

SMART IRRIGATION SYSTEM: A VITAL STEP TOWARDS REVOLUTIONIZING AGRICULTURE IN NIGERIA.

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ABSTRACT

Agriculture is a critical element that is to be considered for the development of a country, fresh water is one of the key requirements for successful agriculture, technological irrigation is an artificial way of watering the soil to promote growth of farm products. In the present day Nigeria, due to the increase in population, there have been food and water scarcity. So to avoid this problem we have to promote the agriculture sector. But water wastage is more in this sector in the form of water logging while watering the agricultural fields through irrigation. Therefore, this paper proposes a smart irrigation system for the proper water supply in the fields. This paper deals with a smart irrigation system which automatically senses the moisture content of the soil and decide whether irrigation is needed or not and how much water is needed for soil. This system uses Arduino microcontroller. Implementing this will thereby eradicate the need of manpower and conserve the time and also save a large amount of water.

INTRODUCTION

Background of Study

Agriculture has been a critical driver of well-being for centuries, ensuring food security and catalyzing productivity needed for economic prosperity (Robin 2001).

It uses 85% of available fresh water resources and this percentage will keep trending upward due to certain unavoidable factors such as increasing population growth and which also in turn leads to high demand in food.

Irrigation is an artificial way of watering the soil for proper growth of plant. It is mainly used in dry areas and the places where rain fall is less.

Tapping into the full potential of agriculture can bring about many positive changes to Nigeria one of the major challenges currently in Nigeria is the increasing unemployment rate, unemployment gives rise to all kind of social vices in the country such as the incessant killings, armed robbery and rape across the country. I believe if over 70% of the total population of Nigeria is employed, all kinds of social vices will take a deep dive downwards on statistics chart.

Employment: it provides employment for about 60% of the work force. Agriculture sector is also capable of reducing the country's state of unemployment due to the fact that the sector is labour intensive.

Agriculture can also contribute to the development of social amenities, this is because development of agriculture requires good road, market yards, storage, transportation railways, postal service and many others for industrial products and the development of commercial sector.

An excessive number of research work has been carried out by the Ministry of Agriculture and Rural Development, IITA, FAO, CBN, and other organizations showing the trend of the agro industry and its embedded prospects, some of which are presented here.

The analysis in fig13 indicates that there have been increasing demands on the international market for our agricultural commodities. In 2010, out of the total value of non-oil exports, the agricultural sector contributed over 75% in value. Due to the rising trend, it is expected to increase subsequently, presenting a huge opportunity for investment(if properly invested in).

Fig12 shows there is over under-utilization of the resources and factors of production in the Nigerian agro sector with both effectiveness and efficiency below par. The typical Nigerian agricultural sector is described as an “effective non-efficient” industry. Effectiveness talks about how an input can be transformed to an output while efficiency takes it a step further to measure how well the input is converted to output in terms of productivity with minimum or no waste in resources.

Research Problem Definition

A report by one of the leading professional services firms, pwc, disclosed that feeding Nigeria’s current and future population is a critical challenge. According to the report with average growth rate of 2.7% annually and fertility rate of 36.9% birth per 1000 peoples, Nigeria’s population will continue to increase in the future. However, as Nigeria’s population continues to grow as shown in fig14, it is becoming increasingly challenging for food supply to meet demand. Coupled with the increasing targets of rural farmers from gunmen and also lack of proper irrigation system, especially in the north, the ratio of access of person per food becomes smaller. Technology improvement has played a vital role in improvement of irrigation patterns through the invent of taps and borehole. So as to prevent water which is being wasted during irrigation using previous methods, a smart irrigation system has been proposed in this paper. This works by sensing the moisture content of the soil and decides whether the pump has to operate or not. The system is not so expensive as compared to others, and its time saving, as the work done by the system is automatic.

Brief Literature Survey

Researchers in the field of Agriculture and technology have been trying to conserve the water wastage amount used for irrigation of plants. Therefore, different technologies can be used to make this possible. Some of the researchers in agriculture field are summarized below;

Ning, Naiqian & maohua(2006) has described the importance of using wireless sensor technologies and standards for wireless communication applied on wireless sensors in agriculture field over traditional methods of irrigation while analyzing the market growth.

Morias, Valente & serodio (2005) has discussed a wireless sensor Network implementation for low data rate applications in agriculture using wireless stations that work on solar energy, and the moisture is sensed using probe method.

Kim, Evans & Williams (2008) has designed an irrigation system which is site specific in which irrigation machine is electronically controlled by a program which updates the geographic location of sprinklers from a GPS and communicate that wirelessly to base station.

Jain, Kudre & Giri (2004) has mentioned remote monitoring systems which uses various wireless syntax introduced by various researchers to improve agricultural yield and, additionally, the author has proposed a model for agricultural monitoring with wireless protocol implemented using field programmable gate array which facilitates the system with re-configurability and re-programmability according to different environmental conditions.

Karan kansara (2015) proposed an automated irrigation system in which the humidity and temperature sensors are used to sense the soil conditions and the microcontroller will control the water flow based on the sensed data. Farmer will be communicated to through GSM.however, this system does not monitor the nutrient content in the soil.

Prof C.H.Chavan & P.V.Karnade (2014) proposed a smart wireless sensor network for monitoring environmental parameters using Zigbee. These nodes send data wirelessly to a central server, which collects data, stores it, analyses the data and then displayed as needed and also be sent to the farmer's mobile phone. Unfortunately, weather forecasting and nutrient content is not available in this system.

G.Parameswaran & K.Sivaprasath (2016) proposed a smart drip irrigation system using IOT where humidity, temperature and pH sensors are used. Irrigation status is updated to the server or local host using personal computer. However, the farmer cannot access about the field condition without internet connection.

S.Reshma & B.A.Sarath (2016) proposed an IOT based automatic irrigation system using wireless sensor networks in which various sensors are used to measure the soil parameters. This system provides a web interface to the user to monitor and control the system from any remote location. Weather monitoring is not done in this system.

Joaquin Gutierrez (2013) proposed a gateway unit which handles sensor information, triggers actuators, and transmits data to web application. It is powered by solar panels and has duplex communication link based on cellular internet interface that allows for data inspection and irrigation scheduling to be programmed through web page.

Archana & 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 does not feedback the farmer about the field status.

Gainwar & Rojatar (2015) proposed a paper in which soil properties such as pH value, humidity, moisture and temperature are measured for getting high yield from soil. This system is fully automated which switch the motor pump ON/OFF as per the level of moisture in the soil. The current field status is not communicated to the farmer.

V. R. Balaji and M. Sudha (2016) proposed a paper in which the system derives power from sunlight through photo-voltaic cells. This system doesn't 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.

Aims and Objectives

The major aims of this research among many others is mainly to;

1. Safeguard life and properties of farmers in Nigeria due to rising gunmen attacks on farmers.
2. Conserve the use of freshwater so as not to water-log a farmland and also not to under-irrigate the farmland.
3. Reduce labour and transportation for the farmers.
4. Increased productivity which in turn boost the quality of life in the nation (Nigeria).

5. Provide job employment for the unemployed mass thereby reducing the rate of social violence in Nigeria.

Scope

This paper is focused on the use of basic Internet of things (IOT) modules which include Arduino, nodemcu8266, etc to solve the irrigational problems for Nigerian farmers.

Intention of the Paper and Impact of the Study

In many developed countries, Agriculture is the backbone of the nation's development, but in Nigeria, Agriculture can be referred to as the "forgotten broken backbone of development".

In as much as this proposed system can solve the problem of water wastage and conservation of the farmer's energy and transportation. My main motivation behind this paper is the alarming rise (inflation) of food products in Nigeria. I believe if technology is fully incorporated in the irrigation of Agriculture in large scale, it will help curb the uncontrollable increased in food production in the nation. In addition to that, it will also give rise to new ideas on how to incorporate technology in other specific agricultural sector.

THEORITICAL ANALYSIS

Agriculture is known to be the backbone of a developing country and it is very important to know the parameter of soil and water for efficient harvesting.

Nowadays agricultural field is facing lot of problems due to lack of water resources. In order to help the farmers to overcome the difficulties, smart irrigation system has been used. In this system, various sensors such as pH, soil moisture sensor, DHT11 sensors are connected to the input pins of Arduino microcontroller. If the sensed value goes beyond the threshold values set in the program, the pump will be automatically switched ON/OFF by the relay circuit. The farmer will be informed about the current field condition through a Thingspeak platform updated in the server. By using this system, the farmer can access the details about the condition of the field anywhere at any time.

MATERIAL USED

- Arduino UNO (microcontroller)
- NODEMCU
- Gravity analog PH sensor
- DHT11 temperature sensor
- Soil moisture sensor
- Relay module (12VDC)
- 5VDC motor pump
- Jumpers
- Power supply
- Bread board

ARDUINO UNO

The Microcontroller used here is an Arduino UNO. The UNO is a Microcontroller board based on ATMEGA 328P. The ATMEGA 328P has 32kB of flash memory for storing code. The board has 14 digital input and output pins, 6 analog inputs, 16 MHz quartz crystal, USB, an ICSP circuit and a reset button. The UNO can be programmed with the Arduino software. The diagram of the microcontroller is as shown in fig1 below.

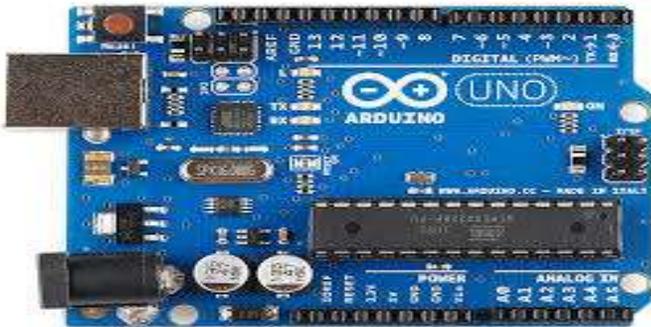


FIGURE1: ARDUINO UNO MICROCONTROLLER

NODEMCU ESP8266

Nodemcu depicted in fig2 is an open source Lua based firmware and development board specially targeted for IOT based applications. It includes firmware that runs on the ESP8266 WI-FI soc from Espressif systems, and hardware which is based on the ESP-12 module.

Nodemcu is used in this project for uploading the present state condition of the soil moisture value, PH value and temperature value on a virtual cloud known as THINGSPEAK.

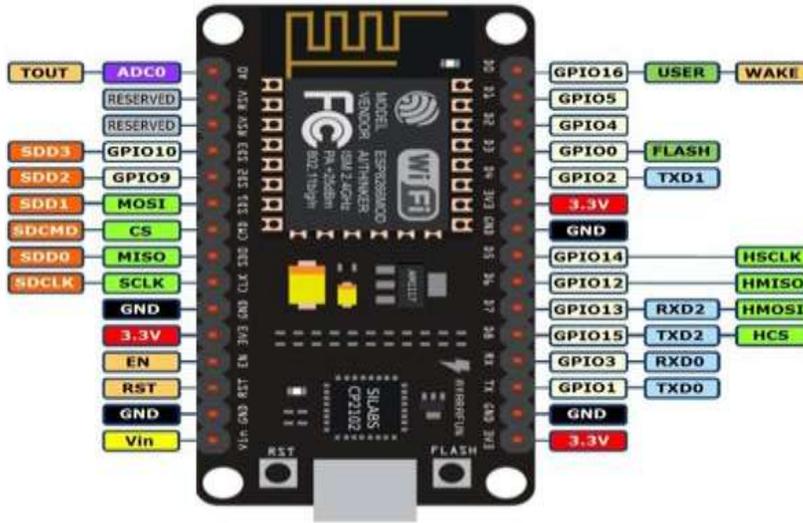


FIGURE2: NODEMCU 8266

GRAVITY ANALOG PH SENSOR

Analog PH sensor is designed to measure the PH value of a solution and show the acidity or alkalinity of the substance. It is commonly used in various applications such as agriculture, wastewater treatment, industries, environmental monitoring etc. The module has an on-board voltage regulator chip which supports the wide voltage supply range of 3.3V to 5V DC, which is compatible with 5V and 3.3V of any control board like Arduino. The output signal is being filtered by hardware low jitter. Fig3 shows the signal conversion board of the PH sensor. It has two connection points; one is connected to the Arduino microcontroller while the other part is connected to the PH electrode. The PH electrode(fig4) is connected to the PH signal conversion board and its electrode is connected directly into the ground.

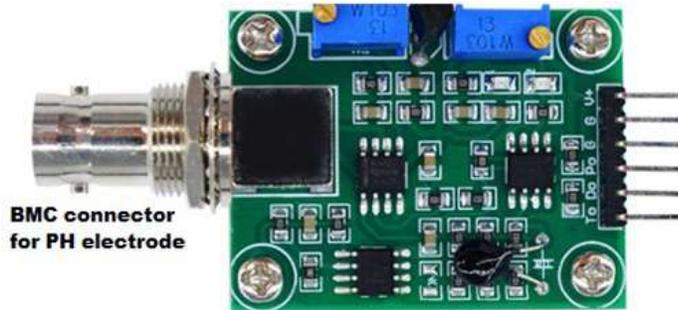


FIGURE3: PH SIGNAL CONVERSION BOARD



FIGURE4: PH ELECTRODE

DHT11 TEMPERATURE SENSOR

DHT11 sensor show in fig5 is used for measuring temperature and humidity. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air. This sensor is cost effective, provides low power consumption and up-to 20-meter signal transmission is possible, which makes it quite effective for constructing a prototype of the smart irrigation system.

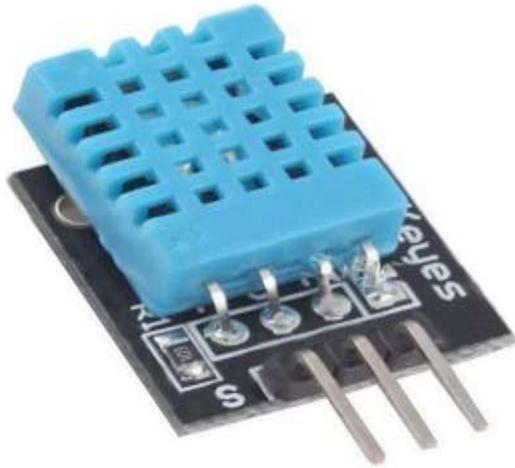


FIGURE5: DHT11 TEMPERATURE/HUMIDITY SENSOR

SOIL MOISTURE SENSOR

Soil Moisture sensor shown in fig6 is used to measure the moisture content present in the soil. When the soil moisture value read by the sensor is above the threshold value, low level (0V) will be the digital output and if it is below the threshold level, high level (5V) will be the digital output. The digital pin is used to directly read current soil moisture value to see if it is above threshold or not. The threshold voltage can be regulated with help of potentiometer.

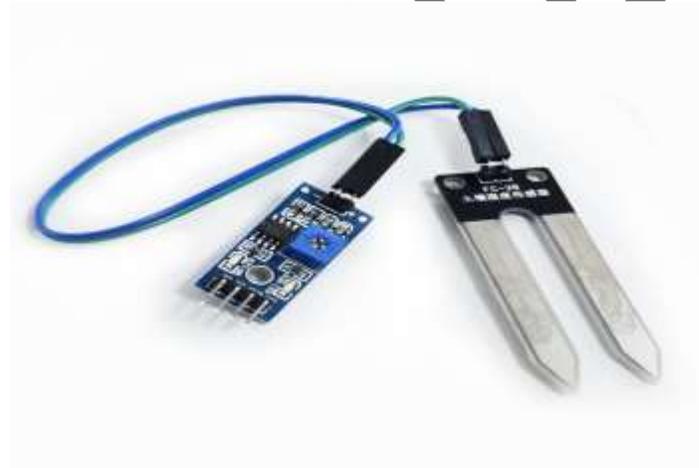


FIGURE6: Soil Moisture Sensor.

RELAY MODULE (12VDC)

A relay as shown in fig7 is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid state relays. Relays are used where it is necessary to control a circuit by a low power signal or where several circuits must be controlled by one signal. The relay gets its input signal from the 12vdc battery the normally open and common terminals are then connected to motor pump.



FIGURE7: 12VDC Relay Module.

5V MOTOR PUMP

5vdc motor pump as shown in fig8 is a low cost submersible pump motor which can be operated from 2.5v to 6v power supply. It can take up to 120 liters of water per hour with very low current consumption of 220mA , it works based on the principle of suction, just connect tube pipe to the motor outlet, submerge it in water and power it.

In this paper the motor pump is connector to the outlet of a relay so that when the micro controllers change the state of the relay, the motor pump can then either be switch ON or OFF.



FIGURE8: 5V SUBMERSIBLE PUMP.

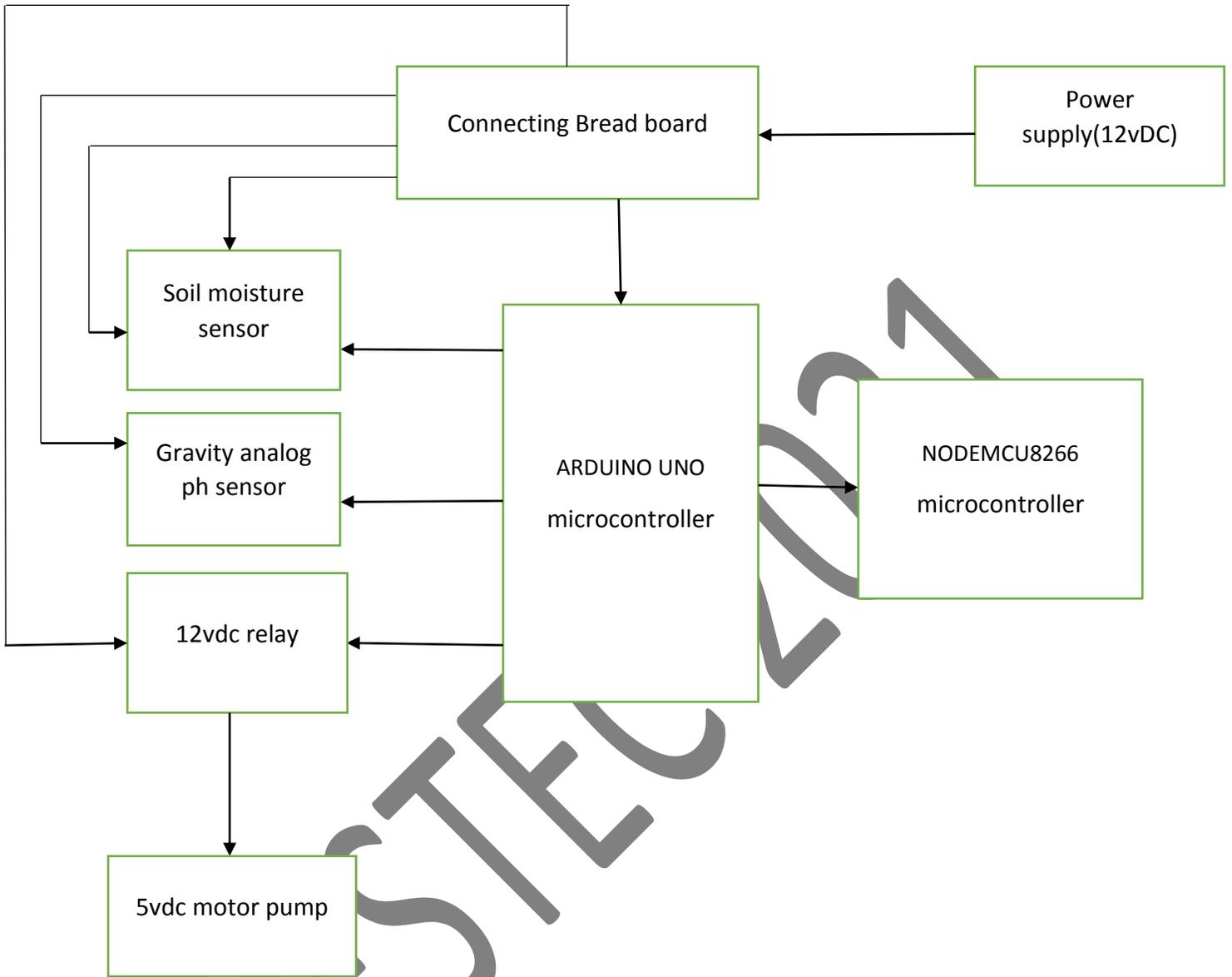


Figure9: Block diagram of smart irrigation system using Arduino Uno.

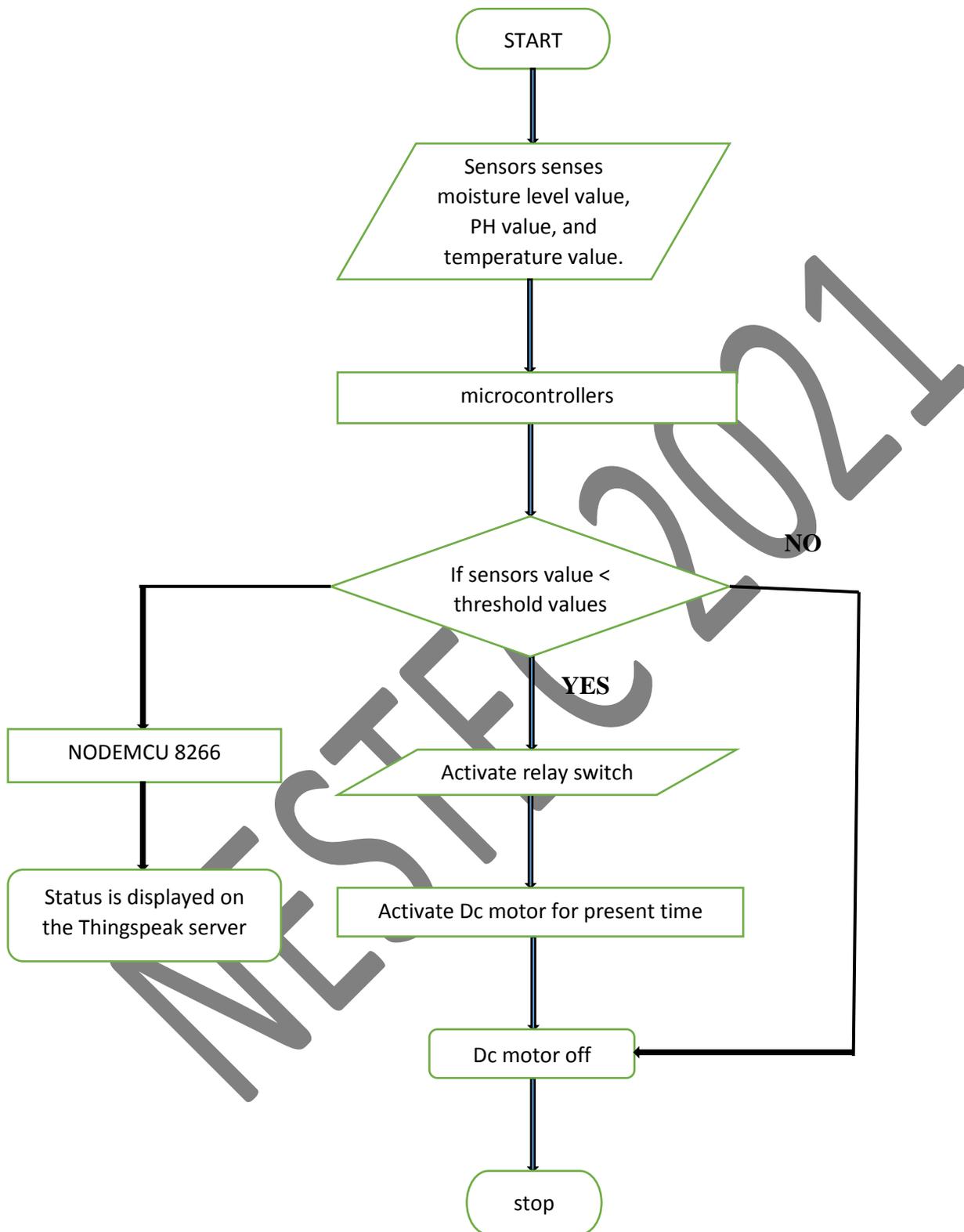


FIGURE10: flow chart of Arduino based smart irrigation system.

FLOW ALGORITHM OF THE SMART IRRIGATION SYSTEM

The fig10: above depicts the flow process chart of the smart irrigation system. As can be seen, the first step of the device is to start it, when the device is started, the various sensors receive electrical power from the battery and senses the present state condition of the soil, then the sensors pass this information to the micro-controllers, the micro-controllers has to make a decision which depends on whether the sensed values are greater than or less than the threshold values that is set by the programmer, if the sensed values are less than the threshold values then the micro-controller will automatically activate the relay switch which is also connected to the irrigating pump and water will wet the plant, but if the sensed value is greater than the threshold value than no operation will be done. But regardless of any of this situations, the NODEMCU 8266 will continue feeding the Thingspeak server the current situation of the farmer's plant.

Finally this is how the data looks on ThingSpeak Dashboard



FIGURE11: THE THINGSPEAK OUTPUT DISPLAY PLATFORM.

Nigeria is an untapped potential agricultural power house

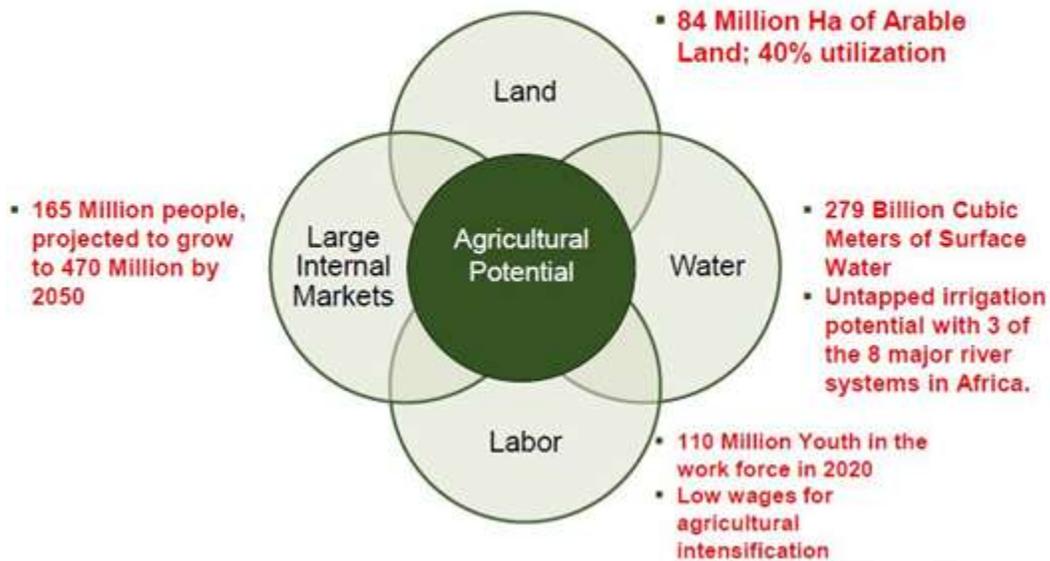


FIGURE12: Untapped Agriculture Potential, Federal Ministry of Agriculture and Rural Development(FMARD)

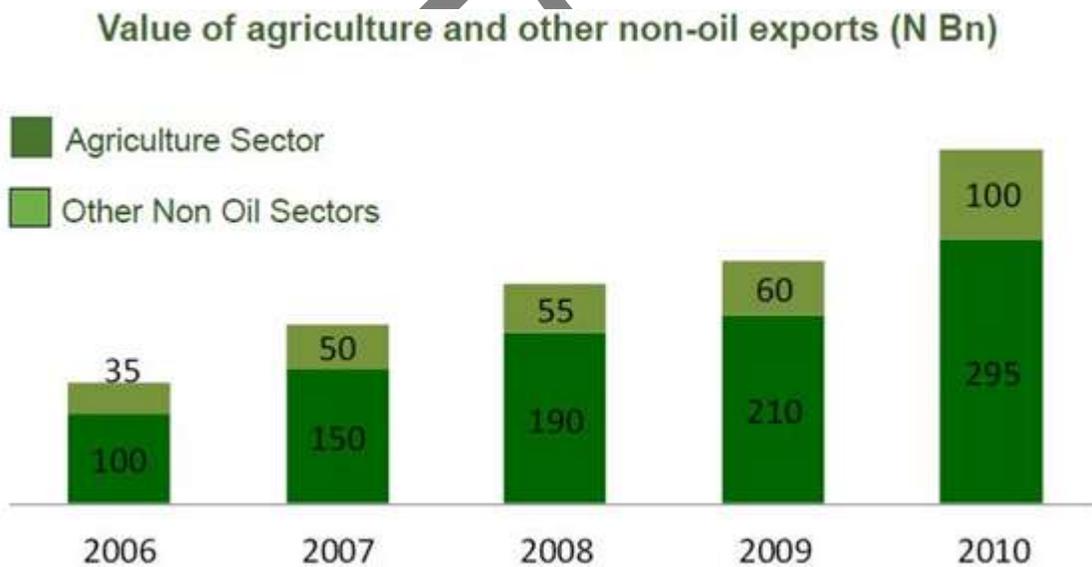


FIGURE13: Value of Agricultural Export 2006 TO 2010, Federal Ministry of Agriculture and Rural Development(FMARD)

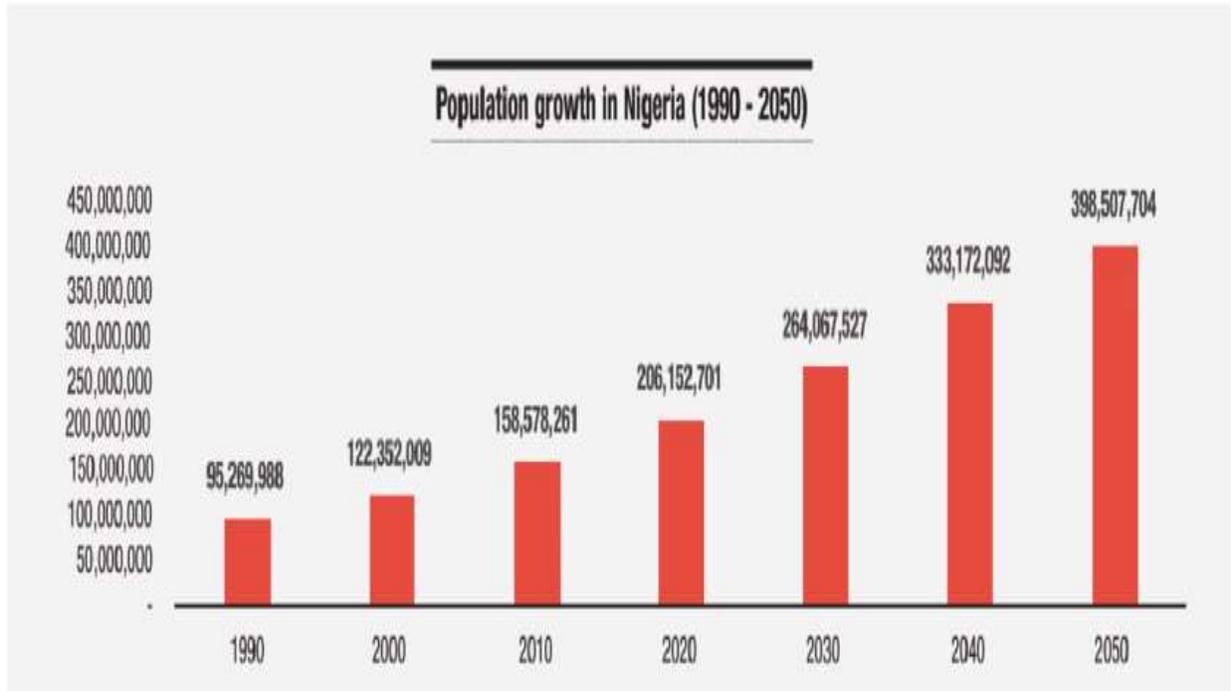


Fig14: Trends in Projection of Nigeria's Population.

RESULT

The project is in a prototype stage and performing the first tests. These are testing different types of sensors to obtain actual data field conditions, in this case moisture. Additional technological innovations will be the development of an expert module that takes into account other parameters like crop types, soil characteristics such as texture, permeability, moisture retention, slope, etc...

This miniature model of smart irrigation system is being tested in two different soils. One soil is wet and the other is dry. Only in the dry condition the pump will start working, since the requirement of water is more for that soil for the proper growth of the crops and in wet soil the pump won't work since the soil does not need any water due to the presence of water in it, hence this project will conserve large amount of water during irrigation for a large scale agricultural firm. it can also be used in our homes, as the number of flower pots increases, we have to use more number of sensors to it. We can also use a more efficient motor to pump the water in the agricultural fields more powerfully.

CONCLUSION

The main objective of this proposed paper is to make the smart irrigation system more innovative, user friendly, time saving and more efficient than the existing systems. Measuring four parameters such as soil moisture, temperature, humidity and pH values. Due to server updates, the farmer can know about crop field nature at anytime, anywhere.

The system components are readily available and they work quite reliably. By improving the irrigation efficiency in agricultural sector, this industry becomes more competitive and sustainable. Also in dry areas (northern Nigeria), where there is no sufficient rainfall, proper rainfall irrigation is not possible. Hence by using this smart irrigation system which monitors the moisture content of the soil, one can almost accurately meet the water requirements necessary for the field. To save effort of farmers, the important considerations are water and time. Usually farmers need to wait until the field is fully watered, these often restricts them to do other activities. In our present era, the farmers are irrigating their crops at regular interval of time. The techniques they use will consume more water by creating water logging and results in water wastage. This system that is designed will completely eliminate the stress of manual labour.

For the future work, this project can be implemented in large scale by using many number of moisture sensors, temperature sensors and by using a powerful motor to pump the water more efficiently. This will result in energy conservation and it is one of the greatest solution for water depletion, water scarcity and food scarcity in Nigeria.

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