

Development of an SMS-Based Prototype System for Controlling Lights, Curtains, and Plant Watering Using Arduino Uno

Susan Anis Rahmawati¹

Computer Engineering Technology, College of Vocational Studies, IPBUniversity
susananis@apps.ipb.ac.id

Alyssa Daniswara², Rahadi A.³, Duta Adithya Dewa⁴, Razan Fajar Raspati⁵, Muhammad Raka Faqihhudin⁶

Computer Engineering Technology, College of Vocational Studies, IPBUniversity
alysadaniswara@apps.ipb.ac.id, rahmawatianis085@gmail.com, dutadewa@apps.ipb.ac.id,
356razan@apps.ipb.ac.id, muhammadrakafaqihhudin@apps.ipb.ac.id

Abstract

Home automation systems provide a practical approach to controlling household devices remotely. One approach is to use Short Message Service (SMS), which allows users to send commands through a mobile phone without requiring a dedicated application. This study aims to analyze an SMS-based home automation system using Arduino Uno to control lights, curtains, and a plant-watering mechanism. The system uses Arduino Uno as the main controller, a GSM modem as the communication medium, a relay as an electronic switch, and servo motors as mechanical actuators. The research method consists of requirements analysis, system design, implementation, and functional testing. Testing was conducted using three main commands: “Pagi”, “Malam”, and “Siram”. The results show that the “Pagi” command successfully turns the light off and opens the curtain, the “Malam” command successfully turns the light on and closes the curtain, while the “Siram” command successfully activates the watering mechanism for 9 seconds before returning to its initial position. All three tested scenarios produced responses consistent with the designed functions. These results demonstrate that SMS can be used as a simple control mechanism for integrating several household devices with different actuator characteristics.

Keywords: home automation, Arduino Uno, SMS, GSM, remote control

INTRODUCTION

Advances in information and communication technology have changed the way electronic devices are operated in everyday life. Home automation systems have developed from conventional manual control toward systems that integrate communication technologies, controllers, sensors, and actuators to provide automated functions. The concept has subsequently developed into smart home systems in which multiple household devices can be connected and controlled through integrated architectures. Reviews of smart home technologies show that automation can involve different categories of household functions and communication technologies, ranging from basic device control to more connected and automated environments (Anam, 2020; Pandiangan, 2021; Kusumawati & Inggi, 2021). More recent smart home research also emphasizes the integration of multiple devices and actuators through a common control mechanism (Siskandar et al., 2022). This development indicates that an automation system does not necessarily need to focus on a single device, but can integrate several household functions within one control mechanism.

Communication is an important component of an automation system because it connects user commands with the devices being controlled. Current smart home systems commonly use Internet-based communication and messaging technologies, while the selection of a communication mechanism depends on the requirements and characteristics of the system. For applications that require more complex connectivity, IoT-based architectures can provide communication between multiple devices and services. However, increasing system connectivity also introduces considerations related to privacy, security, authentication, and user trust (Rahimi et al., 2020; Rao & Deebak, 2023;

Magara & Zhou, 2024). These considerations indicate that the communication mechanism should be selected according to the functional requirements of the automation system rather than based solely on the adoption of newer technologies. For simple remote-control requirements, a communication mechanism that can deliver predefined commands directly to a controller remains relevant.

Short Message Service (SMS) provides an alternative communication mechanism for simple remote-control applications because users can send predefined commands through a mobile phone. SMS-based home automation has been implemented using microcontrollers and GSM modules to control electrical appliances remotely (Nurhadiyan & Saputro, 2019; Tullah et al., 2019). GSM-based systems have also been applied to remotely control household electrical appliances by sending SMS commands to a controller (Juniawan & Sylfania, 2019). These studies demonstrate that SMS can function as a direct command interface without requiring a dedicated mobile application or an Internet-based smart home platform. Therefore, SMS-based control remains applicable when the primary requirement is the remote execution of predefined functions rather than continuous Internet-based monitoring or complex device interaction.

In the Indonesian context, similar SMS- and Arduino-based approaches have been widely explored for household security and lighting control, including smart CCTV systems triggered via Telegram (Setiawan et al., 2019), PIR-sensor-based home security with SMS notification (Tullah et al., 2019; Juniawan & Sylfania, 2019), and remote lamp switching through GSM SIM800L modules (Anam, 2020; Pandiangan, 2021). These studies confirm that SMS remains a practical control channel for Arduino-based household systems in the national research landscape.

In an automation system, a microcontroller can serve as the central controller that connects user input with output devices. Arduino-based systems have been widely used for home automation because the controller can process input commands and activate different actuators according to predefined functions (Siregar & Pangaribuan, 2025). In the system developed in this study, the Arduino Uno receives messages from the GSM modem through serial communication, identifies the message content, and determines the corresponding action. The output devices consist of a relay for controlling the lamp and servo motors for controlling the curtain and watering mechanisms. The use of different actuators requires the controller to distinguish each command and translate it into the appropriate physical response.

Automation can also be extended beyond electrical household appliances to plant maintenance. Plant watering is one of the functions that can be incorporated into an automated system, particularly when users are away from home. Recent irrigation research has increasingly explored sensor-based and IoT-based systems for monitoring and determining watering requirements (García et al., 2020; Obaideen et al., 2022; Bwambale et al., 2022). More advanced approaches may use environmental measurements, data-driven methods, or water-need estimation to determine irrigation requirements (Nsoh et al., 2024; Togneri et al., 2023; Touil et al., 2022). However, when the primary requirement is simply to activate watering remotely, a predefined command-based mechanism can provide a simpler alternative to sensor-based decision-making. The system discussed in this study focuses on the integration of three functions: light control, curtain control, and plant watering using a single SMS-based communication mechanism. These functions have different output characteristics. The lamp is controlled using a relay, the curtain is controlled using a servo motor, while the watering mechanism uses a servo motor to open and close the water channel. The use of different actuators within one control mechanism creates a functional integration requirement because each command must be translated into the appropriate output action.

Arduino-based automatic watering has also been implemented directly through SMS commands rather than continuous sensor-based decision-making, consistent with the approach adopted in this study (Hidayat & Suwandi, 2021; Bantaika et al., 2024). Beyond watering, the same microcontroller-based automation principle has been demonstrated across agricultural and aquacultural contexts, including automatic light-sensing systems (Irzaman et al., 2016; Irzaman et al., 2018), aquaponic control devices (Kusumah & Siskandar, 2019), automatically controlled aeration systems (Kusumah et al., 2020), and greenhouse automation integrating multiple actuators under one control scheme (Siskandar et al., 2022). This pattern of functional integration is the one that this study extends to the household domain.

The research gap addressed in this study concerns the integration of several household automation functions with different output characteristics within a single SMS-based control mechanism. While multi-actuator integration has already been demonstrated in agricultural settings such as greenhouse automation (Siskandar et al., 2022a), smart home automation, SMS-based appliance control, and automated irrigation studies focused on the household domain have generally

still discussed these functions as separate application areas (Anam, 2020; Bantaika et al., 2024; García et al., 2020). Other studies have focused on communication architectures, security, or more advanced IoT-based automation environments (Mocrii et al., 2018; Orfanos et al., 2023; Vardakis et al., 2024). In contrast, this study emphasizes the functional integration of lighting, curtain, and plant-watering control through predefined SMS commands using a single Arduino Uno-based control mechanism.

This study supports previous findings that SMS and microcontroller-based systems can be used for remote device control while extending their application to the integration of multiple household functions with different actuator characteristics. The main contribution of this study lies in analyzing the correspondence between predefined SMS commands and the physical responses of multiple actuators. The “Pagi” and “Malam” commands produce coordinated changes in the light and curtain, while the “Siram” command operates the watering mechanism for a defined duration. This approach provides a simple automation interface in which different household functions can be controlled through the same SMS communication mechanism.

Therefore, this study aims to analyze the operating mechanism of an SMS-based home automation system using Arduino Uno and evaluate the system response to three main commands: “Pagi,” “Malam,” and “Siram.” The results are expected to provide an overview of the application of SMS communication as a simple control mechanism for several household devices with different actuator characteristics.

METHODS

This study uses a system design and functional testing approach. The research consists of several stages, including requirements analysis, system design, implementation, and functional testing. The overall stages are conducted to develop and evaluate the functionality of the proposed automation system.

1. Research Design

This study employed a prototype design and functional testing approach to develop a home automation system capable of controlling lights, curtains, and plant watering through Short Message Service (SMS) commands. Prototyping provides an early representation of a system or design that can be used to examine its intended functions before broader implementation (Camburn et al., 2017). This approach was selected because the developed system integrates hardware, software, SMS communication, and actuators.

The research object was a home automation prototype consisting of an Arduino Uno as the main controller, a Wavecom M1306B GSM modem as the SMS communication medium, an RS232-to-TTL converter as the communication interface, a relay for controlling the lamp, two servo motors for the curtain and watering mechanisms, and a plant-watering mechanism. The system receives SMS commands as input, processes the commands using the Arduino Uno, and produces outputs in the form of changes in lamp conditions, curtain positions, or watering operations. Therefore, the unit of analysis in this study was not a human population or sample but the system functions and the correspondence between the system responses and the commands provided.

2. Research Procedure

The research procedure consisted of four main stages: requirements analysis, system design, implementation, and functional testing. These stages were adapted to the characteristics of prototype development involving the integration of hardware and software components. During the requirements analysis stage, the components required to perform SMS-based control were identified, including the Arduino Uno, Wavecom GSM modem, RS232-to-TTL converter, relay, servo motors, lamp, curtain mechanism, and watering mechanism.

The next stage was system design, which determined the relationship between system inputs, processes, and outputs. The system input consisted of three main SMS commands: “Pagi,” “Malam,” and “Siram.” The “Pagi” command was designed to open the curtain and turn off the lamp, while the “Malam” command was used to close the curtain and turn on the lamp. The “Siram” command was used to activate the watering mechanism for 9 seconds,

after which the mechanism was stopped. After processing each command, the system provided feedback to indicate that the command had been received and executed.

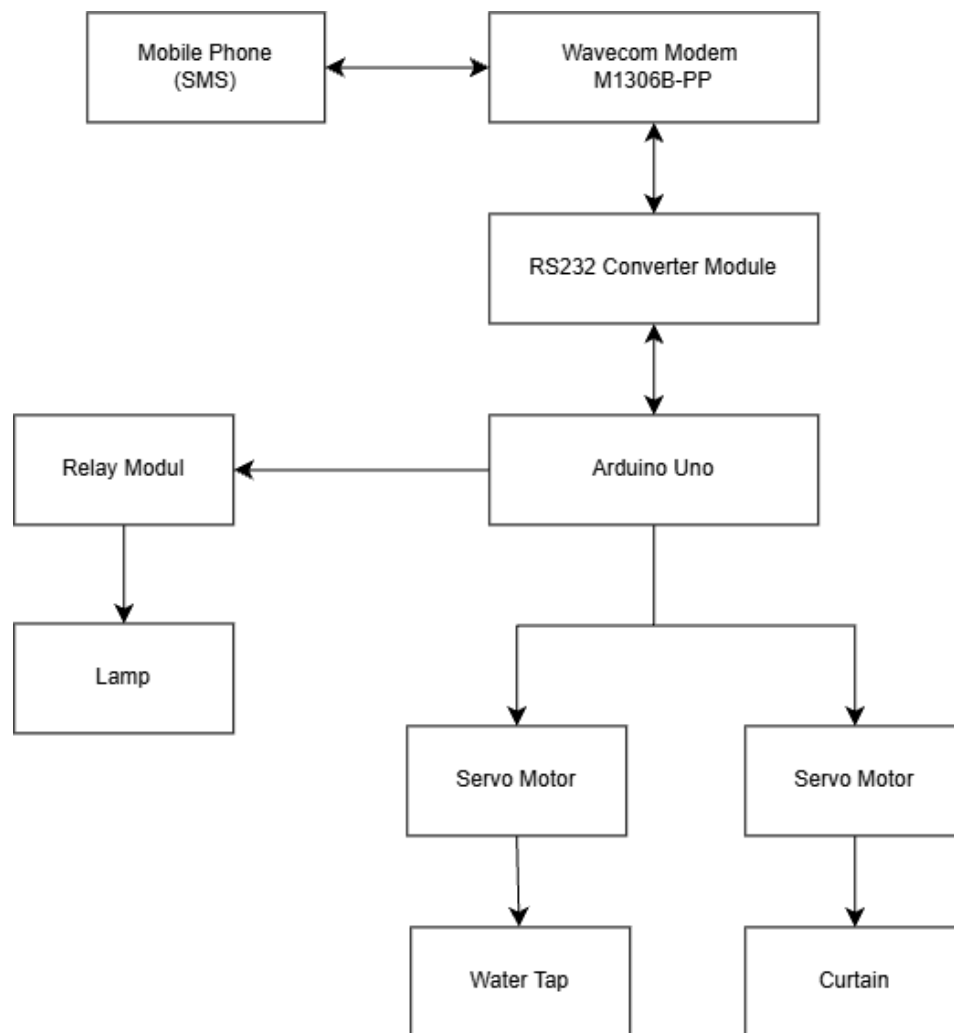


Figure 1. System block diagram

The system consists of a mobile phone as the SMS command source, a Wavecom GSM modem as the communication medium, an RS232-to-TTL converter as the interface between the modem and Arduino Uno, and the Arduino Uno as the main controller. The controller operates the relay for lamp control and the servo motors for curtain and watering mechanisms.

The system operation is based on the three predefined SMS commands. The “Pagi” command opens the curtain and turns off the lamp, the “Malam” command closes the curtain and turns on the lamp, and the “Siram” command activates the watering mechanism for 9 seconds. If the received message does not match the predefined commands, the system identifies it as an unrecognized message and provides feedback to the user. The overall command-processing sequence is illustrated in Figure 2.

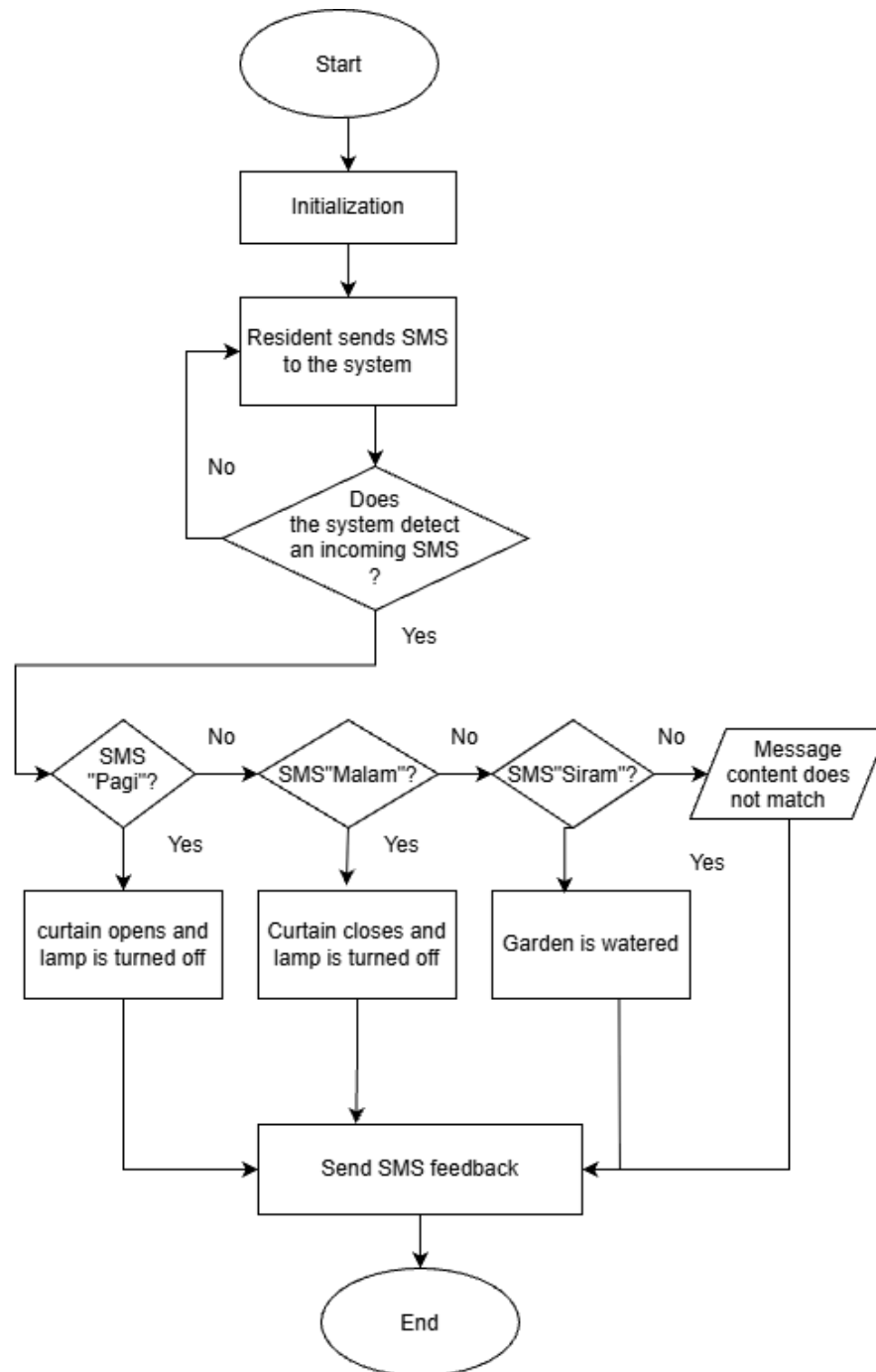


Figure 2. System flowchart

The implementation stage involved integrating the hardware and control program. The Arduino Uno was programmed to receive data from the GSM modem through serial communication, identify the content of the SMS, and execute the function corresponding to the received command. On the output side, the Arduino pins were used to control the servo motors and relay. This integration of hardware and software established the operational flow from SMS reception to changes in the controlled devices. Three predefined SMS commands were implemented: "Pagi," "Malam," and "Siram." The main command logic is presented in Listing 1.

Listing 1. SMS command control logic

```

if (message == "Malam") {
  cell.Message("Sukses Menyalakan Lampu dan Menutup Gorden");
  cell.SendSMS();
}

```

```

digitalWrite(11, HIGH);
myservo.write(-90);
}
else if (message == "Pagi") {
    cell.Message("Sukses Mematikan Lampu dan Membuka Gorden");
    cell.SendSMS();
    digitalWrite(11, LOW);
    myservo.write(90);
}
else if (message == "Siram") {
    cell.Message("Tanaman Telah Disiram");
    cell.SendSMS();
    myservo1.write(-90);
    delay(9000);
    myservo1.write(90);
}
}

```

The final stage was functional testing. Testing was conducted by sending each programmed SMS command and directly observing the response of the corresponding devices. The testing focused on three predefined command scenarios: “Pagi,” “Malam,” and “Siram.” Each scenario was evaluated by comparing the expected output with the actual output produced by the system after the SMS command was received. The test was considered successful when the system response corresponded to the function specified for the command.

The “Pagi” command was tested by observing whether the lamp was turned off and the curtain was opened. The “Malam” command was tested by observing whether the lamp was turned on and the curtain was closed. The “Siram” command was tested by observing whether the watering mechanism was activated for 9 seconds and subsequently stopped. In addition to the actuator response, the SMS feedback sent by the system was observed to confirm that the command had been processed.

The available testing was conducted as a functional demonstration of the three programmed commands rather than as a repeated-trial reliability test. Therefore, the results indicate whether each predefined function operated according to the system design, but they do not represent statistical measurements of repeatability or long-term reliability.

3. Data Collection Technique

The research data were collected through direct observation of the system responses during functional testing. The observed data included the SMS command, expected output, actual device condition after command processing, and function success status. The SMS feedback generated by the system was also observed as part of the functional verification.

Data collection covered three predefined testing scenarios. In the “Pagi” scenario, observations focused on whether the lamp was turned off and the curtain was opened. In the “Malam” scenario, observations focused on whether the lamp was turned on and the curtain was closed. In the “Siram” scenario, observations focused on whether the watering mechanism was activated for 9 seconds and subsequently stopped. The feedback message returned by the system was also checked to determine whether it corresponded to the executed command.

The collected observations were used to compare the actual system response with the expected function specified in the system design. Because the available test data were obtained from functional observations of the three predefined scenarios, the data were used to

demonstrate functional operation rather than to estimate long-term reliability or statistical repeatability.

4. Data Analysis Technique

The data were analyzed descriptively by comparing the actual system response with the expected output defined in the system design. A test scenario was considered successful when the corresponding device produced the expected output after receiving the programmed SMS command. Conversely, a scenario was considered unsuccessful when the device response did not correspond to the specified function.

The analysis focused on the functional correspondence between the three programmed SMS commands and their respective outputs. The results were presented by identifying the command, expected response, actual response, and functional status. The proportion of successfully demonstrated scenarios was calculated as an indicator of functional performance within the conducted test:

Functional Success Rate = (Number of Successfully Demonstrated Scenarios / Total Number of Tested Scenarios) $\times$ 100%

The test results were then used to describe the relationship between the SMS command as the input, command processing by the Arduino Uno, and the resulting device control as the output. Since the collected data consisted of functional observations of the prototype, no statistical testing involving a human population or sample was applied. The success percentage was used only to describe the performance of the three tested functional scenarios and was not interpreted as an overall system reliability rate.

RESULTS AND DISCUSSION

The results of the study present the implementation and functional performance of the SMS-based home automation system for controlling lighting, curtains, and plant watering. The evaluation was conducted by testing three predefined SMS commands, namely “Pagi,” “Malam,” and “Siram,” and observing the corresponding responses of the controlled devices. The results are presented through functional testing data and supporting documentation, followed by a discussion of the system functions and their relationship to home automation and technology-based plant-watering systems.

1. System Implementation and Functional Testing

The developed prototype integrates an Arduino Uno, Wavecom GSM modem, RS232-to-TTL converter, relay, servo motors, lamp, curtain mechanism, and watering mechanism into an SMS-based automation system. The system receives predefined SMS commands, processes the commands using the Arduino Uno, and activates the corresponding actuator. The system also provides SMS feedback after each command has been processed. The system operates using three main commands, namely “Pagi,” “Malam,” and “Siram.” The “Pagi” command is used to open the curtain and turn off the lamp, while the “Malam” command is used to close the curtain and turn on the lamp. The “Siram” command activates the watering mechanism for 9 seconds before the mechanism is stopped.

Functional testing was performed by sending the three predefined SMS commands to the system and observing the resulting device responses. The testing focused on whether the output produced by each command corresponded to the intended system function. The system also returned an SMS feedback message after executing each command as an additional indication that the instruction had been received and processed.

2. Functional Testing Results

The functional testing results are presented in Table 1. The results show that all three predefined commands produced outputs corresponding to their intended functions. The “Pagi” command successfully opened the curtain and turned off the lamp, while the “Malam”

command successfully closed the curtain and turned on the lamp. The “Siram” command activated the watering mechanism and stopped it after 9 seconds. All three test scenarios were recorded as successful.

Table 1. Functional Testing Results of the SMS-Based Automation System

SMS Command	Expected Function	Test Result	Status
“Pagi”	Open the curtain and turn off the lamp	Curtain opened and lamp turned off	Successfull
“Malam”	Close the curtain and turn on the lamp	Curtain closed and lamp turned on	Successfull
“Siram”	Open the water tap for 9 seconds	Watering mechanism operated for 9 seconds and then stopped	Successfull

The terms “Pagi,” “Malam,” and “Siram” are retained in Indonesian because they are the predefined SMS commands used in the prototype HCI and are not translated in the system interface.

The first test involved the “Pagi” command. After the command was received, the Arduino Uno processed the message and activated the corresponding outputs. The lamp was turned off and the curtain was opened. The system subsequently sent feedback confirming that the lamp had been turned off and the curtain had been opened. Figure 3 presents the SMS command, feedback message, and corresponding physical response of the system.

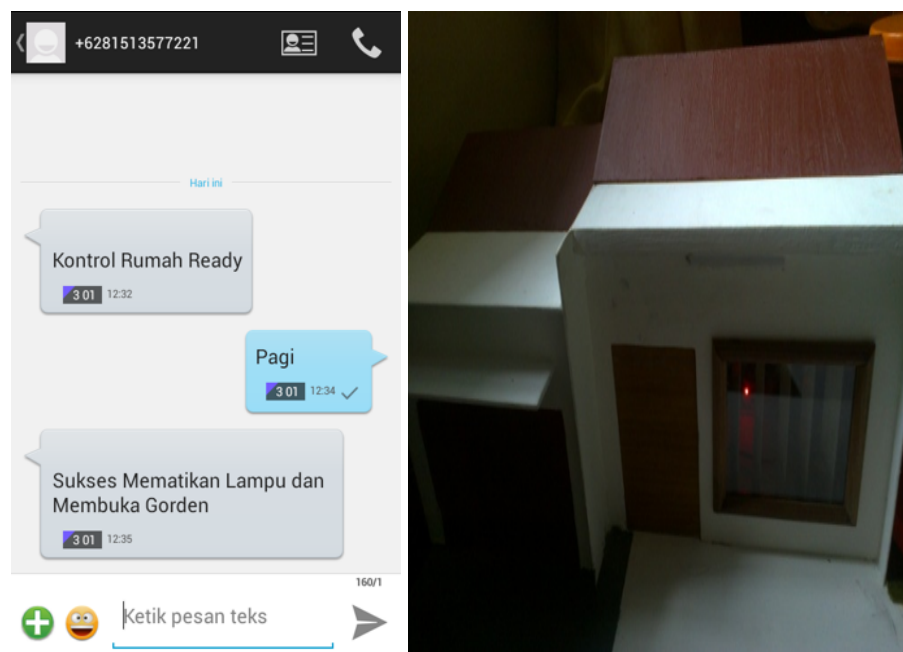


Figure 3. System response to the “Pagi” command

The second test involved the “Malam” command. After receiving the command, the Arduino Uno processed the message and activated the corresponding outputs. The lamp was turned on and the curtain was closed. The system then sent an SMS feedback message confirming that the operation had been executed. The documented response and feedback are presented in Figure 4.

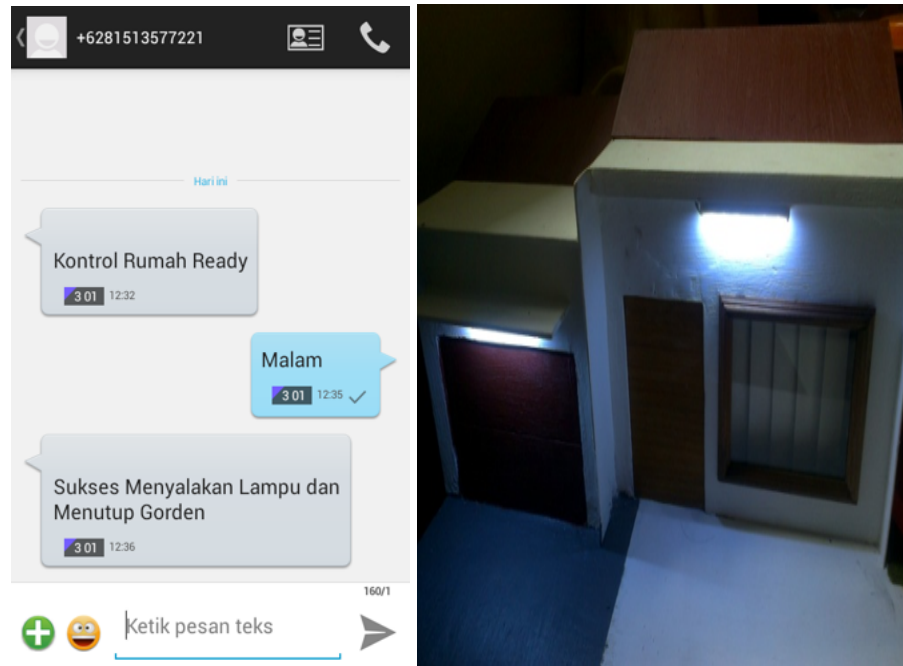


Figure 4. System response to the “Malam” command

The third functional test involved the “Siram” command. After receiving the command, the Arduino Uno activated the servo motor controlling the watering mechanism. The mechanism was opened for 9 seconds and subsequently returned to its initial position to stop the watering process. The system also sent an SMS feedback message indicating that the plant had been watered. The observed response corresponded to the programmed function of the “Siram” command. Figure 5 presents the SMS command and feedback message together with the physical response of the watering mechanism.

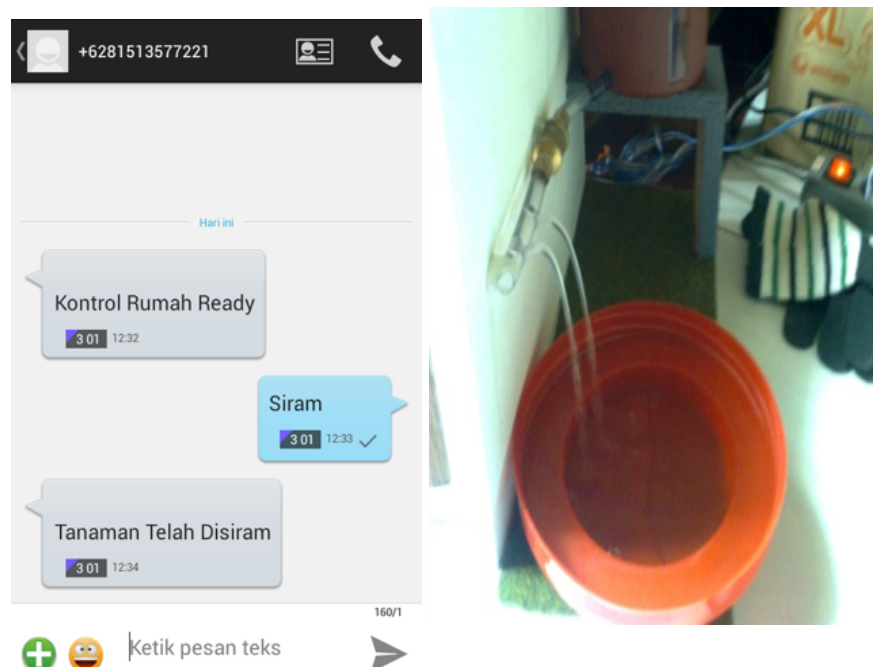


Figure 5. System response to the “Siram” command

Overall, the three tested scenarios were successfully executed according to their predefined functions. Based on the functional testing data, 3 out of 3 tested scenarios were successful, resulting in a functional success rate of 100% for the tested scenarios. This value

represents the proportion of successful test scenarios and should not be interpreted as a general reliability or long-term performance measurement of the system.

3. Discussion

The test results demonstrate that a single SMS-based interface can be used to coordinate several automation functions within the developed prototype. The “Pagi” and “Malam” commands integrate the control of the lamp and curtain into a single instruction, while the “Siram” command provides a separate plant-watering function. Thus, the system does not merely provide individual device control but establishes a common command interface for several physical functions.

This finding is consistent with the concept of smart-home automation, where different devices and functions can be integrated into a unified control system. Previous studies have described smart-home systems as combinations of communication, processing, and actuation components that enable users to control multiple household functions through a common system architecture (Anam, 2020; Pandiangan, 2021; Kusumawati & Inggi, 2021). In the present system, this integration is implemented through SMS communication and Arduino-based control rather than through a contemporary Internet-based smart-home platform.

This is further supported by national studies on SMS- and Arduino-based device control, including remote lamp switching (Anam, 2020; Pandiangan, 2021; Kusumawati & Inggi, 2021) and LDR-sensor-based automatic curtain systems (Siregar & Pangaribuan, 2025), which show that predefined-command control through GSM modules remains a common and reliable approach among Indonesian embedded-system researchers. This is broadly consistent with the wider body of Arduino-based sensor and automation work in related agricultural and energy-monitoring domains (Siskandar et al., 2016, 2022a; Kusumah & Siskandar, 2019).

The watering function also extends the application of the system beyond conventional household device control. Previous studies on smart irrigation have shown that communication and automation technologies can support remote plant-watering and irrigation management (Siskandar et al., 2020). In this prototype, however, the watering process is initiated directly by an SMS command and operates for a predetermined duration of 9 seconds. This is consistent with national implementations of SMS-triggered watering mechanisms (Hidayat & Suwandi, 2021; Bantaika et al., 2024) Android-based automatic plant watering system. The result demonstrates the feasibility of incorporating a basic plant-care function into the same automation interface used for household devices.

The functional integration of lighting, curtain, and watering control represents the main contribution emphasized in this article. Rather than evaluating each device as an independent control unit, the system demonstrates how several functions can be coordinated through predefined SMS commands and a single microcontroller-based control mechanism. This perspective addresses the need for simple integrated automation systems in which multiple physical functions can be accessed through one communication interface.

Nevertheless, the findings should be interpreted within the scope of the conducted functional tests. Compared with more advanced automation systems that incorporate sensor-based monitoring or Internet-based communication, the proposed prototype provides a simpler approach by integrating lighting, curtain, and watering functions through predefined SMS commands. However, the available testing covers only three predefined command scenarios and does not provide repeated-trial measurements of reliability or quantitative measurements of SMS transmission delay. Other aspects, including energy consumption, scalability, and performance under varying environmental and network conditions, were also outside the scope of the present testing. These limitations indicate that further evaluation is needed to assess the system more comprehensively.

CONCLUSION

The developed SMS-based home automation prototype successfully integrated lighting, curtain, and plant-watering control using an Arduino Uno and GSM-based communication. The system was designed to respond to three predefined SMS commands, namely “Pagi,” “Malam,” and “Siram,” with each command producing a corresponding actuator response. Functional testing showed that all three tested scenarios successfully produced the expected system responses, resulting in a 100% functional success rate for the tested scenarios. These findings demonstrate that SMS communication can be implemented as a simple control interface for integrating multiple household automation functions within a single prototype. However, the evaluation was limited to functional testing of the predefined scenarios and did not assess long-term reliability, communication delay, energy consumption, or performance under varying network and environmental conditions. Future development can therefore focus on extended testing and improvement of the mechanical and communication aspects of the system to support more robust implementation.

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