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AGRICULTURE MONITORING SYSTEM: A STUDY

N. M. Z. Hashim*, S. R. Mazlan, M. Z. A. Abd Aziz, A. Salleh, A. S. Ja'afar, N. R. Mohamad

Centre for Telecommunication Research and Innovation (CeTRI), Faculty of Electronic & Computer Engineering (FKEKK), Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

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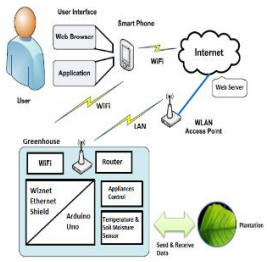
*Corresponding author
nikzarifie@utem.edu.my

Graphical abstract



Abstract

This study is a review on controlling an electronic device (Arduino) apply for temperature and soil moisture process using Android based Smart phone application in order to address the issues of flexibility and functionality. Beside, this study in future will also develop a low cost and flexible for agriculture control due to not to incorporate with an expensive components such as high end personal computers. On peak of that, now anyone, from anytime and anywhere can have connectivity for anything and it is expected that these connections will extend and create an entirely advanced dynamic network of the internet of things. Thus, this study is to review several design of smart monitoring system using an embedded micro-web server, with IP connectivity for accessing. There are three principal components in this study, which are an electronic device (Arduino), software development (eclipse), and system prototype internet protocol layer. The aim is to build the web organization and ultimately to combine all three components together. The solution of this whole study is a complete review to design a complete application with an electronic device that can help landlord agriculture to start out a dependable quality product in the marketplace.

Keywords: Internet of things, micro web server, Arduino UNO

Abstrak

Kajian ini adalah komentari kepada pengawalan alat elektronik (Arduino) untuk suhu dan kelembapan tanah proses menggunakan aplikasi Android berasaskan telefon pintar untuk menangani isu-isu fleksibiliti dan kepelbagaian fungsi. Selain itu, kajian ini pada masa akan datang juga akan membangunkan satu sistem yang mepunyai kos yang rendah dan fleksibel untuk kawalan pertanian kerana tidak menggabungkan komponen mahal seperti komputer berprestasi tinggi. Kini sesiapa sahaja, bila-bila masa dan dari mana-mana sahaja boleh mempunyai sambungan bagi apa-apa dan ia dijangka bahawa sambungan ini akan meluaskan dan mewujudkan rangkaian dinamik sepenuhnya maju daripada internet perkara. Oleh itu, kajian ini adalah untuk mengkaji semula beberapa reka bentuk sistem pemantauan pintar menggunakan pelayan web mikro terbenam, dengan penyambungan IP untuk mengakses. Terdapat tiga komponen utama dalam kajian ini, yang merupakan peranti elektronik (Arduino), pembangunan perisian (gerhana), dan sistem prototaip lapisan protokol internet. Tujuannya adalah untuk membina organisasi web dan akhirnya untuk menggabungkan ketiga-tiga komponen bersama-sama. Penyelesaian kajian ini keseluruhannya adalah kajian lengkap untuk mereka bentuk satu permohonan yang lengkap dengan alat elektronik yang boleh membantu tuan tanah pertanian untuk memulakan produk berkualiti yang boleh dipercayai di pasaran.

Kata kunci: Perkara android, pesanan atas talian, rangkaian, wayarless

1.0 INTRODUCTION

In the modern era of technologies, all activities refers on computing will be outside the territory of the traditional desktop. In the Internet of Things (I.O.Ts) pattern, all things which are everywhere will be on the network in one form or another. At present, many kinds of electronic device such as Radio Frequency Identification (RFID) and sensor network technology will growth to meet this new task, in which information and communication system are unnoticeably embedded in the environments around us. Besides that, cloud computing can provide the virtual infrastructure for such utility computing which integrates monitoring devices, storage devices analytics tools, visualization platforms and client delivery.

The cost based model that Cloud computing offers will enable end-to-end service provisioning for businesses and users to access applications on demand from anywhere. With the growing presence of Wi-Fi and 4G-LTE wireless Internet access, the evolution towards ubiquitous information and communication networks is already evident. However, for the Internet of Things vision to successfully emerge, the computing paradigm will need to go beyond traditional mobile computing scenarios that use smart phones and portables, and evolve into connecting everyday existing objects and embedding intelligence into our environment.

The purpose of this study paper is based on Internet of Things (I.O.Ts) technology which is being applied to the agriculture sector. To successfully construct such a smart-agricultural environment, the development of essential Internet of Things (I.O.Ts) technology optimized for agriculture such as sensor hardware, middleware platforms, routing protocols and application services for agricultural environments is needed. An agricultural environment monitoring system provides environmental monitoring services and facility controlling services, and thus maintains any kind of plants growing environment in an optimal status. This system also can improves the convenience and productivity of user's plantation sector. However, each hardware devices and programming involve to make this project achieved the target will be discussed such as Internet of Things (I.O.Ts), Arduino Uno with an Ethernet shield, Android application, and Micro-web server. Other than that, the main objective of this introduction is to deliver a better understanding on the process that operates in the hardware and software and the collection of theories.

The Internet of Things (I.O.Ts) can be described as connecting everyday objects like smart-phones, Internet TVs, sensors and actuators to the Internet where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves. Building I.O.Ts has advanced significantly in the last couple of years since it has added a new dimension to the world of information and communication technologies. According to the blog of "Progression from M2M to the Internet of Things", it is expected that the number of devices connected to the Internet will accumulate from 100.4 million in 2011 to 2.1 billion by the year 2021, growing at a rate of 36% per year. In the year 2011, 80% machine to machine (M2M) connections were made over mobile networks such as 2G and 3G and it is predicted that by 2021, this ratio will increase to 93% since the cost related with M2M over mobile networks are generally cheaper than fixed networks.

Arduino is a family of open source single board microcontrollers based on the ATmega328. In this project, Arduino UNO R3 was used. This type of Arduino is the latest version among the Arduino UNO Board as it uses the ATmega8U2 instead of FTDI chip. The ATmega8U2 make the transfer rate faster. This family of boards was designed with the aim of making electronics far easier and accessible for the use in various types of disciplines and projects. The Arduino have 14 digital input/output pins, 6 analogue input, a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button. The Arduino have everything needed to support the microcontroller by connecting the USB cable as a power or power it with an AC to DC adapter by using battery to get it started. The Arduino is programmed by using a wring-based language (syntax + libraries), similar to C++ programming with some simplification and modification, and processing-based IDE.

Besides that Ethernet shield has the capability to be used both, as a client or a server. To successfully communicate between remote user and the Greenhouse Gateway, configuration stage and sensor/actuator control stage layers have been implemented on the Arduino Uno. The <Ethernet.h> libraries are used to receive data on Arduino Uno and create output messages in JavaScript Object Notation (JSON) format.

The system consists of a micro Web - server based on Arduino Ethernet, hardware interface modules and the Android compatible Smart phone app. The architecture presented in this work can be customized in different ways in order to accommodate different application scenarios with minimum recoding and design i.e. each time a new device is added to the micro Web-server, a new thread dedicated to the device is automatically created in the Smart phone app. Hence, the aim of the proposed work is not to incorporate expensive components such as high end personal computers. This system allows authorized home owners to remotely control and monitor connected devices at home using any Wi-Fi or 3G/4G enabled Smart phone which supports Java. The smart phone app provides a graphical user interface (GUI) for accessing and controlling the devices at home through server real IP. The objectives of the study are to review on a program development process for controlling an electronic device (Arduino) applies for temperature and soil moisture process using Android based Smart phone application, to identify a smart monitoring system using an embedded micro-web server, with IP connectivity for accessing and to determine a low cost and flexible component or device used for agriculture monitoring system.

2.0 LITERATURE REVIEW

Smart agriculture monitoring system has been focus in the research community in the recent years. This monitoring systems can be classified according to the environment that is used for, such as industrial, home, office, agriculture and others environment. In literature review, this smart agriculture monitoring system project will be discussed among the previous research of a project. There are five selected research papers has been chosen from the previous project as literature review to identify the differences of this project. Table 1 shows the critical review on developed system. The entire previous projects are user friendly because this system actually used to monitor a specific area. However, this smart agriculture monitoring system is low cost and low power consumption project because it causes no hazardous harm in the environment and it is more reliable system.

Table 1 Critical review on developed systems

No.	Functionality	[1]	[2]	[3]	[4]	[5]
1	User Friendly	Yes	Yes	Yes	Yes	Yes
2	Low Cost	Yes	Yes	No	No	Yes
3	Application (Mobility)	Yes	Yes	WSN	WSN	Sensor
4	Power	Low	Low	Low	Low	Low
5	Employ	Home Control	Agriculture Industry	Agriculture Industry	Agriculture Industry	Agriculture Industry
6	User Interaction	Yes	-	Yes	Yes	Yes
7	Security	Yes	-	Yes	Yes	-
8	Load Limit (web server)	Yes	Yes	Yes	Yes	No
9	Simplicity	Yes	-	No	No	Yes
10	Flexibility	Yes	Yes	Yes	Yes	Yes
11	Community	Yes	Yes	Yes	Yes	No
12	Freedom	Yes	Yes	Yes	Yes	Yes
13	Easy Installation & Upgrades	Yes	Yes	No	Yes	Yes
14	Display Control	Yes	-	Yes	Yes	Yes
15	Configure Website	Yes	Yes	Yes	Yes	No

The author choose to applied the monitoring system using android based on handheld device such as smart phone to the home control security [1]. The project also is present a low cost and flexible home control and monitoring system using an embedded micro-web server, with IP connectivity for accessing and controlling devices [2] and appliances remotely using Android based Smart phone application [1]. The system does not require a dedicated server PC and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality. In addition, this system also can control devices such as light switches, power plug, temperature sensor and other sensor that is been integrated in order to use in the home control system. By comparing the author project [1] and [2] with smart agriculture

monitoring system project, the monitoring system is been applied to the agriculture industry because it can be used to increase the size number of product and also can maintain the quality of the agriculture product. Based on the project [1], the system was only use to control devices and appliances remotely by using android smart phone however in this project improvement, user can monitor their plantation status by receiving a message of temperature and soil moisture automatically and also can control the devices implemented in the greenhouse.

Besides that, researcher used agricultural environment monitoring server system for monitoring information concerning an outdoors agricultural production environment utilizing Wireless Sensor Network (WSN) technology [3]. The project was to collect environmental and soil information on the outdoors through WSN-based environmental and soil sensors. It also gathered image information through CCTVs, and location information using GPS modules. The collected information was converted into a database through the agricultural environment monitoring server consisting of a sensor manager, which manages information collected from the WSN sensors, an image information manager, which manages image information collected from CCTVs, and a GPS manager, which processes location information of the agricultural environment monitoring server system, and provides it to producers. In addition, a solar cell-based power supply was implemented for the server system so that it could be used in agricultural environments with insufficient power infrastructure [3]. This agricultural environment monitoring server system could even monitor the environmental information on the outdoors remotely, and it could be expected that the use of such a system could contribute to increasing crop yields and improving quality in the agricultural field by supporting the decision making of crop producers through analysis of the collected information. On the other hand comparing with the smart agriculture monitoring system project, the scopes of this project were mostly applied and utilized in closed agricultural environments such as greenhouses, cattle sheds and etc. It was difficult to apply agricultural monitoring systems in outdoors locations such as paddies, fields, orchards, and etc. because of the cost to build the project in outdoors locations is more expensive and it will be more difficult for user to do the installation process. Based on the project understanding [3], the system required a CCTV to monitor a real-time video and GSM module to transfer information and high technologies is needed. As a conclusion for the improvement, a low cost technology will be used in the project and the hardware and software will be easier to install in order to make the user feels more comfortable.

Other than that, in [4] the project explained about the design and development of a smart wireless sensor network (WSN) for an agricultural environment. Monitoring agricultural environments for various factors such as temperature and humidity along with other factors can be of significance. The capability to document and detail changes in parameters of interest has become increasingly valuable. Investigations were performed for a remote monitoring system using Wi-Fi, where the wireless sensor nodes are based on WSN802G modules. These nodes send data wirelessly to a central server, which collects the data, stores it and allows it to be analyzed and displayed as needed. Thus, by comparing this project [4] with smart agriculture monitoring system, the project used an electronic device such as Arduino which is connected to a temperature and soil moisture sensor in order to collect the information and an android based on smart phone react as a receiving node via wireless communication. However, as an improvement from the previous project [4] micro web server will be implemented in the Arduino not just for collecting information but also can control other appliances remotely using android based smart phone application.

Moreover, the author has been focused on the research data acquisition in greenhouse for multiple sensors to use data for simulation or processing to achieve the better enhancement of growth in greenhouse [5], Graphical User Interfaces (GUI) had been used through Lab VIEW, firmware of Arduino as software and Arduino board and sensors as hardware. By using Arduino mega board provides multiple inputs analogue and I/O digitals to make read data sensor easy to take temperature, humidity, CO2 gas, also measuring the soil moisture that needed for irrigation plants and the intensity of lights that applied for greenhouse. These factors had the major effect on increase growth plants. Greenhouse environments monitoring present difference changes to parameters, the system for this persistence had been provided and given ability to control on climate of greenhouse. Therefore, the improvement through the smart agriculture project is to determine in which the suitable temperature and soil moisture is better for a plant by using the simulation based on the project [5].

3.0 COMPARISON STUDY

From the paper had been researched, there are few methods for agriculture monitoring system that suitable for new Android Development such as using GSM, CCTV system and other more. Table 2 are the list and the few advantages and disadvantages from the previous researches.

Table 2 Comparison Study of Human Notification System [a]

Papers	Advantages	Disadvantages
1. Internet of Things: Ubiquitous Home Control and Monitoring System using Android based Smart Phone	The system does not require a dedicated server PC and offers a novel communication protocol to monitor and control the home environment with more than just the switching functionality	The system is only use to controlling devices and appliances remotely by using android smart phone
2. Internet of Things (I.O.Ts): A vision, architectural elements, and future directions	A framework enabled by a scalable cloud to provide the capacity to utilize the I.O.Ts. The framework allows networking, computation, and storage and visualization themes separate thereby allowing independent growth in every sector but complementing each other in a shared environment.	The evolution of the next generation mobile system will depend on the creativity of the users in designing new applications. I.O.Ts are an ideal emerging technology to influence this domain by providing new evolving data and the required computational resources for creating revolutionary apps.
3. Study on an Agricultural Environment Monitoring Server System using Wireless Sensor Networks.	The system could monitor the environmental information on the outdoors remotely, and by supporting the decision making of crop producers through analysis of the collected information.	The system required a CCTV to monitor a real-time video and GSM module to transfer information and high technologies is needed
4. A Wi-Fi based Smart Wireless Sensor Network for Monitoring an Agricultural Environment	The capability to document and detail changes in parameters of interest has become increasingly valuable. Investigations were performed for a remote monitoring system using Wi-Fi, where the wireless sensor nodes are based on WSN802G modules	The WSN802G modules was been used as a nodes to send data wirelessly to a central server, which collects the data, stores it and allows it to be analyzed and displayed as needed.
5. Data Acquisition of Greenhouse Using Arduino	There are multiple sensors which is used for simulation or processing to achieve the better enhancement of growth in greenhouse	A Graphical User Interfaces (GUI) had been used in these system through Lab VIEW
6. A Design of Greenhouse Monitoring & Control System Based on ZigBee Wireless Sensor Network	As an open and global standard for WSN, ZigBee shows advantages on low cost, low power consumption and self-forming.	ZigBee-based wireless monitoring and control system in one greenhouse is composed of a coordinator and several end devices including sensor nodes and actuator modules organized as a star network
7. A Wireless Sensor Network Prototype for Environmental Monitoring in Greenhouses	A wireless sensor network prototype with two-part framework for greenhouses consist of several sensor nodes parts and a sink node part with embedded terminal.	The current solution is expensive for agricultural application because each node is about $400. The sink node seems too complex due to limited compatibility of WSN products.[6]
8. Development Of A "Smart" Wireless Soil Monitoring Sensor Prototype Using RFID Technology	RFID devices almost exclusively use backscatter modulation as the method of RF transmission. As a mode of communication, it is dependent upon the level of electromagnetic coupling between the reader antenna and tag	Transmission range achieved using the wireless sensor was limited by the selected RFID reader to less than 1 m.[7]
9. Development Of A Smart Mobile Farming Service System	The embedded GIS system is used on the PDA, both the farming information from the WSN and the GPS information of each sampling site were recorded by the smart mobile terminal and the embedded GIS system checked the data.	A NovAtel OEM1 board was selected as the GPS OEM module and a corresponding extending circuit was developed to control this module. The module occupied two serial ports, one was used to set up the serial port and to input the needed instruction. Another was used to apply for the differential information.

10. Smart Energy And Water Meter: A Novel Vision To Groundwater Monitoring And Management	In order to groundwater monitoring and management, a (MDM) meter data management software is used as data compiling, information processing and reporting.	The smart energy and water meter (SEWM) designed based on the requirements of electricity and water utilities[8]
11. FPGA-Based Wireless Smart Sensor For Real-Time Photosynthesis Monitoring	The smart sensor is capable of acquiring and fusing the primary sensor signals to measure temperature, relative humidity, solar radiation, CO2, air pressure and air flow. In addition, is capable of performing signal processing, such as average decimation and Kalman filters, to the primary sensor readings so as to decrease the amount of noise, especially in the CO2 sensor while improving its accuracy	The capability of fusing the information of nodes inside of the sensor network must be taken into consideration. To accomplish this, high performance computational capabilities are required. These days, Field Programmable Gate Arrays (FPGAs) are devices that are being employed in applications where high demand computational resources are necessary[9]
12. Wireless LAN Based Infrared Remote Control	An Infrared IR Photodiode detects and receives Infrared energy levels. The device has some capacitance and its output is a current. To overcome this and to look at faster signals a trans impedance or current to voltage converter is needed	To improve or extend the functionality of a consumer electronic product called the Universal Infrared Remote Control. It is extended by adding Wi-Fi connectivity and automatic volume control.

4.0 DISCUSSION

As a conclusion, by comparing all the selected journal methods there are several technique that is used to monitor a specific area whether inside or outside fields such as using a WSN (wireless sensor network), wireless CCTV, Android Smartphone based on wireless network and these system also may be employ at home, office, public, agriculture environment and etc.[10]-[15]. The system can be used without any worries because it is user friendly, secure, reliable and it is also easier for user to install this system. However, as a suggestion in the future plan project by using Internet of Things (I.O.Ts) via wireless network which can connect through an android application is more efficient compare with the previous project researched. Other than that, using an electronic device also is essential because the functions of this board which is can control things will make the system execute well. In addition, by connecting Arduino board with I.O.Ts may be able to react as feedback systems that can send current status area to android application. This status area is come from the sensors which are connected to Arduino board such as temperature and soil moisture sensor in order to prove the current status is more reliable system[16]-[21].

5.0 PROPOSED METHOD

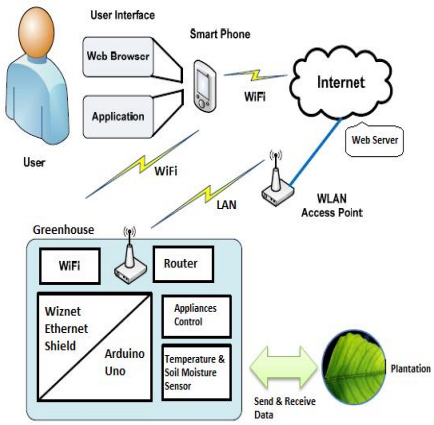


Figure 1 Proposed system's framework

6.0 CONCLUSION

This study paper showed a smart agriculture monitoring system by using an electronic devices and an android based on smart phone as shown in Figure 1. This technology will helps a landlord plantation to monitor and manage the status of their plantation such as fruit plants or other plant in order to increase the production and improvement of quality at various agriculture sites. There are much benefits using this

technology which it is consider as a low cost and reliable system compared to the other system that used such as GSM module which is need more money to build up the system. From the study comparison, there are several technique that are used to monitor a specific area whether inside or outside fields such as using a WSN (wireless sensor network), wireless CCTV, Android Smartphone based on wireless network and these system also may be employ at home, office, public, agriculture environment and other.

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