has three terminal pins first pin is connected to the connected to the pin 2 RAO/AN0 of the PIC, second pin connected to the power supply (Battery) and third pin connected to the ground i.e. Zero voltage. LM35 temperature sensor can measure more accurately than using a thermistor. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. It has an output voltage that is proportional to the Celsius temperature. The scale factor is 0.01V/deg Celsius. Another important characteristic of LM35 is that it draws only 60 micro amps from its supply and possesses a low self heating capability. Motor control pin (RE0 and RE1) and to motor connected through L293d (motor driver). When the temperature value reaches its threshold value the motor turned ON automatically. The DC motor operates with the 12V power supply. Need more efficiently the induction motor will be used in the fields. The induction motor adding the relay circuit to switch over the corresponding respective voltages. Battery power connected to RA1 (analog channel 2). The microcontroller PIC 16F877A which get output from various sensor nodes placed in inside the irrigation fields. PIC which has an inbuilt **ADC** (analog to digital converter) which converts analog signal into digital form. Then measured values are processed using microcontroller. The detected values of temperature, water level, battery power are then displayed by using Liquid Crystal Display LCD16X2. A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

LCD 16x2 has 16 characters*2 lines of 14 pins. pin 7 to 14 are data lines D0,D1,D2,D3,D4,D5,D6 and D7 pin 1 is VCC pin 2 is VDD and pin 3 is VEE. Pin 4 RS of LCD is connected to Pin RD0 of PIC16F877A, Pin 5 RW of LCD is connected to Pin RD1 of PIC16F877A and Pin 6 E of LCD is connected to Pin RD2 of PIC16F877A. Data lines D0 to D7 of LCD are connected to port B output line. The receiver Section consist of a PC interfaced with Zigbee through PC serial port The measured values are transmitted to the receiver section through Zigbee.It can have up to 653356 devices, the distance

between ZigBee devices can be up to 50 meters, and each node can relay data to other nodes. Then the received values are stored in PC using .net process. Web Server runs in the system, being responsible for receiving all the acquisition terminal (regional) data, and according to the area code, sets all data in the database. Then it provides a WEB server functions. System adopts B/S structure .PC terminals service program can be used for access servers, obtains a latest data of each district at anytime and anywhere, and master WSN dynamic data as soon as possible. Zigbee-based oil reservoirs monitoring system serves as a reliable and efficient system for efficiently monitor the environmental parameters.

3. SIMULATION-PROTEUS:

Proteus is design software developed by Lab center Electronics for electronic circuit simulation, schematic capture and PCB design. Its simplicity and user friendly design made it popular among electronics hobbyists. Proteus is commonly used for digital simulations such as microcontrollers and microprocessors. It can simulate LED, LDR, USB Communication etc.

- Proteus has a fully functional, procedural approach.
- Variables are UN typed, do not need to be declared, can be local or public and can be passed by value or by reference.
- All the typical control structures are available (if-then-else; for-next; while-loop; repeat-until; switch-case).

New functions can be defined and used as native functions. Data types supported by Proteus are only three: integer numbers, floating point numbers and strings. Access to advanced data structures (files, arrays, queues, stacks, AVL trees, sets and so on) takes place by using handles, i.e. integer numbers returned by item creation functions

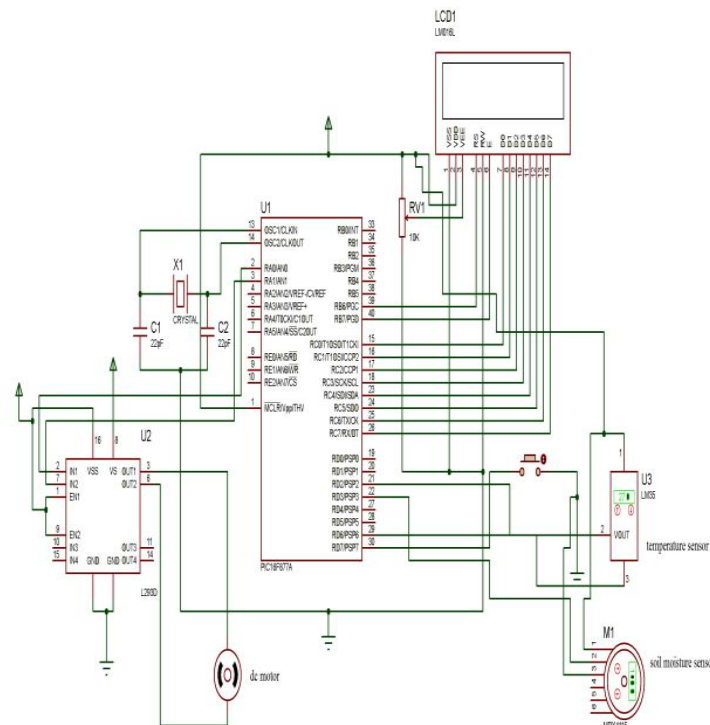


Figure (9): Simulation Circuit Diagram

One of the main components of Proteus 7.0 is the Circuit Simulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with an event-driven digital

simulator that allow users to utilize any SPICE model by any manufacturer. Proteus VSM comes with extensive debugging features, including breakpoints, single stepping and variable display for a neat design prior to hardware prototyping. In summary, Proteus 7.0 is the program to use when you want to simulate the interaction between software running on a microcontroller and any analog or digital electronic device connected to it. The simulation results are described the temperature detection and soil moisture detection and battery power detection. The wireless sensor unit consumes the power can be detected by the photovoltaic sensors. As the sensor can't be implemented in simulation due to incompatibility, switches are used instead of it to describe its functions.

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. It is small and reasonably simpler to learn, understand, program and debug. Compilers are available for almost all embedded devices in use today, and there is a large pool of experienced C programmers. Unlike assembly, C has advantage of processor-independence and is not specific to any particular microprocessor/ microcontroller. .

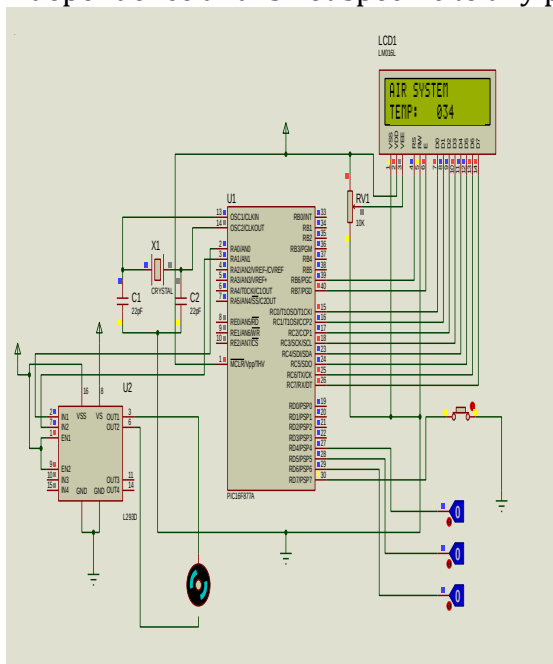


Figure (10): Simulation Result for the System Displaying Temperature value

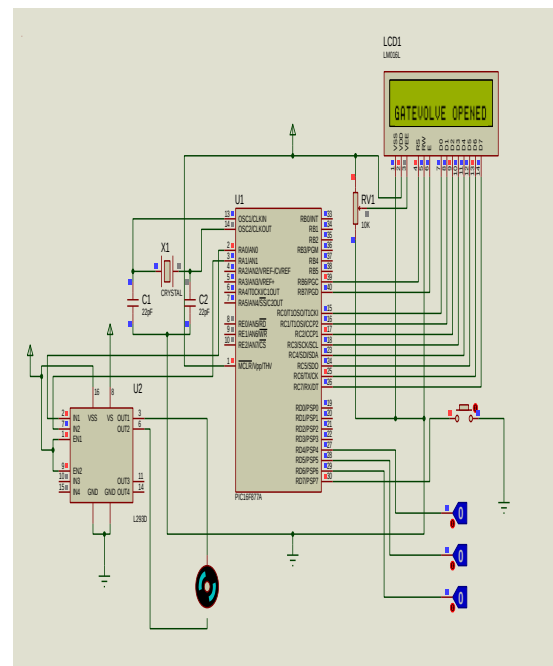


Figure (11): Simulation Result for the System Gate volve opened

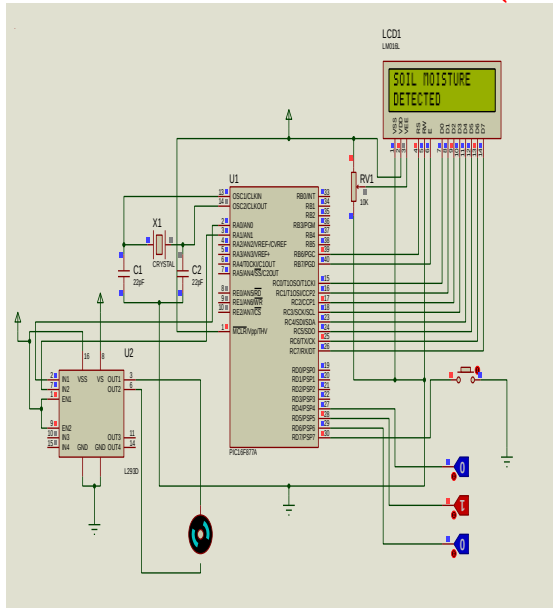


Figure (12): Simulation Result for soil moisture detection

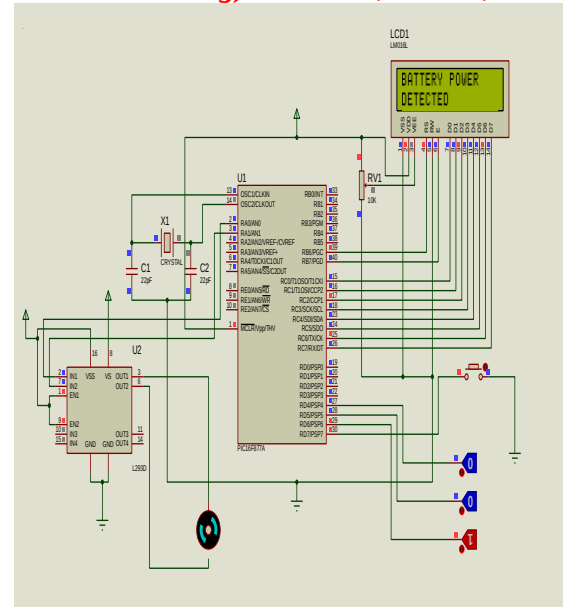


Figure (13): simulation result for battery power detection

4. ADVANTAGES:

- Low cost
- Energy consumption can be minimized
- Feasibility in radiating wireless signals
- High system lifetime

5. APPLICATION:

- Agriculture
- Fuel Industries
- Coal Mine Industries
- Environmental Monitoring in real time
- Monitoring the printing industries

6. CONCLUSION:

The automated irrigation system implemented was found to be 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 automated 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. The irrigation system can be adjusted to a variety of specific crop needs and requires minimum maintenance.

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