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Design and Implementation of Solar Powered Smart Irrigation System using Arduino Uno

Oleka, Chioma Violet, Ozor Godwin Odozo
Department of Computer Engineering, Faculty of Engineering, Enugu State University of Science and Technology (ESUT) Enugu, Nigeria

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ABSTRACT:
The proposed system comprised of an Arduino, moisture sensors, submersible water pump, GSM module, relay mechanism, solar module and 12V battery. The moisture sensor senses the condition of dryness of soil at places on the field and then feeds the signal to Arduino system. The arduino then takes the inputs from the sensors and used the pre-processed value to decide whether water should be supplied to the farmland or not. This system will continue to take the inputs from the sensor until there is sufficient amount of moisture in the soil and then it will automatically turn the pump off. This irrigation system will reduce the water supply deficiency of farmer to their farmlands, save the time and enhance accuracy and effectiveness with relatively minimal cost. The system uses a GSM module SIM900 to communicate with the farm owner via SMS. It is highly an automated system that ensures the farmland is appropriately irrigated; and it keeps the farm owner updated through SMS. The system is solar powered; which means the operation cannot be hindered by power availability,
Keywords: Arduino, irrigation, moisture, sensor, soil, solar, battery

I. INTRODUCTION:

Solar-powered smart/intelligent irrigation system is an intelligent computer aided electronic device which will be used to water the crops in a farmland automatically without the interference of human operator(s). The project as the name suggests is an irrigation system whose source of energy powering system is renewable (solar energy). This means that the project is independent of the general grid power (NEPA) which is quite unreliable. Being a smart device, it is capable of communicating with the farmer(s) through GSM communication network which is controlled via an embedded system programming.The intelligence of this project is taking care of by a microcontroller IC (integrated Circuit) which stores the embedded system programming instructions in its memory. The integration of SMS communication feature in this project helps to ensure the farmer is able to interact with the device via messaging. This simply means that the device can send and receive an SMS to and from the farmer. As such, the farmer can be able to know when the system is irrigating the farmland, when the irrigation process has completed, and when there is no water available for irrigation process to take place.The aim of this study is to design and implement a solar powered irrigation system using arduinouno. Its objectives is to construct a solar panel irrigation system, development of the control system using arduinouno and integration of GSM module to reach the farmer remotely.

II. REVIEW OF RELATED LITERATURE:

Marcela Pírková*, SimonaFialová and MarekBalko (2024) worked on Smart Irrigation System stating that most irrigation systems are built to irrigate field crops in agriculture. However, it has been observed that a sufficient irrigation dose should also be supplied to urban greenery. The areas of interest are prerequisites for reconstruction in the coming years. Therefore, an area in Brno, which the people of Brno call Špitálka, is chosen for the proposal. There are old buildings belonging to the Teplárny Brno (Brno's heating plant). The irrigation system is designed with the validity of known equations describing the hydromechanics of fluids. An experimental model of the selected part is made to confirm the functionality of the design. It is not within the spatial possibilities of the laboratory to build the entire extensive pipe network. The experimental measurement involves pumping the medium into a tank, which is a storage

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tank stored in an old cooling tower. This mentioned tower finds application as a multifunctional reservoir when one of its functions is water accumulation. A section with water transport to the highest point is chosen for the experimental track. It represents green roofs, which are also a part of irrigation, as there is often not enough watering in the form of precipitation in the summer months however they fail to use GSM modules in the work.Archana and Priya (2016) proposed a paper in which the humidity and soil moisture sensors are placed in the root zone of the plant. Based on the sensed values the microcontroller is used to control the supply of water to the field. This system doesnot intimate the farmer about the field status (Smajstrla, & KOO, 1986). SonaliD.Gainwar and Dinesh V. Rojatkar (2015) proposed a paper in which soil parameters such as pH, humidity, moisture and temperature are measured for getting high yield from soil. This system is fully automated which turns the motor pump ON/OFF as per the level of moisture in the soil. The current field status is not intimated to the farmer(Clemens, 1990).V. R. Balaji and M. Sudha (2016) proposed a paper in which the system derives power from sunlight though photo-voltaic cells .This system doesnot depend on electricity. The soil moisture sensor has been used and based on the sensed values PIC microcontroller is used to ON/OFF the motor pump. Weather forecasting is not included in this system (Kenzie, 1995). G.Parameswaran and K.Sivaprasath (2016) proposed a smart drip irrigation system using IOT in which humidity, temperature and pH sensors are used. Irrigation status is updated to the server or local host using personal computer.After reviewing what already existed, it was observed that various researchers and designers have done great work in trying to make an automatic irrigation system. Some used the basin irrigation system design, some used the furrow system of irrigation technology, and some used border irrigation system, while some used the surface irrigation technology and so on. All these technologies are good but none could report the status of the system using a remote SMS system. The system proposed in this paper is fully functional with low cost. It contains an SMS system which is used to report vital information to the farm owner for further improvements.

III. MATERIALS AND METHODS:

The proposed solar-powered intelligent (smart) irrigation system is based on microcontroller, moisture sensor, brushless water pump, Relay and GSM. The power supply system for this project is solar module and battery.The project uses a microcontroller (Arduino, ATmega328P). It has 14 digital input/output pins (of which 5 can be used as PWM outputs), 6 analog inputs, 2 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Arduino UNO. The proposed system uses Soil moisture sensor (MH-Sensor) to measure the water content in soil. The proposed system also uses a wireless system (GSM, SIM900A). The GPRS module is a breakout board and minimum system of SIM900 Quad-band/SIM900A Dual-band GSM/GPRS module. It can communicate with controllers via AT commands (GSM 07.07 ,07.05 and SIMCOM enhanced AT Commands). This module supports software power on and reset.One-channel relay which operates on 12V is also used. The relay consists of three pins which are normally open (NO), normally closed (NC) and common (C). The common pin is connected to NC pin when the relay is off and to the NO pin when the relay is on. The input pin receives logic high from Arduino Uno and in turn switches on the relay, thus common are connected to NO which turns the device on till the relay is on. The “VCC”and “GND” pins of the relay are connected to 5V supply and ground respectively.In this work, solar module is the main source of electricity for the design. This pattern was adopted because of high rate of power outage in Nigeria and obvious unavailability of electricity supply to various farmlands in many parts of the world.

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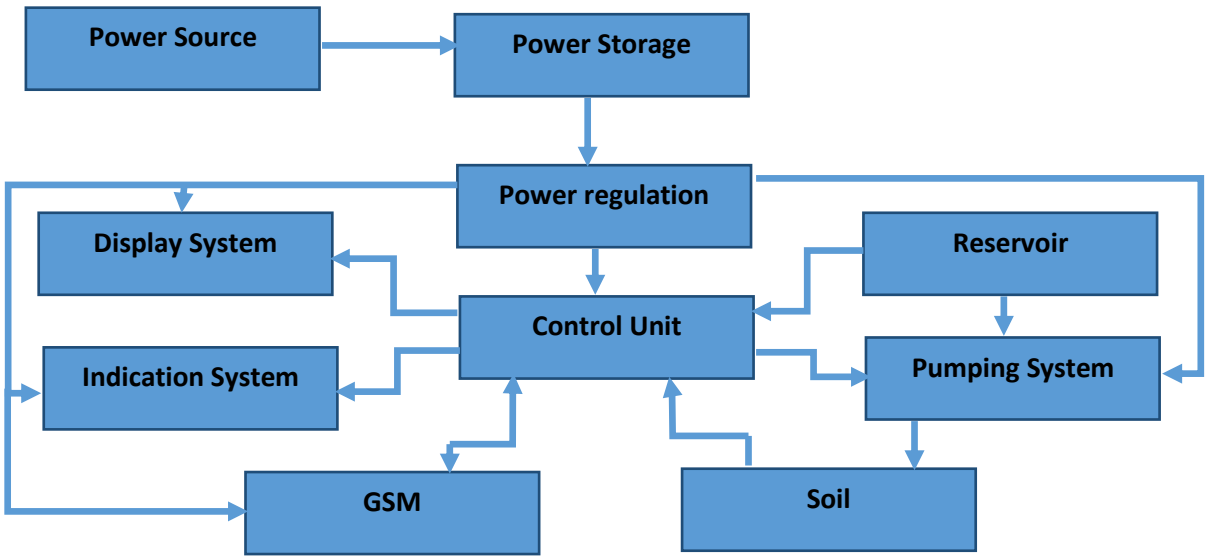

Fig.3.1: Block diagram of the system

This operation starts with the power sources block which supplies energy into the power storage block. The power storage block sends the stored energy into the power regulation block. The work of the power regulation block is to provide a regulated supply energy value that will not harm the control unit of the project and other components of the project that work together with the control unit such as the pumping system, the display system, the indication system and the GSM.

When the control unit receives energy from the power regulation unit, it begins to communicate with the reservoir, the soil, and the GSM system so as to use the status of the communication obtained to determine whether to turn on/off the pumping system and also displays the effect of such action to the display and indication systems respectively. Now, if the report from the soil block which contains a soil moisture sensing component shows that the soil is getting dry, the control unit reads the volume of water in the reservoir to ensure there is enough water for the irrigation process to take place. If water is available for irrigation, then it then triggers the pumping system to start irrigating the planted crops in the soil by watering the farmland. At this time, the controller displays the pumping system operation on the display unit and equally sends an SMS to the farmer regarding this effect.

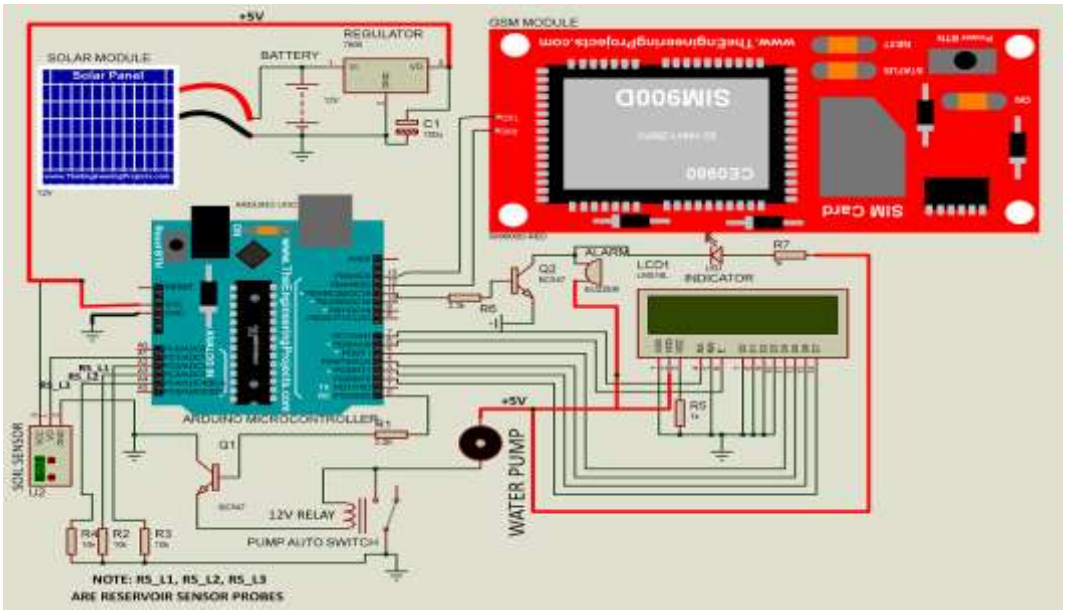

Fig.3.2: Complete circuit diagram of the system

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The working principles of this project are that; when the solar energy is supplied to the battery, the battery sends the stored energy to the regulator which regulates the battery voltage down to 5V. The 5V supplies the entire circuit. And when this happens, the soil sensor module begins to fetch the water content(s) of the soil. As this is happening, the Arduino microcontroller begins to calculate the detected sensor value which is used to determine whether to water the farmland or not. If the report from the soil sensor shows that the farmland is not moisturized, the Arduino microcontroller will read the reservoir through the pins labeled **Rs_L1, Rs_L2, and Rs_L3** to ensure there is water for irrigation to take effect. If there is, the Arduino will instruct the relay to reconnect ground signal to the water pump and this will start irrigation immediately, when the irrigation system is watering the farm land the GSM Module sends an SMS to the farm owner for confirmation of the functionalities of the system. Again, if there is no water in the reservoir, the GSM module also sends an SMS to the farm owner too.

IV. RESULTS AND DISCUSSIONS:

The system was tested for black and red soil under the dry and wet conditions. Using these results, the dryness of the soil is when the ADC reading of the Arduino senses values between zero (0) and 99 and the wetness is when it senses value in the range of 100 and above.Maximum value is taken as 1023 since the soil moisture sensor can measure value up to this. So, if the measured value by the sensor is between 0 and 99 the motor will turn on automatically and initiates supply of water to the crops. However, if the measured value is greater than or equal to 100 (ADC_value>=100), it implies that the soil is wet and hence the motor turns off and remains so until the value drops below 100 again. When the pump turns off, water stops supplying to the crops.The solar-powered GSM automated irrigation system was successfully developed and connected. The developed system consists of a microcontroller, an irrigation pump, a moisture content sensor, GSM module and solar module. Fixed over the irrigation system prototype, the area of study was 1.44 square meters which was irrigated sufficiently to meet the crop water requirements of farmland. Figure (4.1) show the developed automated irrigation system circuit.

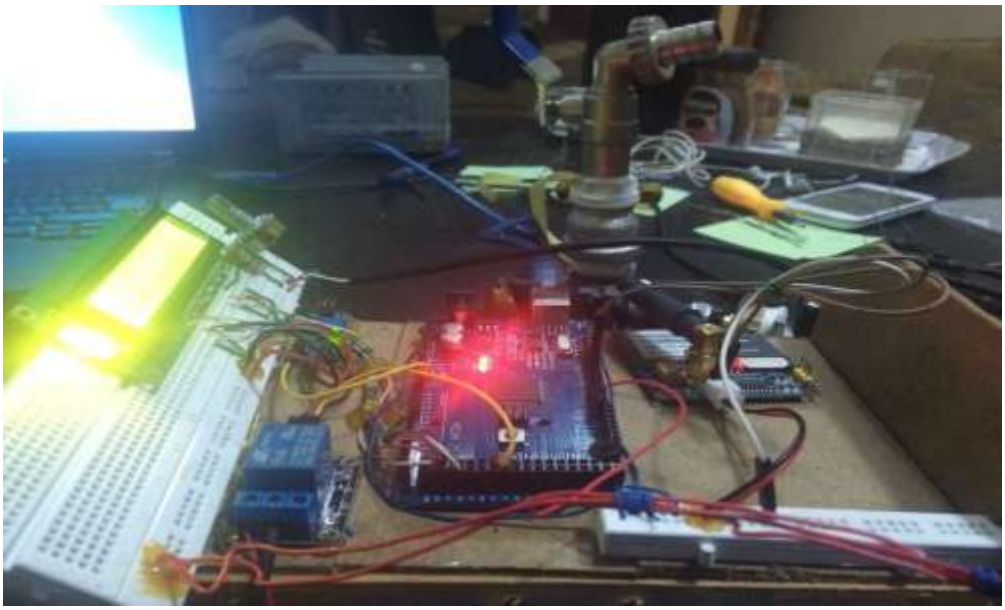

Figure 4.1 wireless automated instrumentation system circuit

The Program was tested and found running. Allowing the required amount of water to pass in its specific time. Also, the monitoring of soil moisture was tested and found to be efficient.

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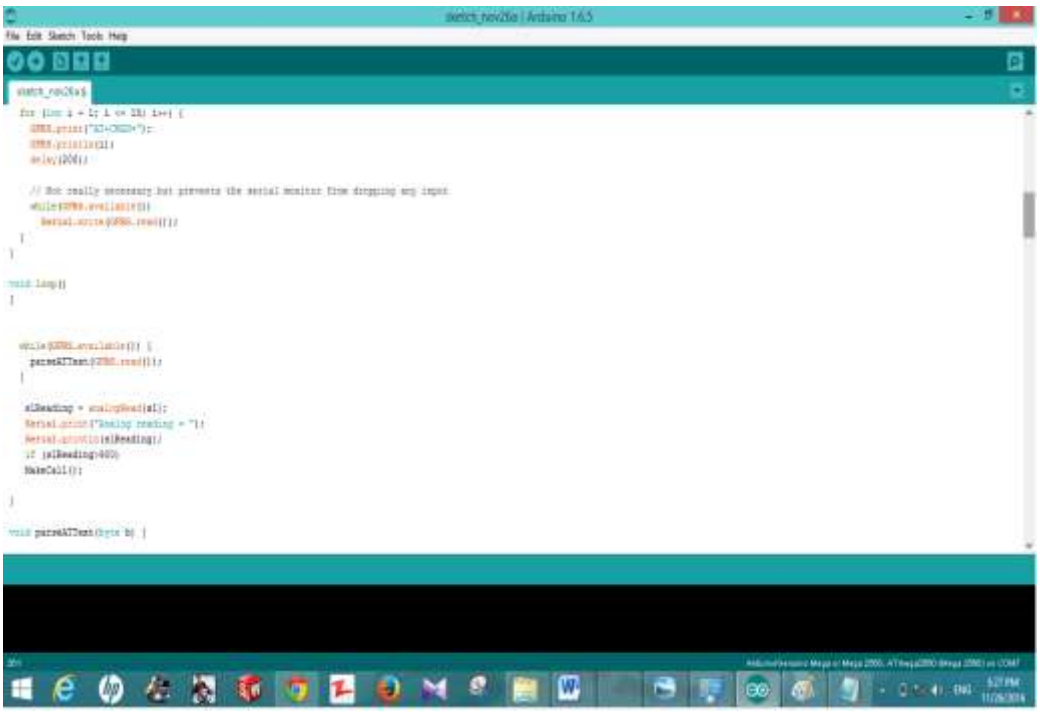

Fig.4.2: Software Development of the System

V. CONCLUSION AND RECOMMENDATIONS:

After proper testing of the developed device, the following conclusions are drawn from the obtained results:First, the solar powered GSM based smart irrigation system was successfully designed and developed. The reservoir sensor works very fine as it was able to notify the farmer through short message services (SMS) regarding water shortage for the irrigation process.Secondly, the soil moisture sensor reports the soil condition accurately and the microcontroller responds swiftly to report.Finally, the existing system that was reviewed in this research proves to be functional with significance drawback which this project has addressed. In the existing system, the reservoir water levels were not monitored and this often led to the damaging of the water pumps. In this project, the issue of inordinate water pump burning due to empty reservoir has been dealt with. The system developed here can monitor the reservoir and stop the pump immediately the level is lower than the pump sucking level. Also, the inclusion of solar energy in this project made it completely outstanding because it ensures irrigation process takes place anytime the soil is dry and water is in the reservoir. In the reviewed works, they depend on grid power for operation which means the irrigation process cannot take place when the grid power fails. The researcher hereby recommends an integration of artificial intelligence to the system by next researcher.

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