Design and Implementation of a Smart Farm System

Lecturer Ahmed A. Radhi

Email. Ali.ahmed100000@gmail.com

Asst.Lecturer Hayder Hassan Mohammed

Technical Computer Engineering Dept.

Al-Mamon University College/ Iraq

Abstract: The farming is important for life of most countries in the world and has influence on the economy. In dry or in case of inadequate rainfall areas the irrigation become difficult, therefore, it required to handled remotely for farmer safety the agro-resources and reduce harm the productivity. Farmers tend to over-irrigation the soil. Different kinds of soil required different irrigation schedules and the irrigation also depends on many other factors like wind speed, existing moisture level, temperature season, stage of growth of crop, etc. In This research suggests a smart farm consist of automated irrigation system with programmable schedule, automatic tank level controlling for storage water of irrigation, and temperature measurement of farm based microcontroller with desired sensors and network server (gateway) which was connected to the internet. This system can be monitored and controlled by using a website of network server over the internet from any location in the world.

Keywords: smart farm, microcontroller, IoT

1. Introduction

Smart Farming is a modular platform made up of sensors that can be integrated in an extremely user-friendly system to enable farmers to get full control over critical processes and events. In the long term, this will enable economic and environmental sustainability of the farm, while promoting a better work environment as well as improved animal upkeep. Smart Farming can be adapted to support any type of farm, from control of what happens and monitoring of the various processes. This includes solutions from monitoring environments, using a user-friendly application on a smart phone or tablet as shown in **Fig. 1** [11], all events on the farm can be monitored and controlled. In this research a prototype of smart farm controlled via microcontroller and PHP web server depending on desired sensors

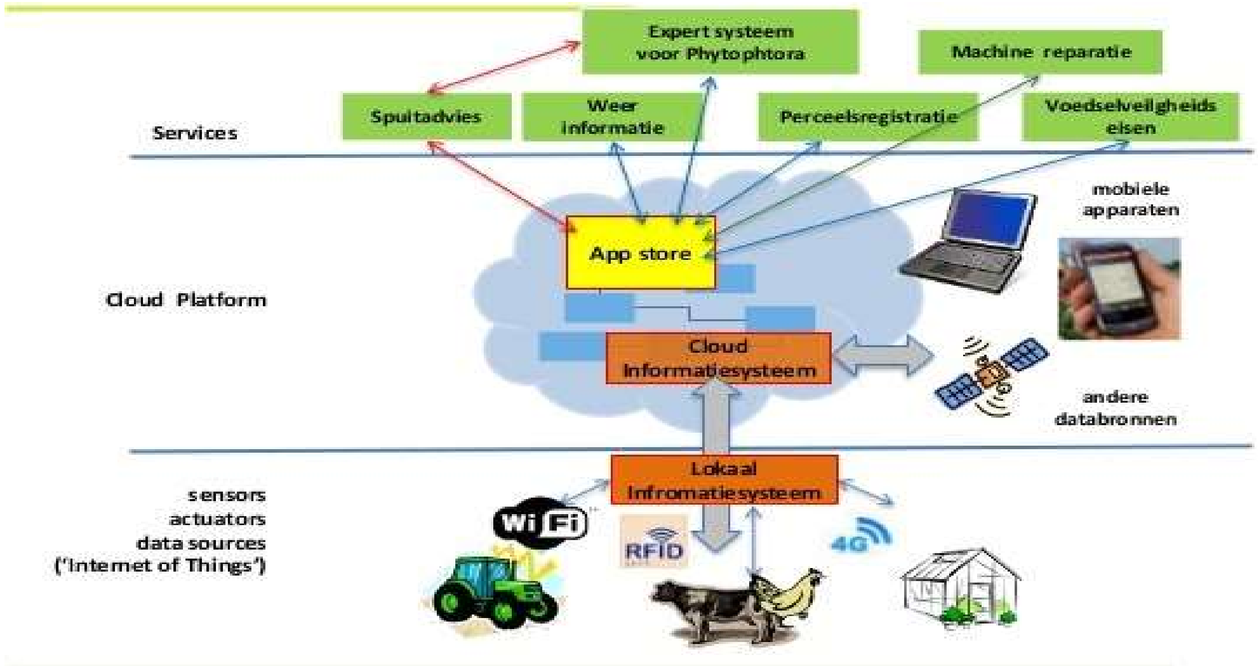


Fig 1. Smart farm based cloud application

2. Related Works

The first automatic irrigation system stusy presented in 1969 [7], and 1970 [5]. In 1973 heat dissipating soil used automatic irrigation plot [1]. In 1980 designed automatic irrigation system operated when two or more tensiometers in the plot less than set point [8]. In 1997 designed automatic irrigation based modified manometer sensor [14]. Automatic irrigation system based wirelesscommunication Such as Wifi, REID, ZigBee, WLAN, and Bluetooth for controlling and monitoring become popular in last years [12]. ZigBee technology is a wireless sensor network (WSN) with high cost and limited distance [4]. Bluetooth technology operated at 2.4 GH up to 3 Mbps bitrate [17]. In 2007 a wireless sensors in the agriculture, uses soil moisture sensors and wateiring system [6]. In 2008 an efficient water mamagmet based on distributed wireless sensor network for cropping system by using PLC [18]. In 2009 review the applications of WSN and RFID in agriculture and industry of food [9]. In 2010 a greenhouse based WSN that can be monitored by using GSM [10]. In 2011 a WSN used in Automatic irrigation system , which depending on data from sensor for decision of watering [13]. In 2012 an automatic cardamom irrigation by real sensor to prevent overflow water in slope area [16]. In 2013 an automatic irrigation system controlled via cell phone with fixed number by using GSM and microcontroller for motor controlling and other devices [15].

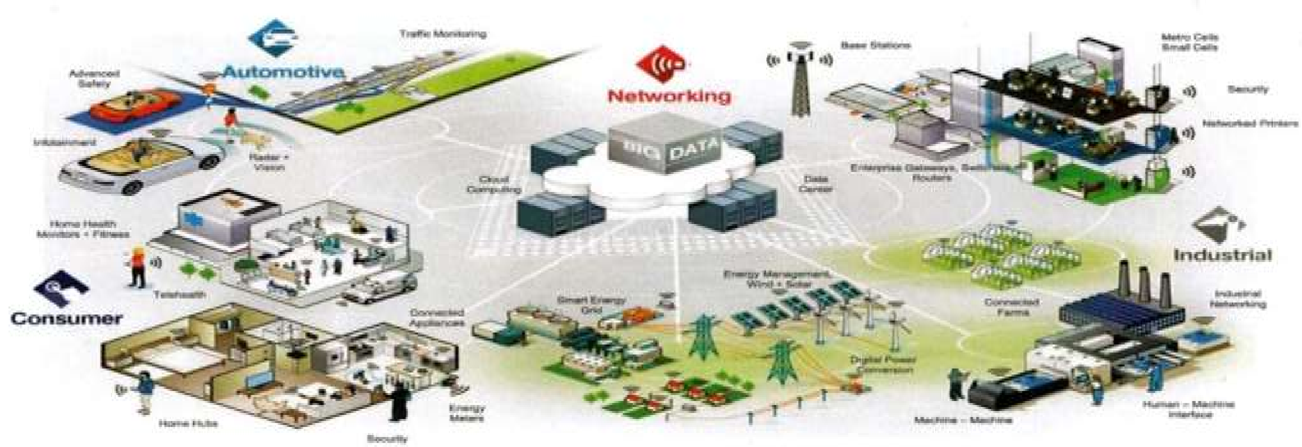


Fig. 2 The Internet of Things applications in the human life

3. Internet of Things (IoT)

The Internet of Things is a technology that has become increasingly relevant in last years. It including connecting devices throw the Internet in order to retrieve information from them at any time and
from anywhere. In the IoT, sensor networks that exchange information wirelessly via
Wi-Fi, Bluetooth, Zigbee or RF are common [2]. As shown in **Fig. 2**.As with many new ideas, IOT origin can be traced back to the Massachusetts Institute of Technology (MIT), from work at the Auto-ID Center founded in 1999.

According to the Cisco Internet Business (IBSG) Group, IoT is simply observed the "things or objects" were used the Internet more than users as shown in **Fig. 3** [3].

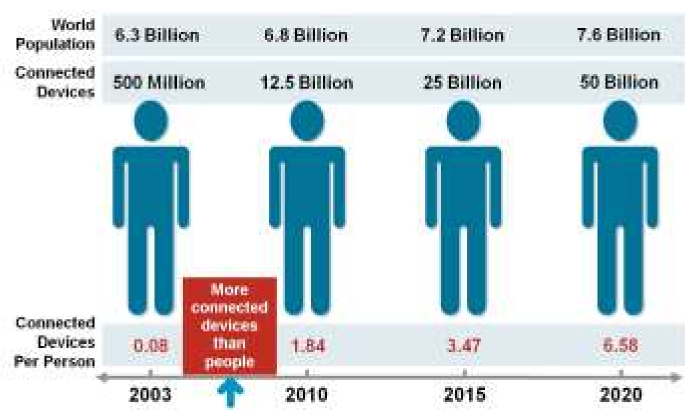


Fig 3. The Internet of Things Was "Born" Between 2008 and 2009

4. Proposed smart farmer control system

In this research, a prototype of a smart farmer designed for monitors the amount of soil moisture, tank level for storage water, light detector, and temperature sensor. The prototype was programmable for varied soil type or type of crop. With the special case taken, the moisture of the soil controlled the watering system is turned on/off. In case of dry soil, the irrigation system by controlling valves for watering the crops will be active; the tank level can be controlled by water level floating detector for auto on/off water pump and light detector for auto on/off lights in the farmer. The prototype can be monitored and controlled locally via microcontroller (Control Unit) and can monitored and controlled from any location in the world via the Internet through a gateway server website (Base Station Unit) as shown in **Fig 4.**

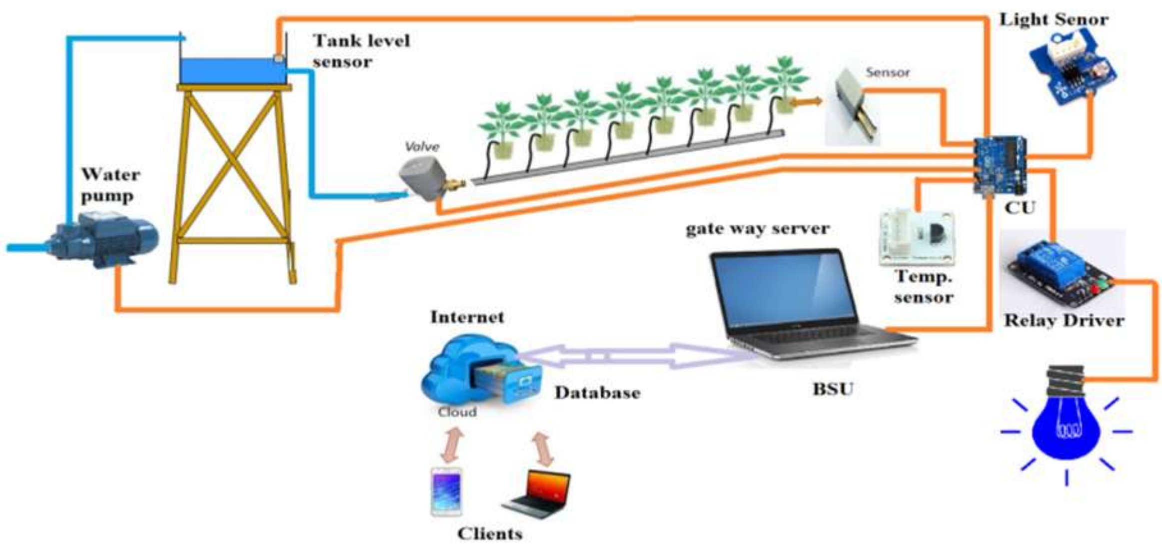


Fig. 4 prototype structure of smart farmer

4.1 Control Unit(CU)

The control unit includes a microcontroller (PIC16F877A) which is the main part of the system. The moisture, light detector, tank level and temperature sensors are connected to the (A/D) of the controller. The water pump, valves, and light driver circuit coupled with the output ports. An LCD monitor indicates status of the control system and the control unit connected with the server via a serial port.

4.1.1Smart Irrigation

Irrigation is most important in crop production in the agriculture areas, Irrigation system is designed to reduce the number of workers needed for watering process, and save time of work. Irrigation can be made automatic by using microcontroller and soil moisture sensors. Moisture sensors estimates the soil water content based on the dielectric constant of the soil. The dielectric constant can be thought of as the soil's capability to electrical transmits. It includes a pair of electrodes to measure the resistance of the soil. The resistance of the soil is reduced when constant is increase, depending on water content of the soil, as shown in **Fig 5.**

4.1.2 Tank level controlling

Automatic tank level monitor presented includes, sensor (floating sensor), microcontroller, LCD 16X2 monitor display, and the pump , the tank controlling detecting the level of water is done by the analog to digital converter (ADC) which was embedded in microcontroller, Relay driver used to switching ON or OFF the pump, depending on receiving signal from the (ADC) as shown in **Fig 5.**

4.1.3 Farmer lights controlling

Lighting automatic control system executing the control unit for electricity saving of the farmer lights. The present system will be turn ON in the night turn OFF in the morning. Light Dependent Resistor (LDR) sensor to indicate a day/night connected to the microcontroller analog input for controlling the light as shown in **Fig 5.**

4.1.4 Temperature measurement

The Lm35 sensor is used as the heat detector in the control unit. Its better used because its attractive features (low cost and highest sensitivity between +2 C° and +250 C° and a low power consumption at only +5v DC).

4.1.5PIC16F877A Microcontroller

A microcontroller is a computer control system on a single chip. It has represent the brain in the control system, which can decode written instructions and convert them to electrical signals. PIC16F877A has an analog to digital converter (10bits ADC) for reading data from analog sensors, and digital input-output ports for read/write data from and to surrounding digital devices such as switching devices and relay driver circuits. The tank level percentage is measured from the output voltage of the sensor based the equation (1).

%Tanklevel= (supply voltage *20*L/ 1024) …………(1)

where supply voltage is 5volt, and L is the sensor output voltage.

The temperature is measured from the output voltage by using the equation (2).

Temp (C°) =temp*(supply voltage * 1000 / 1024) / 10…………….(2)

Where the voltage is used to power the LM35) and 1024 is 2^{10}, the value where measured from ADC can be represented by the PIC16F877A. 1000 is used to change the unit from V to mV. 10 is constant. Each 10 mV is directly proportional to 1ºCelsius.

The light and irrigation sensor depending on threshold value to operated.

The flowchart of the control unit programming shown in **Fig 6,** where the software used to program the microcontroller is MikroC PRO for PIC.

4.2 Base Station Unit (BSU)

BSU was designed to connect the control unit with IoT and design of the website of smart farm .

4.2.1 Communication between the control unit and web server.

The communication between the control unit and the computer device that acts as a web server is made through a connected to the serial port (RS-232) of the computer device as shown in **Fig. 7.**

In order to implement the interface, the visual basic 2013 programming has been chosen to control the serial port by sending one command word for controlling system

via the Internet and receive two status words as shown in **Fig. 7,** then store the information in desired data base which can read and controlled via web server as shown in Fig 8.

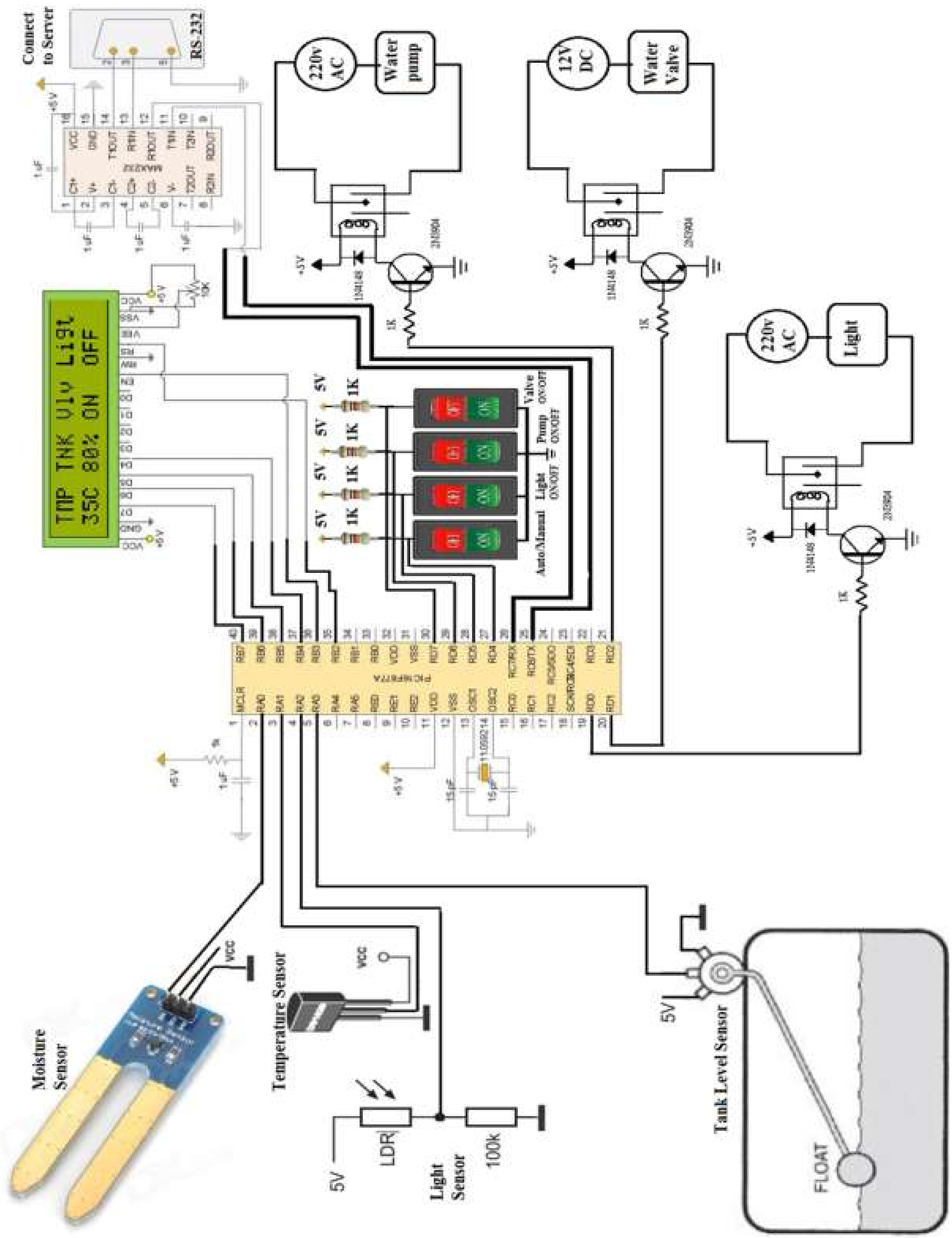


Fig. 5: Smart farm Control unit circuit diagram

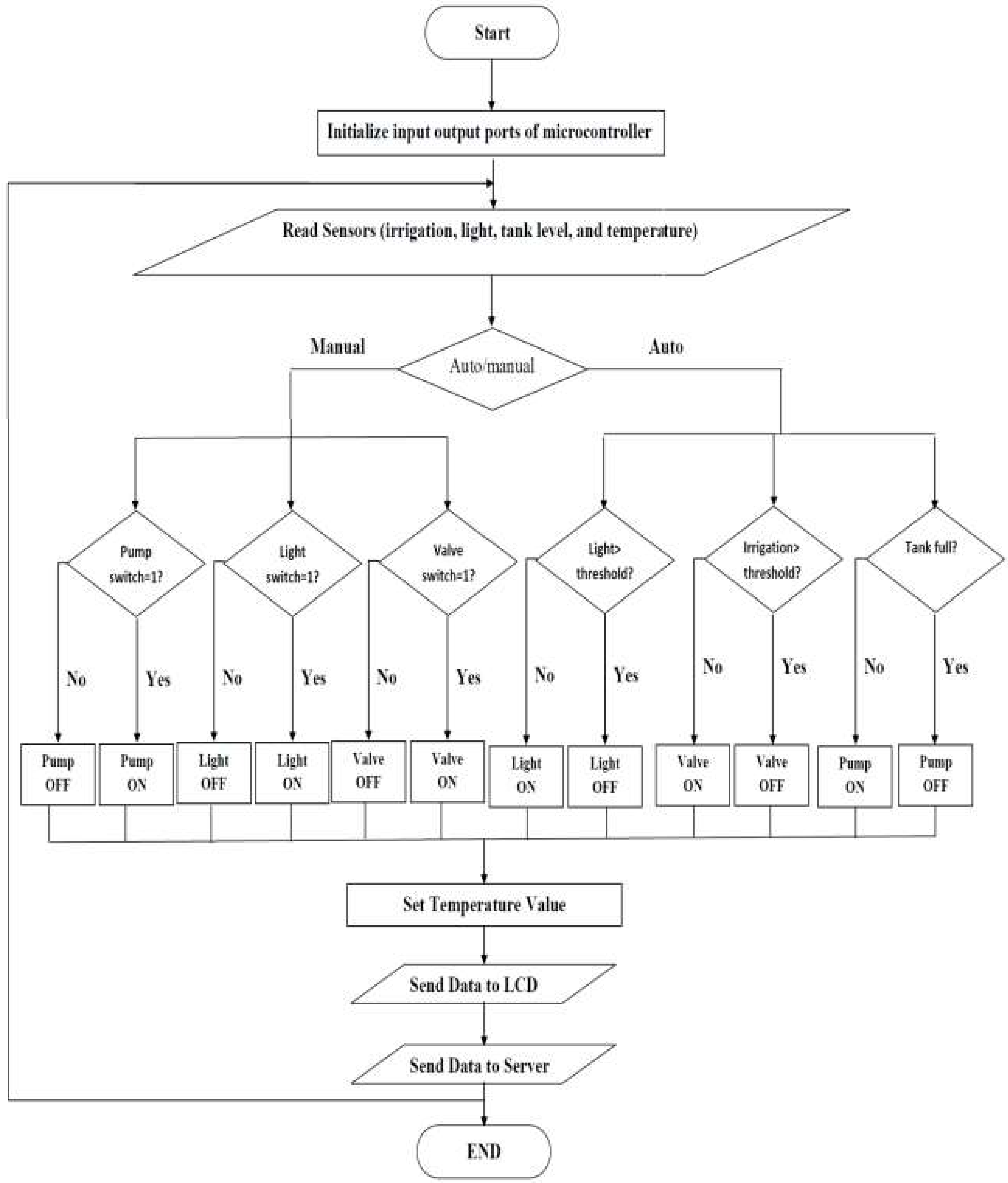
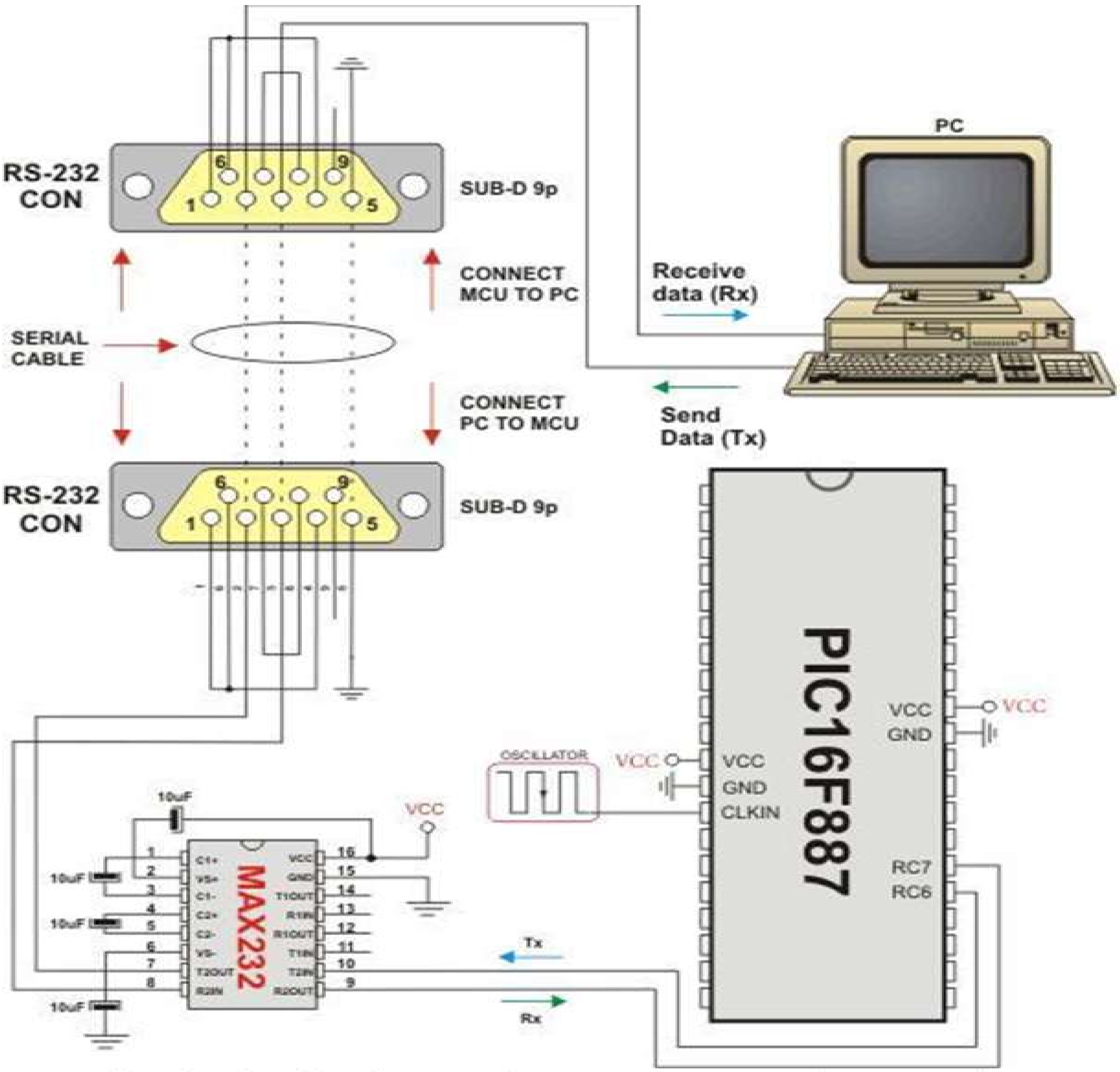


Fig 6: flow chart of control unit



X	X	X	X	A/M	Light	Pump	Valve
Don't care				1-Auto 0-Manual	1-ON 0-OFF	1-ON 0-OFF	1-ON 0-OFF

Command Word transmitted from BSU to CU

0	A/M	Light	Pump	Valve	L2	L1	L0
Status word 1	1-Auto 0-Manual	1-ON 0-OFF	1-ON 0-OFF	1-ON 0-OFF	Tank Level (0%,20%,40%,80%,full)		

Status word1 transmitted from CU to BSU

1	D6	D5	D4	D3	D2	D1	D0
Status word 2	Temperature value(0-127C°)						

Status word2 transmitted from CU to BSU

Fig 7: Interfacing Control unit with server circuit diagram

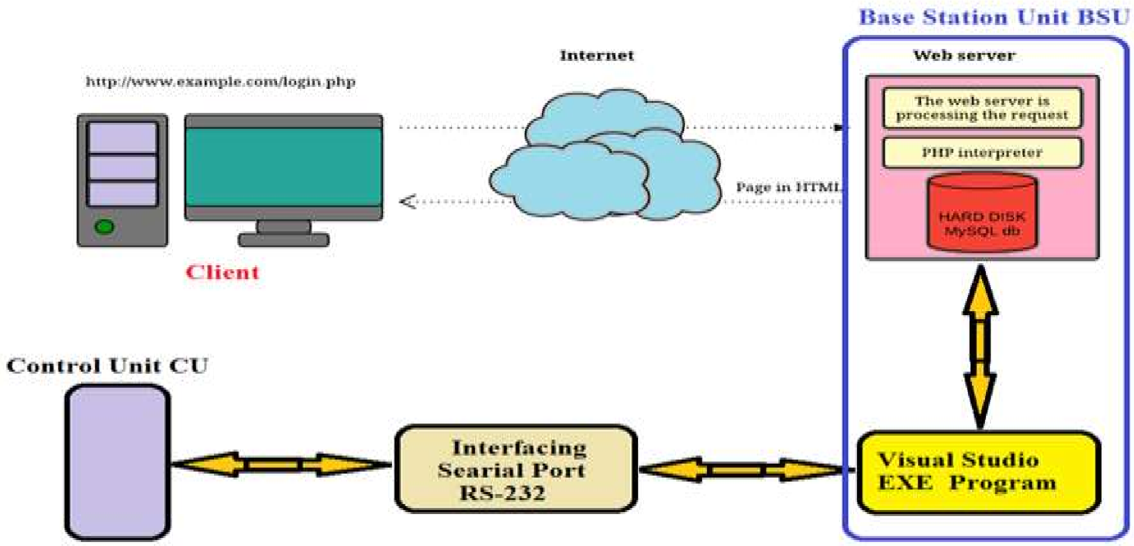


Fig 8: Interactions of system programs

4.2.2 Design of the web server

Apache web server and PHP language. Has been used for website design of smart farm. When a user want to monitor the status of smart farm a page that contains some PHP code to communicate with the farm's control unit for monitoring and controlling the farm as shown in **Fig 9**, where the status of smart farm stored in the database as shown in **Fig 8.** The implementation prototype of smart farm shown in **Fig 10.**

The flowchart of web server shown in **Fig 11.**

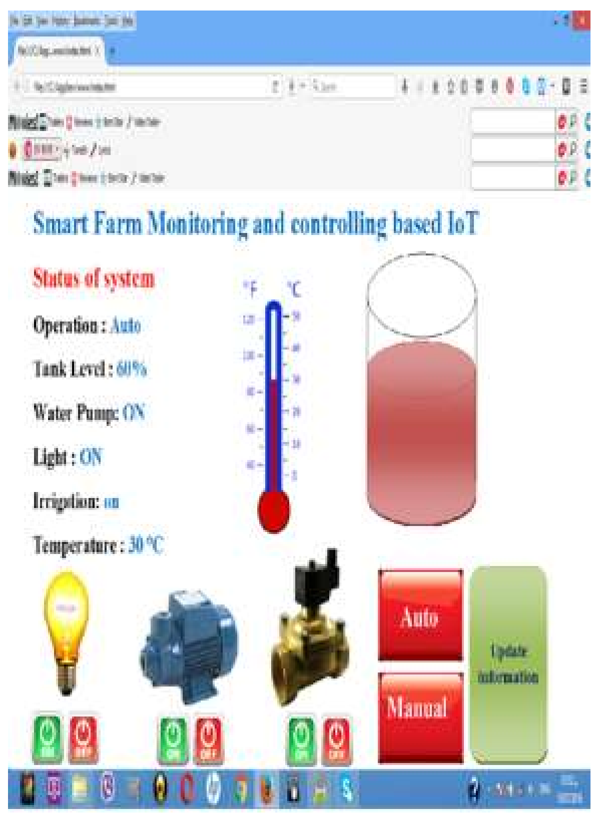


Fig 9: Server homepage of smart farm based IoT

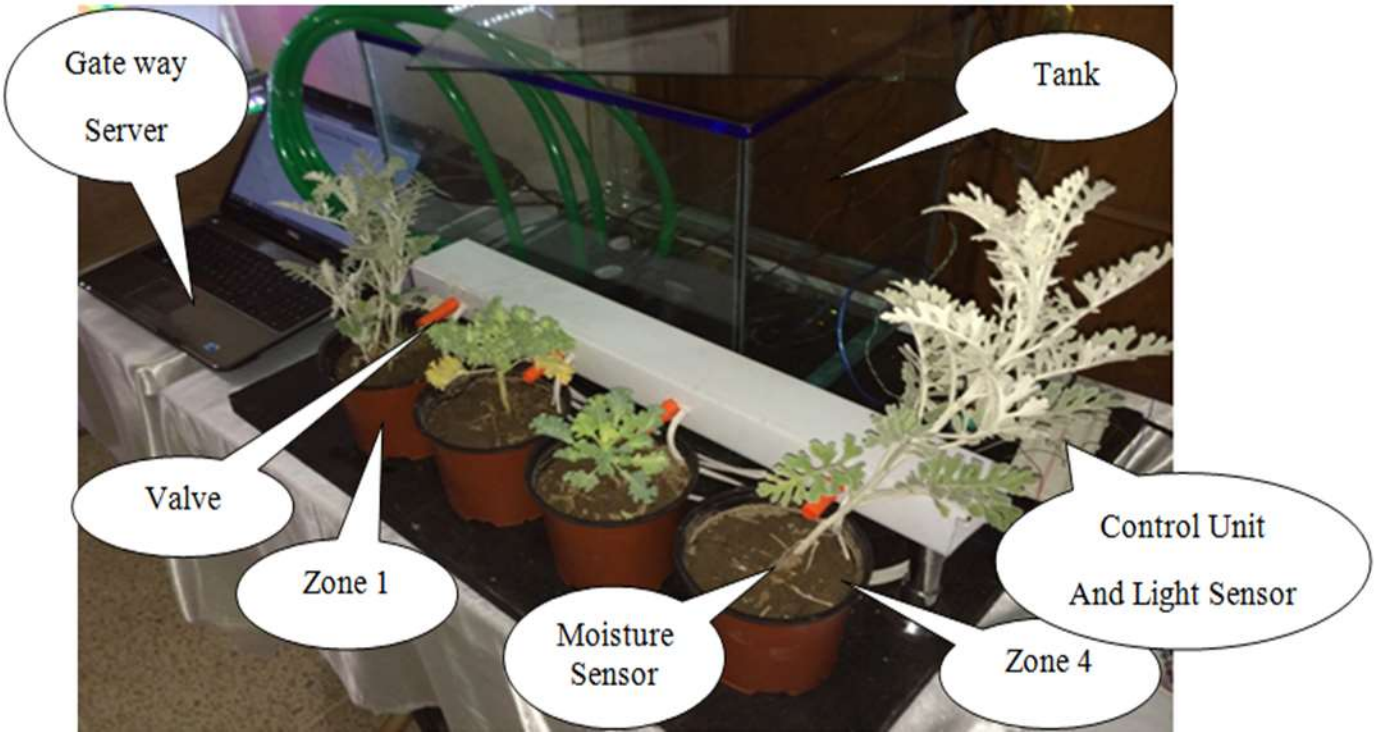


Fig. 10 Suggested prototype of smart farm based IoT

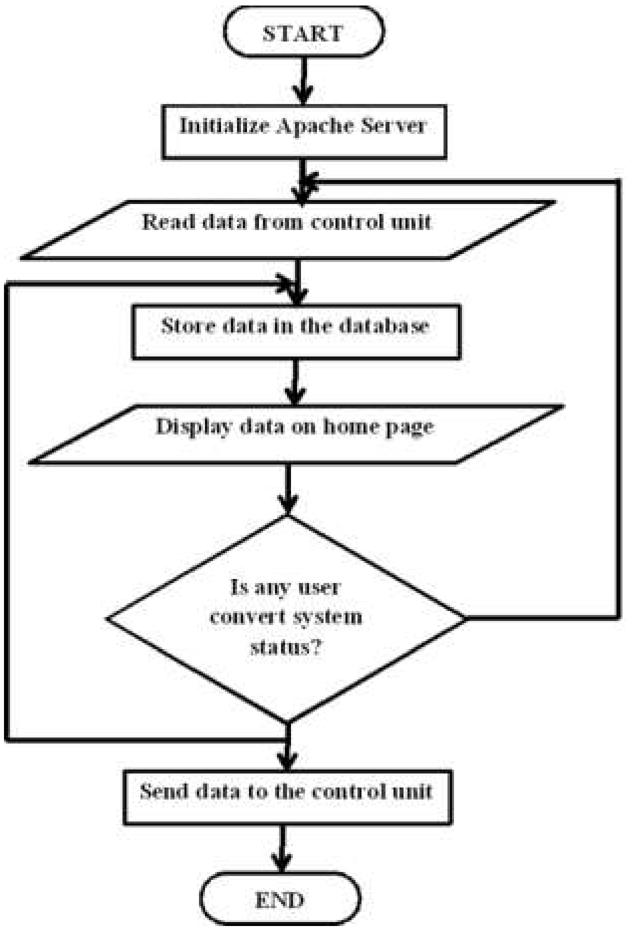


Fig 11. Flow chart of web server

5. Results and Discussion

The system was tested for 90 days and water savings up to 60% compared with conventional irrigation systems.

6. Conclusion

In this research, a prototype of smart farm based microcontroller and IoT has been designed and implemented in which suggested an automated irrigation system to reduce the waste water and workers use for agricultural crops. The system has a distributed of moisture and temperature sensors placed in the multi zone of the farm. It is also has a webserver unit handles sensor information, and transmits data to a database which can be read via web applications. It is also can be controlled manually or automated from anywhere in the world via the Internet.

References

[1] Austin, R. S. and Rawlins, S. L. (1977), Optoelectronic level detector for mercury manometer, J. Agric. Eng.(Instr. News Sect.), vol. 58:pp. 29-30.

[2] Daniel Palma.(2014) , An internet of things example: "classrooms access control over near field communication”,www.mdpi.com /journal/sensors ,vol. 14, pp. 6998-7012;ISSN 1424 8220.

[3] Dave Evans.(2011), The Internet of ThingsHow the Next Evolution of the InternetIs Changing Everything, Cisco Internet Business Solutions Group (IBSG).

[4] Dr. Esther T. Ososanya, (2015), "Design and implementation of a solar-powered smart irrigation system", American Society for Engineering Education, ASEE conference paper ID #13224.

[5]Fischbach, P.E, Thompson, L.T. and Stetson, L.E. (1970), Electric controls for automatic surface irrigationsystem with reuse system, Trans. ASAE, vol.13: pp.286-288,.

[6] G. Vellidis, V. Garrick, S. Pocknee, C. Perry, C. Kvien, M. Tucker. (2007),How Wireless Will Change Agriculture, Sixth European Conference on Precision Agriculture, University of Georgia, Tifton, Georgia, USA pp. 57-67.

[7]Haise, H.R. and Kruse, E.G.(1969) ,Automation of surface irrigation systems, ASCE J. Irrig. Drain. Div., vol. 95:pp.503-516.

[8] Hollis, S. and Dylla, AS.(1980), Irrigation automation with moisture sensing system, Trans. ASAE, vol.23:pp.649-656.

[9] L. R. Garcia, L. Lunadei, P. Barreiro, J. I. Robla.(2009),A review of wireless sensor technologies and applications in agriculture and food industry", International journal of Sensors and Applications, Vol. 9, pp. 4728-4750.

[10] L. Xiu-hong , X. Cheng , K. Yan and P. Gong. (2010), A monitoring system for vegetable greenhouses based on a wireless sensor netwo, International Journal of Sensors and Applications, Vol. 10, pp. 8963-8980.

[11] Ms. Deweshvree Rane, Prof. P. RIndurkar, Prof. D. M. Khatri,(2015), " Review paper based on automatic irrigation system based on RF module" IJAICT Volume 1, Issue 9, pp. 736- 738.

[12] Ms. Tasneem Sanglikar, Prof. Puranik V. G., (2016), "Design and implementation of automated irrigation control system using wsn: an overview", International Journal on Recent and Innovation Trends in Computing and Communication, Volume: 4 Issue: 4, pp. 157 - 161

[13] R. Atta1, T. Boutraa, A. Akhkha.(2011) Smart irrigation system for wheat in Saudi Arabia using wireless sensors network technology, International Journal of Water Resources and Arid Environments, Vol. 1, PP. 478-482.

[14] S.K. Luthra , M.J. Kaledhonkar, O.P. Singh, N.K. Tyagi.(1997), Design and development of an auto irrigation System, Agricultural Water Management, vol. 33: pp. 169- 181.

[15] V. Divya, A. Umamakeswari.(2013), Smart irrigation technique using vocal commands, International Journal of Engineering and Technology, Vol. 5, pp. 385-390.

[16] V. Ramya, B.Palaniappan , B.George.(2012),Embedded

system for automatic irrigation of cardamom field using Xbee-PRO technology ", International Journal of Computer Applications, Vol.53, pp. 36-43.

[17]Yiming Zhou, Xianglong Yang, Wang, L. Yibin Ying Sch.of Biosystems Eng. & Food Sci., Zhejiang Univ., Hangzhou.(2009), A Wireless Design of Low-Cost Irrigation System Using ZigBee Technology, IEEE 2009 International Conference on Networks Security, Wireless Communications and Trusted Computing, vol. 1, pp.572 – 575.

[18] Y. Kim, R. G. Evans and W. M. Iversen .(2008), Remote Sensing and Control of an Irrigation System using a distributed Wireless Sensor Network, IEEE Transactions on Instrumentation and Measurement, vol. 57, No. 7, pp. 1379-1387.

تصميم و تنفيذ نظام مزرعة ذكية

مدرس أحمد علي راضي

مدرس مساعد حيدر حسن محمد

قسم هندسة تقنيات

كلية المامون الجامعة

الخلاصة :

الزراعة هي مصدر مهم لحياة معظم دول العالم ولها تأثير على اقتصاد البلاد .في حالة المناطق الجافة أو هطول الأمطار غير كافية تصبح عملية الري صعبة بالتالي فإنه يحتاج إلى معالجة عن بعد لسلامة المزارع و الموارد الزراعية وتقليل الضررالإنتاجية . حيث ان المزارعين يميلون إلى الإفراط في ري التربة و كذلك ألانواع المختلفة من التربة تتطلب جدولة ري مختلفة ويعتمد الري أيضا على العديد من العوامل الأخرى مثل سرعة الرياح , مستوى الرطوبة الموجودة، المرحلة النمو للمحاصيل، درجة حرارةالموسم, ...الخ. تم في هذا البحث اقتراح نظام مزرعة ذكية تحتوي على نظام الري الآلي مع جدولة زمنية للري قابلة للبرمجة ، السيطرةالتلقائية على مستوى خزان الماءلتخزين مياه الري، وقياس درجة حرارة المزرعة بالاعتماد على المتحكم الدقيق و مجموعة متحسسات وكذلك خادم الشبكة الذي يجب ان يكون متصلا بالإنترنت حيث يمكن من خلاله مراقبة هذا النظام والتحكم به باستخدام موقع خادم الشبكة عبر الإنترنت من أي مكان في العالم.

الكلمات المفتاحية: المزرعة الذكية, المسيطر الدقيق, السيطرة من خلا الانترنيت