Implementation Of GSM Based Irrigation Systems In Nigeria

Okonba Brown .J
Department of Electrical/Electronics Engineering, MOUAU, Abia State
Nigeria

Iroegbu Chibuisi
Department of Electrical/Electronics Engineering, MOUAU, Abia State
Nigeria
elderchibyke29@gmail.com

***Abstract*—Apart from oil, agriculture is Nigeria's second backbone and irrigation is called the lifeline. Irrigation is the method of synthetically providing water to land where crops are cultivated. Prior to the inconsistent atmospheric conditions which vary from place to place in large farm lands, it became very tedious to uniformly and manually irrigate a large farm land at the same time. To meet the demand, a new type of system is needed to regulate the irrigation. Automatic irrigation is a form of irrigation system that incorporates the theory of digital control and feedback system with irrigation. In this system of irrigation, critical information (soil moisture content, humidity, sunlight) is sent to a microcontroller which is provided by sensors which is used by the microcontroller to schedule irrigation by turning on or off a water pump that supplies water to the farmland. The proposed system implemented GSM is used to report the detailed about irrigation.**

Keywords—Agriculture, Irrigation, Nigeria, GSM

1. INTRODUCTION

With the recent advancement of technology, it has become necessary to increase the annual crop production output of our country Nigeria, an entirely agro-centric economy. The ability to conserve the natural resources as well as giving a splendid boost to the production of the crops is one of the main aims of incorporating automatic irrigation system into the agricultural domain of the country. To save farmer's effort, water and time has been the most important consideration [1]. Hence systems need to be designed to provide this ability efficiently using wireless sensor networking, sprinkler irrigation, GSM, SMS technology and readily available mobile phone devices is a certain help to the farmers to get better yield on a large scale and thereby increasing the agricultural wealth and the economic growth of our country.

In this technology, the humidity and temperature of plants are precisely controlled. Irrigation is the science of planning and designing an efficient, low-cost, economic irrigation system tailored to fit natural conditions [2]. By the construction of proper distribution system, the yield of crop may be increased because of controlled water supply.

In this paper we presented a modern approach of irrigation systems based on GSM. These systems are all remotely controlled systems which proposed a low cost information exchange via SMS and GSM network. The soil moisture, humidity and various other environmental factors influencing growth of crops are periodically sensed using high quality accurate sensor and those values are passed on to the processor/controller to calculate required amount of water and fertilizers and various other inputs during irrigation and accordingly supplied to the farm. This leads to a better and a more efficient agricultural development for the future generations to come [3].

2. IRRIGATION SYSTEM

The irrigation system consists of four different sensors which are used to measure various parameters related to the crop production. They are Light Dependent Resistor (LDR), Humidity Sensor, Soil moisture Sensor and temperature Sensor. In general we are using the only a single set of sensors to carry out the operation of this irrigation system. But in the case of crops, the whole crop area is divided into sections and each section can be provided with its own set of sensors [4]. The Light dependent resistor is a type of resistor whose resistor ranges about a few kilo Ohms during the presence of light and about a Mega Ohm during the absence of light. The LDR is used to determine the intensity of light or the time of the day. This helps the system to regulate the irrigation from time to time. The Soil moisture sensor is used to determine the moisture content present in the soil. This information is given to the microcontroller in terms of resistance. The best of determining the soil moisture is by using the electrodes. The resistance and the soil moisture are inversely proportional to each other [5]. So with the increase in soil moisture there is a decrease in the resistance between the electrodes and vice versa. The Humidity sensor is used to determine the amount of humidity present at the crop level. The humidity sensor used in the design is a module which is the combination of a humidity sensor and temperature sensor. The humidity sensor measures the percentage of relative humidity in the air. During summer season the crops lose moisture content from the leaf which is converted into water vapor that goes up in the air resulting in the drying of leaves and

withering. In order to resolve this problem a humidity sensor is placed at crop level. When the moisture in the leaves is converted into vapor, the humidity sensor is triggered because of the increase in the humidity level and the microcontroller sends out a signal to activate the sprinkler system. The temperature sensor is used to determine the occurrence of the fires in the crop area [6]. When the fire occurs the temperature sensor is activated. Then the microcontroller drives the sprinkler system via relay. Figure 1 is the block diagram of the system.

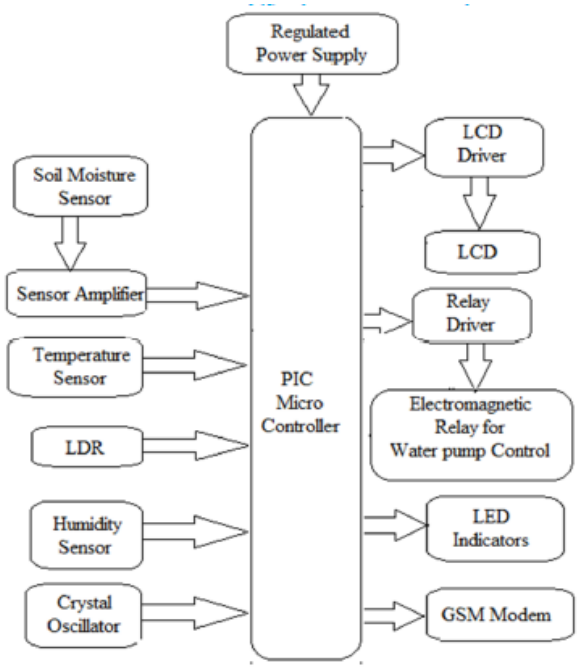

Figure 1: Block diagram of GSM based irrigation system [7]

(1) Power Supply
(a) Step down transformer: The design uses a centre tap transformer that converts 230V from AC mains into 15V AC and gives - 15V, 0V, 15V and 0.5 ampere. Transformer selection is based on the fact that regulator ICs require around 14v as input considering dropout voltage (around 2v), in order to obtain 12v power supply. The transformer steps down ac voltage from 230v ac to 15v AC. It is then given to bridge rectifier. Bridge rectifier converts the AC voltage into pulsating DC. It is then given to regulator IC which gives a constant dc voltage. These voltages are given to other ICs as VCC or reference.
(b) Bridge Rectifier: Rectifier converts ac voltage into dc voltage. In the rectifier four diodes are connected in the form bridge along with a capacitive filter to generate the DC signal. Its input is from transformer and output is given to the voltage regulator IC.
(c) Voltage regulator: The Voltage regulator IC gives constant DC voltage at output in spite of fluctuations in input. The design uses IC 7805 as the voltage regulator. It gives an output of 5V DC.
(2) Microcontroller
The design uses PIC16F877A microcontroller. PIC16F877A is a family of modified Harvard Architecture microcontroller made by Microchip Technology. This is powerful microcontroller with nanosecond instruction execution and easily programmable with only 35 single word instructions. The entire automation of the system is done by this microcontroller. It has an inbuilt Analog to Digital converter. Because of this we do not require any ADC to be connected externally.

(3) Soil Moisture Sensor
The commonly used soil moisture sensors are the electrodes or steel probes. In the design we are using the normal wires as electrodes. The soil moisture sensor follows the basic principle of a megger. The principle is that the moisture content in the soil is inversely proportional to the earth resistance. So the decrease in soil moisture results in the increase in earth resistance. This information is used by the microcontroller to drive the relay connected to the irrigation motor.
(4) Light Dependent Resistor (LDR)
The design uses NSL19-M51 Light dependent resistor. In the night the resistance is very high and up to 1MΩ but in the day time the resistance drops to a few ohms depending on the light intensity. So depending on the output resistance, the light intensity or the time of the day is determined. This helps us in generating the conditions
(5) Temperature Sensor
The design uses LM35 temperature sensor. It is a precision integrated-circuit with an output voltage linearly-proportional to the Centigrade temperature. It can determine the temperatures over a range of −55°C to 150°C.It does not require any external calibration or trimming to provide typical accuracies. Here the temperature sensor is used to determine the fire accidents in crops.
If there is a fire accident, the microcontroller drives the relay connected to the sprinkler system to put off the fire. For the sake of safety a message is sent to the farmer with the help of GSM Modem. The output voltage of temperature sensor rises at a rate of 10mV/°C. The output voltage ranges between 6V and -1V.
(6) Humidity Sensor
The design uses HMTC1A2 Humidity sensor module. It comprises of HSS1101 Humidity sensor and LM35 Temperature sensor.
It has the characteristics of stable, high accuracy, quick response and good crossing-over. In the design humidity sensor is used to check the humidity in the air around the crops. The increase in humidity is because of evaporation of water from the leaves which results in withering of the leaves. So the increase in humidity is checked and the sprinklers are activated to attain the moisture on the crops. The reason for the usage of temperature sensor

separately is because this model cannot determine the temperatures beyond 50°C.

(7) Light Emitting Diode (LED)

It indicates the need of sprinkler and water supply. When LED is on, that means sprinkler or water supply should be on. If it is off there is no need of water.

(8) Pump and Relay Unit

The relay unit is designed in such a way that when a control signal is obtained from the microcontroller, the acts as a switch that turns ON/OFF the pump connected in the output. The relay unit consists of a BC547 transistor, 5 pin 12V relay and 1N4007 p-n junction diode. The transistor is connector in Common emitter configuration where the collector is connected to the 12V supply and the emitter is grounded. When the supply is given to the base of the transistor, it turns ON the relay and when the supply is cut off, the relay is cut off. The diode is added in the circuit to provide the protection of the circuit from back EMFs.

(9) Liquid Crystal Display (LCD)

The LCD will display the alphabets, numbers, characters and symbols. The LCD used here is eight bit parallel type and the display size is 16x2. Liquid Crystal Display is used for displaying the sunlight, humidity, temperature and soil moisture values. LCD consists of three control pins and eight data pins. Based on the commands given to the control pins, data i.e the parameter values are written simultaneously to the LCD. The four data pins D4 to D7 of the LCD are connected to the PORTB pins RB0 to RB3 while the remaining data pins are grounded. Two control pins RS and E are connected to PORTB pins while the RW is grounded. RB4 and RB5 are used for register select (RS) and enable (E) respectively. Initially the display is shows four parameters names along with their values. The parameter values to be displayed are sent to the LCD simultaneously. LCD accepts only the ASCII values as input. Hence the hexadecimal values are converted into ASCII values and it is fed to the LCD to display the temperature.VCC and VSS are provided with 5V and ground respectively. VEE used for controlling LCD contrast was grounded so as to have a standard contrast.

(10) Sensor Interfacing

The PIC microcontroller consists of inbuilt analog to digital converter. The PORTA is configured as the analog input channels. The outputs of the sensors are fed to the RA0 to RA3 pins of the PIC microcontroller. The inbuilt ADC of the PIC microcontroller converts the analog signal from the sensors in digital signals. The digital outputs thus converted are made available for the further process. The LDR is connected to the RA0 pin, the Temperature sensor for the RA1 pin, the Humidity sensor to the RA2 pin and finally the Soil moisture sensor probes are connected to **the RA3 pin.**

3. CIRCUIT DIAGRAM OF THE SYSTEM

Figure 2 below is the complete circuit diagram of the system

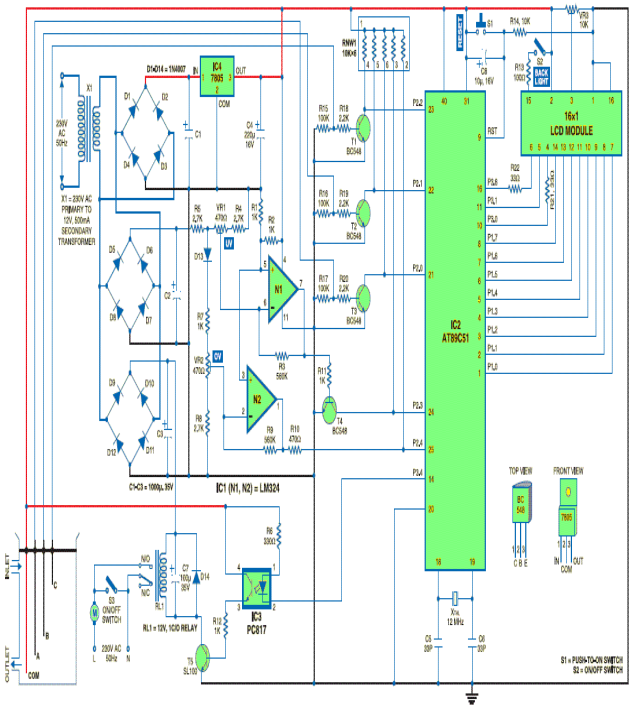

Figure 2: A complete circuit diagram of the system

4. OPERATION OF THE SYSTEM

The connections between the two mobiles are done using GSM. The GSM module and microcontroller are connected using UART (universal asynchronous receiver / transmitter). When the moisture sensor senses the low moisture content of the soil, 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 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.

5. CONCLUSION

Automatic irrigation of agricultural field offers a potential solution to support site- specific irrigation management that allows producers to maximize their productivity while saving the water. Water is allowed to the field of crops depending upon the particular season. By knowing the status of moisture and temperature through GSM with the use of moisture and temperature sensors, water flow can be controlled by just sending a message from our mobile. This system avoids over irrigation, under

irrigation, top soil erosion and reduce the wastage of water. This leads to a better and a more efficient agricultural development for the future generations to come.

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AUTHORS

Okonba Brown .J received his B.Eng. degree in Electrical and Electronics Engineering from University of Portharcourt, Rivers State Nigeria in 2002, and currently doing a Master of Engineering degree in Electronics and Communication Engineering, Michael Okpara University of Agriculture, (MOUAU) Umudike, Abia State Nigeria. He is a member of Nigerian Society Engineers. His research interests are in the fields of, Electronic and Communication Systems design, Security system design, Network design etc.

Iroegbu Chibuisi is a scholar in the department of Electrical and Electronics Engineering (Electronics and Communication option), Michael Okpara University of Agriculture, (MOUAU) Umudike, Abia State Nigeria. He holds a Bachelor degree (B.Eng) and Master's degree (M.Eng) in Electrical/Electronics Engineering (Electronics and Communication option). Iroegbu Chibuisi is also a member of International Association of Engineers. His research interests are in the fields of Radar systems, wireless sensor networks, Electronic and Communication Systems design and modeling, Security system design, Expert systems and Artificial Intelligence, Design of Microcontroller based systems, Channel coding, fading channels, interference management etc.