exeley INTERNATIONAL JOURNAL ON SMART SENSING AND INTELLIGENT SYSTEMS

Article | DOI: 10.21307/ijssis-2020-025 Issue 1 | Vol. 13 (2020)

Development of an automated water management system in orchards in southern Thailand

Panjit Musik*

Faculty of Science and Technology, Nakhon Si Thammarat Rajabhat University, Tha Ngio, Nakhon Si Thammarat, Thailand.

*E-mail: panjit_mus@nstru.ac.th

This paper was edited by Subhas Chandra Mukhopadhyay.

Received for publication June 18, 2020.

Abstract

Traditional agriculture-based orchards often encounter quality problems that do not meet the market demand. Technology development is required for increasing the quality of the production and reducing the production costs. The objective of this research is to develop an automated water management system to improve production in orchards and implementing them in the field. The proposed water management system contains the equipment for water supply systems, automatic measurement, and control systems. The system was developed first inside a demonstration fruit garden. Afterward, a set of water management systems was installed in the mangosteen and durian gardens of farmers, and the system was controlled via mobile phones. The results are promising and showed that the proposed system might be useful for reducing production costs by reducing labor, water, and electricity costs. Moreover, the farmers were able to produce a higher amount of quality products in Nakhon Si Thammarat Province.

Keywords

Durian, Mangosteen, Nakhon Si Thammarat, Automatic water management systems.

The economy of Nakhon Si Thammarat, Thailand, is based on agriculture. It has a lot of farmland, including mangosteen and durian, which generate revenue for Nakhon Si Thammarat each year as high value (Office of Agricultural Economics, 2018). Mangosteen is approximately 1,800 million baht (personal contact with the Regional Office of Agricultural Economics, Thailand), but the quality of mangosteen and durian is not enough to market demands. The lack of a water management system for maintaining the mangosteen and the durian throughout the growth phase is the primary concern in this regard.

From the academic reports, such as spraying water droplets in the air can prevent the destruction and outbreak of thrips in the garden, which thrips is the pest of mangosteen. Thrips will absorb the water from the soft blossoms and soft fruit, causing flowers and fruits to have brown (Somporn na Nakorn, 2014). It provides a sufficient and consistent amount of water throughout the fruiting period of the mangosteen (personal contact with Chumphon Provincial Agricultural Extension Office in 2017). Water is an essential factor for the production of mangosteen as well as for obtaining a high quality and quantity product (Agricultural Research Development Agency, 2019).

The automated water management system encourages the farmers to replace traditional water management system. The system consists of the electronic technology, such as Arduino microcontrollers (Alahi et al., 2017; Alahi, Pereira-Ishak, Mukhopadhyay and Burkitt, 2018; Shilpa, 2018), sensor devices (Alahi et al., 2016; Alahi, Mukhopadhyay, and Burkitt, 2018; Ray, 2017; Rawal, 2017; Poursafar et al., 2017; Nag et al., 2019), and a smartphone that can operate, display, measure, and interact. The objective of this research was to build and develop an automatic water

management system in orchards in order to increase the production with efficient water management systems in Nakhon Si Thammarat province. The proposed system is trialed in the field for farmers.

Materials and methods

The design of the automatic control system is shown in Figure 1. It consists of microcontroller board, NodeMCU ESP-WROOM-32, Wi-Fi, and Bluetooth, connected to the pump, solenoid valve, and sensors. Open-close pumps, solenoid valves, and sensors are used with a smartphone connected to the internet via Wi-Fi using the application Blynk.

The demonstration of open-close pumps and solenoid valves of automatic water management systems in orchards using smartphones are shown in Figure 2. The design of the water pipe system and a set of 6-valves automatic water management systems in orchards are shown in Figure 3. This demonstration set was created to demonstrate the farmers how to use the system, as shown in Figure 4.

Figure 5 shows the electronic circuit for controlling the automatic water management system in an orchard, and Figure 6 shows the complete equipment installation. The system was installed in a farmer's field in Phrom Khiri District, Nakhon Sri Thammarat Province for real use in the durian garden.

In this study, questionnaires were used to determine the farmers' satisfaction level regarding automatic water management systems in orchards, and transfer the technology to the farmers in Nakhon Si Thammarat Province.

Results and discussion

Figure 7 shows the developed system for the demonstration purpose, which can be installed in the

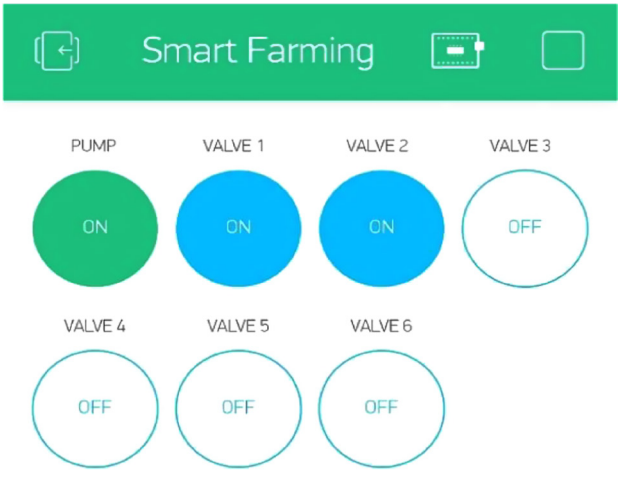

Figure 2: The demonstration set of 6-valves automatic water management system by using a smart phone.

sampling field. There are two techniques of the water distribution system. One is hand-on-off technique installed below the 1.27 cm water pipes. Another technique is an electric on-off system. It has also used 24 VDC, 0.635 cm solenoid valve, 220 V AC pump, relay, and microcontroller board. It is a 5 V 8-channel relay interface microcontroller board. Relay 1–relay 6 connects to the solenoid valve 1–solenoid valve 6, respectively. Relay 7 is connected to relay 8, which has 24 volts, then it is connected to a 220 V electric water pump through a magnetic.

The smartphone controls the system via Blynk server, which connects to the internet via Wi-Fi using application Blynk. The system was tested by sending a command from the smartphone to control the opening and closing of the solenoids valves in

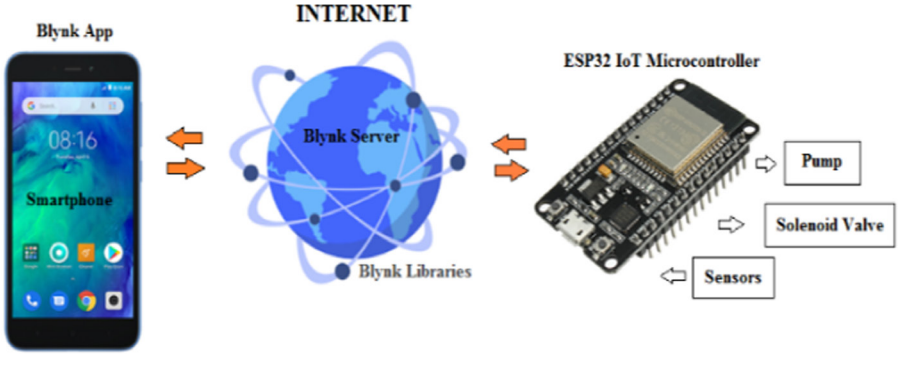

Figure 1: An automated water management system.

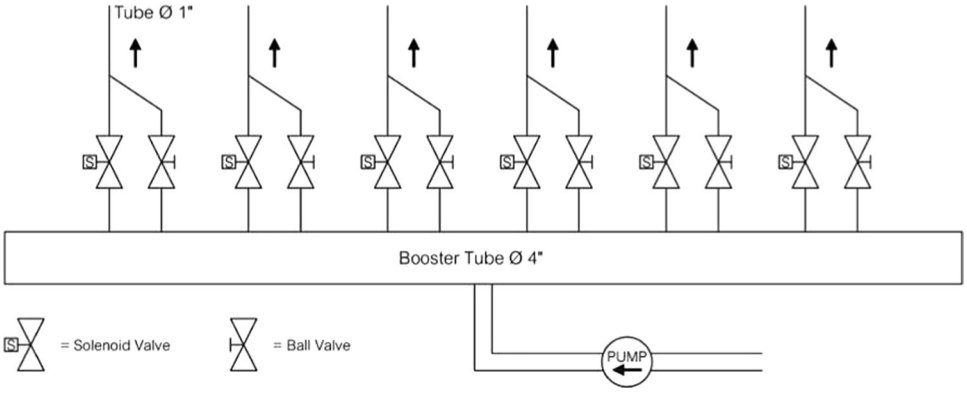

Figure 3: The design of the water pipe system (6-valves automatic water management systems).

the sampling field. It was found that the pump and solenoid valve worked correctly and thus this system can be operated via a smartphone.

Figures 8 and 9 show the 6-valves automatic water management system in the mangosteen garden. The on-off water system was ordered through a smartphone installed in the mangosteen plantation. The water sources were groundwater and wells. Water was sprayed in the air approximately 0.5 meters higher than the trunk to control the temperature and relative humidity of the air. The water pipes were placed in two different locations, 0.5 meters above the ground, and 1 meter above of each trunk. The

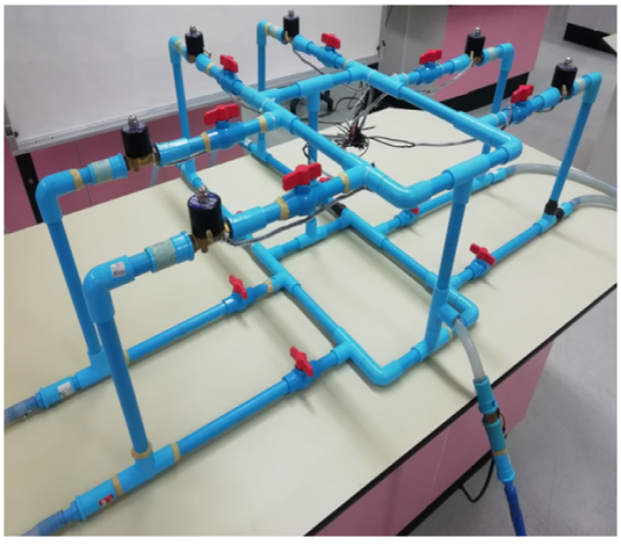

Figure 4: The real 6-valves automatic water management system for installing in the field.

automatic control system is demonstrated similarly as 6-valves automatic water management systems in orchards. The results showed that the system can be operated via a smartphone. According to the farmer, the working status of the pump and solenoid valve was displayed correctly, as shown in Figure 10.

The construction and development of the 2-valves automatic water management system in the durian garden are shown in Figures 11 and 12. There are two techniques of water distribution systems, which include the manual (hand) on-off water systems. Two sprinkler water pipes were placed 1 m above of the trunk, and 0.5 m above the ground. The control pump used solid-state relays, which is an electronic switch for increasing the service for a long time. The automatic water management system in the durian garden also has a rain sensor. When it rains, the water pump stops working.

The test result of the 2-valves automatic water management system in the durian garden confirms that the system can be operated via a smartphone effectively. This 2-valves system also shows the working status of pumps and solenoid valves correctly. A similar result was observed in the case of the 6-valves automatic water management system in the mangosteen garden. If it rains, the automatic water management system in the durian garden stops the solenoid valve.

In total, 79 farmers in Nakhon Si Thammarat province tested this proposed system. Farmers' satisfaction level with the automatic water management demonstration system was assessed in fruit orchards. The results of the satisfaction assessment are shown in Table 1. The satisfaction level of the technology transfer recipients regarding the on and off system of water through smartphones was an average of 4.61, which is 94.25%. The satisfaction level for the safety of on and off system of

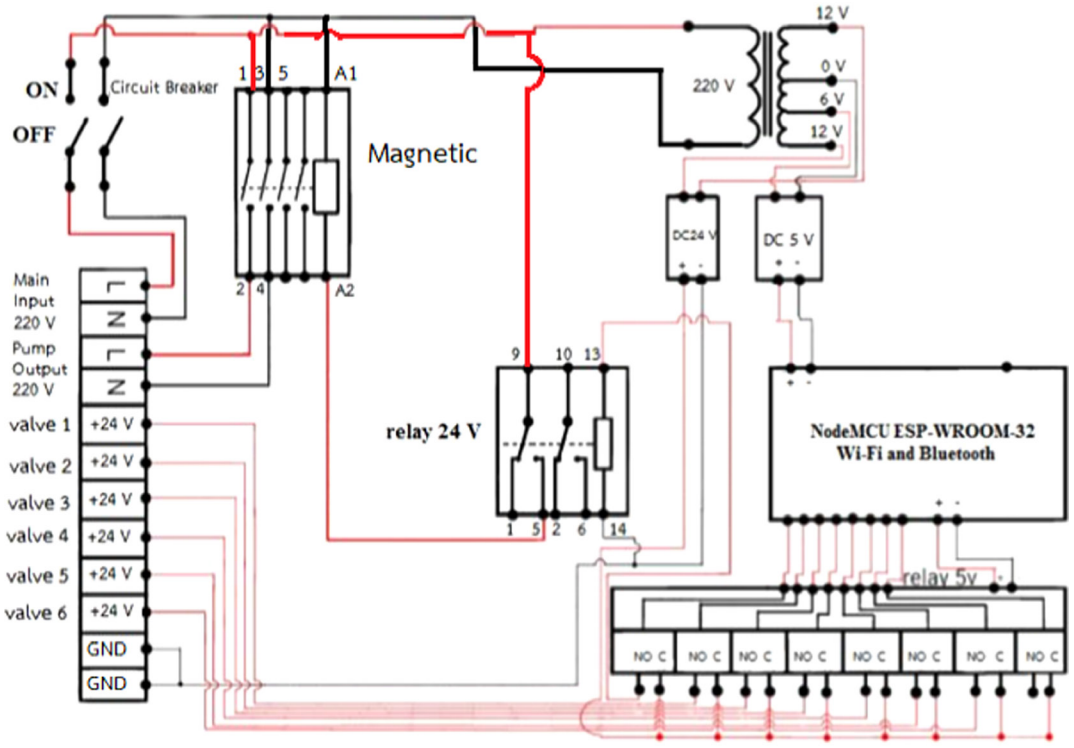

Figure 5: The schematic diagram of a control circuit for automatic water management system in orchards.

water through smartphones was an average of 4.57, representing 92.13%. In both cases, the satisfaction levels were very high.

For creating an automatic water management system in mangosteen and durian gardens, it is needed to build two systems; an open-close system by hand, and an electric on-off system ordered via smartphone. If the internet system has a problem, farmers can turn on or turn off the water manually

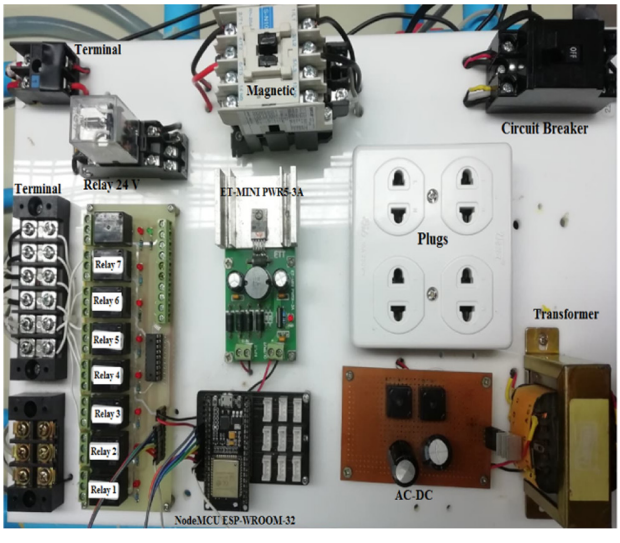

Figure 6: The 6-valves automatic control system in orchards.

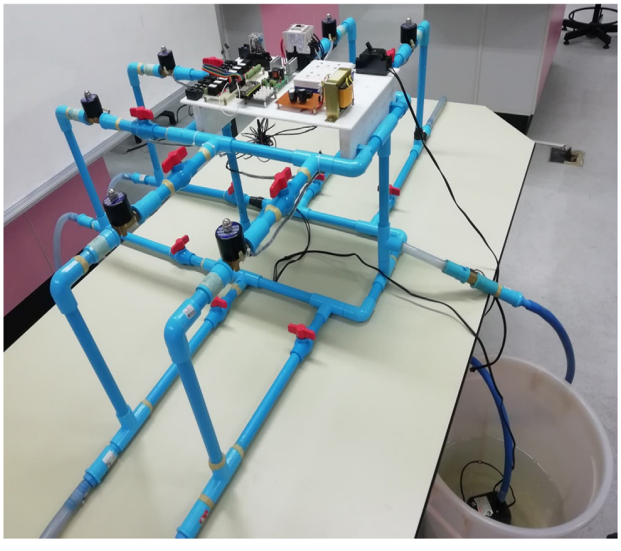

Figure 7: Overall view of the demonstration set of 6-valves automatic water management systems.

Figure 8: Using of 6-valves automatic water management system in the mangosteen garden.

as needed. Electric water on-off system order via smartphone connects to solenoid valves, water pumps, and sensors. This system is easy to build, and it requires cheap devices. Furthermore, it uses free software. The system works correctly as the users want. Because of these reasons, the application of

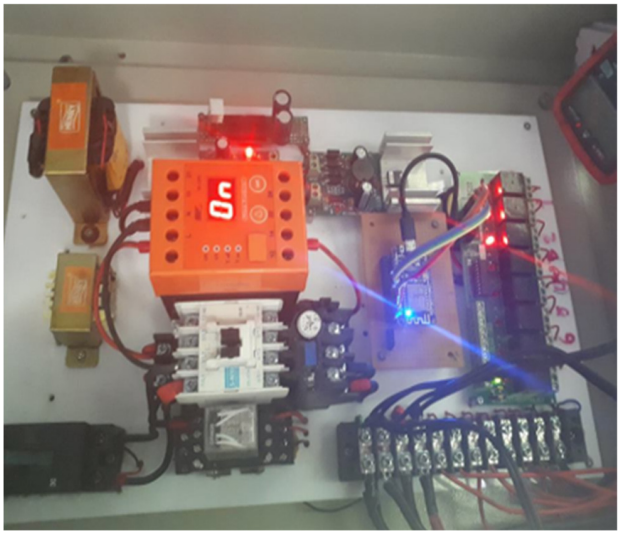

Figure 9: Automatic control system set of 6-valves automatic water management system in the mangosteen garden.

Figure 10: Farmers using smartphones to control the water management system in the mangosteen garden.

Microcontroller IoT and sensor in agriculture is widely used (Suganya et al., 2017; Muangprathuba et al., 2019; Khoa et al., 2019).

Figure 11: Using of 2-valves automatic water management system in the durian garden.

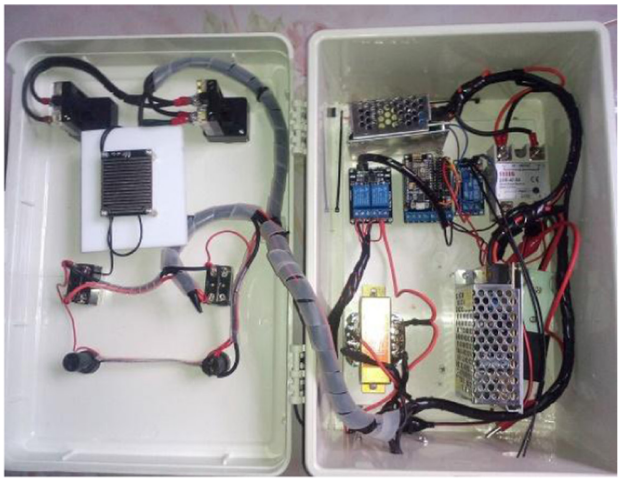

Figure 12: Automatic control system set of 6-valves water management system in the durian garden.

Conclusion

The development of automatic water management systems in orchards has been conducted to improve the water distribution systems. It is an open-close valve system which can be controlled by hand and through smartphone at the specified time. The farmers can use the proposed system in the mangosteen and durian gardens to manage the watering system effectively. Based on the experimental results, it is noted that the farmers are satisfied with the convenience, cost, and safety of the system. Further research can be conducted on the development of water storing system through smart farming in mangostene farms in Nakhon Si Thammarat province in where lack of water is a problem in dry season. Research on development of automatic water on-off system based on soil moisture level should be conducted in mangostene farms in southern Thailand. Based on the soil moisture information, the system can be developed as auto controlled smart system. In addition to that, IoT controlled water management system will be developed for further improvement of the large farming area.

Acknowledgments

This work was supported by the Ministry of Higher Education, Science, Research and Innovation, 2018. I am grateful to Mr. Piyawit Jayangkool and Mr. Nattapol Jayangkool for assisting in water management for orchard. I am thankful to Mr. Surak Mangsathong and Mr. Pongphat Thepthong for their help during conducting this research, and to Dr. Fahmida Wazed Tina for providing useful comments on this manuscript.

Table 1. Satisfaction of the recipients of automatic water management system in orchards.

Opinion	Average	SD	Percentage	Interpret satisfaction
1. Knowledge and understanding before the transfer of technology	3.34	0.52	88.95	Moderate
2. Knowledge and understanding after the transfer of technology	4.32	0.51	92.33	High
3. Training on using of smartphone to operate the water automation system	4.47	0.42	89.47	High
4. The convenience of water on-off system via smartphone	4.61	0.36	94.25	Higher
5. Safety of water on-off system through smartphones	4.57	0.41	92.13	Higher
6. The cost of water on-off system via smartphone	4.53	0.38	90.55	Higher
7. The response speed of the command to turn on and turn off the water via smartphone	4.52	0.37	90.24	Higher
8. Using knowledge for good purpose	4.56	0.39	91.25	Higher

Literature Cited

Agricultural Research Development Agency. 2019. Mangosteen, available at: http://www.arda.or.th/kasetinfo/south/mangosteen/controller/01-02.php (accessed June 25, 2019).

Alahi, M. E., Xie, L., Zia, A. I., Mukhopadhyay, S. and Burkitt, L. 2016. Practical nitrate sensor based on electrochemical impedance measurement. 2016 IEEE International Instrumentation and Measurement Technology Conference Proceedings, 1–6.

Alahi, M. E. E., Mukhopadhyay, S. C. and Burkitt, L. 2018. Imprinted polymer coated impedimetric nitrate sensor for real-time water quality monitoring. *Sensors and Actuators B: Chemical* 259: 753–761.

Alahi, M. E. E., Pereira-Ishak, N., Mukhopadhyay, S. C. and Burkitt, L. 2018. An internet-of-things enabled smart sensing system for nitrate monitoring. *IEEE Internet of Things Journal* 5: 4409–4417.

Alahi, M. E. E., Xie, L., Mukhopadhyay, S. and Burkitt, L. 2017. A temperature compensated smart nitrate-sensor for agricultural industry. *IEEE Transactions on Industrial Electronics* 64: 7333–7341.

Khoa, T. A., Man, M. M., Nguyen, T., Nguyen, V. D. and Nguyen, H. N. 2019. Smart agriculture using IoT multi-sensors: a novel watering management system. *Journal of Sensor and Actuator Network* 8: 1–22.

Muangprathuba, J., Boonnama, N., Kajornkasirata, S., Lekbangponga, N., Wanichsombata, A. and Nillaorb, P. 2019. IoT and agriculture data analysis for smart farm. *Computers and Electronics in Agriculture* 156: 467–474.

Nag, A., Alahi, M. E. E., Feng, S. and Mukhopadhyay, S. C. 2019. IoT-based sensing system for phosphate detection using Graphite/PDMS sensors. *Sensors and Actuators A: Physical* 286: 43–50.

Office of Agricultural Economics. 2018. Planting and care for the mangosteen, available at: http://www.oard8.go.th/information/kpi/mangosteen/58/mgPDF/3.pdf (accessed December 14, 2019).

Poursafar, N., Alahi, M. E. E. and Mukhopadhyay, S. 2017. Long-range wireless technologies for IoT applications: a review. 2017 Eleventh International Conference on Sensing Technology (ICST), 1–6.

Rawal, S. 2017. IOT based smart irrigation system. *International Journal of Computer Applications* 159: 7–11.

Ray, P. 2017. Internet of things for smart agriculture: technologies, practices and future direction. *Journal of Ambient Intelligence and Smart Environments* 9: 395–420.

Shilpa, A. 2018. Smart drip irrigation system. *International Journal of Trend in Scientific Research and Development* 2: 1560–1565.

Somporn na Nakorn. 2014. “Off-season Mangosteen Production in Nakhon Si Thammarat”, The Thailand Research Fund (TRF), Nakhon Si Thammarat.

Suganya, P., Subramanian, A., Yagneshwaran, B., Khan, F. and Sushmitha, S. R. 2017. Automatic irrigation system using IoT. *International Research Journal of Engineering and Technology* 4: 1571–1574.