The International Journal of Engineering and Science (IJES)
|| Volume || 8 || Issue || 3 Series I|| Pages || PP 53-58 || 2019 ||
ISSN (e): 2319 – 1813 ISSN (p): 23-19 – 1805

Smart Irrigation: An ICT Application in Agriculture

Ismaila Adeniyi Kamil[*1] and Olatunji Julius Ojoawo[2]
[1,2]*Department of Electrical & Electronic Engineering, University of Ibadan, Nigeria*
Corresponding Author: Ismaila Adeniyi Kamil

---***ABSTRACT:*** ---
Irrigation is done to ensure availability of water for plant growth. Traditional irrigation methods are not very efficient and require human operator for there day-to-day operations. Automatic irrigation systems are more efficient and less dependent on human operators and are therefore cheaper on the long run. Different approaches at developing automatic irrigation system have been reported with their different advantages and disadvantages.In this paper, a smart irrigation system which has capacity to remotely monitor essential farm variables such as soil moisture, and remotely operate the irrigation equipment is developed. Experimental tests on the developed system show that it is effective and could be adapted easily for practical use.
Keywords*: Smart, Soil moisture, Plant growth, Automatic, Human operator*

Date of Submission: 20-02-2019 Date of acceptance: 08-03-2019

I. INTRODUCTION

ICT Information and Communication Technologies (ICT) refers to technologies that provide access to information through telecommunications medium such as the radio, television, cell phone, computers, satellite technology; internet including email, instant messaging, video conferencing and social networking websites which have made it possible for users across the world to communicate with each other to give users quick access to ideas and experiences from a wide range of people, communities and cultures.

Agriculture is an important sector with the majority of the rural population in developing countries depending on it. The sector faces major challenges of enhancing production in a situation of dwindling natural resources necessary for production. The growing demand for agricultural products, however, also offers opportunities for producers to sustain and improve their livelihoods. Information and communication technologies play an important role in addressing these challenges and uplifting the livelihoods of the rural poor.

In Nigeria, the economy over the year has depended solely on the revenue accruing from crude oil. The dwindling price of oil and recent development of electric cars in many developed countries that are major crude oil importers have become great threats to an oil-based economy such as Nigeria. There is therefore a need for diversification of Nigerian economy to non-oil based one. Nigeria has good potential for agriculture. Before the discovery of oil, agriculture was the main stay of Nigerian economy. During this period, there was a relatively stable economy that ranked among the best in the world. Diversifying the economy to agriculture is expected to bring back the past glory.

If agriculture is to take us away from the present situation, it has to be a fully mechanised one with ability to plant throughout the year.

Like humans and animals, plants need both water and nutrients (food) to survive. Most all plants use water to carry moisture and nutrients back and forth between the roots and leaves. Water, as well as nutrients, is normally taken up through the roots from the soil. This is why it's important to water plants when the soil becomes dry. Environmental temperature and carbon dioxide concentration among other factors also affect the growth of plants [1].

Increase in agricultural production and productivity depends, to a large extent, on the availability of water. Insufficient, uncertain and irregular rain causes uncertainty in agriculture. The period of rain is restricted to only certain months in a year. Provision of irrigation facilities can make possible the growing of two or three crops in a year in most areas of the country. This will considerably enhance agricultural production and productivity.There is therefore a need to improve our irrigation system. One of the ways to do this is to adopt ICT as it has been reportedthat increased utilization ofICT could have a positive effect on irrigationefficiency [2].

In this work a smart irrigation system is developed which has capacity to remotely monitor essential farm variables such as soil moisture, and remotely operate the irrigation equipment. This is expected to reduce the number of human labour required and increase the efficiency of the irrigation system.

In recent times, water shortage has become one of the biggest challenges in the world especially during the dry season [3] and various methods have been implemented for water conservation. Agriculture is a major field where water is required in tremendous quantity and its wastage could pose a serious problem especially in the cultivation of crops, thus affecting human sustenance.

Irrigation is the artificial application of water to the soil for the purpose of supplying the necessary moisture for plant's growth. This is the most cultural practice and most labour-intensive task in agriculture.

Although, different systems have been implemented for irrigation, most of them are crude and labour-intensive as they require human intervention at every stage of the process. A typical sprinkler irrigation system is illustrated in Figure 1. The need to eliminate human intervention in irrigation and water management has necessitated the development of technology in the direction of automated plant irrigation and remote monitoring of basic soil parameters for plant growth.

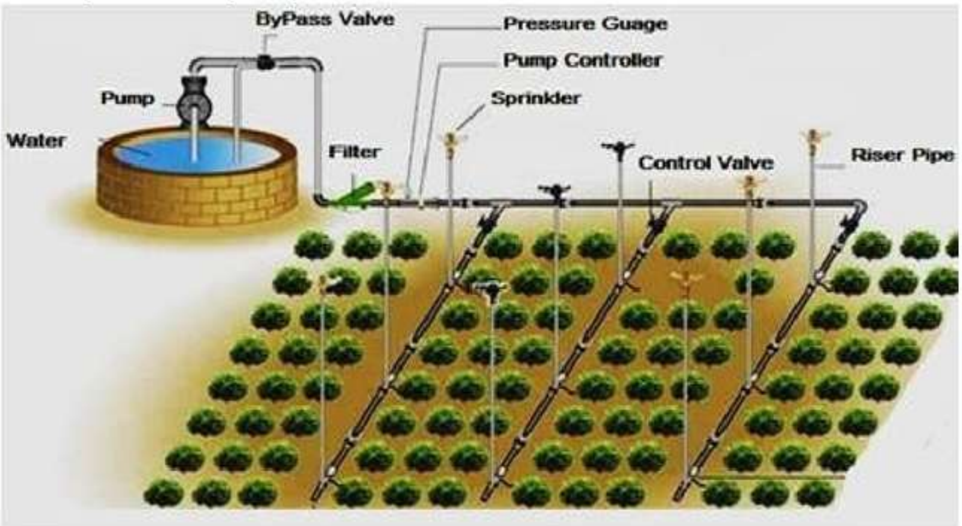

Figure 1: A Typical Sprinkler Irrigation System [4]

II. REVIEW OF PREVIOUS WORK

Many researchers have proposed automatic irrigation system which employs sensors to take the soil parameters such as temperature, humidity and soil moisture level around the crop roots. The outputs of the sensors are then used to determine the on and off time of water pump used for pumping water or the opening and closing of the water valves for irrigating the farm. These include [5] [6] [7] [3] [8]. In most of them the control circuit is microcontroller-based but the systems do not have remote monitoring facilities for the processes. The control of the water pump in these schemes is on/off control.

[9] proposed a control scheme for water valves which is based Artificial Neural Network. The scheme is reported to perform optimally in water valve control as the oscillations generated in on/off control of valves is eliminated. The scheme was implemented using simulations. It is however noted that some of the assumptions made in the scheme may fail under practical implementation.

[10] implemented a system a system similar to those mentioned earlier but the pumping process in the irrigation system is powered by solar. This system has the advantage of having application in rural areas which are not connected to the grid.

The scheme proposed by [11] include a feature that allows remote monitoring/control of the scheme by a human operator through a communication link. In this scheme, the status of the soil parameters is communicated to the remote operation by SMS over a GSM network. The operator on the hand can also perform the on/off control of the pump by SMS.

The proposed scheme which is similar to that of [11] in many respects makes provision for automatic on/off control of water pump depending on the water level in the storage tank.

III. SYSTEM OVERVIEW

The proposed smart irrigation system, illustrated in the block diagram of Figure2, is made up of the sensing circuit to measure certain soil parameters, the irrigation level control unit consisting of a solenoid control valve which regulates the water inflow into the farm, the water level and pump control unit for irrigation water management, the display unit consisting of an LCD display which indicates the status of the sensed parameters and the communication unit which connect the remote farmer to the farm under irrigation. The microcontroller unit is programmed to coordinate the activities of all the units.

The sensing unit consists of a soil moisture sensor, a temperature sensor and a carbon dioxide sensor. The moisture sensor is a 10HS Large Soil Moisture sensor which measures the volumetric water content. LM35 from Figaro is used as the temperature sensor while MQ-135 is used as the carbon dioxide sensor.

The solenoid valve is APLO-1/2-12V dc plastic solenoid valve which is a two-way direct acting valve with a normally open operating position. Itcontrols the flow of water to the irrigation pipes when necessary. The water level controller consists of an LV41 Series Float Switch for water level control. When the water level is low, the switch connects the power supply to the pump to commence the pumping operation. As the water level rises, the float also rises resulting in a tilt of the micro-switch located within the device housing. This tilt leads to the opening of the switch at maximum water level to disconnect power from the water pump and stop the pumping operation. SIM 900A GSM Module is the heart of the communication system. The microcontroller used is PIC 18F4550 which is among the advanced microcontrollers from Microchip Technology. The circuit diagram for the entire system is illustrated in Figure3.

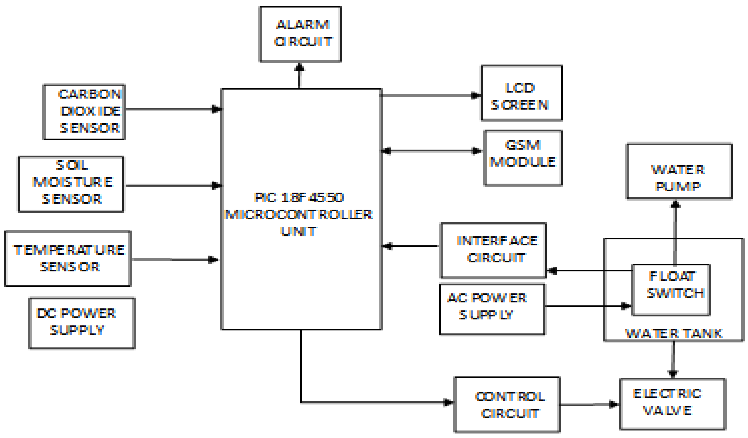

Figure2: Block Diagram of Smart Irrigation System

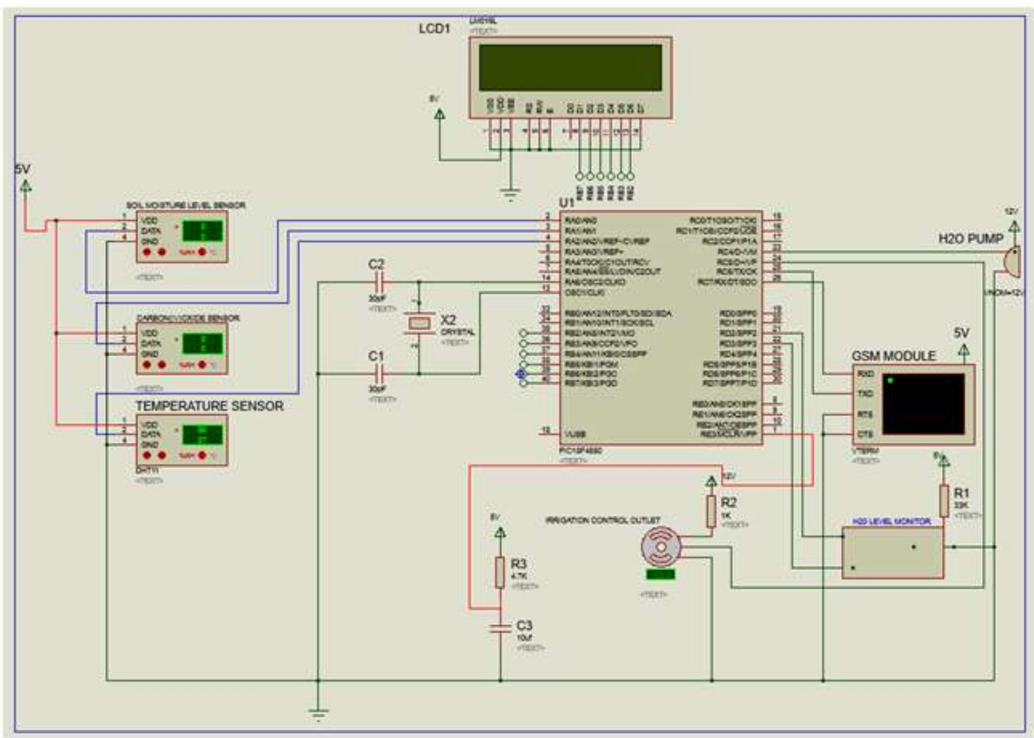

Figure3: Schematic Diagram of Smart Irrigation System

IV. SYSTEM OPERATION

The system operation is as illustrated in the flowchart of Figure4. When the system is powered on, it takes about 2-3 minutes to initialize, after which its display unit indicates the CO_2 and temperature levels of the soil. The display unit also indicates the current lower and upper thresholds of soil moisture. This information is also sent through the communication unit to a predefined remote user. The status of the irrigation pump is also sent.

If the moisture content is greater than them lower threshold‘lower et’, and the water level in the tank is high, both the control valve and the water pump are off. This situation indicates that the plants have adequate moisture and the amount of water in the storage tank is adequate.

If the moisture content is greater than the lower threshold but the water level in the tank is low, the control valve is off but the water pump is on to fill the tank to the desired level. The buzzer also turns on to alert a local operator of low water level.

If the moisture content is lower than the lower threshold, but the water level is high, the control valves turns on to supply water to the farm, but the water pump is off. The control valve turns off when the soil moisture reaches the upper threshold ‘upper et’. The status of the sensors is sent to the remote user when the valves turns on and when it eventually turns off (i.e. just before the start of irrigation and at the end). If the water level becomes low during this process, the water pump turns on to fill the tank and the buzzer turn on to alert the local operator of low water level.

Although the moisture level thresholds and the telephone number of the remote user have been pre-programmed, they can be changed by sending text messages in the recommended formats to the irrigation system.

To change the threshold levels, the recommended format is

LOWER ET *** UPPER ET ***

Where *** indicate the numerical values of the new moisture threshold values.

To change the telephone number of the remote user, the format is

NUMBER *********** JT

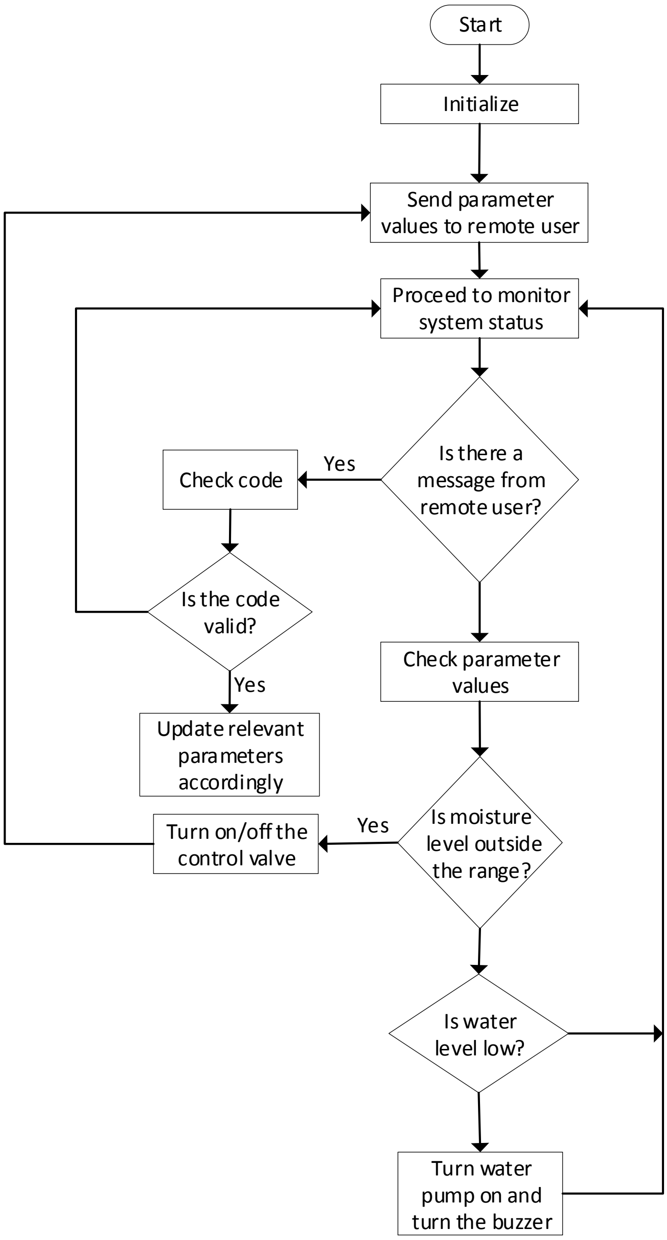

Figure4: Flowchart showing System Operation

V. EXPERIMENTAL RESULTS AND DISCUSSION

In order to test the effectiveness of the system, experiments were conducted with different soil moisture and storage tank water levels, and soil moisture threshold levels. The results of the tests are illustrated in Table 1 to

Table 1: Experimental test with soil moisture thresholds of 2.2% and 3.0% full water tank level

Soil Moisture Level, Y (%)	Ambient Temperature (⁰C)	Status of Control Valve	Status of Float Switch	Status of Buzzer
<2.2	35.1	ON	OFF	OFF
2.2≤ Y ≤3.0	34.1	ON	OFF	OFF
Y >3.0	34.0	OFF	OFF	OFF

Table 2: Experimental test with soil moisture thresholds of 2.0% and 3.4% full water tank level

Soil Moisture Level, Y (%)	Ambient Temperature (⁰C)	Status of Control Valve	Status of Float Switch	Status of Buzzer
<2.0	38.1	ON	OFF	OFF
2.0≤ Y ≤3.4	38.0	ON	OFF	OFF
Y >3.0	37.5	OFF	OFF	OFF

Table 3: Experimental test with soil moisture thresholds of 1.9% and 2.1 % low water tank level

Soil Moisture Level, Y (%)	Ambient Temperature (^{0}C)	Status of Control Valve	Status of Float Switch	Status of Buzzer
<1.9	35.1	ON	ON	ON
$1.9 \leq Y \leq 2.1$	34.5	ON	ON	ON
$Y > 2.1$	34.0	OFF	ON	ON

The results show that the control valve is always ON (Open) whenever the moisture level is lower than the upper threshold level. The show that irrigation of the soil will continue as long as the field capacity of soil has not been reached. The control valve closes immediately the level of the soil field capacity is attained.

The float switch is always off is long as the water level is above the minimum level. The float switch comes on when the water falls below the minimum level thereby turning on the water pump. At the same time the buzzer comes on to alert a local operator, and stops when the level rises above the minimum level. The pumping operation continues until the maximum point is reached. At this point the float switch turns off again to stop the pumping operation.

The displayed information at the system display unit and the remote mobile unit showed that the communication with the remote user at different stages was effective both for system parameter information and system settings.

VI. CONCLUSION

A smart irrigation system capable of automatic farm irrigation without a local operator was developed and tested to be effective. The inclusion of remote information exchange between the system and the user serves as feedback unit to ensure an almost fail-safe autonomous irrigation system. Although the system developed is a sort of prototype unit, it could easily be adapted for practical use by increasing the number of sensors. An important feature of this system is that it could be configured for use with different types of soils and plants.

REFERENCES

[1]. K. J. van Groenigen, X. Qi, C. W. Osenberg, Y. Luo and B. A. Hungate, "Faster Decomposition Under Increased Atmospheric CO2 Limits Soil Carbon Storage," Science, vol. 344, pp. 508-509, 2014.

[2]. E. Yonazi, T. Kelly, N. Halewood and C. Blackman, "ICTs for Agriculture in Africa," in eTransform Africa: The Transformational Useof ICTs in Africa, 2012, pp. 1-32.

[3]. V. N. Gunturi, "Micro Controller Based Automatic Plant Irrigation System," International Journal of Advancements in Research & Technology, vol. 2, no. 4, pp. 194-198.

[4]. E. S. Mohamed and N. T. Abdo, Overview of Pumping Systems with Focus on Deferrable Irrigation Loads, 2017.

[5]. C. Soni, D. D. Vaishnav, D. Bairwa, H. Mittal, H. Vijayvargiya, A. Vijayvargiya and V. Singh, "Automatic Irrigation System," International Journal of Technical Research & Science, vol. 2, no. 3, pp. 111-116, 2017.

[6]. K. Anitha, "Automatic Irrigation System," in 2nd International Conference on Innovative Trends in Science, Engineering and Management, New Delhi, 2016.

[7]. S. Agarwal, S. Pandey, S. Kumar and K. Chaudhery, "Automatic Irrigation System," International Journal of Advance Research and Innovation, vol. 2, no. 1, pp. 92-94, 2014.

[8]. A. Rajpal, S. Jain, N. Khare and A. K. Shukla, "Microcontroller-based Automatic Irrigation," in Proc. of the International Conference on Science and Engineering (ICSE 2011), 2011.

[9]. S. M. Umair and R. Usman, " Automation of Irrigation System Using ANN based Controller," International Journal of Electrical & Computer Sciences IJECS-IJENS , vol. 10, no. 02, pp. 45-51, 2010.

[10]. S. Harishankar, R. S. Kumar, K. P. Sudharsan, U. Vignesh and T. Viveknath, "Solar Powered Smart Irrigation System," Advance in Electronic and Electric Engineering, vol. 4, no. 4, pp. 341-346, 2014.

[11]. D. S. Parithra and M. S. Srinath, "GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop Planning by Using an Android Mobile," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 11, no. 4, pp. 49-55, 2014.

Ismaila Adeniyi Kamil" Smart Irrigation: An ICT Application in Agriculture" The International Journal of Engineering and Science (IJES), 8.3 (2019): 53-58