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Embedded System based Agricultural Field Monitoring System

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Abstract

Agriculture provides as one of the economic solid foundation to the majority of the rural India. Majority of the people in rural places establish their own farms for their livelihood. The conventional methods that they use require a lot of human labour and consume energy. There is no ideal irrigation method for all weather conditions, soil structures and variety of crop cultures. Because of lack of knowledge in the advancement of technology, many a times they suffer a great loss due to sudden change in weather conditions, lack of supply of water or excess supply of water as well as the use of fertilizers and insufficient capital to buy equipment's. This work proposes an embedded system based agricultural field monitoring design that develop and implement the use of different sensors embedded to an AVR microcontroller. The sensors incorporated are temperature, soil moisture and rain detector sensors. Based on the condition of the soil sensed by the soil moisture sensor and the condition of rain, it turns ON/OFF the pump for supply of water to the field. LCD is used to display the condition of field provided by the various sensors. This system is expected to allow the farmers in evaluating the soil conditions through which it can reduce the unwanted usage of water and allowing proper yield of crops as well as reducing human labour.

Keywords: AVR microcontroller, LCD, Temperature Sensor, Soil Moisture Sensor and Rain Detector Sensor.

1. INTRODUCTION

Agriculture which is considered as one of the prime occupation of human being has 64% of the total available land occupied by agriculture out of which it consumes 85% of available fresh water [1].The problems faced by the traditional instrumentation based on discrete and wired method has been solved through the implementation of wireless method which provides with a low-cost wireless controlled irrigation solution and a real-time monitoring of the field [2]. Many new ideas are being taken up to allow agricultural automation to flourish and deliver its full potential. The introduction to this modern technology not only consumes less time but it also allows the farmer to carry out his agricultural activities more efficiently. In this system, all the devices work on their own with the help of the inputs received from the sensors. The sensors which are placed in the field provide us with the data in regard to the field which is then controlled and monitored by programmable controller. The agricultural field monitoring server system proposed in this work collects the information such as temperature, soil moisture content and detection of rain which affects the growth of crops and soil formation through the sensors installed outside. One of the major factor aims at controlling the unwanted usage of water. Most of the system aims keeping in view the educational and financial background of the average Indian farmers [4]. Both greenhouse based as well an open field can be considered for monitoring the field. One of the important factors to keep in mind is maintaining the humidity and temperature which are greatly influenced by the outside atmosphere. The greenhouse must be equipped with extra sensors and actuators for real-time monitoring and control [5]. The cultivation of crops in the greenhouse is very complex issue and thus it can be simplified if a data is available which represents the amount of water, temperature, fertilizer etc. required at that movement. The longevity, fertility and development of crops depend upon microclimate [6]. The system mainly aims for providing a cheap, reliable, cost efficient and easy to use technology which would help in conversion of resources such as water and in automatizing farms [4], focuses on exploring energy efficient mechanisms to minimize the energy at various block levels such as the microcontroller, the communicating radio, and the sensors [7], predicting the start of germination of the disease depending on particular set of temperature, soil moisture, and relative humidity which is a key factor for the degradation of the yield of crop [8] and replacing the wired traditional method of watering[9] with an automatic system thus conserving water and allowing proper growth to the plants [10]. The commonly used sensors are temperature, humidity and soil moisture sensor. Apart from these sensors: CO_2 sensor module is used for CO_2 gas sensing and light sensor, BH1750 is mounted inside and outside of green house for measurement of light intensity [6] and an LDR (Light Dependent Resistor) is also used to estimate the amount of surrounding light and thus indirectly knowing the level of insolation [11], rain sensor for sensing the rain and returning the result to the microcontroller [9], pH sensor for measuring the acidity of nutrient solution and concentration of the salts in the nutrient solution by measuring the electrical conductivity using the WQ301 conductivity probe [12]. The microcontroller is the heart of the system that is responsible for controlling the irrigation on field. Various types of microcontrollers have been used such as 8051 [16], PIC [8] and more advanced controllers like AVR [4, 9, 13, 14, 15], ARM [2, 3] and Arduino [6, 10].GSM technology allows communicating with the other end user by allowing monitoring the field in real time and sending messages [9], [10] and [13]. Other communication technologies used include: Zigbee technology which is a low-cost, low-power and wireless mesh network standard allows the technology to be widely deployed in wireless control and monitoring application and low power-usage allows longer life with smaller batteries [11], the mesh network implemented by these modules provides high reliability and more extensive range [14]. RF technology which works by creating electromagnetic waves at a source and being able to send the electromagnetic waves at a particular destination. The advantages of a RF communication are its wireless feature so that the user needn't have to lay cable all over the green house. Irrigation being kept the major concern can be achieved by establishing an automated system that allows the watering of the fields when required, knowledge of weather forecasting and monitoring of environmental conditions and of soil moisture also allows in proper maintaining to the field as well as fighting with the disease.

2. SYSTEM OVERVIEW

The system consists of an AVR microcontroller which is the heart of the system. Various sensors such as LM35 temperature, YL-69 soil moisture and raindrop detector sensors are used. A pump is attached to a relay which is then connected to the controller that pumps water depending on the water requirement by the soil and LCD for displaying the condition of the field. The code for the system is developed using embedded C in AVR studio programming software which can be further checked using proteus software and programming interface to the hardware using avrubd.

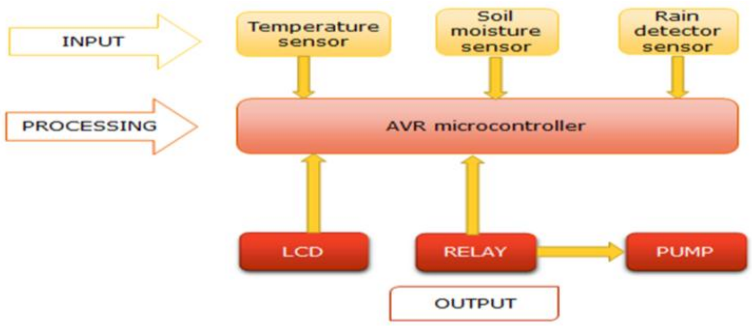


Figure 1: Block diagram of the proposed system

3. CALIBRATION OF SENSORS

LM35 temperature sensor:

Calibration of LM35 temperature sensor has been performed under three temperature conditions: normal, hot and cold conditions. The sensor's working base is the voltage that read across the diode. V_{in} of 4V has been set in the power supply and the output readings were observed in terms of millivolt through V_{out}. The general equation used to convert output voltage to temperature is:

$$\text{Temperature } (°C) = V_{out} * (100°C/V)$$

From the graph, we can conclude that the temperature rises whenever the voltage increases. The sensor records any voltage drop between the transistor base and emitter. Thus the output voltage varies linearly with temperature.

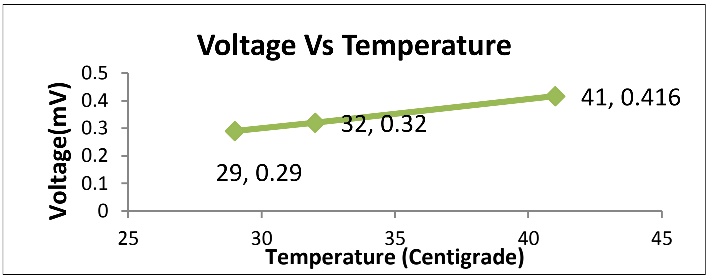


Figure 2: Sensitivity graph for Temperature Sensor

YL-69 soil moisture sensor:

Calibration of YL-69 soil moisture sensor has been performed by setting the input voltage V_{in} 4V and 80g of soil kept in a glass beaker. By adding 10ml of water after every time interval the following readings were observed.

From the graph, we can observe that as current is passed across the electrodes through the soil; the resistance to the current in the soil determines the soil moisture. If the soil has more water, resistance will be low and thus more current will pass through. On the other hand when the soil moisture is low, the sensor module outputs a high level of resistance.

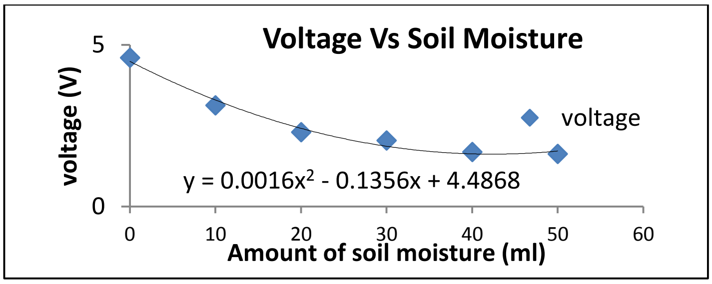


Figure 3: Sensitivity graph for Soil Moisture Sensor

Rain detector sensor:

The calibration of rain detector sensor has been done by connecting to a 5V supply and allowing the water to fall in droplets in the rain board sensor.

From the graph, we can conclude that as the value of voltage decreases, water intensity increases.

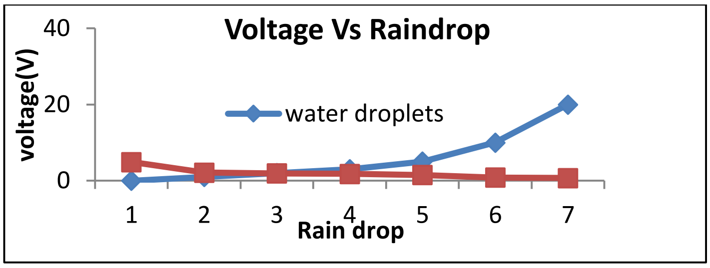
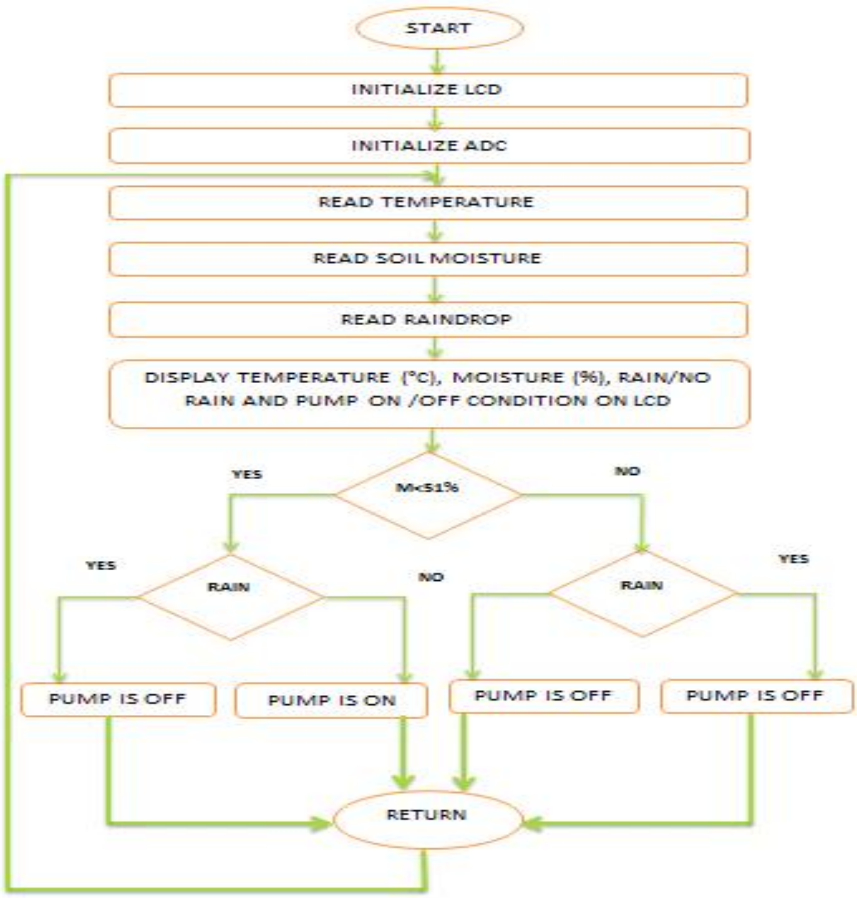


Figure 4: Sensitivity graph for Raindrop Sensor

4. FLOWCHART



5. RESULTS

When the soil moisture is less than 51%, the sensor voltage is amplified which is then given to the controller. Depending on the condition of the rain from the raindrop sensor board, the voltage received is enough to drive and turn on the relay. LCD displays the results as "PUMP ON" or "PUMP OFF" and "RAINING" or "NO RAIN".

Similarly, when the soil moisture is greater than 51%, the voltage obtained is not enough to drive and turn on the relay. Thus, during this condition the relay is turned off. Considering whether it rains or not, the pump will not work in this condition as the soil moisture level is high. LCD displays the results as "PUMP OFF" and "RAINING" or "NO RAIN".

Table 1: Results

Soil Condition	Raindrop Sensor Board Condition	Pump Condition
>51%	"RAINING"	"PUMP OFF"
>51%	"NO RAIN"	"PUMP OFF"
<51%	"RAINING"	"PUMP OFF"
<51%	"NO RAIN"	"PUMP ON"

6. CONCLUSION

Embedded system based monitoring of the field proves to be a real time feedback control system which covers up all the necessary requirements needed for agricultural field monitoring system. The model presented leads to a contribution in modernizing the agricultural field system where the system is obtained in low cost and in reliable operation which can be installed in urban remote places as well, prevents from wastage of water thus reducing the manual labour which is very useful for the farmers and increasing yield of crops. Furthermore, more sensors can be added up for proper monitoring of the field and installation of communication systems to the user for providing the real time condition of the field in the form of SMS as well as MMS facility for video capturing of the field.

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