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Design and Implementation of an IoT-Based Smart Chicken Feeder System Using an ESP32 Microcontroller

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ABSTRACT

Manual chicken feeding still faces various obstacles, such as inaccurate scheduling, dependence on the presence of farmers, and less than optimal monitoring of feed availability, which can affect the efficiency of farm management. This study aims to design and implement an Internet of Things (IoT)-based Smart Chicken Feeder system using an ESP32 microcontroller to automate chicken feeding and monitor feed availability in real-time. The research method uses a prototype approach that includes needs analysis, hardware and software design, implementation, and system testing. The hardware consists of an ESP32, a servo motor as an actuator to open and close the feed chute, an HC-SR04 ultrasonic sensor to detect feed height, and an IoT platform as a monitoring medium. Tests were conducted on the timeliness of feeding, sensor detection accuracy, actuator response, and internet communication stability. The test results show that the system is able to carry out automatic feeding according to schedule, detect feed conditions properly, and transmit monitoring information in real-time. The developed system can improve feed use efficiency, reduce errors due to human factors, and support the implementation of the smart farming concept in chicken farms.

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1. Introduction

Chicken farming is a crucial sector in supporting food security because it provides a source of animal protein in the form of meat and eggs, essential for the community. The increasing demand for livestock products encourages farmers to increase productivity by implementing more effective and efficient husbandry systems. One factor influencing the success of chicken farming is feed management. Adequate feed availability, appropriate amounts, and timely feeding play a crucial role in supporting chicken growth, health, and productivity. Therefore, feed management is a key aspect that requires attention in modern livestock systems[1].

On small- to medium-scale farms, the feeding process is still largely manual. Farmers must manually fill feeders and provide feed according to a schedule. This method has several drawbacks, including requiring a relatively large amount of time and effort, relying on the farmer's presence, and potentially causing delays or inconsistencies in feed delivery. This can lead to feed waste, increased operational costs, and reduced farm management efficiency. Furthermore, delayed feeding can also affect the physiological condition of the chickens, thus impacting their growth and productivity[2].

Another problem often faced by livestock farmers is the difficulty in continuously monitoring feeder conditions. In conventional systems, checking feed levels is still done directly, which is time-consuming, especially on farms with a large number of pens or pens located far apart. Lack of awareness of feed conditions can lead to delays in refilling, thus disrupting feed availability[3]. Therefore, a system is needed that not only automatically provides feed but also provides information on feeder conditions quickly, accurately, and remotely[4].

The development of Internet of Things (IoT) technology opens up opportunities for developing more modern livestock systems through the concept of smart farming[5]. IoT technology allows various electronic devices to be connected via the internet, allowing data acquisition, monitoring, and control to be carried out automatically and in real time[6]. In the livestock sector, IoT applications have been utilized for various needs, such as monitoring pen temperature, humidity, air quality, feed consumption, and automated feeding systems. The use of this technology is expected to improve operational efficiency, reduce reliance on manual processes, and support decision-making based on directly obtained data[7].

One of the essential components of an IoT system is a microcontroller, which functions as the central control center for the entire process. The microcontroller is capable of receiving data from sensors, processing the information according to a pre-designed algorithm, controlling actuators, and sending data to the IoT platform via the internet. This study used an ESP32 microcontroller due to its robust processing capabilities, relatively low power consumption, and Wi-Fi module, supporting the implementation of a real-time monitoring and control system. By utilizing the ESP32, the system can automatically schedule feeding and send information about the device's condition to the user[8].

In addition to the use of a microcontroller, the integration of hardware and software is crucial for creating a reliable system. The hardware consists of an HC-SR04 ultrasonic sensor used to detect the level or availability of feed in the feed trough, and a servo motor as an actuator to open and close the feed trough. The ultrasonic sensor works by measuring the distance between the sensor and the feed surface, allowing for continuous monitoring of the feed's condition[9]. The obtained data is then processed by the ESP32 to determine the condition of the feed trough and sent to the IoT platform for user monitoring. On the other hand, the software functions to manage control logic, data communication, feeding scheduling, and monitoring interfaces so that all components can work in an integrated manner[10].

Several previous studies have developed automatic feeding systems based on microcontrollers and IoT. However, most studies still focus on automating time-based feeding without providing real-time information on feed conditions. Other studies have implemented monitoring systems but have not integrated monitoring and control functions[11].

A system that is easy for farmers to use. This situation indicates that there is still an opportunity to develop a system that can combine automated feeding, monitoring feed availability, and internet-based control in a single, integrated platform. Therefore, the developed system is expected to provide a more effective solution to support chicken farm management[12].

Based on these challenges, this research designed and implemented an Internet of Things (IoT)-based Smart Chicken Feeder using an ESP32 microcontroller[13]. The developed system integrates an HC-SR04 ultrasonic sensor to detect feed availability, a servo motor as a feed actuator, and an IoT platform to support real-time monitoring and control[14]. The feeding mechanism is carried out automatically according to a predetermined schedule, reducing reliance on manual processes while increasing feed efficiency[15][16].

To ensure the system's performance meets the research objectives, several aspects were tested, including the accuracy of feeding timing, actuator response, sensor capability in detecting feed conditions, and the stability of data communication over the internet network[17]. The test results are expected to demonstrate the system's ability to automatically carry out the feeding process, provide real-time feed condition information, and improve the effectiveness of chicken farm management. The contribution of this research not only provides alternative solutions in the application of IoT technology in the livestock sector, but also becomes a reference for the development of microcontroller-based automation systems that support the implementation of the smart farming concept in the future[18].

2. Research Method

This research employed an experimental research method with an engineering approach. The aim was to design, build, and test an Internet of Things (IoT)-based Smart Feeder system for chicken farms. This approach was chosen because the research focused not only on testing a phenomenon but also on producing a technological product in the form of an automated feeding system capable of operating in real time[19]. The developed system was designed to automate the feeding process based on a predetermined schedule, continuously monitor feed availability, and provide device monitoring and control facilities via an internet network. Thus, the resulting system is expected to improve farm operational efficiency while supporting the implementation of the smart farming concept[20].

The research phase began with identifying problems encountered in conventional chicken feeding systems. At this stage, observations were made of the manual feeding process, which revealed several obstacles, such as irregular feeding times, delays in feed refills, and high operator dependence. Based on this identification, a literature review was conducted to obtain information on developments in IoT technology, microcontrollers, sensors, actuators, and relevant previous research to serve as a basis for system design[21].

Next, a system requirements analysis was conducted, encompassing both functional and non-functional requirements. The functional requirements analysis encompassed the system's ability to automatically provide feed according to a schedule, detect feed availability, control the feed valve opening and closing mechanism, transmit sensor readings to an IoT platform, and display real-time monitoring information. Meanwhile, non-functional requirements included system reliability, ease of use, power efficiency, data communication stability, and the system's ability to operate continuously[3].

The system design was carried out by integrating hardware and software. The hardware consisted of an ESP32 microcontroller as the system's control center, an HC-SR04 ultrasonic sensor to detect the feed level in the container, a servo motor to open and close the feed chute, a power supply, and other supporting devices. The ultrasonic sensor was mounted on the top of the feed storage container to measure the distance between the sensor and the feed surface. The obtained distance data was then processed by the ESP32 to determine the feed stock level based on a predetermined threshold. When the feed stock falls below the minimum limit, the system notifies the user via the monitoring application so that the refill process can be initiated immediately[22].

On the software side, the ESP32 was programmed using the Arduino IDE using the C++ programming language. The program was designed to regulate periodic sensor readings, control servo motors based on feeding schedules, and send sensor readings via Wi-Fi to the IoT platform. The transmitted data includes sensor distance values, feed availability percentage, feeding time, servo motor status, and device connection conditions. This information is then displayed in an Android-based monitoring application, allowing users to monitor and control the system from different locations in real time[12].

The system development method used was Prototyping. This method was chosen because it aligns with the characteristics of IoT-based engineering research, which requires a gradual development process through initial model creation, testing, evaluation, and refinement until a system meets user needs[23]. The stages of the Prototyping method include requirements analysis, system design, prototype construction, hardware and software implementation, functional testing, system performance evaluation, and refinement based on test results[24].

The implementation stage is carried out by integrating all hardware and software components to form a complete Smart Feeder system. Testing is then conducted to ensure each component performs according to its designed function. Testing included testing the ultrasonic sensor to detect feed height, testing the servo motor to open and close the feed chute, testing data communication between the ESP32 and the IoT platform, and testing the monitoring application to ensure data can be displayed in real time. In addition, testing was conducted on a predetermined feeding schedule to determine the system's success rate in carrying out its functions Automation[25].

The final stage is system performance evaluation by analyzing test results against predetermined parameters, such as sensor reading accuracy, actuator response, data communication success, internet connection stability, and the system's ability to automatically feed according to schedule. The evaluation results are used as a basis for system improvements to produce an IoT-based Smart Feeder device with optimal reliability and performance[26].

The final result of the research is an Internet of Things-based Smart Feeder system capable of automatically feeding chickens according to schedule, monitoring feed availability using ultrasonic sensors in real time, and providing monitoring and control facilities through an Android-based application. The developed system is expected to improve farm management efficiency, reduce reliance on manual processes, minimize the risk of delayed feeding, and support the implementation of the Smart Poultry Farming concept as part of the digital transformation in the modern livestock sector[27].

3. Result and Discussion

The system developed in this research is an Internet of Things (IoT)-based Smart Feeder that aims to automate the chicken feeding process and provide real-time monitoring and control features. This system is designed to help farmers overcome the challenges of manual feeding, which requires direct supervision, allowing for more effective and efficient chicken rearing[28].

In general, the Smart Feeder system consists of three main parts: input, process, and output. The input part consists of an ultrasonic sensor that detects the level of feed availability in the storage container. The sensor readings are then sent to the processing part, namely the ESP32 microcontroller, which acts as the system's data processing and control center.

In the processing part, the ESP32 receives and processes data from the sensor based on a pre-designed program. The microcontroller determines the appropriate actions based on system conditions, such as activating the feeding mechanism when the feeding time has reached or receiving commands from the user over the internet. The ESP32 also functions as a link between the Smart Feeder device and the IoT system, allowing data on the device's condition to be transmitted and monitored remotely.

The system's output consists of a servo motor, which functions as an actuator to regulate the feed dispensing mechanism from the storage bin to the chicken feeder. The servo motor moves based on commands from the ESP32, allowing for automatic control of the amount and timing of feed dispensing. Furthermore, the system is equipped with a monitoring feature that allows users to monitor feed availability and the device's operational status through an app or IoT platform.

The system's workflow begins when an ultrasonic sensor reads the feed condition in the storage bin. This data is then processed by the ESP32 to determine the system's condition. If the feeding time is in accordance with the schedule, or if the user issues a manual command through the monitoring system, the ESP32 activates the servo motor to open the feed dispensing mechanism. Once the feeding process is complete, information about the system's condition is sent back via the internet, allowing users to monitor it in real time.

With the integration of sensors, microcontrollers, actuators, and IoT technology, the developed Smart Feeder system is expected to provide a solution for automated chicken feed management. This system can help improve time efficiency, reduce reliance on manual processes, and support the implementation of smart farming concepts in modern livestock farming[25].

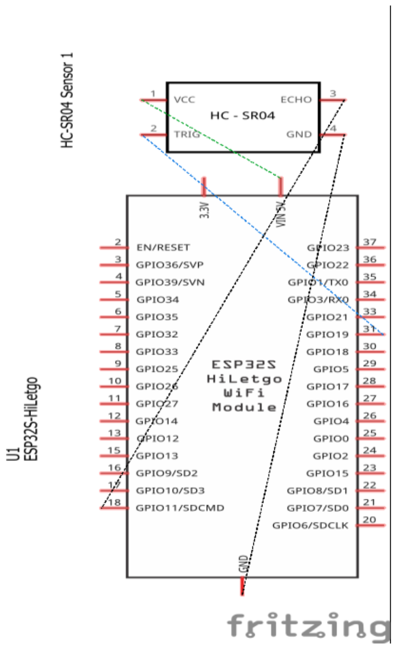

Figure 1. Schematic diagram of the ESP32 microcontroller circuit configuration and HC-SR04 ultrasonic sensor

The schematic diagram shows the circuit configuration between the ESP32 microcontroller and the HC-SR04 ultrasonic sensor used as a feed availability detection subsystem in the Internet of Things (IoT)-based Chicken Smart Feeder system. The ESP32 functions as a control center (controller), responsible for controlling the sensor data acquisition process, processing the readings, and sending information to an internet-based monitoring platform. The ESP32 was selected based on its integrated capabilities with Wi-Fi and Bluetooth modules, making it highly suitable for implementing IoT systems that require real-time data communication without the need for additional communication devices[29][14].

According to the circuit schematic, the HC-SR04 sensor obtains its voltage source through the 5V VIN and GND pins on the ESP32. A 5V voltage is required for the sensor to optimally produce ultrasonic waves.

The HC-SR04 sensor has four main pins: VCC, TRIG, ECHO, and GND. The TRIG pin is connected to one of the ESP32's digital output pins, which sends a 10-microsecond pulse to trigger the sensor to emit ultrasonic waves at a frequency of approximately 40 kHz. These waves are reflected by the surface of the feed in the storage container and then received back by the sensor's receiver. The ECHO pin then sends a signal in the form of a reflection time to the ESP32, which is used to calculate the distance between the sensor and the feed surface[30].

The received reflection time data is processed by the ESP32 using the sound wave velocity equation to obtain a distance value. A greater distance measured indicates a lower feed volume in the container, while a smaller distance indicates a full container. This distance value is then compared to a threshold set in the software. If the measurement results indicate that the feed stock is below the minimum limit, the ESP32 activates the feeding mechanism via a servo motor actuator and sends this information to an Android-based monitoring application via Wi-Fi. Conversely, if the feed stock is still at a safe level, the system simply performs periodic monitoring without activating the actuator.

The HC-SR04 sensor was chosen for this study because of its non-contact measurement characteristics, meaning the measurement process does not come into direct contact with the feed and is more resistant to contamination than mechanical sensors. Furthermore, the sensor has a measuring range of approximately 2–400 cm with sufficient accuracy to detect changes in feed level in storage containers. The integration of the ESP32 and HC-SR04 enables automatic, continuous, and real-time monitoring, reducing reliance on manual inspection by farmers[13].

From a software engineering perspective, sensor readings are taken periodically using a polling method at specific intervals to maintain data stability. The readings are then processed using a simple filtering algorithm, such as a moving average, to minimize fluctuations due to uneven feed surface conditions. All processed data is then sent to an IoT platform, allowing users to monitor feed levels, device status, and feeding history in real time through a monitoring application. Thus, the integration of the ESP32 and HC-SR04 sensors not only functions as a feed level detection system but also serves as a key component in supporting the implementation of Smart Poultry Farming, making it more efficient, accurate, and adaptable to developments in Internet of Things technology[31].

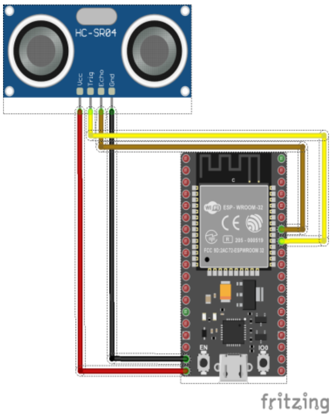

Figure 2. Component Circuit

This configuration is designed to obtain information regarding changes in feed volume in the storage container automatically without requiring direct observation by the farmer. ESP32 functions as a processing unit that is responsible for reading sensor data, processing information, and sending reading results to the monitoring platform via a Wi-Fi connection.

Based on the circuit configuration, the HC-SR04 sensor obtains a power supply via the VIN and GND pins on the ESP32 so that the sensor can work stably during the measurement process. Communication between the two devices is carried out via two digital paths, namely Trigger as a trigger signal for sending ultrasonic waves and Echo as a feedback path which carries information on the travel time of the reflected wave. These two paths allow the ESP32 to carry out the process of measuring distance periodically at certain time intervals according to a pre-programmed algorithm[32].

In its implementation, the sensor is placed at the top of the feed storage container so that the direction of the ultrasonic wave emission faces directly at the feed surface. Changes in the position of the feed surface due to chicken consumption will cause changes in the distance value received by ESP32. The data is then converted into a feed level indicator in percentage form so that it is easier for users to understand through the monitoring application interface. This approach allows farmers to quickly find out the condition of feed stocks without having to physically inspect the storage containers.

The integration of ESP32 and HC-SR04 in this research produces a monitoring system that is responsive, easy to implement, and has relatively low development costs. Apart from supporting the automation of the feeding process, this series also provides continuous feed condition data so that it can be used as a basis for decision making in managing digital technology-based chicken farms. With the ESP32's wireless communication capabilities, all measurement results information can be accessed in real-time, thereby increasing the effectiveness of monitoring and efficiency of livestock operations.

The sensor's operating principle begins when the ESP32 microcontroller sends a trigger pulse lasting approximately 10 microseconds to the TRIG pin on the HC-SR04. Upon receiving the pulse, the sensor emits eight ultrasonic waves with a frequency of approximately 40 kHz toward the feed surface. These waves propagate through the air until they hit the feed surface, where they are then reflected back to the sensor's receiver.

When the reflected waves are received, the ECHO pin generates a pulse with a duration proportional to the ultrasonic wave's travel time. The ESP32 then measures the pulse's duration using its pulse width measurement function. The resulting time value is then used to calculate the distance between the sensor and the feed surface based on the speed of sound in air, which is approximately 343 m/s at room temperature. The equation used is:

$$\text{Distance} = \frac{V \, x \, T}{2} \tag{1}$$

Where:
Distance = sensor distance from the feed surface (cm)
v = speed of sound (34,300 cm/s)
t = ultrasonic wave travel time (seconds)
A factor of 2 is used because the wave travels a round-trip.

In this research, the distance value obtained is not directly used as an indicator of feed quantity. The ESP32 first performs a calibration process by determining the minimum distance when the container is full (full level) and the maximum distance when the container is almost empty (empty level). Based on these two values, the system calculates the percentage of feed availability using the equation:

$$\text{Feed Level \%} = \frac{\text{Maximum Distance} - \text{measured distance}}{\text{Maximum Distance} - \text{Minimum Distance}} \; x \; 100 \tag{2}$$

The feed level percentage is then compared to a predetermined threshold. If the feed level falls below the minimum limit, the ESP32 activates the servo motor to open the feed valve for a pre-programmed duration. Furthermore, sensor readings are sent via Wi-Fi to a monitoring application, allowing users to monitor feed stock levels in real time.

From a systems engineering perspective, the HC-SR04 offers several advantages: it does not come into direct contact with the feed, making it more hygienic; it has a fast response time; it is easy to integrate with the ESP32; and it can perform continuous measurements at a relatively low implementation cost. However, sensor accuracy can be affected by uneven feed surfaces, dust, changes in ambient temperature, and the sensor's installation position. Therefore, this study implemented repeated sensor readings and used a moving average to reduce measurement fluctuations, resulting in more stable and representative data.

Distance Calculation Using HC-SR04 Sensor

The HC-SR04 sensor works by calculating the travel time of ultrasonic waves from the sensor to the feed surface and back.
v = speed of sound = 343 m/s = 0.0343 cm/µs
Suppose the ESP32 reads the echo time as:

$$t = 700 \ \mu s$$

Then:

$$\begin{aligned} \text{Distance} &= \frac{0.00343 \, x \, 700}{2} \\ &= \frac{24.01}{2} \\ &= 12.005 \text{ cm} \end{aligned} \tag{3}$$

The distance between the sensor and the feed surface is approximately 12 cm.

Calculating Feed Level Percentage :
Suppose the hopper height is

Hopper full → sensor reads 5 cm
Hopper empty → sensor reads 25 cm

This means that the minimum distance is 5 cm and the maximum distance is 25 cm, Measured distance = 12 cm

$$\begin{aligned} \text{Feed Level \%} &= \frac{25-12}{25-5}\, x\, 100 \\ &= \frac{13}{20}\, x\, 100 \\ &= 65\% \end{aligned} \tag{4}$$

The feed stock in the hopper is still around 65%.

Decision Making by ESP32

Table 1. ESP32 Decision

Feed Level	Condition	System Action
80–100%	Full	Monitoring only
50–79%	Safe	Monitoring
20–49%	Starting to run low	Send notification
<20%	Almost out	Servo opens the feed valve

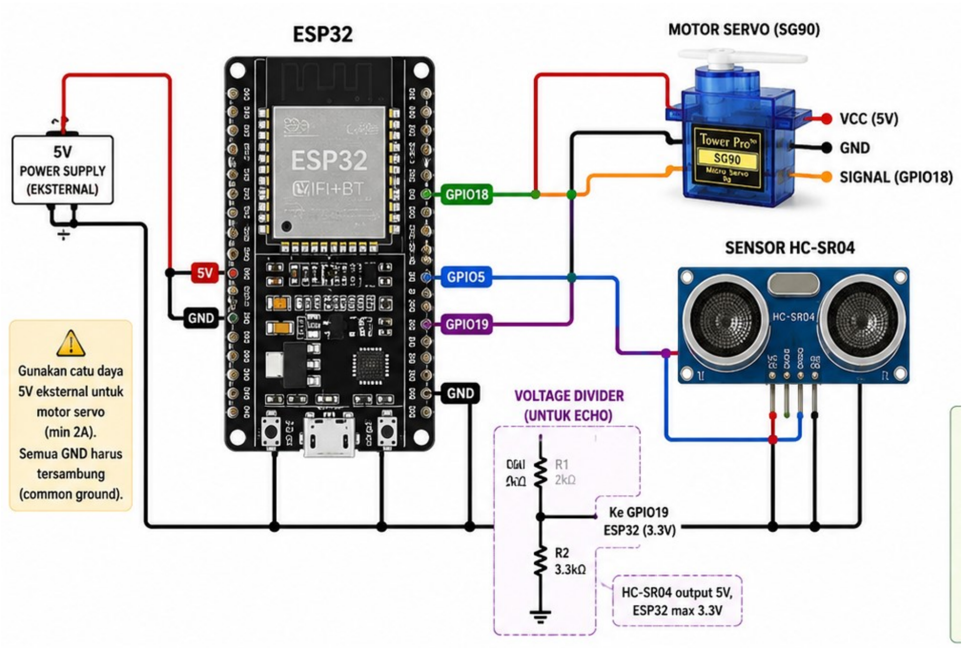

Figure 3. ESP32 Circuit Diagram

The figure shows the hardware configuration used in the development of an Internet of Things (IoT)-based Smart Chicken Feeder system. This system integrates an ESP32 microcontroller, an HC-SR04 ultrasonic sensor, and an SG90 servo motor as the main components to support the monitoring and automatic chicken feeding process. The ESP32 serves as the central controller, processing sensor readings, controlling actuators, and sending information to the monitoring application via a Wi-Fi network.

The HC-SR04 sensor is connected to pin GPIO5 as the Trigger line and GPIO19 as the Echo line. A voltage divider circuit consisting of 2 kΩ and 3.3 kΩ resistors is installed on the Echo line to reduce the sensor output voltage from 5 V to approximately 3.3 V, ensuring a safe environment for the ESP32 input pins. The sensor receives a 5 V power supply and is used to measure the distance between the sensor and the surface of the feed inside the storage container. The resulting measurement data is processed by the ESP32 to determine feed stock levels based on predetermined threshold values.

The SG90 servo motor is controlled via the GPIO18 pin and is powered by an external 5V voltage source. The use of a separate power supply ensures system stability, as the servo's current requirements are relatively higher than the ESP32's output capacity. All ground lines (GND) on the ESP32, sensors, servo motors, and power supply are connected to a common ground to maintain the same voltage reference for all components and ensure stable communication between devices.

The system begins when the HC-SR04 detects a change in feed level. If the reading indicates feed stock is below the minimum limit, the ESP32 sends a PWM signal to the servo motor, causing it to open the feed valve for a pre-programmed duration. Once the feeding process is complete, the servo returns to its original position, closing the feed channel. Simultaneously, data on feed levels and actuator status are sent to an Android-based monitoring application, allowing users to monitor and control the system in real time. The integration of these three components results in an automated, efficient feeding system that supports the implementation of the IoT-based Smart Poultry Farming concept.

Figure 4. WEB Application Dashboard

The image shows the Internet of Things (IoT)-based Chicken Smart Feeder web dashboard interface, designed for real-time monitoring and control of the chicken feeding system. This dashboard serves as an information center, displaying device condition, feed availability levels, feeding activity, and system connectivity status in one integrated display. The interface is designed to be simple and informative, making it easy for users to monitor without having to be on-site at the farm.

On the left side, there is a navigation menu consisting of Dashboard, Feed History, Feeding Schedule, Settings, Notifications, and Device Information. This menu structure allows users to access various system features in an organized manner, from viewing device condition to configuring feeding schedules. Device connection status information is also displayed at the bottom of the navigation panel, indicating that the ESP32 is connected to the internet and ready to transmit monitoring data.

The main dashboard displays several information cards that present important system parameters. These parameters include feed level percentage, HC-SR04 ultrasonic sensor reading distance, daily feed amount, and system operational status. All data is updated periodically based on sensor readings and device activity in the field. This information provides an overview of the current condition, allowing users to determine whether feed stocks are sufficient or require replenishment.

The dashboard also features a Feed Level (%) graph, which displays changes in feed availability based on the observation time. This graph helps users analyze chicken feed consumption patterns over a specific period. Additionally, a 24-Hour Feeding History graph displays the amount of feed dispensed by the system at each feeding schedule. Visualizing data in graphical form simplifies the process of evaluating system performance compared to using only numerical data.

The bottom of the dashboard displays information about the device status, including the condition of the ESP32, HC-SR04 sensor, servo motor, and internet connection. All indicators are displayed using visual statuses, allowing users to quickly determine whether each component is operating normally. Information about the last feeding is also displayed, including the amount of feed dispensed, the duration of the servo motor movement, and the status of the feeding process.

Another available feature is a notification panel, which provides important information such as sufficient feed stocks, the success of the feeding process, and the system's condition during the monitoring process. This dashboard also provides manual control features in the form of Open Feed and Close Feed buttons, allowing users to directly operate the servo motors when needed, for example during system testing or under certain conditions requiring user intervention.

Overall, this web dashboard serves as the primary interface for the IoT-based Smart Chicken Feeder system, integrating monitoring, data visualization, notification, and device control functions in a single platform. This dashboard allows for real-time monitoring of feed conditions and system operation, improving farm management efficiency, reducing reliance on manual monitoring, and supporting the implementation of the Smart Poultry Farming concept based on Internet of Things technology.

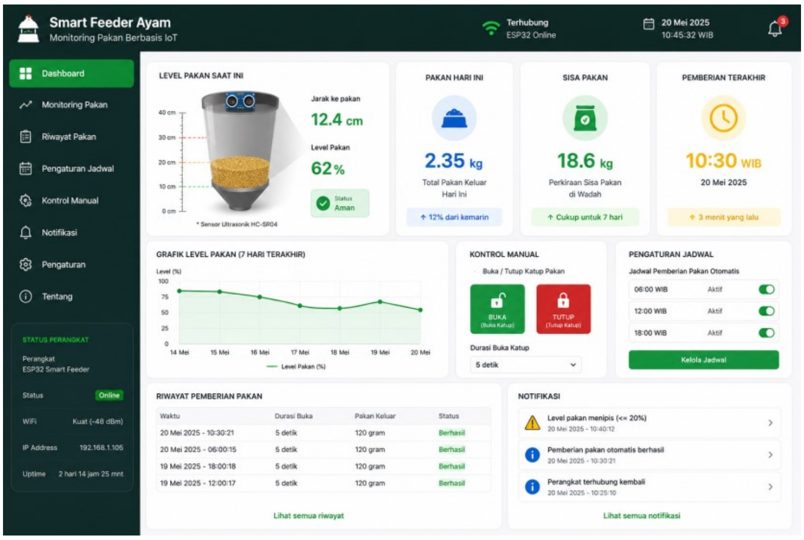

Figure 5. Chicken feed graphic display

On the left side of the dashboard is a navigation panel containing several main menus: Dashboard, Feed Monitoring, Feed History, Schedule Settings, Manual Control, Notifications, Settings, and About. This navigation structure is designed to provide easy access to all system features. The bottom of the panel also displays device status information, including the ESP32's condition, Wi-Fi network connection status, the device's IP address, and the system's uptime. This information is useful for ensuring the device is operating normally and remains connected to the internet.

The main section of the dashboard displays monitoring information obtained from the HC-SR04 ultrasonic sensor. The Current Feed Level panel displays a visualization of the feed level within the feed container, along with the sensor's distance reading of 12.4 cm and the feed level percentage of 62%. This information is obtained by converting the sensor distance to the effective height of the feed container, allowing users to quickly and accurately monitor feed stock levels. Furthermore, the dashboard also displays information on the amount of feed dispensed that day, the estimated feed remaining in the container, and the time of the last feeding as an indicator of system activity.

To support the analysis process, the dashboard provides a graph of the feed levels over the past seven days, showing changes in feed stock percentage based on the observation period. This graph can be used to evaluate chicken feed consumption patterns and help users estimate feed replenishment needs. A feeding history table is also available at the bottom, recording the execution time, servo motor movement duration, feed amount dispensed, and the success status of each feeding process.

The dashboard also features a manual control feature that allows users to directly open or close the feed valve using the Open and Close buttons. Users can set the valve opening duration as needed, allowing the system to remain manually operated if necessary. Furthermore, a schedule settings menu displays automatic feeding times and their active status, allowing users to manage the schedule more flexibly.

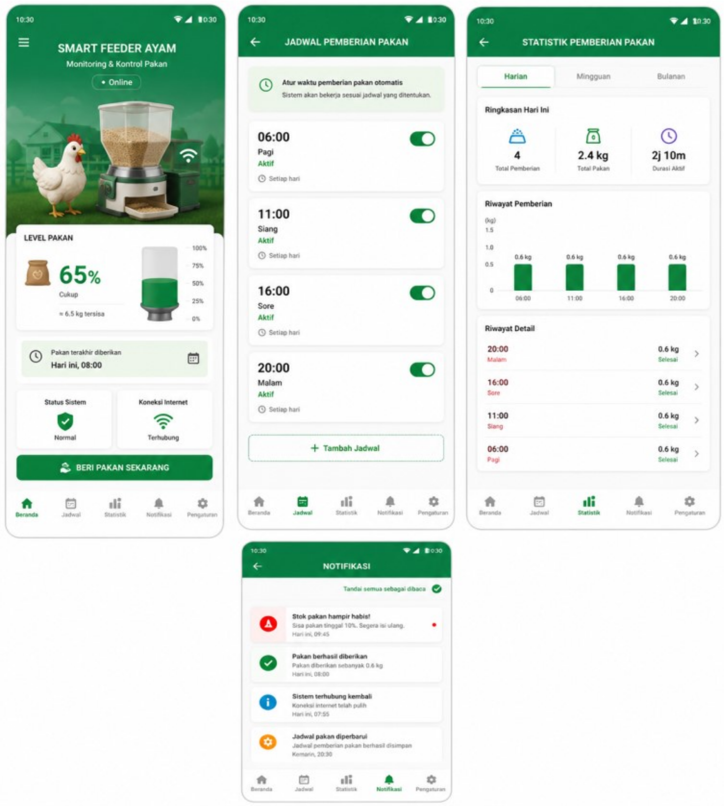

Figure 5. Android menu display

This is a user interface for the Android application developed to monitor and control the Internet of Things (IoT)-based Smart Chicken Feeder.

The Home page provides information on overall system conditions, including device connection status, feed level percentage, estimated remaining feed, last feeding time, system status, and internet connection status. This page also features a "Feed Now" button, allowing users to manually activate the feeding process if needed. Feed level information is obtained from the HC-SR04 ultrasonic sensor, which is processed by the ESP32 microcontroller and sent to the application via the internet.

The Feeding Schedule page is used to automatically set feeding times. Users can define multiple feeding schedules per day and activate or deactivate each schedule using the toggle button. Configurations made in the application are sent to the ESP32, allowing the system to perform feeding at the specified times without user intervention.

Furthermore, the Feeding Statistics page displays a summary of system activity, including the number of feedings, total feed dispensed, operation duration, a graph of feeding history, and records of each feeding process. This information provides an overview of chicken feed consumption patterns and can be used as evaluation material for farm management.

To support the monitoring function, the application also provides a Notifications page that displays various important information, such as warnings about low feed stocks, confirmation of successful feeding, device connection status, and changes to operational schedules. The notification feature allows users to quickly obtain information so that corrective action can be taken immediately if a system disruption occurs.

Overall, this Android application integrates monitoring, scheduling, statistics, notifications, and manual control functions in one easy-to-use platform. Integration with the ESP32 and HC-SR04 sensors allows all data to be updated in real time, supporting the implementation of a Smart Poultry Farming system that is more efficient, practical, and adaptable to developments in Internet of Things technology[12].

4. Conclusion

This research successfully designed and implemented an Internet of Things (IoT)-based Chicken Smart Feeder system utilizing an ESP32 microcontroller, an HC-SR04 ultrasonic sensor, and a servo motor as the main components. The ESP32 acts as a control center, integrating sensor readings, data processing, actuator control, and data communication over the internet. The HC-SR04 sensor is capable of detecting changes in feed level in the storage container in real time, automatically obtaining information on feed availability without the need for direct inspection. Based on this data, the ESP32 controls the servo motor to open and close the feed chute according to a schedule or based on predetermined feed stock levels.

In addition to automation, this research also produced a web-based and Android-based monitoring application that allows users to monitor feed levels, set feeding schedules, view feeding history, receive system status notifications, and perform manual control from different locations. The integration of hardware and software demonstrates that the system can support the monitoring and management of feed provisioning more effectively, efficiently, and flexibly than conventional methods.

The implementation of this system provides benefits in reducing dependence on manual feeding processes, improving the timeliness of feeding, and facilitating continuous monitoring of feed stock conditions. Thus, the developed system has the potential to improve the operational efficiency of chicken farms while supporting the implementation of the IoT-based Smart Poultry Farming concept. However, this research still has limitations, particularly the use of ultrasonic sensors that only measure the height of the feed surface and cannot directly identify the feed weight. Therefore, further research is recommended to integrate load cells, environmental sensors such as temperature and humidity, and analytical algorithms or artificial intelligence to predict feed requirements based on the age, population, and consumption patterns of chickens. This development is expected to improve system accuracy and support smarter decision-making in modern livestock management.

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