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Simulation of Monitoring the Automatic Dosing System on the Vending Machine for Wonosobo Coffee Tubruk

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Abstract

The traditional process of making Wonosobo coffee involves manual steps, starting with mixing the main ingredients Wonosobo coffee and sugar. This is followed by brewing with warm water, which often results in inconsistent quantities and flavor variations. To address this issue, this study proposes a machine monitoring system that can be remotely tracked in real-time via a smartphone application. The primary goal is to enhance the consistency of servings, thereby improving the coffee's taste quality. Utilizing Internet of Things (IoT) technology, this system allows devices to communicate and interact with each other. A key feature is the notification system that alerts users to any discrepancies in measurements, ensuring up-to-date information on the coffee-making process. In this automated process, human intervention is replaced by an automatic filling system, reducing errors and increasing efficiency. The system uses the Haiwell Cloud SCADA application, which connects to a Programmable Logic Controller (PLC) and allows users to control and monitor the system anytime, anywhere, via TCP/IP protocol. The final outcome is a Wonosobo coffee vending machine equipped with a monitoring system accessible through smartphones. Measurable indicators include dose monitoring with an average error rate of 0.61% for sweet menu, 0.31% for bitter menu, and 0.70% for customized menu, allowing users to monitor the process in real-time and receive notifications of any issues. Overall, this study significantly contributes to the development of automation technology in the coffee industry, making the Wonosobo coffee-making process more efficient and consistent while enabling real-time remote monitoring.

A. Introduction

In the contemporary era, the utilization of automated machines is increasingly favored by entrepreneurs. This preference stems from the fact that automated machines can enhance production efficiency and reduce errors in the production process, thereby yielding products of superior quality with fewer defects [1]. Wonosobo district is renowned as a coffee-producing region. Situated amidst Mount Sindoro, Mount Sumbing, and Mount Kembang, Wonosobo district possesses highlands that are ideal for the cultivation of Arabica coffee plants. For optimal results in growing Arabica coffee, the land used should ideally be located at an altitude between 1000 to 2000 meters above sea level with temperatures ranging from 15°C to 25°C [2]. Based on monitoring results, it has been revealed that inconsistencies in baristas' coffee preparation or non-compliance with standards can lead to significant variations in the quality of the beverages served. These variations can negatively impact the reputation of coffee shops and disappoint customers, especially during busy office hours [3]. In the development of a powder dosage system, there are several functions and methods that can be integrated to achieve accurate and effective dosages. One approach that can be used is the concept of modular dosing, which allows for the combination and modification of the dosing system according to the specific needs of the user [4]. To address this issue, remote monitoring technology has emerged as an innovative and effective solution. This technology enables real-time and efficient monitoring and management of the production process, without the need to be at the same location. In the coffee-making process, human intervention is no longer fully required, having been replaced by a pre-designed filling system [5], [6]. Remote smartphone monitoring is a technology that enables operators to oversee and control machines or systems from different locations. In the industry, this technology plays a crucial role in monitoring machine performance, collecting data, and taking responsive actions. Through touch screen integration and mobile devices, remote smartphone monitoring further strengthens its role as a key link between humans and technology in the digital era [7], [8] . This research proposes a system concept that focuses on monitoring the operational process of the Wonosobo coffee machine. The system is designed with a significant enhancement in terms of remote monitoring capabilities. This allows for more efficient and effective supervision without the necessity of being in the same location. This system uses the Transmission Control Protocol/Internet Protocol method [9]. TCP/IP is a widely used and standard protocol for Internet communication due to its many advantages. It provides unique addresses for each device, enabling clear identification and accurate data delivery. TCP/IP supports a hierarchical addressing system, simplifying IP address management. With TCP/IP, computers and devices can connect and communicate globally, forming the basis of today's internet connectivity [10] [11]. In addition, the system also incorporates a maintenance mechanism operated by a maintenance team. This mechanism is designed to facilitate the reporting process of potential issues that may arise in the automatic dosing system. Consequently, the maintenance team can promptly address these issues and prevent unnecessary operational disruptions [12] . Overall, this research demonstrates that the use of remote monitoring technology and automated machines can enhance the efficiency

and quality of Wonosobo coffee production. Thus, this research makes a significant contribution to the development of automation technology for the coffee industry.

B. Research Method

The architectural design for this automated coffee vending machine system will be constructed based on the PLC A8 Haiwell platform. This platform possesses the capability to integrate the Programmable Logic Controller (PLC), Human-Machine Interface (HMI), and IoT Gateway into a comprehensive system unit. As a result, this system can operate at a high level of reliability and utilizes high-quality industrial components. This reliability and quality not only ensure the operational stability of the Wonosobo automated coffee vending machine system but also guarantee that the technology employed is robust and state-of-the-art within the industrial scope. This integration yields an efficient and reliable solution to meet the needs of the Wonosobo coffee measurement system, which requires precision and consistency in its process. The primary focus in the creation of this system is on the implementation of remote monitoring on the system. With this feature, users can monitor and control the operational activities of the automated coffee vending machine from a distance, thereby enhancing flexibility and efficiency in machine operation

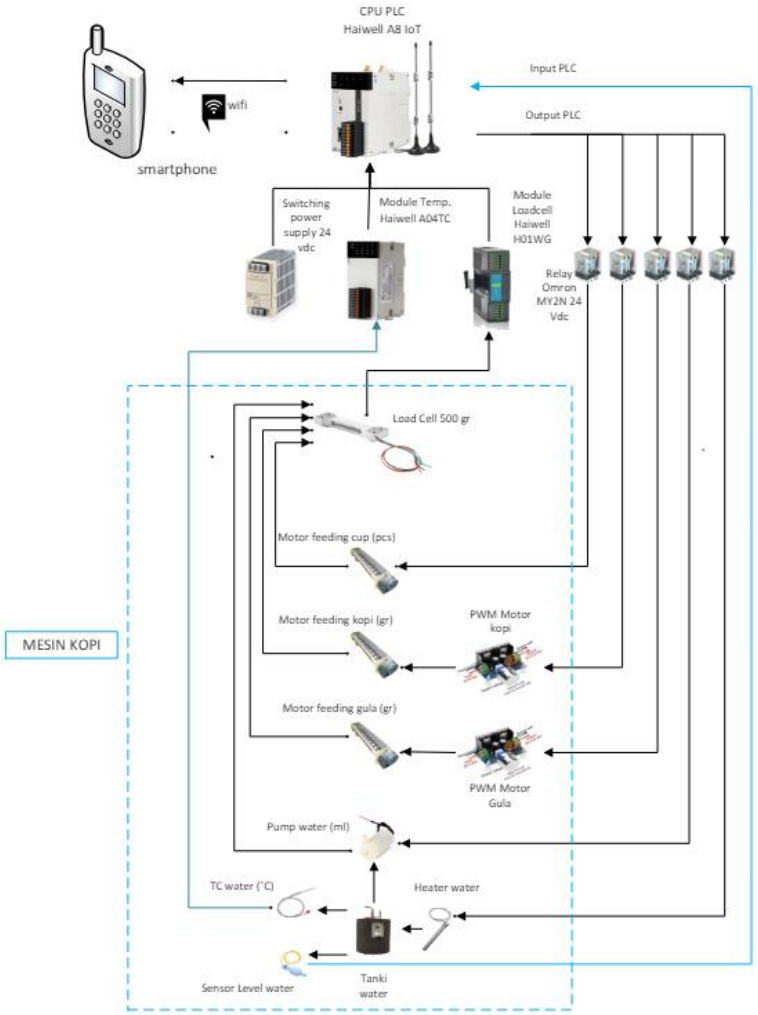

Figure 1. System Overview

In this advanced communication design concept, information related to the coffee menu selected by the user is conveyed to the communication system via an internet connection. The system then processes this information, reading and understanding the process associated with the selected Wonosobo coffee menu. Subsequently, the system orchestrates each stage of coffee production automatically and monitors the mechanical process to ensure that each step proceeds smoothly. To enable remote control and monitoring, this system employs the Haiwell Cloud SCADA application. This application can connect with the Programmable Logic Controller (PLC) and allows users to control and monitor the system anytime and anywhere. This system employs the TCP/IP protocol, which boasts several advantages. One of its primary strengths is its ability to assign a unique address to each device, facilitating clear identification and accurate data transmission. Furthermore, the IP protocol supports a hierarchical addressing system, simplifying the management and configuration of IP addresses. With IP, computers and devices can establish global connections and communication, forming the foundation of today's internet connectivity. The application is also equipped with an alarm notification feature that alerts users if there are issues within the system. In addition, the application has the capability to conduct audits and control access behavior, thereby ensuring that the system is secure from external threats. The Haiwell Cloud App also utilizes 128-bit SSL encryption to ensure data transmission stability and safeguard information. Therefore, the integration of monitoring and mechanical systems forms a crucial foundation in designing a user experience that is efficient and remotely accessible

Figure 2. Communication Design

The interface design for this automated Wonosobo coffee vending machine system is crafted with a keen consideration of user needs and flexibility in menu selection. The process commences by offering an array of menu choices to the user. Two of these menu options have been pre-determined, with compositions approved and verified by professional baristas, thereby ensuring the quality and consistency of the coffee's taste. However, the system also accommodates the creativity and individual preferences of users by providing additional options that allow users to customize their orders according to their tastes. Furthermore, the system is equipped with a commentary indicator that functions to display up-to-date information about the machine's operational process. This indicator enables users to comprehend the ongoing process within the machine and ensures that the process is proceeding smoothly. The system is also designed with the consideration of maintenance needs and sensor adjustments. Therefore, the system is equipped

with a tolerance feature for sensor maintenance prediction. This feature allows the system to continue operating accurately even if the sensor may no longer be accurate.

C. Result and Discussion

In order to gather data, the dosing system is designed utilizing a load cell, thereby enabling readings on the interface. The employment of the load cell is based on the principle of shear or stress that occurs in a metal object. Shear or stress refers to the force or pressure exerted on the metal object in the load cell. In the context of the load cell, the working principle based on shear or stress refers to the elastic deformation of a metal element, such as a spring or beam, when a load or force is applied. This deformation is then converted into an electrical signal, which can be measured to determine the weight or force acting on the load cell. Thus, shear or stress in this context characterizes the change in shape or pressure on the metal element used in the load cell. The system in Fig.1 is then integrated with a smartphone by accessing the Haiwell Cloud application, thereby enabling remote control. To access the Haiwell Cloud application, it is necessary to add the device to the account using a QR code to confirm the device to be linked. In addition, the Haiwell Cloud APP supports multiple platforms such as PC, iPad, and iOS. To monitor the status of the device, one enters the Cloud and selects the device, where one can ascertain the status of the device, whether it is Online or Offline.

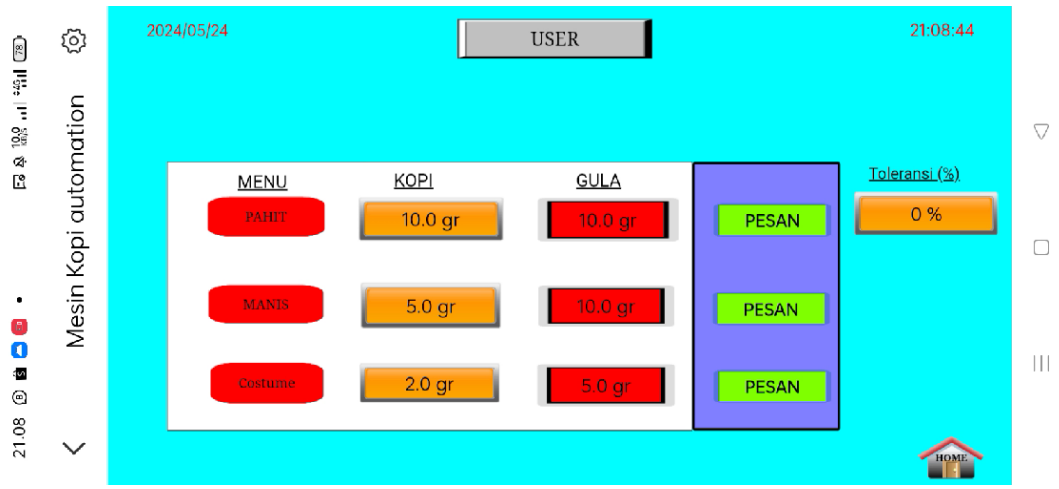

Figure 3. Display Select Menu

When users first access the automated Wonosobo coffee vending machine system, they are greeted with an initial display showcasing a variety of coffee menu options, as depicted in Figure 4. Users are granted the freedom to select the type of coffee they desire, be it sweet, bitter, or custom. For the sweet and bitter coffee options, the proportions of the ingredients have been predetermined by professional baristas. This ensures that each cup of Wonosobo coffee produced consistently possesses the taste and quality in accordance with the standards set by the baristas. Meanwhile, for the custom coffee option, users are given the liberty to determine their own proportions of coffee and sugar. They can choose the number of grams of coffee and sugar they wish to use, thereby enabling them to create a Wonosobo coffee flavor that aligns with their personal preferences. Consequently,

this automated coffee vending machine system not only offers a range of delicious and high-quality Wonosobo coffee options but also provides users with the flexibility to customize their orders to suit their tastes. This results in a more personalized and enjoyable Wonosobo coffee drinking experience for each user.

Figure 4. Sweet Coffee Making Process

Tabel 1. Making Sweet Coffee

No	Coffee Menu	Set Coffee (Gr)	Set Sugar (Gr)	Set Water (Gr)	Total Set Load	Actual Coffee (Gr)	Actual Sugar (Gr)	Actual Water (Gr)	Total Actual Load (Gr)	Manual Weight (Gr)
1	Sweet	5,0	10,0	100,0	115,0	5,1	10,7	101,3	117,1	116
2	Sweet	5,0	10,0	100,0	115,0	5,0	11,2	99,8	116	115
3	Sweet	5,0	10,0	100,0	115,0	5,1	10,5	100,6	116,2	116
4	Sweet	5,0	10,0	100,0	115,0	5,0	10,6	100,9	116,5	116

Figure 5 illustrates the operational process of the Automatic Dosing System in the automated coffee vending machine for the sweet menu option. The figure displays the predetermined weight measurement during the selection of the sweet menu. This display is, in fact, a reading from the integrated load cell sensor within the system. The function of this load cell sensor is to measure the weight of the ingredients used in the coffee-making process, thereby ensuring that the proportions of the ingredients align with the predetermined measurements. Consequently, the quality of the coffee flavor produced can consistently be maintained. Meanwhile, Table 1 presents evidence that this Automatic Dosing System is capable of making sweet coffee from a distance with a very low error rate, averaging only 0.61%. This indicates that the system possesses a high level of accuracy in the automatic dosing process, thereby ensuring the quality and consistency of the coffee flavor produced.

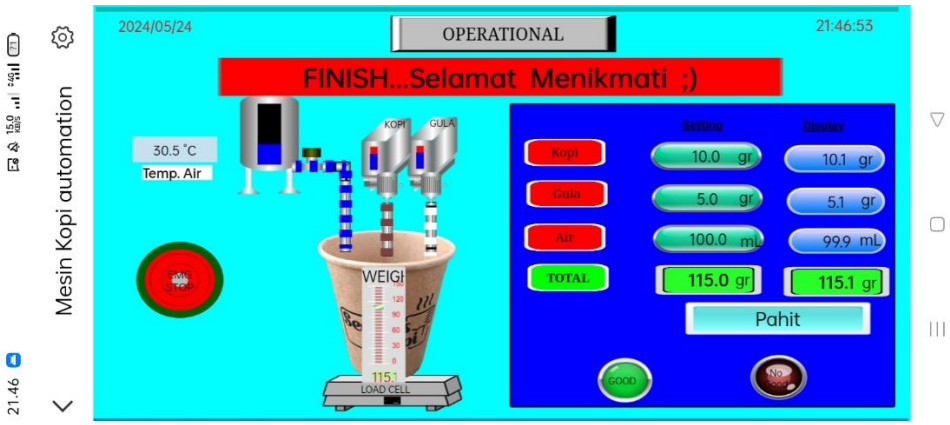

Figure 5. Bitter Coffee Making Process

Table 2. Making Bitter Coffee

No	Coffee Menu	Set Coffee (Gr)	Set Sugar (Gr)	Set Water (Gr)	Total Set Load	Actual Coffee (Gr)	Actual Sugar (Gr)	Actual Water (Gr)	Total Actual Load (Gr)	Manual Weight (Gr)
1	Bitter	10,0	5,0	100,0	115,0	10,1	5,7	100,6	116,4	116
2	Bitter	10,0	5,0	100,0	115,0	10,3	5,8	101,2	117,33	117
3	Bitter	10,0	5,0	100,0	115,0	10,3	6,1	100,2	116,6	116
4	Bitter	10,0	5,0	100,0	115,0	10,1	5,1	99,9	115,1	115

Figure 6 illustrates the operational process of the Automatic Dosing System in the automated coffee vending machine for the bitter menu option. The figure displays the predetermined weight measurement during the selection of the bitter menu. This display is, in fact, a reading from the integrated load cell sensor within the system. The function of this load cell sensor is to measure the weight of the ingredients used in the coffee-making process, thereby ensuring that the proportions of the ingredients align with the predetermined measurements. Consequently, the quality of the coffee flavor produced can consistently be maintained. Meanwhile, Table 2 presents evidence that this Automatic Dosing System is capable of making bitter coffee from a distance with a very low error rate, averaging only 0.31%. This indicates that the system possesses a high level of accuracy in the automatic dosing process, thereby ensuring the quality and consistency of the coffee flavor produced.

Figure 6. Customized Coffee Making Process

Tabel 3. Making Customized Coffee

No	Coffee Menu	Set Coffee (Gr)	Set Sugar (Gr)	Set Water (Gr)	Total Set Load	Actual Coffee (Gr)	Actual Sugar (Gr)	Actual Water (Gr)	Total Actual Load (Gr)	Manual Weight (Gr)
1	Customize	6,0	7,0	137,0	150,0	6,3	7,2	138,2	151,7	151
2	Customize	6,0	7,0	137,0	150,0	6,2	7,9	137,2	151,3	150
3	Customize	6,0	7,0	137,0	150,0	6,5	7,8	137,5	151,8	151
4	Customize	6,0	7,0	137,0	150,0	6,3	7,8	137,3	151,4	150

Figure 7 illustrates the operational process of the Automatic Dosing System in an automated coffee vending machine for the Customize menu selection. The figure displays the predetermined weight size at the time of Customize menu selection. This display is, in fact, a reading from the integrated load cell sensor within the system. The function of this load cell sensor is to measure the weight of the ingredients used in the coffee-making process, thereby ensuring that the proportion of ingredients aligns with the predetermined settings. Consequently, the quality and taste of the coffee produced can remain consistent. Meanwhile, Table 3 presents evidence that this Automatic Dosing System is capable of remotely preparing a Customize coffee with a very low error rate, averaging only 0.70%. This indicates that the system possesses a high level of accuracy in the automatic dosing process, thereby ensuring the quality and consistency of the coffee's taste.

Figure 7. The Red Light is On

Figure 8. The Green Light is On

Figures 8 and 9 provide a visual illustration of the notification process within the system. This process commences when a significant discrepancy arises between the settings displayed on the menu and the readings from the load cell sensor. If this discrepancy exceeds 5%, the system activates an alarm light on the smartphone interface via the Haiwell Cloud application. This alarm light has two color formats, namely green and red. The green light signifies that the system error is less than 5%, indicating that the system is still operating within the established tolerance limits. Conversely, the red light signifies that the system error has exceeded 5%, indicating a problem that requires attention. In addition to the alarm light, users will also receive notifications on their smartphone notification bar, as shown in Figure 10. These notifications serve as an additional warning to users that the system requires maintenance and repair. Thus, this system not only ensures consistency and accuracy in the automatic dosing process but also provides an effective monitoring and warning mechanism to ensure that the system always operates under optimal conditions.

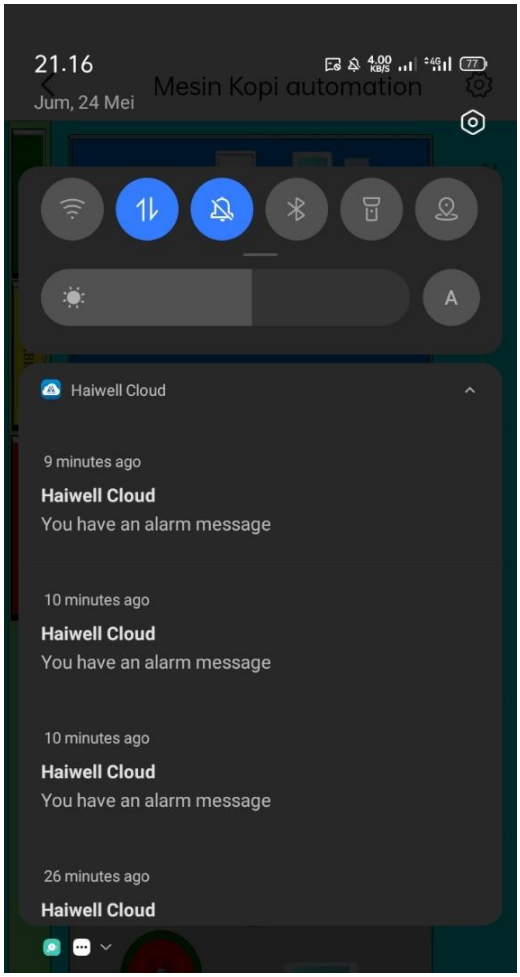

Figure 9. Alarm Notification

D. Conclusion

The completion of the design and testing phases of the 'Simulation of Monitoring the Automatic Dosing System on the Vending Machine for Wonosobo Coffee Tubruk', several conclusions can be drawn. The implementation of the Automatic Dosing System for Wonosobo Tubruk coffee has been successfully executed and has yielded an error parameter of less than 1%. This low error rate significantly minimizes inaccuracies in the measurement of ingredients, thereby ensuring the consistent quality of the coffee produced. The testing phase also incorporated the use of the Haiwell Cloud application. This application allows for remote control of the system, providing a significant advantage in terms of convenience and efficiency. In the event of a discrepancy in the error parameter between the settings displayed on the menu and the readings from the load cell sensor, the application is designed to trigger a notification. This feature serves as an effective alert system, enabling prompt identification and resolution of any issues that may arise. In essence, the Automatic Dosing System not only ensures the precise measurement of ingredients for Wonosobo Tubruk coffee but also incorporates an effective monitoring system. This combination of precision and monitoring contributes to the consistent production of high-quality coffee, regardless of the distance from which the system is controlled. Furthermore, the low error parameter demonstrates the system's

reliability and accuracy, reinforcing its suitability for use in automated coffee vending machines.

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