



Fertilizer Mixing Device for Fertigation System Integrated with Home Assistant Platform

Azrul Mahfurdz^{1,2*}, Zainora Kamal Ludin¹, Suhardi Che Ahmad¹

¹Department of Electrical Engineering, Politeknik Sultan Idris Shah, Sabak Bernam, Malaysia

²Center of Environmental Technology (CENTA), Politeknik Sultan Idris Shah, Sabak Bernam, Malaysia

Email: *azrul@psis.edu.my, azrul@psis.edu.my

How to cite this paper: Mahfurdz, A., Ludin, Z.K. and Ahmad, S.C. (2025) Fertilizer Mixing Device for Fertigation System Integrated with Home Assistant Platform. *Open Access Library Journal*, 12: e12917.

<https://doi.org/10.4236/oalib.1112917>

Received: January 4, 2025

Accepted: February 18, 2025

Published: February 21, 2025

Copyright © 2025 by author(s) and Open Access Library Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Fertigation is becoming increasingly popular among farmers as it ensures consistent and adequate nutrition for each plant. Typically, type A and B fertilizers are mixed manually to achieve the desired EC value, which requires considerable effort from the farmer. In addition, the EC value of the fertilizer mixture varies based on the plant type and growth rate. This is what makes an automatic fertilizer mixing system highly desirable. This project aims to develop an integrated automatic fertilizer mixing system using IoT. The system uses a smart Wi-Fi device connected to a Home Assistant platform for real-time monitoring and control of the EC value in the fertilizer tank. Fertilizer mixing is managed by a dosing pump that precisely delivers fertilizer into the main tank. This system reduces the farmer's workload and minimizes the need for manual labor in fertigation management. Test results show that the water quality sensor and EC meter readings are closely aligned, and the system performs well across multiple test locations.

Subject Areas

Agrotechnology

Keywords

Fertilizer Mixer System, Fertigation System, Home Assistant, Control and Monitoring IoT System

1. Introduction

The fertigation system is an advanced water and fertilizer management approach that delivers irrigation and nutrients simultaneously to plants. This system applies a dilute fertilizer solution multiple times per day, based on the specific needs of each plant, ensuring precision and adequacy. Fertigation has become an attractive

method of fertilization in modern intensive agriculture systems. This has assumed added importance after the introduction of micro-irrigation systems like drip irrigation in irrigated agriculture [1]. The system optimizes the nutrient balance in soils by supplying the nutrients directly to the effective root zones as per the requirement, reducing labor and energy costs [2]. Additionally, fertigation minimizes environmental impact by reducing nutrient runoff and improving nutrient uptake efficiency [3].

Fertigation promotes plant health by reducing the risk of soil-borne diseases such as *Fusarium*, *Rhizoctonia*, and bacterial wilt, which are typically transmitted through the soil. This approach supports sustainable farming practices, leading to improved crop yield, healthier plants, and more efficient resource use. Fertigation offers several advantages, including enhanced water and fertilizer use efficiency, reduced nitrogen losses due to leaching, direct nutrient delivery to the root zone in readily available forms, better control over nutrient concentrations in the soil solution, and cost savings in application [4]. Moreover, integrating IoT-based monitoring systems in fertigation has proven to further enhance resource management and crop productivity. For a fertilizer mixing system, the main requirement is to determine the EC value required for a particular crop. Each crop requires a different amount of EC value based on the type and stage of growth. Usually, the quantity of fertilizer is given according to the age of the plant, which is crucial for plant growth because if the EC value is lower than recommended, the plant may not receive enough nutrients. The goal of this project is to produce an automatic fertilizer mixing system that is used with a fertigation system.

2. Fertilizer Mixture System

The fertilizer mixture for the fertigation system consists of component A, which includes calcium nitrate and iron, and component B, which consists of potassium nitrate, magnesium sulfate, monopotassium phosphate, manganese sulfate, zinc sulfate, copper sulfate, boric acid, and ammonium molybdate. Traditionally, the mixing of fertilizers for fertigation systems is done manually, where Components A and B are combined with water in a single tank. However, for large-scale fertigation systems serving hundreds of plants, the need for a larger fertilizer tank makes manual mixing increasingly inefficient and challenging. The most common methods for mixing fertilizers and water during irrigation include mixing tanks, injectors for applying fertilizers, and devices mounted on the hydrant of an irrigated area [5]. Emerging algorithms and technologies in water and fertilizer integration aim to address challenges such as improving blending response speed, stability, and enabling remote blending control. Experimental results have shown that the control strategy significantly enhances performance [6]. Numerous innovations in mixer method of AB fertilizer have been designed. Studies on multi-channel fertigation machines have proven successful in improving water and nutrient efficiency [7]. Additionally, integrating a microcontroller with a Human Machine Interface (HMI) allows farmers to easily monitor and operate the fertilizer mixing system via a smartphone [8]. Overall operational cost comparison of

different organic fertilizer production methods showed that the automated organic fertilizer prototype provides operational cost savings of over 5 times when compared to current automated systems [9]. The design of an IoT-enabled fertilizer mixing system includes several interconnected components for optimal performance and efficiency. These components include the fertilizer unit, pump, electronic valves, fertilizer mixing container, sensor nodes, and a cloud database for real-time data storage and analysis [10]. This project integrates a Wi-Fi-enabled device with the Home Assistant platform to enhance functionality and automation.

3. Methodology

The development of the system is to facilitate the work of mixing fertilizers at the Urban Farm Fertigation Project of Sultan Idris Shah Polytechnic. This project has received funding from Maybank to assist and provide modern agricultural knowledge to the zakat Asnaf among students. The original system used timer control where fertilizer was given to the trees 3 times a day with timer control. The fertilizer mixing system A and B were done manually. To facilitate the mixing of fertigation fertilizers, a system for mixing fertilizers A and B was developed based on IOT as shown in **Figure 1**.



Figure 1. Fertilizer system.

This fertigation system is designed to irrigate 300 tree bags, utilizing two 400-gallon polyethylene tanks. The AB fertilizer is separately diluted in two water barrels (fertilizer A and B). This system is specifically designed for the cultivation of Chili trees, as shown in **Figure 2** meanwhile **Figure 3** illustrated a complete system of fertigation.

The improvement to the existing mixing system is to use a multi-input sensor that can measure electrical conductivity (EC), temperature, Total Dissolve solid (TDS), potential of hydrogen (PH), salinity, oxidation-reduction potential (ORP) and conductivity factor (CF). The system can be controlled via mobile phone and via Home Assistant platform as shown in the system (**Figure 3**) and also the system flowchart (**Figure 4**). **Table 1** shows the devices involved in developing this

system which consists of wifi sensor EC, 2 dosing pump, wifi smart socket and wifi control valve.



Figure 2. Urban farm fertigation site.

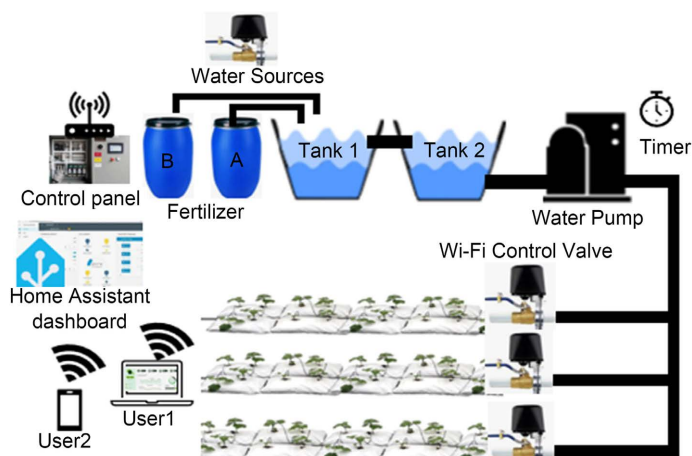


Figure 3. Illustrated system.

Table 1. Equipment and device of the system.

Equipment/Device	Specifications	Quantity
Yieryi-Tuya Smart WiFi water quality	pH 0.00 - 14.00 pH EC: 0 - 19,000 us/cm TDS: 0 - 19,990 ppm Temp: 0°C - 50°C	1
Wifi Socket	Wifi standard: Wifi 2.4 Ghz Wifi Frequency: IEEE 802.11	3
Wifi Control Valve	frequency: 2.4 G Gate valve pressure: 1.6 Mpa Voltage: 12 V Wattage: 5 W	4
Dosing Pump	Flow rate: 100 ml/min Noise: less than 40 DB	2

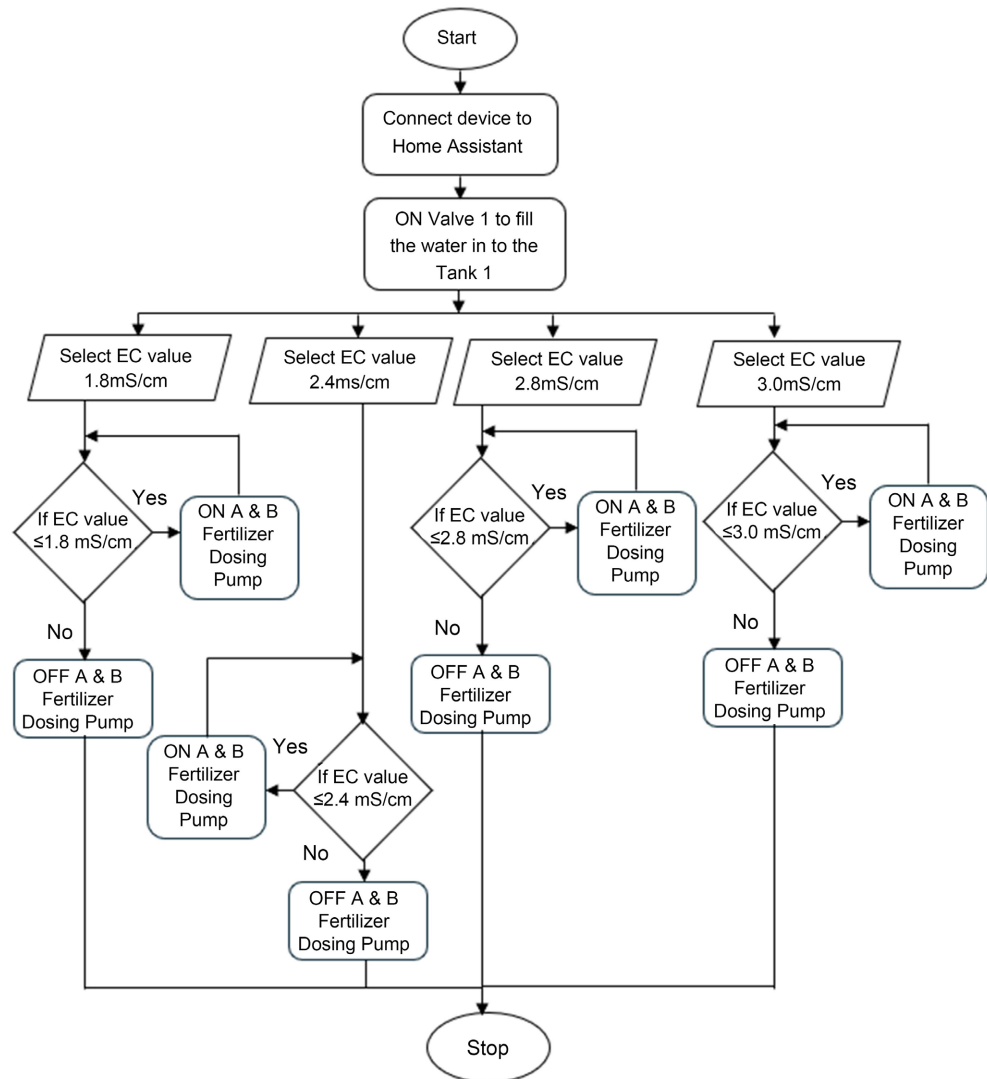


Figure 4. Flowchart of the system.

Table 1 shows the devices involved in developing this system which consists of Smart WiFi water quality, dosing pump and wifi control valve.

4. Result and analysis

The EC value in this system can be set depending on the needs of the plants planted in the fertigation system. There are 4 type of EC value setting which is 1.8 $\mu\text{S/cm}$, 2.4 $\mu\text{S/cm}$, 2.8 $\mu\text{S/cm}$ and 3.0 $\mu\text{S/cm}$. Control and monitoring can be done either using a phone or through a home assistant. The developed system allows for control and monitoring via both mobile phone and computer, with integration into the Home Assistant platform, as illustrated in **Figure 5**. Testing of the system was carried out by looking at the EC accuracy value that had been set. In this experiment, the value of the fertilizer mixture A and B was set at 2.1 mS/cm . The EC reading from the sensor was compared with the meter reading. **Figure 6** shows water parameters which are TDS, salt level, Ph, water temperature and EC value

readings from the Water quality sensor while **Figure 7** shows a comparison of the EC readings from the water quality sensor and the EC meter.

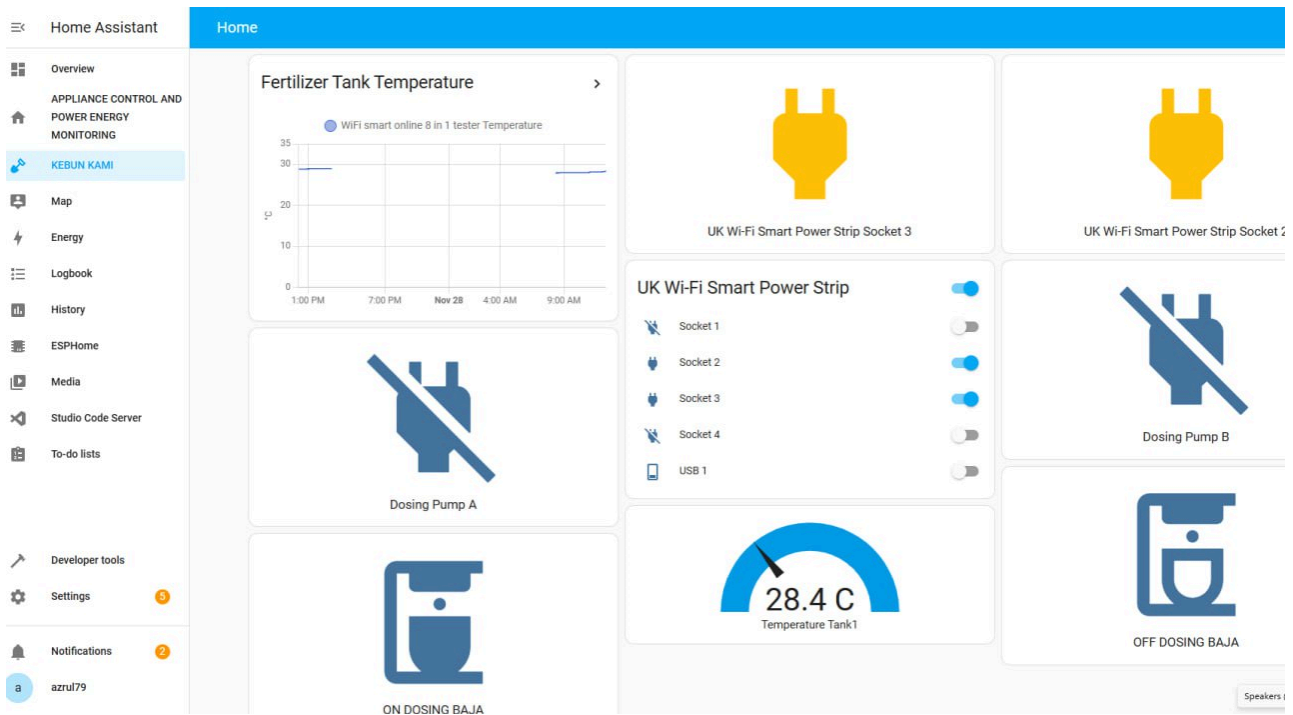


Figure 5. Dashboard of the system.

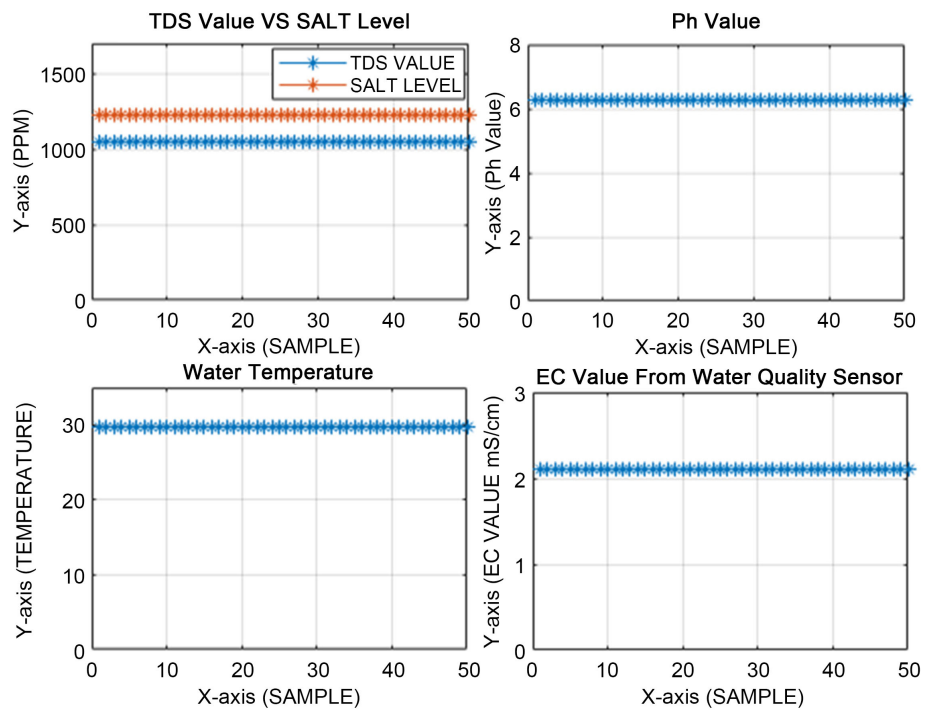


Figure 6. Water Quality parameter recorded.

A total of 50 samples were obtained. There was no significant change between

the readings from the water quality sensor and the EC meter. The average EC reading for the water quality sensor was 2.09 ms/cm while the reading from the EC meter was 2.12 ms/cm. The difference value for the devices was 0.03 ms/cm.

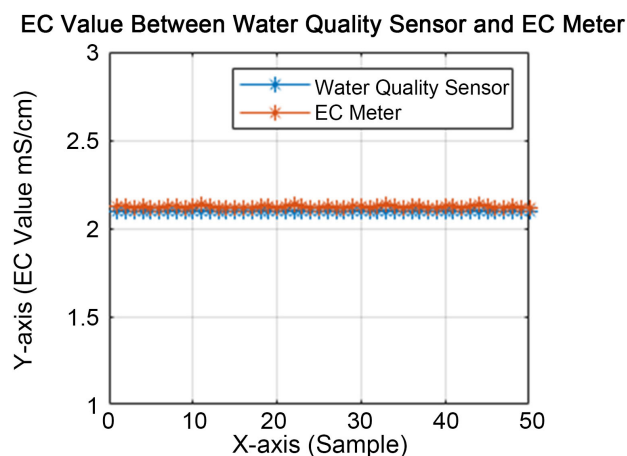


Figure 7. Comparison EC value between water quality sensor and EC meter.

In addition, the system was also tested for effectiveness in terms of control and monitoring in several places around Sabak Bernam. **Table 2** shows the results of the system tests in several locations. As a result of the tests, the overall system can be accessed and controlled according to the testing location. The results of the tests conducted show that the system can be reached and all devices can be controlled in the selected locations.

Table 2. System testing at several locations.

Location	Distance from Device	Condition
Parit Baru	3.9 Km	success
Kampung Sungai Apong	4.9 Km	success
Bagan Nakhoda Omar	11.1 Km	success
Pekan Sabak Bernam	24.4 Km	success
Pekan Sungai Besar	28.5 Km	success
Sungai Hj Dorani	34.7 Km	success

5. Conclusion

The research proposes the development of fertilizer mixing systems integrated with home assistant platforms. The system can be accessed through Home Assistant mobile application and using computer. The system development allowed users to control and monitor EC value of the fertilizer in the tank. The system helps to facilitate fertilizer mixing which was previously done manually. The use of this system can save time, reduce farmers' workload and reduce manpower in managing fertigation fields. The results of the test show that there is no significant difference between the readings from the water quality sensor and EC meter. The

system can also provide a good response during testing in several specific locations. Although the system successfully controls all devices installed in the system, the use of wifi valve to control the flow of fertilizer sometimes causes misalignment. Therefore, it is recommended that other types of devices can be used to replace the use of wifi valve. In addition, in the future, it is also proposed that EC value measurements are also measured on each tree.

Acknowledgements

Thanks to Urban Farming Maybank Project to provide financial support and Department of Electrical Engineering, Polytechnic Sultan Idris Shah for providing facilities and instruments during the experiment. We would also like to thank the Smartgreen team for helping us prepare the device in this study and not forgetting all those involved directly and indirectly in completing this study.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Biswas, B.C. (2010) Fertigation in High Tech Agriculture. *Fertilizer Marketing News*, **41**, 4-8.
- [2] Pibars, S.K., Gaballah, M.S., Mansour, H.A. and Khalil, S.E. (2022) Management of Fertigation and Its Effects on Irrigation Systems Performance and Crop Yield. *International Journal of Mechanical Engineering*, **7**, 882-896.
- [3] Solaimalai, A., Baskar, M., Sadasakthi, A. and Subburamu, K. (2005) Fertigation in High Value Crops—A Review. *Agricultural Reviews*, **26**, 1-13.
- [4] Patel, N. and Rajput, T.B.S. (2020) Fertigation in Modern Agriculture: An Overview of Benefits and Challenges. *Agricultural Water Management*, **241**, Article 106398.
- [5] Tarasyants, S.A., Rudakov, V.A., Urzhumova, Y.S. and Degtiareva, K.A. (2021) The Calculation Basis for a Four-Component Jet Mixer for Fertilizer and Water. *E3S Web of Conferences*, **262**, 01035. <https://doi.org/10.1051/e3sconf/202126201035>
- [6] Wang, H., Zhang, L., Hu, X., Wang, H. and Zhang, X. (2023) Research on Water and Fertilizer PH Control Strategy of Automatic Fertilizer Application System in Cotton Field. Preprints. <https://doi.org/10.21203/rs.3.rs-2878782/v1>
- [7] Sun, G., Li, X., Wang, X., Li, Y., Chen, M., Zhang, Y., *et al.* (2015) Design and Testing of a Nutrient Mixing Machine for Greenhouse Fertigation. *Engineering in Agriculture, Environment and Food*, **8**, 114-121. <https://doi.org/10.1016/j.eaef.2014.12.001>
- [8] Ramli, R.M., Mohamed, M. and Abdullah, N.R. (2022) Smart Fertilizer Mixer System for Fertigation. 2022 *IEEE 8th International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA)*, Melaka, 26-28 September 2022, 205-210. <https://doi.org/10.1109/icsima55652.2022.9928966>
- [9] Kamyod, C. (2023) Smart Melon Farm System: Fertilizer IoT Solution. *Journal of Mobile Multimedia*, **19**, 1107-1128. <https://doi.org/10.13052/jmmm1550-4646.1951>
- [10] Hadi Ishak, A., Hajjaj, S.S.H., Rao Gsangaya, K., Thariq Hameed Sultan, M., Fazly Mail, M. and Seng Hua, L. (2023) Autonomous Fertilizer Mixer through the Internet of Things (IoT). *Materials Today: Proceedings*, **81**, 295-301. <https://doi.org/10.1016/j.matpr.2021.03.194>