Abstract—Over the years, a lot of irrigation systems have been developed to aid crop farming but most of them are manually operated. The few automatic irrigation systems available in the country are very expensive and therefore not easily available to the peasant farmers. The need for improved non-seasonal crop farming gave rise to this research work on a low cost irrigation system made from locally sourced components. The system designed in this work makes use of a locally made soil humidity sensor to check the water level in the soil. If the water level is below the required level, the irrigation system is turned on by sending a signal to the relay connected to the pump which opens the valve to let water out. Once the required humidity is obtained, it is turned off through a similar mechanism. The control also has six buttons for time-based control of irrigation for crops that demand irrigation at specific times of the day. With a system like this, non-seasonal farming is ensured thus increasing food supply and reducing hunger.

Index Terms—Automatic Irrigation; Humidity Sensor; Farming.

I. INTRODUCTION

Agriculture is a very important part of human existence. It is not only the source of food for a nation; it is also a major source of revenue generation. Crop production is a very important aspect of agriculture. Greater percentage of what we consume as humans are crops. There is need therefore for non-seasonal crop production to ensure all year round availability of seasonal crops. This can only be possible if all year round availability of water is ensured. Africans depend mostly on rainfall as the major source of water for crop production. Crop production is not only affected by the total amount of rainfall in a particular season, but also by the frequency, duration and severity of water stress in the plants at different stages of growth. This dependency on rainwater places limitation on potentials of crop farming to feed world population. Again the current climate change has adversely affected crop production as some crop producing regions of the world are experiencing drought while some other regions are faced with flooding. To effectively address these challenges, irrigation is necessary.

However, irrigation in developing nations like Nigeria comes with the challenge of manually pumping water from reservoir to the farm land making it labor intensive. Some of the existing ones making use of electric pump that still require manual control of the pump operation. This process comes with the challenges of water wastage and delay due to human factors. Automatic irrigation system was introduced to take care of these and other challenges faced by farmers in irrigating their farms. Prisilla et al [1] proposed a model of variable rate automatic microcontroller based irrigation system. Solar power was used as the only source of power to control the overall system. They made use of sensors that sense the soil water level in a paddy field. The water level is then sent to the farmer who controls the irrigation system using a cellular phone. The irrigation system automatically starts without confirmation from the farmer if the water level reaches what they termed “the danger level”. This system has the advantage of remote operation and a more reliable power supply if used in tropical regions but it is very expensive. The work, in [2] talked about an automatic water irrigation and drainage system designed to increase the yield production of rice and improve water use efficiency. The system made use of water level sensors placed in a rice field which continuously measure the soil water level. The system automatically irrigates the farm through the entrance gate when the water level is lower than the desired level. The entrance gate closes after the water level reaches the desired level. When the water level in the rice field is higher than the desired level, the system either opens the exit gate if the drain is empty, or switches on the pump if the drain is full of water. Some of the existing irrigation systems are not fully automated while some do not have a means of checking the soil moisture content and as such the farm may suffer from dryness or the challenges of excess water supply. Most of the automatic irrigation systems used by farmers in developing countries are imported and very expensive and as such only very few farmers can afford them. It is a well-known fact that food supply in most developing nations come from the peasant farmers who cannot afford these imported irrigation systems. Thus the need for a Low Cost Indigenous Automatic Irrigation System as proposed in this work.

II. DESIGN OF THE PROPOSED SYSTEM

The design of the proposed system is grouped into the hardware design and the software design.

A. Hardware Design

The hardware part of the control system consists of seven sub-systems as shown in Fig.1.

1) Power Supply Module

The power supply unit converts the 220V AC mains supply to 5V DC required by the circuit components. The 240V/50Hz input is supplied into the transformer. The transformer steps down the AC voltage to 15volts and then passes it to the bridge diode that rectifies it to a DC voltage. Smoothening of the dc voltage is carried out by the capacitor. The 7805 voltage regulator regulates the voltage outputs to get a +5V DC as the input voltages into the system. This unit provides the power needed for the

Published on March 18, 2019.
Authors are with the Electrical/Electronic Engineering Department, University of Port Harcourt, Nigeria.
operations of the other parts of the system.

![Block diagram of the proposed system](image)

**Fig. 1. Block diagram of the proposed system**

2) **Input Module**

The input unit of the system consists of the humidity sensor module and the input buttons. The system has six input buttons designed to select six different hours of irrigation. The soil humidity sensor is a module that gives output of “HIGH” when the soil moisture content is high and LOW when soil moisture content is low. The output of the sensor is sent to the microcontroller. The soil humidity module senses the soil moisture content and alerts the controller once it is below the required level. It is made from locally sourced materials.

3) **Timer Module**

This unit consists of the DS1307 serial real-time clock (RTC) which is a low power, full binary-coded decimal (BCD) clock having 56 bytes of NV SRAM. Address and Data are transferred serially through an I2C bi-directional bus. The clock provides seconds, minutes, hour and date information. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power-sense circuit that detects power failures and automatically switches to the backup CMOS supply. This helps in ensuring the continuation of timing operations even in the event of a power failure from the external power supply. The DS1307 uses an external 32.5 kHz crystal. The oscillator circuit does not require any external resistors or capacitors to operate. This unit is used by the control unit to keep time for the entire system operation. The control queries the timer unit and receives back the time at that moment.

4) **Display**

This unit consists of HD 44780 based LCD. It is a general purpose alphanumeric LCD with two lines and 16 characters. It has 14 pins with additional two pins for back light. It displays the status of the system at any particular time interval.

5) **Pump Driver**

The pump driver is an output unit that consists of the relay as the main component. The unit is connected to the microcontroller which sends control signal for the pump to it. The output of this unit is connected to an AC water pump. The relays are responsible for switching on and off of the water pump for the irrigation system.

6) **Central Control**

The central control unit is responsible for the coordination of other units. It performs the logical and processing function needed to link up all the units. It consists of the AT89C51 microcontroller with the control program.

**Fig. 2. The circuit diagram of the proposed system**

DOI: [http://dx.doi.org/10.24018/ejers.2019.4.3.1190](http://dx.doi.org/10.24018/ejers.2019.4.3.1190)
B. Software Design

The control algorithm employed for this system is such that when the system is powered ON, the microcontroller initializes the input and output terminals and then seeks synchronization with timer module. The timer module receives address of a time segment and releases the value to the AT89C51. The value is stored in the controller’s memory and displayed on the LCD. The AT89C51 compares the time with the input button selected if any. When there is a match, the soil moisture sensor input is also sampled and compared. If the soil moisture content is low, water pump control signal is activated. The activity of the controller is described in the flowchart shown in Fig.3.

III. PRINCIPLE OF OPERATION OF THE SYSTEM

The operation of the system is controlled by the AT89C51 microcontroller. Upon power up, the microcontroller code initializes its ports and sets up the system for operation. The name of the system will be displayed on the LCD. Then time is displayed on the first line. When a corresponding input button is activated, a status indicator is shown for that input button on the second line of the LCD. The second line will indicate for the status of all the six input buttons. When the time reaches for any input button, the microcontroller will activate the AC water pump through the pump driver unit. The pump is run for pre-defined length of time before it is switched OFF. The process is the same for all the input buttons that are activated. The input buttons are used to select time to operate the irrigation pump. At the instant of time to operate irrigation, soil moisture sensor is activated to sense soil moisture content. If the soil moisture is high, irrigation pump will not be operated by the control unit. But if the soil moisture content is low, irrigation pump will be turned to irrigate a farm land.

IV. CONCLUSION

In this era when a lot of countries in the world are experiencing economic meltdown, agriculture comes readily as a good alternative with the advantage of its ability to sustain life and improve a nation’s revenue generation both internally and externally. This project, automatic irrigation system was designed to explore available indigenous expertise to automate irrigation at low cost thereby increasing crop yield at minimal cost. This was realized as the components used were sourced locally at very low cost. The mass production of this system will create employment locally. The system is user friendly. It will help minimize water wastage and improve water availability to areas lacking it. It is a very useful tool in ensuring the availability of seasonal foods all year round.

REFERENCES
