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Automatic feces removal system for small and medium scale chicken farms

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ABSTRACT

The increased productivity of chickens in terms of their health is the primary goal of farmers. Chicken growth is influenced by several factors, one of which is maintaining the cleanliness of the coop, such as routinely removing chicken waste daily to prevent ammonia gas buildup that can hinder growth. Most farmers still use manual cleaning methods, which often lead to issues such as neglect in waste removal and excessive accumulation. This study proposes replacing manual cleaning with an automated system by designing a device that cleans chicken waste using a belt conveyor, operating daily at 08:00 AM and 05:00 PM to prevent excessive waste buildup. Additionally, a gas sensor is used as a precautionary measure to detect increased ammonia levels. Based on field testing and observations, the proposed system has successfully met scheduling accuracy for waste disposal and ammonia gas detection. The system has proven effective and is suitable for small to medium-scale operations. With these positive results, it is hoped that this system can provide significant benefits to farmers.

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1. INTRODUCTION

The development of automation technology is an advancement that enables business processes to be transformed through automation technology. The development of technology can increase work productivity and further optimize routine tasks performed by humans [1]. Technology is very helpful for human work, human labor has begun to be reduced to save time and energy. For example, most people who work on chicken farms are responsible for feeding, drinking, and especially maintaining the cleanliness of the coop [2]. The progress of the livestock sector is very rapid and has a real contribution to food security in every country, especially in West Sumatra, where most people live from farming, trading and raising livestock [3]. However, dirty chicken coops are often a major source of problems for chicken farmers. Direct human intervention to clean the coop in the traditional way, farmers must first remove the board that collects the manure and then dispose of it directly. This process is time-consuming and is carried out at least three times a day consistently and regularly. This is certainly a big problem. If the coop is not properly maintained, manure can accumulate and become a source of disease [4]. For this reason, a system is needed that can keep the chicken coop clean, especially if the coop has an automatic manure disposal system [5].

The process of decomposing chicken manure produces large amounts of ammonia, a toxic gas that causes a pungent odor. This volatile ammonia can cause irritation to the eyes and respiratory tract, both in chickens and humans. As a result, livestock health is disturbed and farm productivity decreases [6]. To achieve optimal chicken quality, farmers need to pay attention to aspects of cleanliness and air circulation in the coop. The use of modern equipment such as ventilation systems, automatic manure disposal, and cleaning equipment can help maintain coop cleanliness and create a healthy environment for chickens, thereby increasing productivity and reducing the risk of disease [7]. based on Arduino uno R3 which uses a Load Cell sensor. The obstacle of this tool is the inefficiency of using the load Cell sensor which detects objects from their weight, because in chicken manure it is not always certain how much weight the manure carries.

Several studies have been conducted on automatic chicken manure disposal devices for livestock farming, including those conducted by [8]. This device faced challenges with its ultrasonic sensor, which tends to have an inaccurate detection range and cannot measure distances from soft objects such as chicken manure, which has a relatively irregular shape. Subsequent research by [9] involved designing a weight-based chicken coop manure cleaner based on an Arduino Uno R3 that used a load cell sensor. The constraint of this device was the inefficiency of using the load cell sensor, which detects objects by their weight, due to the indeterminate weight of chicken manure. Observations from researcher Jufri, who interviewed Mr. Yogi, a chicken farmer in Riau, revealed that coop cleanliness is a critical factor in the success of chicken farming. He explained that the accumulation of chicken manure can cause various problems, ranging from a foul odor to diseases that can lead to mass mortality in chickens. Although Mr. Yogi currently uses manual cleaning methods, this method is considered ineffective and labor-intensive. A more efficient solution is needed to address the problem of coop cleanliness on chicken farms.

Based on the results of previous research comparisons, which still have several shortcomings and obstacles, such as the inefficient use of sensors that are still inaccurate in the automated manure disposal process, it is necessary to develop an automated manure disposal system for small and medium-scale chicken farms.

2. METHOD

Design is a crucial initial stage in the process of creating an automatic manure disposal system for the poultry industry. At this stage, a thorough analysis of the needs and conditions in the field is conducted to determine the appropriate equipment specifications. The purpose of this design is to provide a clear picture and thorough calculations regarding how the equipment can be designed, manufactured, and implemented effectively. Furthermore, this design also aims to ensure that the equipment developed can function optimally in the harsh and varied environments of poultry farms and can adapt to dynamic operational needs. This design stage also involves selecting the appropriate technology and materials to ensure long-term durability. The design process must consider the entire equipment lifecycle, from initial design through testing to maintenance, to ensure that the equipment not only functions well during initial use but also remains reliable over the long term. Furthermore, the design also focuses on how the equipment can provide added value to farmers. With accurate, real-time temperature and humidity data, farmers can make more timely and informed decisions, ultimately improving productivity and animal welfare. Therefore, the design stage must consider the user-friendly aspects and ease of integration of this tool with existing systems on the farm.

Through careful planning, the author will develop an innovative automatic chicken manure disposal system. This device is designed to improve the efficiency of coop management and reduce the workload of farmers. The development of this device in this final project begins with the development of hardware and software. The components used in this final project can be seen in the block diagram in Figure 1.

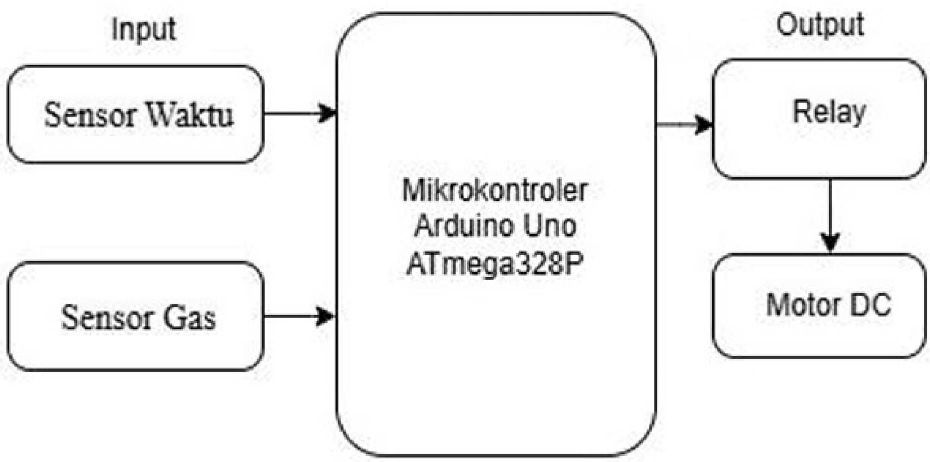


Figure 1. Diagram block of proposed system

The following is an explanation of the function of each component of the block diagram: 1) Arduino UNO is part of the controlled tool system. The Arduino used is an ATMega328-based microcontroller with 6 pin output and 14 pin input as PWM. It has a 16 MHz USB connector, 6 pin analog input, reset button, and power connector. To operate the Arduino UNO, its output must be connected to a computer with a voltage of 7-12 volts [10]. 2) A DC motor is an electrical device used in smart industrial machines that functions to push or rotate objects. In this final project, a DC motor is used as an output to move the swiper horizontally so that dirt will be pushed out to be sent to the provided dirt collection container. 3) The working principle of the relay moves the switch contact so that it conducts higher voltage electricity with low electric current [12]. In the relay, there is usually an iron-core coil that will become a magnet when exposed to electric current, then it will attract the contact [13]. In an automatic manure disposal system using Arduino Uno as a microcontroller by combining relay outputs is very important to control and activate the manure disposal mechanism. 4) The DS3231 RTC module is a module device used as a real-time timer [14]. In this final project the DS3231 RTC sensor is used as a timer for scheduling manure disposal in chicken coops. 5) The MQ-135 sensor works by converting the presence of gas into an electrical signal in the form of changes in resistance values. This analog signal can then be processed to detect various types of gases such as ammonia and alcohol [15]. This sensor is very suitable for detecting air pollution because it has low power consumption and is easy to use.

The basic principle of this device is to assist farmers in automatically cleaning and disposing of chicken manure in the coop. It automatically schedules the removal of chicken manure using a real-time clock (RTC) sensor and detects ammonia gas using an MQ-135 sensor. The microcontroller used is an Arduino UNO Atmega328P, which acts as the central control unit for the entire system. When the scheduled time arrives, the output, a DC motor, operates to drive the conveyor, sending the manure to the designated manure collection container. When the data from the scheduled manure disposal time and ammonia gas levels are detected from each sensor, the microcontroller commands the actuator, the DC motor, to move the conveyor, sending the manure to the designated manure collection container. Figure 2 is a three-dimensional representation of an automatic waste disposal system, providing a comprehensive view from all angles. This 3D design clearly shows the dimensions, shape, and details of each component, helping to understand how the system will look and function in the real world, as well as how each component interacts with each other to form an efficient system.

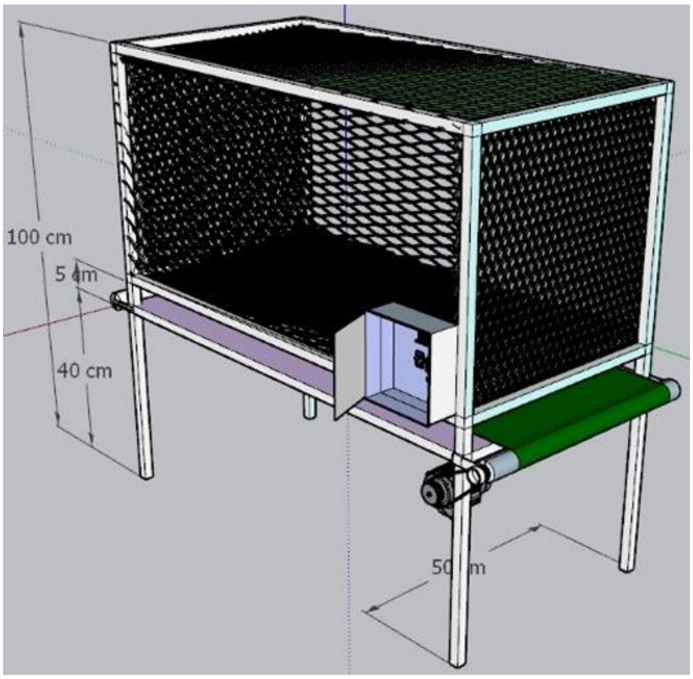


Figure 2. Design of automatic feces removal system

Figure 3 shows the overall design of the device, which aims to determine the connection of each pin on the components used in this final project. After the hardware design stage, the software design stage, including a flowchart, is carried out. A flowchart presents the sequential actions and options required to execute a process in a computer program. The primary purpose of this diagrammatic representation is to provide a complete picture of how the program progresses from one process to the next.

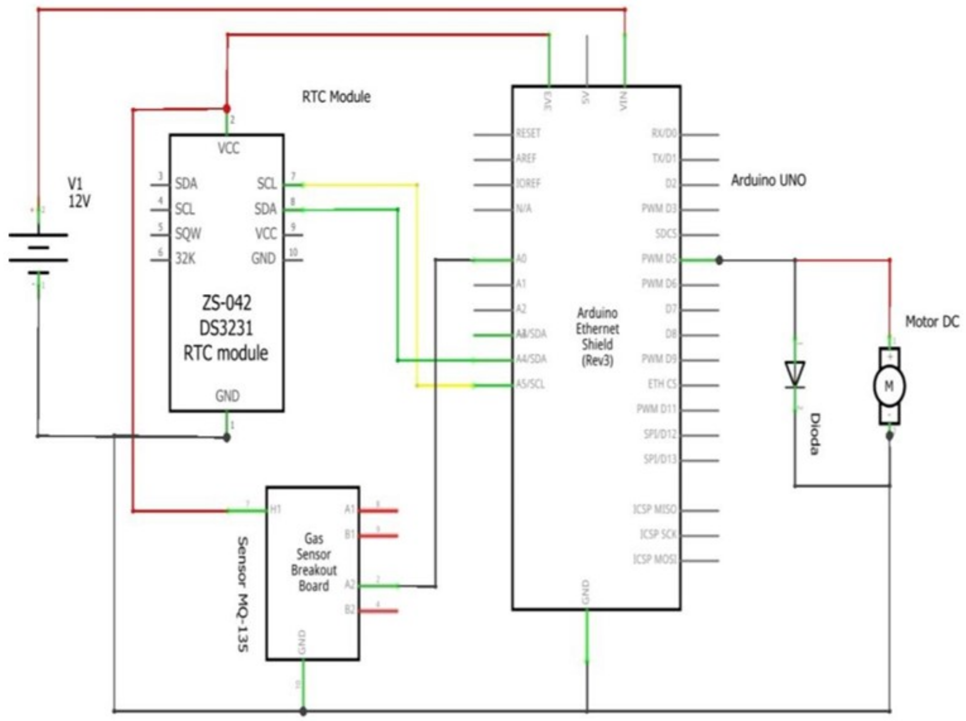


Figure 3. Control system circuit schematic

Figure 4 shows the steps of the program to be designed in this study, which begins with system initialization, where hardware such as the Arduino Uno Atmega328P microcontroller along with time and gas sensors are activated. After initialization, the system enters a main loop that runs continuously as long as the system is turned on. In the main loop, the system first reads the scheduled time data, this data is then analyzed to determine whether the time and ammonia levels are within acceptable ranges.

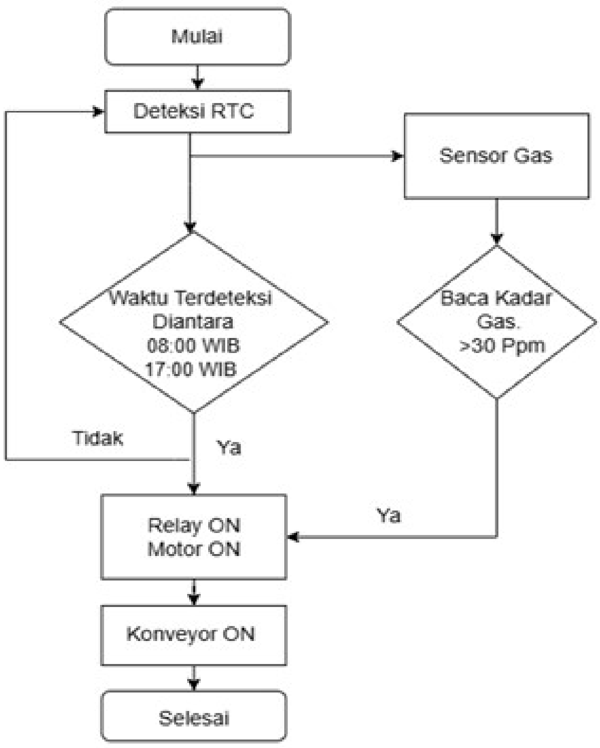


Figure 4. Flowchart of proposed system

3. RESULTS AND DISCUSSION

This tool was tested to obtain concrete data and evidence that the hardware and software were working properly. The results of the hardware design for the entire automatic feces disposal system for chicken farms can be seen in the figure. The design includes the shape and layout of the components used in the tool, such as the Arduino Uno, time sensor, gas sensor, 24-volt DC motor, and conveyor belt.

Figure 5(a) shows the design results of an automatic feces disposal device that basically uses iron material as the main frame and uses iron wire mesh as a protective top, base and side. There is a main part, namely the conveyor belt using iron material on the tube on both sides and using conveyor cloth for the base of the waste collection. Figure 5(b) is the overall circuit of this tool made using a PCB where the legs of all components are soldered to maintain the durability of each component. This circuit is arranged in such a way in the box so that it can be arranged well and makes it easier for farmers to control or repair if a problem occurs.

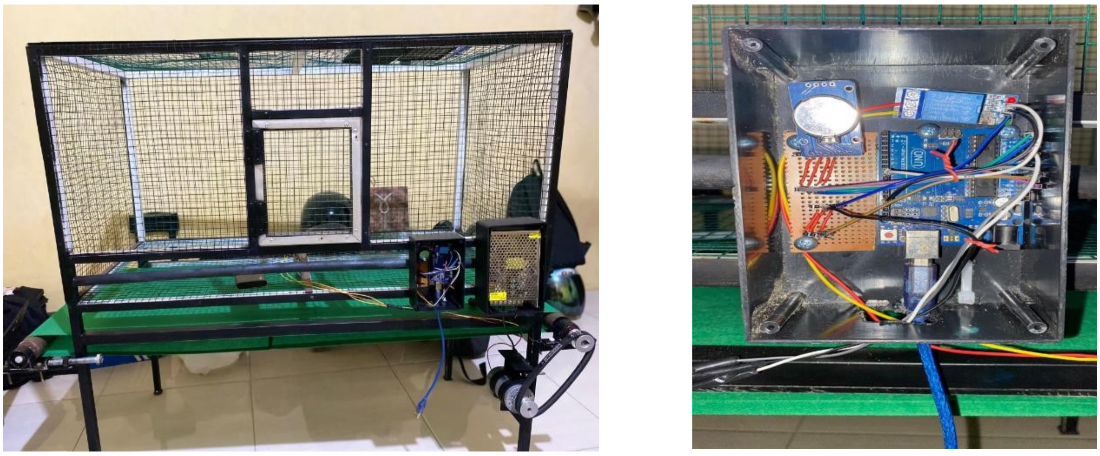

(a) (b)

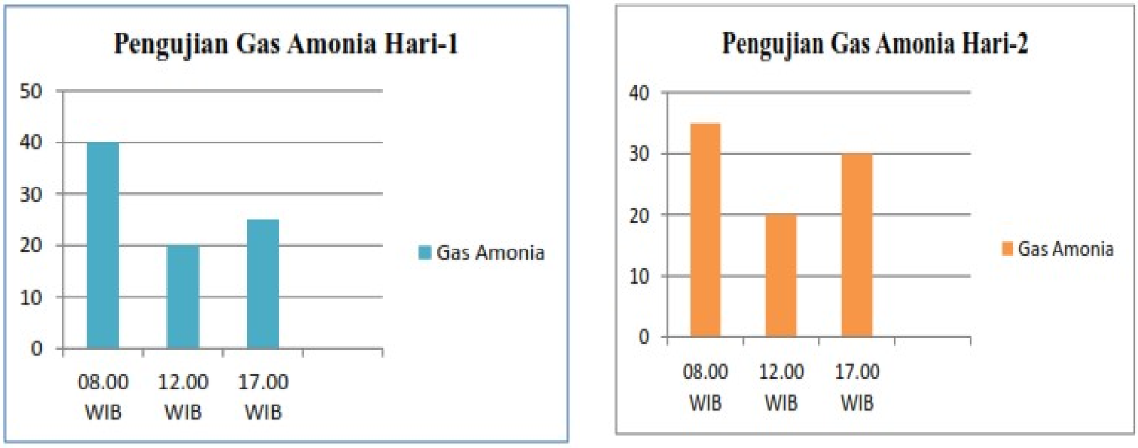
Figure 5. Hardware manufacturing results. a) Hardware manufacturing results, b) Control circuit

Table 1 presents data on gas concentration measurements, the volume of manure produced, and the discharge status conducted in nine experiments over three days. These measurements show significant variation, with the highest gas concentration reaching 45 ppm on January 15, 2025. Manure discharge is considered "Required" when gas concentrations are high, indicating the need for action to reduce harmful gas emissions. Conversely, at times with low gas concentrations, discharge is declared "Not Required," but if the scheduled time, such as 8 a.m. and 5 p.m., is entered, the discharge will remain active even if the gas status does not exceed the threshold. Below are several comparison graphs of each ammonia gas test at different times.

Table 1. Test data

Time	Gas Concentration	Stool Volume	Disposal Status
13-01-2025 08.00	40 Ppm	591 g	Required
13-01-2025 12.00	20 Ppm	213 g	Not required
13-01-2025 17.00	25 Ppm	352 g	Required
14-01 -2025 08.00	35 Ppm	617 g	Required
14-01-2025 12.00	20 Ppm	278 g	Not required
14-01-2025 17.00	30 Ppm	404 g	Required
15-01-2025 08.00	45 Ppm	553 g	Required
15-01-2025 12.00	20 Ppm	276 g	Not required
15-01-2025 17.00	30 Ppm	345 g	Required

Figure 6 shows the results of ammonia gas testing on two different days. Figure 6 shows that on the first day of ammonia gas testing, the highest gas concentration peaked at 40 ppm at 08.00 WIB, and on the second day, the highest point reached 35 ppm at 08.00 WIB. While on the third day, it reached 45 ppm at 08.00 WIB. From this comparison, it can be seen that each ammonia gas level obtained from the waste per hour and even per day varies.



(a) (b)

Figure 6. Results of ammonia gas testing. a) First day, b) second day

Table 2 describes the results of gas level testing and waste disposal times, which are performed automatically according to a predetermined schedule, as well as measurements of the gas concentrations in the waste. The system can monitor gas levels in real time and control conveyor output based on detected conditions. The conveyor is activated based on both the scheduled time and high gas levels. The table shows fluctuations in ammonia gas levels that affect conveyor status throughout the day. At 7:00 a.m. Western Indonesian Time (WIB), ammonia gas levels were recorded at 20 ppm, causing the conveyor to be deactivated. However, at 8:00 a.m. Western Indonesian Time (WIB), the gas levels increased to 35 ppm, prompting the conveyor to be activated. This increase in ammonia gas levels indicates a potentially higher risk, possibly caused by specific activity in the surrounding environment.

Table 2. Results of waste disposal automation testing based on ammonia gas levels

Testing	Time (WIB)	Gas Concentration (ppm)	Conveyor status
1	07.00	28	Non active
2	08.00	35	Active
3	10.00	20	Non active
4	15.00	30	Active
5	17.00	20	Active

Subsequently, after the active period at 8:00 a.m. Western Indonesian Time (WIB), ammonia gas levels decreased again to 20 ppm at 10:00 a.m. Western Indonesian Time (WIB), causing the conveyor to be deactivated again. At 3:00 PM WIB, the gas level increased again to 30 ppm, and the conveyor was reactivated. However, at 5:00 PM WIB, although the ammonia level remained at 20 ppm, the conveyor remained active. This indicates that the waste disposal scheduling system is operating properly.

4. CONCLUSION

This study aims to improve the efficiency of the feces disposal system in chicken farms through the development of automation technology. This research includes the installation of an automatic conveyor system using RTC as a routine scheduling to prevent buildup, namely at 8:00 AM and 5:00 PM. It is equipped with a gas sensor to anticipate increased ammonia gas levels. The results of field testing conducted over three days and based on existing observations, the system proposed in this study has performed well and is suitable for use in cleaning feces on a small and medium scale. With these positive results, it is hoped that the system will provide significant benefits to livestock farmers.

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