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Design and implementation of a programmable remote controlled and monitored irrigation system

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Abstract: **-** Irrigation is the process of artificially supplying water to land where crops are cultivated. Considering the characteristic and methods of irrigation in Sudan, this paper brings forward new programmable device for remote control and monitoring of irrigation system. Three levels are included in the system: the microcontroller for information processing using atmega32 with a control program for real time measurement and control , GSM unit to provide wireless communication via cell phones for monitoring of field parameters and control requirement, with the aid of sensors (temperature, moisture and humidity sensors). RF transmitter is used to collect and transmit data from field to the controller which includes RF receiver. The System operates in three modes: the first one is for closed field (green houses) where the weather parameters must be set according to the plant requirement via system keypad for automatic control of irrigation process. The second mode is used in case of regular irrigation where the plant is to be irrigated in regular intervals ,while the third mode is for the case where the plant is to be irrigated in irregular intervals. The system has also the ability to operate as a weather station through the explanation mode provided with the system. In this mode the user can feed the system with the weather parameters(temperature ,humidity, dew point and rainfall) ,then the user will receive a real time feedback SMS explaining the condition.

Keywords: **-** Microcontroller, automated irrigation, RF, GSM, real time system, sensors

I. INTRODUCTION

Agriculture is a source of livelihood of majority Sudanese and has great impact on the economy of the country. In dry areas or in case of inadequate rainfall, irrigation becomes difficult. So, it needs to be automated and handled remotely for farmer safety and high productivity through adaptive control of irrigation using economic method .The technique of GSM and microcontroller systems will be used here .The system is designed to operate in three modes as below:

The first one is a pre-programmed mode used for closed field (Green house) where the farmer is asked to enter the essential weather parameters according to irrigated plant and the amount of plant moisture level required (temperature, humidity, plant moisture). These parameters are saved and used to automate the system running. The system always feed the farmers with the action **t**aken to adapt the field environment through SMS with the ability to cancel any action taken by the system through feedback SMS from farmer.

In the second mode the system is operated in irregular irrigation for open field, it is difficult to control the weather parameters here, so the system here can only control the irrigation.It also stops the system and solve the problem of excessive water in case of rains through discharging pumps. This is done by the ability to be in contact with farmer through sending SMS to inform him about the field irrigation state, or receiving SMS from farmer for control or explanation requirements.

The third mode is the explanation and monitoring mode, where the farmer can feed the system remotely with the weather parameters through the SMS technique, to receive a real time measurement of the field parameters temperature, humidity, dew point and rains existence.

II. APPROCH

The Block diagram of the programmable remote irrigation Control system, is shown in Figure(1) .It includes the use full component and the links which exist between them. Here the Mobile phone is connected to a GSM via wireless network then to the microcontroller.Hence the system provides the real time transmitting and receiving of data. The microcontroller used here is atmega32.

The microcontroller responds according to the input data. The program written performs control over the irrigation system. It is also connected with the wireless transceiver to communicate with the sensor nodes at the field. The output of the microcontroller is then used to control the relays through a relay driver ULN 2003 for valves and pumps control. The system is connected to a keyboard for setting the control parameters . LCD is

used to display the data entry .,The crystal oscillator is to provide the system with the real time clock for regular irrigation control .

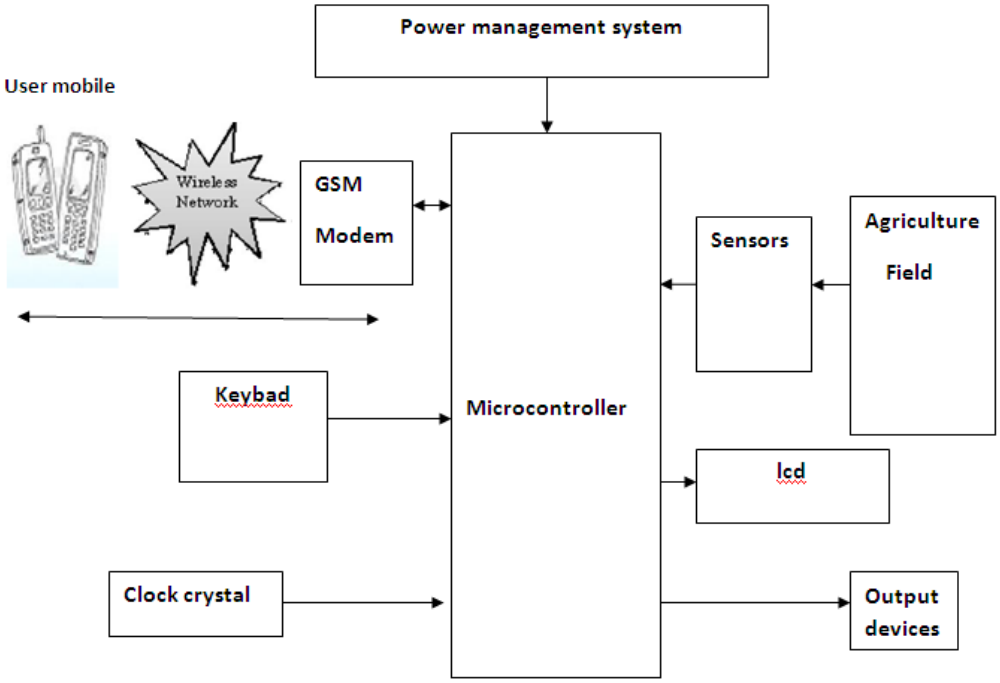


Figure -1 Block diagram of the system

The devices in the system are :

1. GSM mode module:

GSM stand for global system for mobile communication. GSM networks operate in four different frequency ranges. Most GSM networks operate in the 900 MHz or1800 MHz .The subscriber has the advantage to communicate from everywhere and to be called in any area served by the GSM cellular network using the same assigned telephone number. This mobility feature is preferred by many business people who constantly need to be in touch.

The MODEM is used to generate, transmit or decode data from a cellular network, for establishing communication between the cellular network and the microcontroller. 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 microcontroller through AT commands.

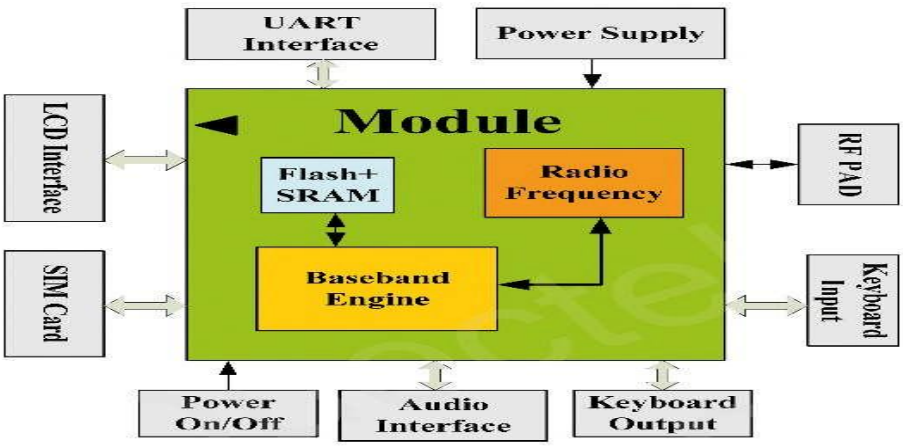


figure (2) GSM modem module

2. Temperature sensor :

The two main types of semiconductor temperature sensors are temperature sensitive voltage sources and temperature-sensitive current sources. An example of the first type is the National LM35 which is used here for temperature measurement. The voltage output from this circuit increases by 10 mV for each degree centigrade temperature increase. If the output is connected to a negative reference voltage Vs, the sensor will give a meaningful output for temperature range of -55 to +150 degree centigrade. The output is adjusted to 0V for 0 degree centigrade. The output voltage can be amplified to give the voltage range we need for a particular application. The accuracy of this device is about 1 degree centigrade.

3. Humidity sensor:

Humidity measurement instruments usually rely on measurements of some other quantity such as temperature, pressure, mass or a mechanical or electrical change in a substance as moisture is absorbed. By calibration and calculation, these measured quantities can lead to a Measurement of humidity. DHT11 is the humidity sensor used in this research. .

4. Soil moisture sensor:

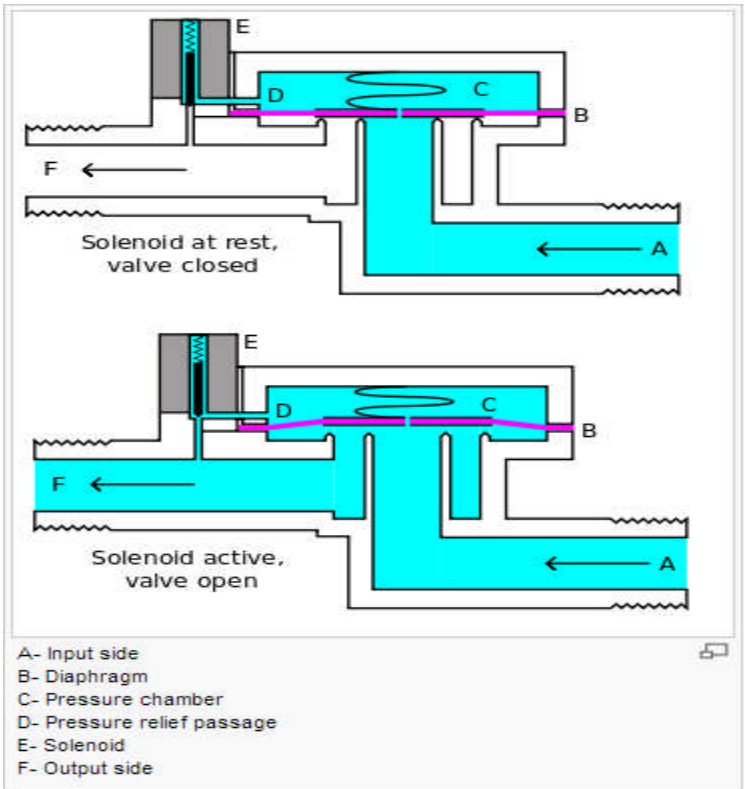
The Moisture sensor is the resistive type of sensor which senses the change of resistivity between the probes and accordingly gives the output. Soil moisture probes can be permanently installed at representative points in an agricultural field to provide repeated moisture readings over time that can be used for irrigation management. Special care is needed when using soil moisture devices in coarse soils. The sensor used in this research is the ECH2O (EC-5) Dielectric Aqua meter sensors for measuring soil water content. These innovative sensors enable to measure soil moisture accurately and with suitable calibration equation for all types of soils. The sensor contact with soil is Shown in figure(3) below:

Figure (3) EC-5 soil moisture sensor in the soil

5. solenoid valve:

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. Here, 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[1].

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 microcontroller using ULN2803 current driver. 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.



Figure(4)solenoid valve

III. SOFTWARE IMPLEMENTATION

There are two parts in the software design, one for the main controller circuit (atmega32) which is connected to the temperature sensor, humidity sensor ,relays as well as RF receiver ,while the other is for the moisture sensor that is connected to atmega8 and transmit plant moisture data to the main controller via RF transmitter .The software package used here is BASCOM.

BASCOM is an Integrated Development Environment (IDE) that supports the 8051 family of microcontrollers and some derivatives as well as Atmel's AVR microcontrollers. Two products are available for the various microcontrollers - BASCOM-8051 and BASCOM-AVR. In a microcontroller project one needs to know the hardware base, i.e. the microcontroller with internal and connected peripherals, and the software used.It contains the 8051 assembler and AX51 cross compiler. It operates under basic and assembly languages and it has a very powerful set of instructions and containing a useful simulation capability. The programming language used is BASCOM:

IV. ALGORITHM

The proposed computer algorithm includes a sequence of steps for the operation of the system .The algorithm is ;

Start
--- Put the system in the initial state.
- Clear all controlled devices .
--- Check the incoming mobile message dial no. for authorization.
- If authorized , continue processing.
- If not authorized , deny access and wait for a mobile message.
Analyze:
--- Analyze the incoming SMS.
--- If the code is equal to (D) , then activate the air conditioner .
--- If the code is equal to (E) , then close the air conditioner .
--- If the code is equal to (F) , then activate the sprayer .
--- If the code is equal to (G) , then close the sprayer .
--- If the code is equal to (H) , then activate the pump .
--- If the code is equal to (J) , then close the pump .

--- If the code is equal to (R) , then activate the fan .
--- If the code is equal to (S) , then close the fan .
--- If the code is equal to (T) , then activate the discharge pump .
--- If the code is equal to (U) , then close the discharge pump .
--- If the code is equal to (X) , then end the program .
--- Goto nalyze
End.

V. RESULTS

Following are the results from implementing the proposed system design.

Table 1 System commands and their correspondent action on the devices

SMS number	SMS	Result
1	D	Air condition ON
2	E	Air condition OFf
3	F	SPrayer ON
4	G	Sprayer OFF
5	H	Pump ON
6	J	Pump OFF
7	R	Fan ON
8	S	Fan OFF
9	T	Discharge pump ON
10	U	Discharge pump OFF
11	X	End the system operation

VI. CONCLUSION

The design of a programmable GSM- based remote monitoring and control of Automatic irrigation system is achieved. Any cell phone can send order to the controllers or browse the information from the controllers through the explanation mode using SMS. GSM network and radio provides credible communication for the devices. The system has successfully overcome quite a few shortcomings of the existing systems by reducing the power consumption, maintenance and complexity, at the same time providing a flexible and precise form of maintaining the environment, as well as using the existing wireless communication technology. The system provides the ability to remotely control all irrigation methodologies used in Sudan(drip irrigation, pump irrigation ,flood irrigation) . programmed values can be entered via the keypad .

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