Smart Agriculture Monitoring System

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Abstract

Manual irrigation is still widely used in agricultural field using traditional drip and can watering. However, traditional irrigation systems are in efficient and in exact, leading to either insufficient or excessive watering. Moreover, it is difficult for farmers to predict suitable quantities at the appropriate time. Manual monitoring of the crop field may also lead to human error and is potentially risky for rural areas. Farmers may also not be aware of intrusions if they are not on location. The scientific and technical improvement in this modern era has led to advancement in sensors and cloud computing technology. An attempt is being made to make use of them in irrigation field. Internet of Thighs (IoT) is one of such emerging technology which can be used in Agriculture. This paper focuses on the implementation of IoT technology in agriculture to help farmers increase their productivity and reduce the cost of production. This system can be used to monitor irrigation, soil moisture, the humidity of the environment, soil nutrients and process data to study further.

Keywords*: Cloud computing, Internet of things (IoT); Smart Agriculture, Agriculture monitoring*

1. Introduction

Agriculture leads the world's water consumption, with farming and food production accounting up to 70% [1] and is also one of the major sectors that contributes to the economic growth. With so much water consumption used in this sector, one would expect an over-abundance of water resourcesdedicated to agriculture. However, one of the largest contributors to water wastage is no doubt caused by low irrigation efficiency.

However, an important limitation is that farmers have difficulties in monitoring and irrigating crop fields in remote locations. Inefficient use of water leads to excessive water consumption dedicated to plants. Moreover, farmers sometimes cannot predict a suitable level of water consumption, which affects the quality of the plants (too much or too little) and may lead to the water wastage. Furthermore, manual monitoring of the crop-field may lead to human error, and is also risky and potentially dangerous for certain types of rural areas, such as those bordering on wildlife areas.Manual monitoring is also time-consuming since most of the farmers spend a lot of time in the crop field. Besides, in manual monitoring method, farmers will not be aware of any intruder (animals or humans) in the crop that could damage or steal the plants. Hence, considering the crucial desire to improve crop productivity, as well as ensure water consumption efficiency and ensuring quality of the crops, an automated irrigation system that can help farmers automatically and efficiently water their plants is developed in this project. The work herein aims to provide efficient water consumption based on specific conditions using sensors to trigger watering of the crop field.

With the development of technologies such as Internet of Things (IoT), cloud computing, mobile computing, implementation of such technologies in real-life problems are increasing. One such field of application of IoT is agriculture. Thus, Smart Agriculture can help the farmers a lot by, helping them to increase their productivity and in return help make them profits. IoT Based Smart Agriculture deploys a technique which helps in automation of irrigation, monitoring of humidity, temperature and other environmental parameters required by the crop to grow. Furthermore, a system which stores the monitored data into a database or cloud can help in studying the nature and environment of thefield.

2. Related Work

Research on developing a smart agriculture system have attracted significant amount of attention from researchers over the years. The following subsections discuss several smart agriculture and intrusion detection available in the markets.

Several related works have been found in literature. Prathibha, S. R., Hongal, A., &Jyothi, M. P.[2] developed a system to monitor plants and control the water supply through a smartphone. The system integrates various sensors to measure the water content of soil and detect the temperature using soil moisture and temperature sensors respectively. This project makes used of Raspberry Pi to connect between the sensors and cloud server, and users can connect their smartphone to the raspberry pi using Bluetooth module.

Next, an improvement has been done by Jindaratand Wuttidittachotti [3] which has introduced a system that can track ambient of weather conditions including humidity, temperature, atmosphere performance and fan power control in chicken farm. Using this design, farmers can easily monitor and control their farm condition using their smartphone. A similar approach has been proposed in [4]. Further enhancement has been done in this design which includes farm monitoring using smartphone and web application. This significantly makes the system easier to be used and can monitor farms from multiple devices.

Further improvement can be seen in [5] using Web Camera to monitor remote location of crop field by capturing time lapse images of the plant efficiently. A similar approach is also implemented in [6] with more secure design. The system used an IoT platform such as System Under Analysis based on Agro-Meteorology system for Viticulture Disease Warning. This system is used to monitor the vineyard using secure wireless or actuator sensor while server sub-system is used to transmit data to server.

The article in [7] describes a system that is developed to manage water flow and power management for an irrigation system. In this design, the optimal water supply was calculated using the approximate information of an ambiguous expert method. A similar technique has been proposed by the authors in [8].Thislatersystemassessedanevent-basedirrigationsystembyutilizingtomatoplants.Thismethod is used to reduce water consumption to improve the efficiency of the system. Apart from that, a system proposed by authors in [9] make usedof renewable source such as solar power to implement automatic irrigation system. The main goal of this method is to develop a low cost and time-based irrigation system.

The article in [10] developed a system to monitor plants and control the water supply through a smartphonebyintegratingvarioussensorstodetectssoilmoistureandtemperatureofthecrop.Asimilar technique hasbeenproposedby[11].

3.Proposed Work

Figure 1 shows the overall structure of the proposed system. The microcontroller serves as the brain of the system where the temperature and humidity, infrared and soil moisture sensor provide the digital information to and where it will process the information. The input from these sensors will be used to either turn on or off the motor pump based on the prescribe instructions. The soil moisture sensor is put inside the soil which is located near the crop to detect the moisture of the soil. The temperature and humidity sensor are positioned behind the crop to measure the temperature and humidity of surrounding air. All data that have been collected from all sensors will be displayed in the LCD located near the crop field for monitoring purposes. Collected information will be uploaded to the firebase cloud using microcontroller where all the data will beinstructed by the server to be stored in the database. Moreover, the developed mobile app will display the data retrieved from the database. Users can have access and control to their automatic irrigation system and monitor the crop through their smartphones. Using this approach, userscan monitor the crop efficiently and track the real time data condition of the soil, temperature and humidity of air surroundcrop.

Phase 1: Data acquisition. This phase starts by initializing LCD and is the subsequent process after initializing all sensors and setting the RTC. Two sensors are used to measure the current data of crop condition. The first sensor use is soil moisture sensor. This sensor measures the condition of the soil based on the resistance receive by the soil moisture. This sensor has two types of input which are analogue and digital. If the value is set to analogue, the user can only see the current voltage receive by this sensor. However, if the user set the value to digital, the user can read the value in ASCII value which is from 0 to 1023. The lower value reflects that the soil moisture is more dryand viceversa.

The second sensor is temperature and humidity sensor (DHT11). This sensor measures the current temperature and humidity surrounding the crop. Depending on amount of water of natural surrounding such as rain, the humidity and temperature reading will be higher on rainy days. However, if the condition is dry, the humidity and temperature will be lower. Furthermore, all the data that were measured by these sensors are collected and send to cloud using Wi-Fi connection. This phase will then continue to the next phase as indicated by ‘B’ which represents the intruder detection phase.

2.1.1 Intrusion Detection. This paper is using passive infrared (PIR) sensor to detect if intrusion occurs at crop field. The PIR sensor can detect living obstacles such as human and animal. The sensor operates by detecting the temperature and wavelength of objects. If an object or obstacle detected by the sensor meet the requirement as the sensor detect human and animal presence, the sensor will send the data to the NodeMCUmicrocontroller. Once detected, the microcontroller will activate the alarm by turning on the buzzer and camera module. The camera will record the current situation and transmit the real time data of the captured image to thecloud.

*Phase 3: Smart Irrigation and Monitoring System.*The automated irrigation system must meet specific predefined requirements to perform its task. First, when the system entering into an automated mode, it will measure the current time by using RTCmodule.

Ifthesystemdetectsthattimeisdaylight,thesystemwillmeasuretheconditionofthesoilusing soil moisture sensor. It measures the condition of the soil during daylight every one hour. If the sensor detect that soil is in dry condition, serial monitor will display message “*dry*” on LCD .

Phase 4: Data storage and notification. The data storage is located at the cloud storage and IoT application such as Firebase Database platform. After the data is store at specific location, the data is sending back to the smartphone and other device to be monitor by the farmer. The farmer can receive the notification if the intruder is occurred and temperature of the crop field is toohot.

The data that been send by the Wi-Fi via NodeMCU will then transmit to the cloud server inside the local. This cloud server is located inside the computer. The data that have been received by the cloud server will then be transmitted to the Firebase Database Platform which will store the data from the sensors. Apart from that, this platform can display the current data that have been transmitted from the microcontroller. This cloud database can be used to send the notification to the farmer if certain threshold is reached.

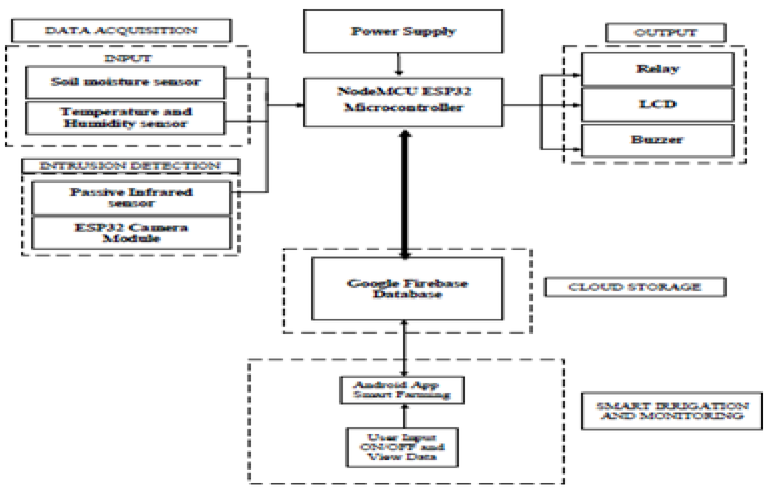

Fig.1

4.BENEFITS OF PROPOSEDSYSTEM

Excelled efficiency

Today the agriculture become extremely fast, and it is a competition now. Farmers need to grow more crops in a less amount of time to meet the requirements of the people. Atmospheric conditions are a major part of concern for the farmers because agriculture depends on that fully. The IoT enabled systems can help farmers to monitor the conditions in real-time and take necessary actions.

Reduced resources

This method has reduced the resources and only care about the main resources needed by the plants not the unnecessary details. This is just an advance for of precision farming in which sensors collect the relevant data and take actions based upon that.

Cleaner process

The traditional method has the irrelevant use Pesticides and fertilizers which is very harmful for human health. IoT based system reduces the use of the pesticides and focuses more on the greener farming with the less use of water and energy at the sametime.

5. Results andDiscussion

Figure 2 shows the prototype of the Smart Monitoring and Automated Irrigation. Water irrigation is in two modes: manually or automatically based on user's input. Apart from that, it can also monitor the current data from temperature, humidity, soil moisture and motion sensor surrounding the crop-field.This system has camera that captures the current images of the crop field to detect if intruder is present or not. Results of the project implementation can be seen illustrated in Figure 2-3.

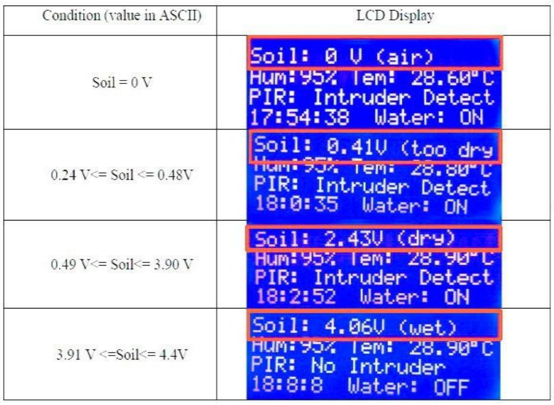

Fig.2

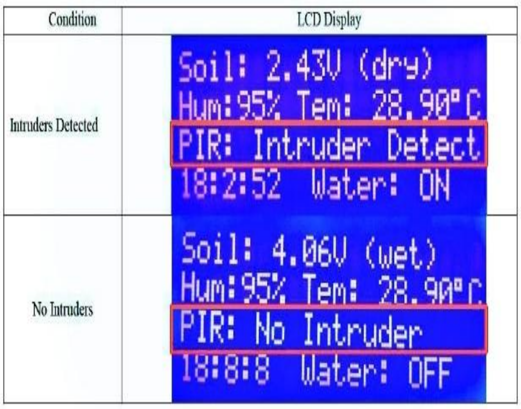

Fig.3

Conclusion and FutureWork

IOT-enabled agriculture system is greatly beneficial to the farmers as it reduces the manpower and harmful chemicalsforincreasingtheamountofthecrops. Proper design is necessary for the farming with the reduces complexities. All the data should be properly taking into count for the better agriculture. The sensor placement and the connectivity are a vital step. The data redundancy should not be there in order to meet the accurate results. The farmer should be skilled with some experience or prior knowledge otherwise it would take much time to switch him to the traditional form of thefarming.Nevertheless, the work herein represents a working prototype of a real system. For commercialization, some enhancement need to be considered. First, the use of camera with machine learning can improve detection accuracy of intruder without the help of farmer.

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