Prototype of Control and Automation of Irrigation System for the Paddy Fields

By Giva Andriana Mutiara

Advanced Science Letters
Vol. 23, Number 5

Prototype of Control and Automation of Irrigation System for the Paddy Fields

Giva Andriana Mutiara[1,2], Gita Indah Hapsari[1,2], Dimas Jati Kusumo[1,2]

[1]Computer Engineering, Department of Science School, Telkom University, Bandung 40257, Indonesia
[2]Network and Embedded Research Group of Computer Engineering of Department of Science School, Telkom University, Bandung 40257, Indonesia

The paddy fields have arable soil with average surface as a place to plant paddy. The paddy fields are connected to a source of irrigation. To produce good quality rice, it would require a sufficient water supply and fertilization treatment. In addition, there are several factors that can affect the growth of paddy, which are the changes of climate, acidity of water, the level of water irrigation, and the use of fertilizers that do not fit with the characteristic of paddy field. It is very difficult to control all factors, manually. Therefore, it needs a prototype which consist of sensors and microcontroller that can control all of these factors. This prototype will give water level information automatically through SMS, automatically turn on/off the water according to the schedule, provide the information of pH value of water, and control the provision of the appropriate amount of fertilizer to the soil and paddy characteristics. This prototype aims to help farmer to control their paddies field. Based on test results, the entire system can function properly and be able to control the entire system and giving information on the display and the farmer through SMS.

Keywords: Microcontroller, Sensor, Paddy Fields, Control and Automation.

1. INTRODUCTION

Paddy cultivation is a part of land farming system that uses a physical flat surface of land which needs good watering and fertilizing for the seed to grow well. Traditionally, there are several factors that can effects the quality of the harvest. There are the lack of water during the dry season and even during rainfall due to a bad watering channel[1,22], less effectiveness in the change of water to the rice fields that are still using the drainage holes in the footpath between the square of paddy fields, unsuitable pH levels of water that enters into the field, as well as the lack of good quality fertilizers and wrong dose of fertilizer[2]. All of the activities above are still done manually by the farmer. Currently, the applications of technology for paddy fields are still being developed.[5,6,7,8,9]. But according to reports from the Ministry of Agriculture the actual implementation has not reach the target of productivity and quality needed.[28] This is due to the research that had been developed that the research was limited to only one of the factors that affect agriculture.

The role of microcontroller electronics as a basic of controlling unit could be used to support more control for tools such as sensors and actuators for improving the paddy cultivation system[3]. This research offer an integrated system that embedded with several sensors which can be used to informed the farmers as alternative solution to improve or provide more control for the farmers in the field. The system will be based-on microcontroller systems, which include instrument that can detect water level through short message notification, water changes with controllable time period, pH or acidity and alkalinity detection in water, and liquid fertilizer control using Short Message Service (SMS).

*EmailAddress: giva.andriana@tass.telkomuniversity.ac.id

2. LITERATURE STUDY

We start to study the literature from reading a journal in a similar work which related to the research. Fahrunisa[4], do research by making a prototype of water level measuring instrument using microcontroller. Andayyani[5], make a prototype automatic control system for irrigation. Aguillar,J[6], make an irrigation scheduling to manage water resources effectively using soil moisture sensors and the evapotranspiration (ET)-based KanSched Chaitali, et al[7], they make design and implementation of real time irrigation system using a Wireless Sensor Network, while R.K. Prasad et al.[8], design a multi-parameter monitoring system which is based on low-power ZigBee wireless communication technology for system automation and monitoring. We also study the review of precision irrigation technologies and their application by Smith R J, et al[9].

Based on the literature study above, we can conclude that there has been no research that makes a prototype of paddy irrigation systems by considering various factors that affect soil fertility and agricultural conditions integrally as embedded system. This research will make a prototype of control and automation of irrigation system for paddy fields which is embedded among water level substitution, water exchange, pH measurement system and liquid fertilizer system. All the information about the irrigation system will be sending to the farmer through short message services (SMS).

After decided the description of this research, we start to study of literature about the component that will be used in this research. We use IDE Arduino 1.6.5, Cad soft EAGLE 6.3.0 Professional, PROGISP V1.7.2, HyperTerminal, *Liquid Crystal Display,* ***Microcontroller ATMEGA 328PU, ATMEL USBISP V20., TTL Converter MAX232, USB to Serial DB9,*** Modem GSM Wavecom Fastrack, RTC *(Real Time Clock)* DS1307, Sensor water Analog, Analog pH Meter Kit, Mini Regulated Power Supply RoHS, Head Nozzle Sprayer, Water Pump 220 Volt. All of these components will be designed as a prototype of integrated embedded system.

3. DESIGN AND ANALYSIS

After doing study literature, we design the diagram block of prototype. We can see from figure 1 that the diagram block described the whole system into water level/substitution and control-based liquid fertilizer and pH measurement of water.

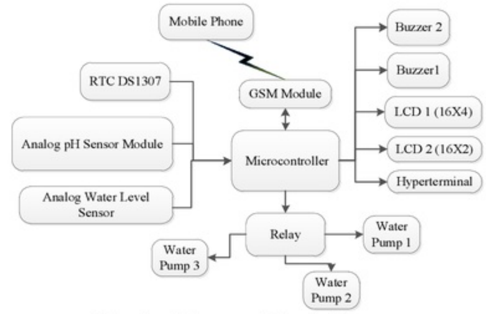

Fig. 1. Diagram Block System

Control and automation systems in these paddy fields serve as a control liquid fertilizer, mechanical automation, notification through SMS and data information from the sensors. So, it can help users to manage their fields to make it more effective.

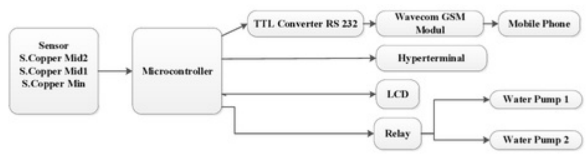

Fig. 2. Water Level automation Diagram System

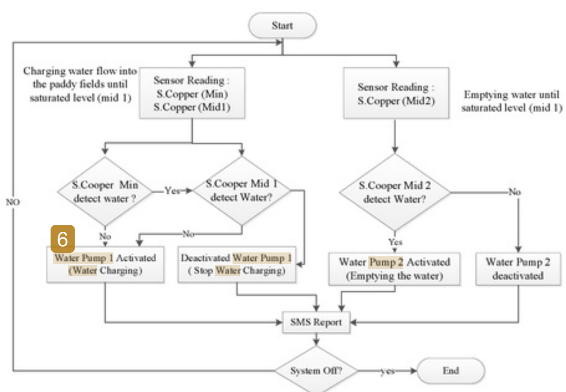

Fig. 3. Water Level Automation Flowchart

Figure 2 shows a block diagram of the water level automation. It is designed using a sensor known as a copper sensor arranged vertically with a height of 1 cm, 3 cm, and 5 cm. The microcontroller will process the data and inform the farmer through mobile phone and LCD. The water level automation system works as the charging and emptying water level as described in Figure 3. If the sensor copper (min) in the bottom of the prototype does not detect the water then the water pump 1 will be activated and run the water flow into the paddy field (charging water) through the pipe until reach the sensor copper in middle 1 (mid1) as saturation level. When the water reached the saturation level, then the water pump 1 will be deactivated.

The sensor copper (mid2) on the top of the system will be activated the water pump 2 which is used to emptying the water. If the water reached sensor copper (mid1) then the water pump 2 will be deactivated. Sensor mid2 should be placed approximately 2 cm from the surface of the saturated level water.

Design Water Exchange Automation works by DS1307 RTC module. Substitution of water is based on a fixed schedule is 3 hours. Drainage is done by activating the water pump 2. When copper sensor (Min) does not detect water, water pump 2 is off. Furthermore, relay 1 on the water pump 1 is used as a water supplier. As describe in Figure 4 and 5, when copper sensor (Mid1) detect water (saturation level), water pump 1 is off. Each of water exchanged indicated by the sound of a buzzer indicator, display text on the LCD (Liquid Crystal Display) and HyperTerminal.

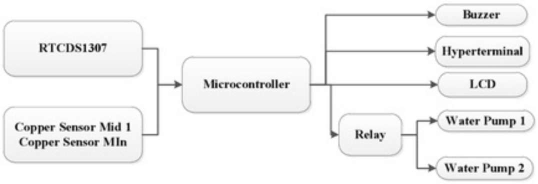

Fig. 4. Water Exchange Automation

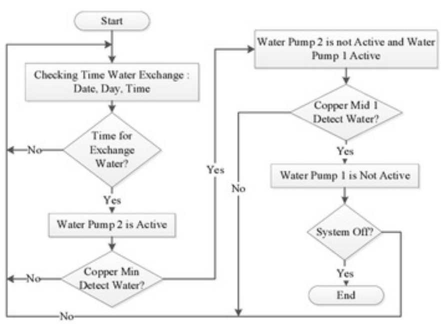

Fig. 5. Water Exchange Automation Flowchart

The design of pH measurement of the water is using Analog sensor pH Meter Kit. Sensor Analog pH Meter reads pH value of water mixed with liquid manure in the soil or land surface. If the pH-value is 0-5, the water can be categorized as acidic. If the sensor reads the pH of water with the results of 6-7, the water is on neutral category. Otherwise, if the sensor reads the properties of the water is equal with 8-14, the water can be categorized as alkaline. Values and properties of water from the sensor readings can be displayed on the LCD and HyperTerminal. The following figure 6 and 7 overview of the pH measurement of water and flowchart.

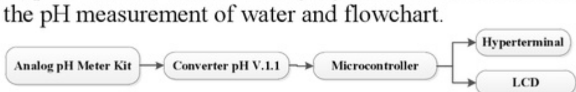

Fig. 6. pH Measurement System

Fig. 7. pH Measurement System Flowchart

Figure 8 shows the design of the Control-Based Liquid Fertilizer by sending SMS using mobile phones through GSM Modem Wavecom. The SMS is converted by the TTL RS232 Converter, and then processed by a microcontroller to perform data matching (parsing data). If the SMS does not comply with the order, we have to retransmit the SMS. When it is appropriate, the SMS Relay 3 activate the Water Pump 3 which is used as a liquid fertilizer supplier. Furthermore, liquid manure released through Nozzle Head Sprayer, indicated by sound through a buzzer and displayed them on the LCD and HyperTerminal.

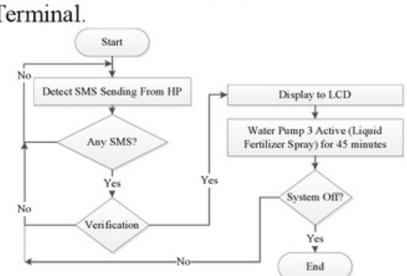

Fig. 8. Control-Based Liquid Fertilizer Flowchart

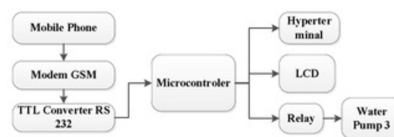

Fig. 9. Control-Based Liquid Fertilizer

4 IMPLEMENTATION AND EXPERIMENTAL RESULT

Figure 10 shows the implementation of the whole system. Implementation includes the automation level of the water surface to detect and manage the high or low water level of the ground and send notifications to mobile phones, automation exchange water to replace the water with a term to be determined as well as the use of audible indicator, monitoring the pH value of the water to determine the pH value and display to the LCD, and control of liquid fertilizer that can do by sending an SMS message to run the spraying of liquid fertilizer.

Fig. 10. Implementation the Prototype

Testing the water level of automation is done with copper 4 sensors are arranged vertically (Figure 11). Then miniature rice field filled with water up to the position of each sensor copper. Tests have been conducted on SMS notification and activation of the water pump. The test results obtained are shown in Table 1.

Fig. 11. Water level automation experiment

Table. 1. Water level automation experiment result

Water Level	Action 1	Action 2
1 Cm= Too Low	*Water Pump* "Active"	SMS Notification= 1 Cm
3 Cm = Appropriate Level	*Water Pump 1 / 2* "Off"	SMS Notification = 3 Cm
7 Cm = Too High	*Water Pump 2* "Active"	SMS Notification = 7 Cm

Based on test results, the testing of water level automation experiment is appropriate with the design and algorithm on designing system.

The Automation experimental water changed was done by activating the device and monitoring the change of the water during 24 hours. The results are shown in Table 2 shows that the change of the water is done appropriate in every 3 hours. Based on this experimental, we can say that the result is appropriate with the design on the algorithm above.

Table. 2. Experimental result of Automation Water Changes

date	Time	Discharging Water » Water Level	Charging Water » Water Level
Saturday : 26/09/15	03:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm
Saturday : 26/09/15	06:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm
Saturday : 26/09/15	09:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm
Saturday : 26/09/15	12:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm
Saturday : 26/09/15	15:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm
Saturday : 26/09/15	18:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm
Saturday : 26/09/15	21:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm
Monday: 27/09/15	00:00:00	Relay 2: *Water Pump 2* » Low 1 cm	Relay 1: *Water Pump 1* » appropriate 3 cm

Testing of water pH value is done by using multiple solutions with different pH values. Experiment done by using litmus paper conducted to determine the accuracy and calibration of the pH measurement. pH meter Analog sensor testing using litmus paper seen through four color changes (figure 12).

Table. 3. Measurement of pH Solution

Liquid	measure	water	pH	Analog pH meter Kit	Lakmus universal
1	1tbs	150 ml	Strong acid	1.65	1
2	1tbs	150 ml	Moderate acid	3.10	3
3	1tbs	150 ml	Weak acid	4.07	4
4	-	150 ml	neutral	7.40	7
5	1tbs	150 ml	Neutral	7.68	7
6	1tbs	150 ml	Basa	8.25	8
7	1tbs	150 ml	Basa	8.45	8
8	1tbs	150 ml	Strong Base	12.35	12

Based on test results shown in Table 3, the results of the measurement of pH using a pH meter was around pH by using litmus paper.

Fig. 12. Liquid Fertilizer Control Testing

5. CONCLUSIONS

The conclusion of the analysis, documentation, and testing of the entire system are : water level automation by using copper sensor can work properly between 1 cm, 3 cm, 7 cm of water level and can transmit that information through SMS notifications on Mobile Phone.

Water exchange automation can work properly in accordance with the schedule set on the water exchange DS1307 RTC module and can perform charging and discharging of water based on the water level detected from the sensor copper.

Based on the data sheet on Analog pH Meter Kit proved 00:06 eject volt low voltage and has measurement accuracy at ± 0.1 pH.

Testing the pH value of the water detection sensor Analog pH Meter Kit stated that pH value on pH Meter converted through module-gap V1.1 results an accuracy of ± 0.99 pH using litmus paper of universal indicator.

Liquid fertilizer control system can work well with the activation of SMS delivery and spraying fertilizer with the duration about 45 seconds.

REFERENCES

[1] Suastika, I Wayan; N, Basarudin; T, Turmalan, "Budi Daya Padi Sawah di Lahan Surut," Badan Penelitian dan Pengembangan Pertanian, 1997. [Online]. Available: http://www.mamud.com/Docs/budi_daya_padi_sawah.pdf

[2] J. Bobihoe, "Inovasi Teknologi Untuk Meningkatkan Produktivitas Tanaman Padi," in *Pengelolaan Tanaman Terpadu (PTT) Padi Sawah*, 2007. [Online]. Available:http://jambi.litbang.pertanian.go.id/ind/images/PDF/bu

kusaku07.Pdf

[3] Suharto, Teknik Sistem dan Kontrol Otomatis, Djambatan, Jakarta, 1985.

[4] Fahrunisa, "Perancangan Alat Ukur Ketinggian Air Menggunakan Sensor HC-SR04 berbasis mikrokontroller AT Mega 8535" Program Studi D3 Metrologidan Instrumentasi Fisika Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Sumatera Utara Medan. 2014. [Online].

[5] Andayyani, F. Trias Pontia, Tedi Rismawan. "Prototype Sistem Kontrol Pintu Otomatis Pada Saluran Irigasi Lahan Pertanian Padi Daerah Aliran Sungai (DAS) Air Asin". Jurnal Coding System Komputer Untan, Volume 4, No.2 (2016), hal 35-46, ISSN 2338-493X.

[6] Aguilar, J.; Rogers, D.; and Kisekka, I. (2015) "Irrigation Scheduling Based on Soil Moisture Sensors and Evapotranspiration,"Kansas Agricultural Experiment Station Research Reports: Vol. 1: Iss. 5.

[7] Chaitali et al." Design and Implementation of Real Time Irrigation System using a Wireless Sensor Network",International Journal of Advance Research in Computer Science and Management StudiesVolume 2, Issue 1, January 2014 pg.401-404

[8] R.K. Prasad et al., "Design &Implementation of Wireless Transceiver for Data Acquisition in Wireless Sensor Network " International Journal of Advanced Research in Computer Science and Software Engineering 3(7),July-2013, pp. 521-526

[9] Smith R J, Baillie J N, McCarthy A C, Raine S R, Baillie C P., "Review of precision irrigation technologies and their application." National Centre for Engineering in Agriculture Publication 1003017/1, USQ, Toowoomba, November. 2010.

[10] A. G. Smith, "Introduction to Arduino". Patent ISBN-13: 978-1463698348, 30 September 2011. [Online]. Available: http://www.introtoarduino.com/downloads/IntroArduinoBook.pdf.

[11] T. Clarke, "The EAGLE Schematic & PCB Layout," in Editor – A Guide, London, 2008. [Online]. Available: https://intranet.ee.ic.ac.uk/t.clarke/EAGLE/The%20EAGLE%20Guide.pdf.

[12] T. Fischl, "usbasp-zhifengsoft," Github, 28 May 2011. [Online]. Available: https://github.com/kubov/usbasp-zhifengsoft. [Accessed 3 November 2013].

[13] D. S. R. Sinurat, "Pengertian Hyperterminal," Dunkom, [Online].Available:https://dunovteck.wordpress.com/2010/01/01/pengertian-hyperterminal/. [Accessed 1 Januari 2010].

[14] Alghansomy, "Cara Mengaktifkan HyperTerminal di Windows 7," Tips & Trik, [Online]. Available: https://alghansomy.wordpress.com/2012/02/23/cara-mengaktifkan-hyperterminal-di-windows-7/. [Accessed 23 Februari 2012].

[15] A. Munandar, "Liquid Crystal Display (LCD) 16x2," Les Elektronika,[Online].Available:http://www.leselektronika.com/2012/06/liguid-crystal-display-lcd16 -x-2.html. [Accessed 27 Juni 2012].

[16] Vcc2GND, "IC Mikrokontroller AVR ATmega328P-PU," [Online]. Available: http://blog.vcc2gnd.com/2013/11/ic-microcontroller-avr-atmega328p-pu_10. html. [Accessed November 2013].

[17] I. Electronics, "DT-HiQ AVR USB ISP". Surabaya 4 May 2015.[Online].Available:http://www.innovativeelectronics.com/innovative_electronics/download_files/manual/Manual%20DT-HiQ%20AVR%20USB%20ISP.pdf

[18] J. Rahardiansyah, "IC MAX232," Electronics, 5 Oktober 2010.[Online].Available:https://jimmyrahdiansyah.wordpress.com/2010/10/05/ic-max232/.

[19] A. Hasan, "Interfacing Port Serial / RS-232 dengan UART," Jaringan,[Online].Available:http://abizmalhasan.blogspot.co.id/2010/06/interfacing-port-serial-rs-232-dengan.html. [Accessed Juni 2010].

[20] I. Ware, "Wavecom M1206B RS232". Jawa Tengah 6 Juni 2015. [Online]. Available: http://indo-ware.com/produk-2569-wavecom-m1206b-rs232.html

[21] Splashtronic, "RTC / Real Time Clock Module," Miscellaneous,[Online].Available:https://splashtronic.wordpress.com/2012/03/17/rtc-real-time-clock-module/. [Accessed 17 Maret 2012]

[22] H. Putranto, "Sistem Deteksi dan Peringatan Dini Bencana Alam Banjir Berbasis Mikrokontroler ATMEGA 8535 dan SMS GATEWAY di Aliran Sungai Code," in Naskah Publikasi,Yogyakarta,2011.[Online].Available:http://repository.amikom.ac.id/files/Publikasi_04.11.0666.pdf

[23] Instrumentasi, "Alat Untuk Mengukur pH," Tugas Instrumentasi,[Online].Available:http://tugasinstrumen.blogspot.co.id/2012/10/alat-untuk-mengukur -ph.html. [Accessed 16 Oktober 2012]

[24] DFRobot, "Analog pH Meter Kit". Shanghai Patent ID.1025, 23Juni2015.[Online].Available:http://www.dfrobot.com/index.php?route=product/product&product_id=1025#.VpPS_vl9600.

[25] B. Nabilla, "Power Supply Unit dan Komponen Lainnya," [Online].Available:https://dewshin3112.wordpress.com/2012/11/26/power-supply-unit-dan-komponen-pembantu lainnya/. [Accessed 26 November 2012].

[26] Made-In-China, "35W 12V Mini Size Power Supply for LED/LED Driver (MS-35-12)," LED Power Supply Product, 10 Juli 2015. [Online]. Available: http://chnwh1.en.made-in-china.com/product/soCEcgPKIeRN/China-35W-12V-Mini-Size-Power-Supply-for-LED-LED-Driver-MS-35-12-.html.

[27] O, Sastra W; S, Achmad A; W, Ari;, Pengaruh Variasi Panjang Nozzle Terhadap Efisiensi Jet Pump, Malang: Universitas Brawijaya, 2 April 2015. [Online]. Available: http://www.mesin.ub.ac.id/jurnal/jurnal/data/jurnal%20SATRYA.pdf

[28] Kementrian Pertanian, "Pompa Air Irigasi (Irrigation Pump)," Badan Penyuluhan dan Pengembangan SDM Pertanian, 2015.[Online].Available:http://www.pertanian.go.id/pajale2015/i1.4.alsintan%204.%20Modul%20Pompa%20Air%20Irigasi.pdf.

Received:. Accepted

Prototype of Control and Automation of Irrigation System for the Paddy Fields

ORIGINALITY REPORT

4%

SIMILARITY INDEX

PRIMARY SOURCES

1	www.ijarcsse.com Internet	21 words — 1%
2	pure-oai.bham.ac.uk Internet	17 words — 1%
3	www.msscientific.de Internet	16 words — 1%
4	www.ijarcsms.com Internet	14 words — 1%
5	npsi.gov.au Internet	11 words — < 1%
6	Yao Chen, , Dawei Yao, Wenxiao Ma, Jiuping Pan, Lars Gertmar, Arash Babaee, and Richard Vesel. "Study on coordinated reactive power control strategies for power plant auxiliary system energy efficiency and reliability improvement", 2010 International Conference on Power System Technology, 2010. Crossref	10 words — < 1%
7	newprairiepress.org Internet	9 words — < 1%

EXCLUDE QUOTES ON

EXCLUDE BIBLIOGRAPHY ON

EXCLUDE MATCHES OFF