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An Automatic Farmland Irrigation System for Northern Ghana

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Abstract- Agriculture plays a very important role in Ghana and Africa at large. It's a source of income and sustenance for the large majority of Ghanaians. Recently, there have been huge drawbacks in the development of the agricultural sector in the country due to incidents of drought most profoundly in the northern region, which has led to the deterioration of several farmlands. This has directly and indirectly affected the lives of many, most especially those who depend on it for a living. This project is thus developed with the main objective of helping to address the issues of crop destruction due to the inability of farmers to store water in the rainy season and use it later on when there is not much water or lack of rainfall. The proposed system would address this challenge by having a water tank, which would store the water to be used for irrigation. The system would then have a soil moisture sensor in the soil, to measure the amount of water in the soil. If the water in the soil falls below a preset threshold for the farmland, the system would automatically irrigate that portion of the farm to keep the soil in good condition. This system is achieved by the use of a PIC16F887A microcontroller, which is connected to the soil moisture sensor, which takes the readings for the microcontroller. The microcontroller upon receiving the soil moisture readings from the soil moisture sensor would display the readings on an LCD and if the soil is in good condition the system performs no action, but if the soil is dry, the water pump is activated to pump water for the purposes of irrigating the soil.

Keywords: *water tank, soil moisture sensor, microcontroller, irrigation.*

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ANAUTOMATICFARMLANDIRRIGATIONSYSTEMFORNORTHERNGHANA

An Automatic Farmland Irrigation System for Northern Ghana

Enoch Tetteh Amoatey [α] & Henry Kwame Atiglah [σ]

Abstract- Agriculture plays a very important role in Ghana and Africa at large. It's a source of income and sustenance for the large majority of Ghanaians. Recently, there have been huge drawbacks in the development of the agricultural sector in the country due to incidents of drought most profoundly in the northern region, which has led to the deterioration of several farmlands. This has directly and indirectly affected the lives of many, most especially those who depend on it for a living. This project is thus developed with the main objective of helping to address the issues of crop destruction due to the inability of farmers to store water in the rainy season and use it later on when there is not much water or lack of rainfall. The proposed system would address this challenge by having a water tank, which would store the water to be used for irrigation. The system would then have a soil moisture sensor in the soil, to measure the amount of water in the soil. If the water in the soil falls below a preset threshold for the farmland, the system would automatically irrigate that portion of the farm to keep the soil in good condition. This system is achieved by the use of a PIC16F887A microcontroller, which is connected to the soil moisture sensor, which takes the readings for the microcontroller. The microcontroller upon receiving the soil moisture readings from the soil moisture sensor would display the readings on an LCD and if the soil is in good condition the system performs no action, but if the soil is dry, the water pump is activated to pump water for the purposes of irrigating the soil.

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I. Introduction

In the fast-paced world, human beings have resolved to be living much easier by incorporating automated systems in their day to day activities. The continuous increase in demand of food is leading to the development of food production technologies to increase food supply and availability. In the world of advanced electronics, the life of human beings should be more convenient, thus the need to develop an automated form of an irrigation system. It is a simple and precise system for farmlands with no close reach to the water supply. It also helps in saving time and reducing the manual labor required in agriculture, hence those resources such as human effort and time can be put into other areas, thus increasing productivity and eventually maximizing the net profit of farmers. The main reason, which calls for such technological systems, is the lack of proper irrigation on farmlands. Irrigation is the artificial application of water to the soil or crops to help growth, typically by means of channels or water reservoir. In the present era, farmers have been using the conventional irrigation methods which involve irrigation overhead through manually controlled sprinklers, flood type feeding systems and farmers making small gutters from river banks to their farm. This system is good but for the fact that some irrigation is being done on timely basis and also when the farmer is available, while some amount of water entering the farmland can't be regulated, this leads to the plants or soil having too much water at a particular time or less than required. Thereby, not facilitating the growth of plants and also not improving agricultural production. An automated system, on the other hand, would be measuring the amount of water present in the soil and would irrigate when required. This would make it a lot easier for the farmer to irrigate more lands and increase crop yield without putting in as much effort as would be required by the conventional system currently being used.

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II. Block Diagram And Description

The block diagram of the system is shown in figure 2. The system has a power supply, which consists of a voltage regulator used to stabilize the current flowing into the circuit. The output voltage of the power supply system is 5 volts as that's what is required for the microcontroller. The PIC16f887A microcontroller acts as the brain of the system. The soil moisture sensor, which measures the amount of water present in the soil, sends this data to the comparator, which compares this data with a pre-defined value to check if the amount of water in the soil is below or above the permissible value. The output of the comparator is then sent to the microcontroller. The water level indicator indicates the level of water in the tank from which water is pumped into the soil. The water level sensor sends the level of the water to the microcontroller. The microcontroller then processes these received data from the water level indicator and also for the amount of water in the soil. It then turns ON a number of LEDs to indicate the level of the water. A relay is attached to the microcontroller which is activated to pump water into the soil if there is not enough water in the soil and there is water in the water tank. A liquid crystal display is connected to the microcontroller, which displays all ongoing processes of

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the system and also displays the status of the various readings from the soil moisture sensor and the water level indicator.

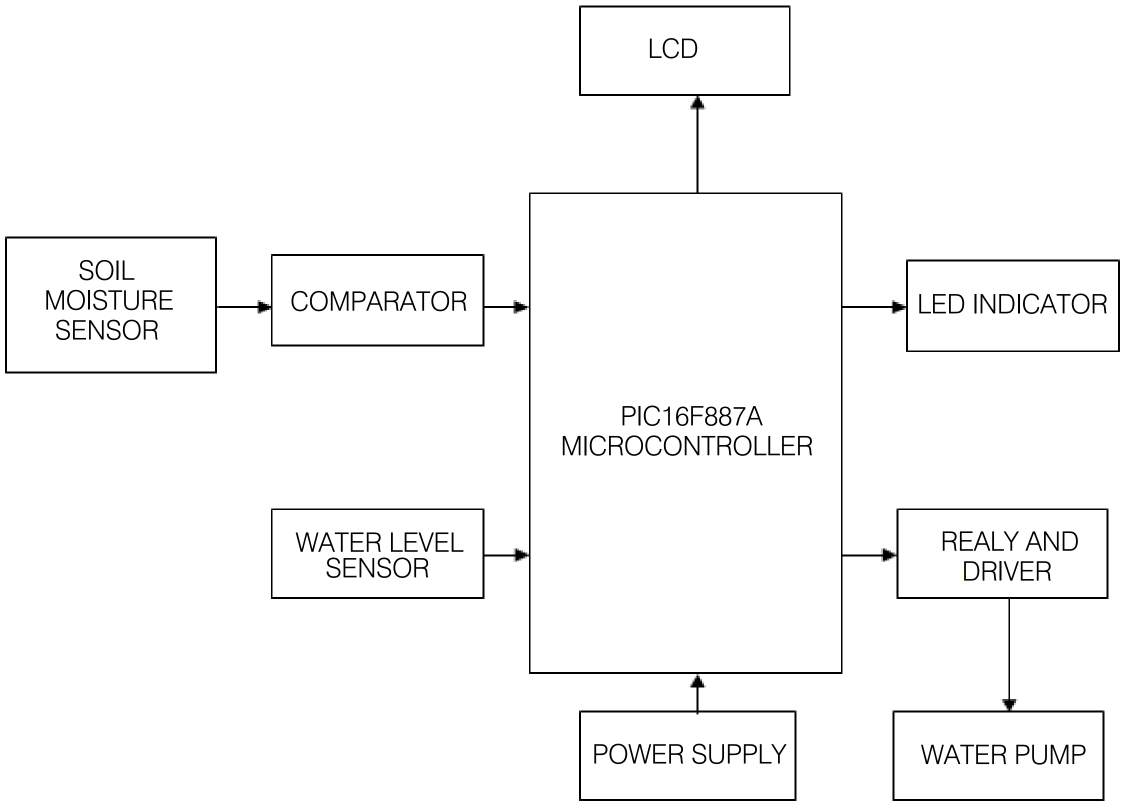

Fig. 1: Block Diagram of the System

III. Circuit Diagram and Operation

There is an LM7805 voltage regulator connected to two 100uf capacitors which serve as the power supply of the system. They regulate the voltage flowing into the system to a fixed 5v since almost all the components of the circuit require 5V to operate. The voltage from the voltage regulator then goes to power the microcontroller, LCD and other components in the circuit. There is a PIC16f887A microcontroller which controls all the activities of the system. It has a crystal oscillator with the appropriate load capacitors to drive the microcontroller to a specified frequency. An LCD is connected to the microcontroller to display the readings of the sensors and also display any operation of the system. An LM393 op-amp is used as a comparator to compare the reading of the soil moisture sensor with that of a predefined value, hence the reading of the soil moisture sensor is first sent to the comparator microcontroller. A reset button is attached to the microcontroller in order to pull its reset pin low to reset the microcontroller then the output of the comparator is sent to the There is also a water level indicator, whose float switches are placed at certain levels in the tank. This conducts when water reaches those levels, and the appropriate signal is sent to the microcontroller. The microcontroller then sends a high signal to turn ON the corresponding LED to indicate the level of the water in the tank. The LEDs have a limiting resistor each of 220 Ohms to limit the amount of current flowing through them. A ULN2003 Darlington transistor IC is placed in the system to serve as a driving transistor for the relay so only one transistor in the array is used. A 12V relay is then connected to the transistor IC which has a water pump connected to it. The relay activates the water pump to begin the pumping process if the water in the soil is below the required level and also if there is enough water in the water tank. A LED and its limiting resistor of 220 Ohms is placed in parallel with the water pump to indicate the ON and OFF status of the water pump

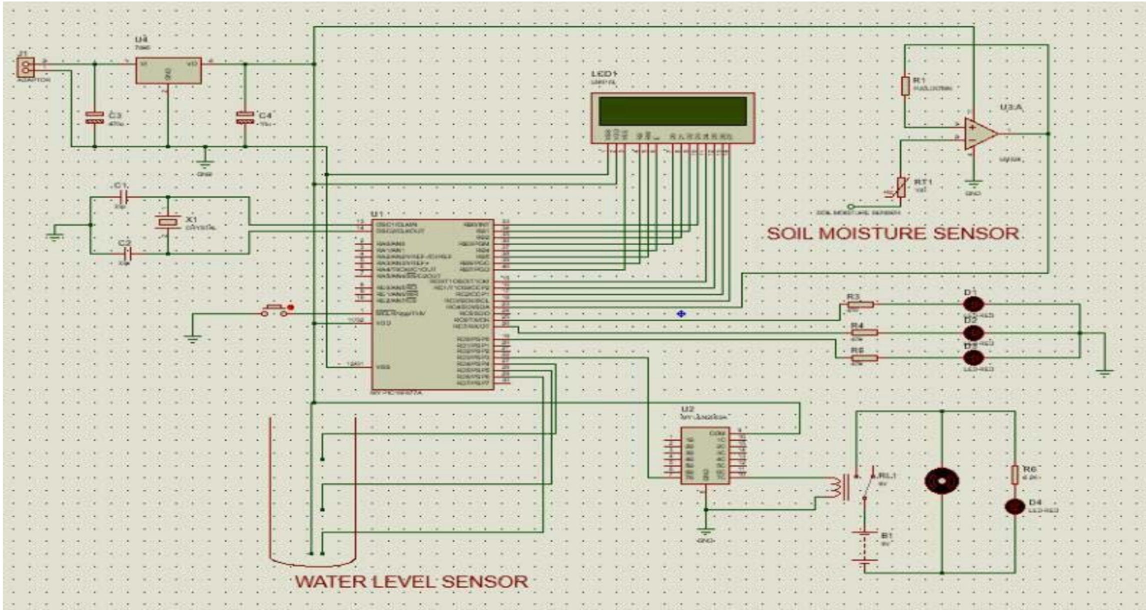

Fig. 2: Circuit Diagram of the System

IV. Results And Discussion

The project was successfully designed and constructed after which we performed some experiments in order to make some observations. The device was tested on the 2nd and 4th of April 2018 on the Tamale Technical University Campus. Both tests produced the expected results which were as follows. It should be noted that there was no rain for some days before the experiment was performed on the 2nd of April whereas there was rain on the 4th of April 2018.

Table 1: Observations for 2nd April 2018

Condition	Status
Soil is dry and tank is empty	Water pump on
Soil is dry and tank is full	Water pump off
Soil is wet and tank contains water	Water pump off

2nd April 2018

Table 2: Observations for 4th April 2018

Condition	Status
Soil is wet and tank is full	Water pump off
Soil is wet and tank is empty	Water pump off

4th April 2018

Thus, it was realized that on the 2nd of April because there was no rain several days before this experiment was conducted the soil was dry hence, there was the need for it to be irrigated. The water pump however did not operate when there was no water in the tank but remained off. The water tank however began to pump water to irrigate the soil once there was enough water in the water tank. After irrigating the soil for some time thought there was enough water in the tank, the water pump was deactivated and this was because the soil now had enough water after a period of irrigation.

On the 4th of April however, there was enough water in the soil from the rain, which had fallen earlier on. Hence, there was no need to irrigate the soil. It could then be observed that for both instances where there was water in the tank and when there was no water in the tank the water pump still remained off to indicate that the soil did not require any water to irrigate it. The system thus worked just as we expected.

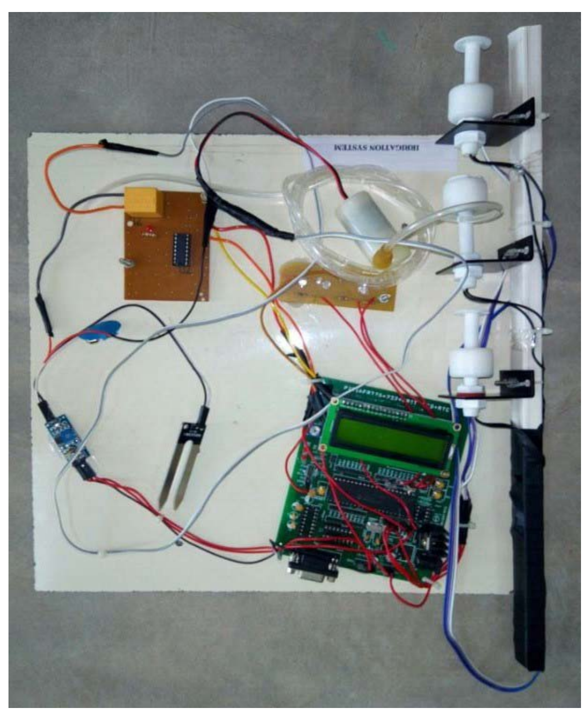

Fig. 3: Diagram of Complete System

V. Conclusion

The design and implementation of an automatic irrigation system using soil moisture and water level indicator was successfully carried out. The objective to measure the water level in an overhead tank and irrigate the soil efficiently was successfully achieved. In the process of testing the system, it was observed that the soil moisture was measured and thus the system was able to efficiently measure the amount of water in the soil. Only that there were some challenges in the design of the hardware especially when we worked with the float switch as it could not measure the water level continuously but only in steps. Thus, the water level could be determined only for specific levels. Continuous testing also showed that the station would not be effective if the hardware parts of the stations are not of higher standards. The automatic irrigation system using soil moisture and water level indicator can be deployed in the conventional open farming systems as well as in advanced agricultural systems such as greenhouses.

VI. Future Scope

In future expansions of this project, the automatic irrigation system using soil moisture and water level indicator could have an option to connect to the internet so that the system can be controlled by the user for other specific purposes and for the user to be able to monitor the real-time status of the farm soil. The measured data of the soil should also be stored to allow for analysis of those data for better understanding of the system and solving data analysis problems. Also, higher standards of components parts should be used so that when the station is installed it can withstand adverse conditions.

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