Automation System for the Disposal of Feces and Urine in Rabbit Cages Using Arduino

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ABSTRACT

Farming rabbits in large numbers produce large amounts of feces and urine. A cage full of feces and urine can cause health problems for rabbits. This research aims to produce an automation system for the disposal of feces and urine in rabbit cages using an Arduino board and implemented in a prototype form. This system uses electronic devices including load cells, HX711 Module to make it easier to read load cells in measuring weight, real-time clock (RTC) for timing, ultrasonic sensor HC-SR04 to detect the presence of a certain object, dc motor, L298N motor driver module to control a dc motor, an LCD 16x2 module to display the weight and height of feces and urine, a buzzer as a notification of the status of the container if it is full, and an Arduino Uno as a controller of the entire system. The system operates so that the feces excreted by the rabbit fall onto the conveyor belt. At the same time, the urine passes via the conveyor belt and falls into the cross-section before being pumped into the urine collection container. The feces on the conveyor belt will be moved with a dc motor towards the stool container based on a certain time. Each stool and urine container is weighed with a load cell and ultrasonic sensor to detect when the container is full. Then the condition of the load cell and the ultrasonic sensor is displayed on an LCD 16x2. When one or both containers are full, a buzzer will sound as a notification. The method used in this research is an experimental method by manipulating or controlling natural situations into artificial conditions. The artificial condition is the provision of deliberate control over the object of study. The test results show that this system can remove waste based on the time using a belt conveyor and monitoring the weight and height of the dirt. If the dirt has met the specified limit, the system can activate an alarm as a notification.

Keywords : Arduino, Rabbits, Automation System, Load Cell, Ultrasonic Sensor

Article History

Received : Nov, 17rd 2021	Revised : Nov, 28th 2021	Accepted : Nov, 29th 2021

I. INTRODUCTION

Rabbits, apart from being pets, are also farm animals. Rabbits are popular as pets because of their cute shape. In addition, rabbit meat is soft, rich in protein, and low in cholesterol [1]. Rabbits are productive animals in giving birth. In one year, the mother rabbit can give birth 3-4 times, with 4 -12 rabbits each giving birth [2]. Therefore, rabbit farming is something worth considering.

Raising rabbits in large numbers requires maintenance that is not easy. When it comes to raising rabbits, keeping the cage clean is critical. An unclean cage can cause rabbits to become ill with colds [3], and even harmful germs can enter the rabbit's anus and cause harm to the unborn child [4]. A large number of rabbits will produce a lot of feces and urine as well. Everyday cleaning of the rabbit's cage is recommended to maintain their health. Cleaning the cage by hand will take a significant amount of time and work, making it inefficient.

Previous researchers have carried out the development of controlled cages for livestock. Muhtadin et al. developed a chicken coop cleaning system based on ammonia gas detection, with cleaning tools in the form of a sweeper and water sprayer [5]. Qamar et al. also developed a system for cleaning manure in chicken coops based on weight [6]. Lestari et al. developed a temperature controller for chicken coops [7]. Turesna et al. developed monitoring of chicken temperature, cage temperature, and humidity [8]. Mansyur developed an automatic temperature and humidity control system [9]. Susanti et al. developed an IoT-based chicken coop temperature control and monitoring system [10]. Adi et al., applied fuzzy logic to an IoT-based automatic monitoring and control system for chicken coops [11]. Nalendra et al. applied Artificial Intelligence for Temperature and Humidity Control in Broiler Cages based on the Internet of Things [12]. Laksono developed a system for feeding and monitoring the temperature and humidity of chicken coops based on Atmega328 [13]. Supriyono et al. developed a monitoring system for temperature and ammonia gas for small-scale chicken coops [14], and Saputra et a developed temperature and humidity monitoring system in broiler chicken coops based on the internet of things [15]. Widianto et al. developed an automation system for cleaning manure and temperature regulation in rabbit cages based on Arduino mega2560 [16]. However, previous studies referring to feces only did not consider the presence of urine. Chicken droppings are different from rabbit droppings. Chicken consists of one type of feces, whereas rabbit is divided into feces and urine. Rabbit feces and urine both have high economic value and must be separated.

In contrast to chicken manure which does not need to be separated. Likewise with the texture of feces. Chicken tends to be soft and sticky, while rabbits tend to be dry and form small grains like goat feces.

This study aims to develop an automatic system for removing feces and urine in rabbit cages using Arduino. Feces disposal automation system is carried out periodically based on the time using a conveyor belt to the disposal container replace the sweep function on [5]. The conveyor belt is liquid translucent wire mesh, which functions as a separator for feces and urine. Weight sensors such as [6] and [16] are used to detect the full drain container. As a comparison, an ultrasonic sensor such as [17] and [18] is added to detect the disposal container is full. The buzzer is used as a notification that the drain container is full. The system design is implemented in the form of a prototype. It is hoped that this method can clean and separate feces and urine properly.

II. METHOD

The research was carried out in four steps: identification system requirements, the system design, the implementation system, and testing and analysis. Identification of system requirements is the initial stage that must be passed before building an automated system to dispose of feces and urine in rabbit cages using Arduino. This stage describes the background of the system to be built, describes how the system to be made can answer the problems, and the kind of system created. In this stage, functional and non-functional requirements are assessed. Applicable requirements include what features or functions must be provided to meet system requirements. Non-functional requirements include system requirements specifications or limitations that the system can do. Identification of system requirements for automated disposal of feces and urine in rabbit cages using Arduino includes functional requirements in the form of:

- The system can rotate the conveyor belt with a dc motor.
- The system can provide timely information with the RTC module.
- The system is capable of monitoring the weight through the load cell module.
- The system can detect the distance through the ultrasonic sensor HC-SR04.
- The system can display the results of distance and weight readings to an LCD 16x2.
- The system can provide notification via buzzer sound if the storage container is full. While the non-functional requirements are:
    - The system is made using the C programming language with the Arduino IDE software running on the Windows 7 operating system.
    - The system is run on a 12 volt DC power supply.
    - The prototype is an iron wire cage measuring 60x50x40 cm.

System design describes the design of system functions consisting of input, process, and output. At this stage, the system function design is described using a block diagram. System design is the next stage of identifying system requirements. The data obtained from the identification of system requirements is used as material for system design, including input devices, processes, and output devices. At this stage, produce a block diagram of the system as shown in Fig. 1.

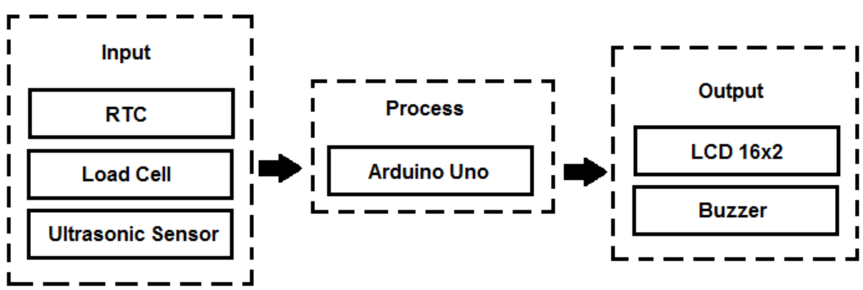

Fig. 1. System Block Diagram

System implementation is the realization of the system, both hardware, and software, which is based on the system design made. Implementation of the system created, the results can be operated and used optimally following the purpose of the system is designed.

Testing and analysis aim to collect test data, both hardware, and software. The analysis is carried out to see the suitability between the test results and the system requirements specifications. Tests carried out are testing input devices, external devices, and functional requirements of the system.

III. RESULT AND DISCUSSION

The results of the design are implemented into hardware and software. The hardware realization used is RTC module, DC motor,

motor driver, load cell, Hx711 Module, LCD 16x2, I2C, ultrasonic sensor, buzzer, power supply and step down module. The hardware realization of the whole system is represented through the circuit schematic in Fig. 2. Meanwhile, the completion of the software is described using a flow chart, as shown in Fig. 3.

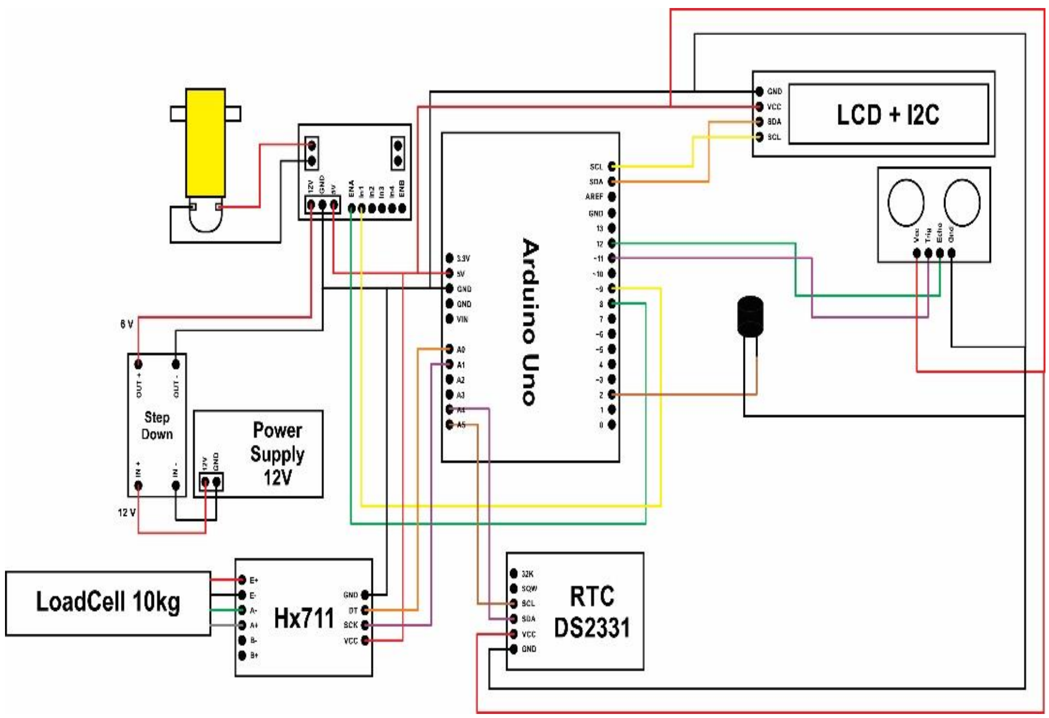

Fig. 2. Overall System Circuit Schematic

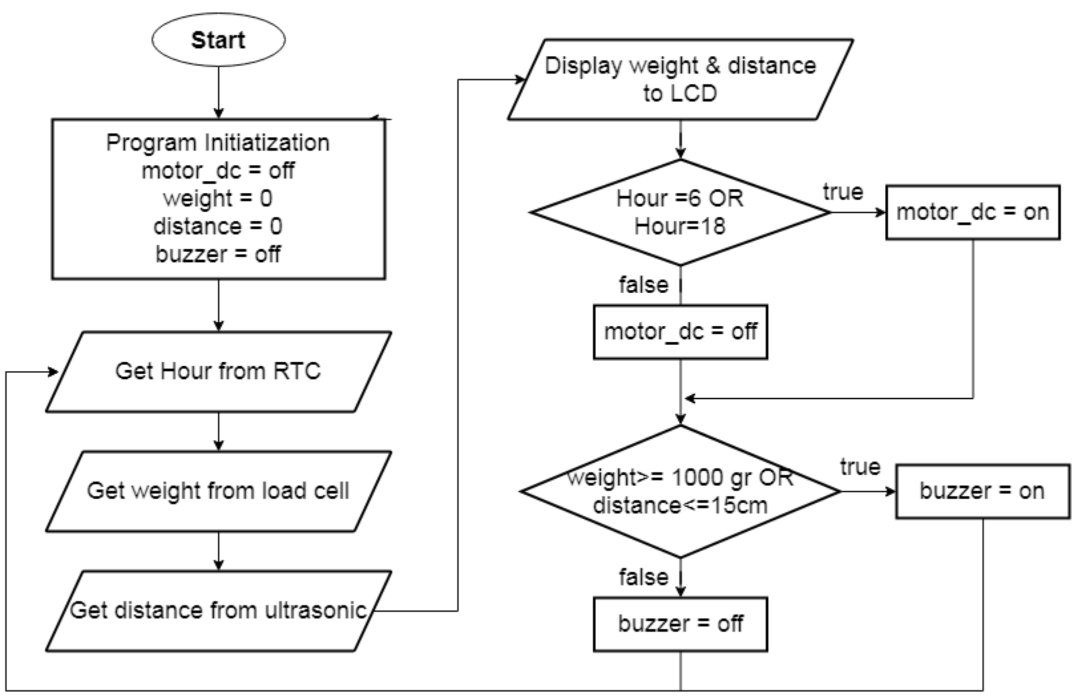

Fig. 3. Overall System Flowchart.

When the system flowchart starts, the program's initialization, which says that the variable is given its initial value, is shown. Specify that a direct current motor is driven by the system, represented by the motor DC variable, with the initial value set to off.

When a load cell is used, its weight value is represented by the weight variable, with an initial value of 0. The distance value of the ultrasonic sensor is represented by the distance variable, which starts with a value of 0. The distance variable is initially set to 0. The buzzer variable represents the function of sounding the alarm through a buzzer, and its initial value is the value off.

The next step is to get the clock value from the RTC, the weight value of the stored load cell on the variable weight, and distance values from the ultrasonic sensor and stored in the variable distance. The values for the weight and distance variables are then displayed on an LCD 16x2. The value in the Hour variable is checked, whether it is equal to 6 or 18. If true, it will be processed motor_dc=on so that the dc motor rotates to move the conveyer belt. If Hour is not equal to 6 or 18, it will be processed motor_dc=off so that the dc motor is off and the conveyer belt is stationary. Next, the value of the weight and distance variables is tested whether the weight variable is greater than or equal to 1000 grams or the distance variable is less than or equal to 15 cm. If true, then the variable buzzer = on, which means the alarm will sound through the buzzer. In addition, the variable buzzer=off, and the notice does not sound.

A complete system, including prototype cage rabbits that were utilized as system installation chambers, was completed in one day. There is an electronic circuit board that serves as a connector for the electronic components that are employed in the primary system. As illustrated in Fig. 4, the rabbit cage prototype comprises a number of components connected to form a functional system.

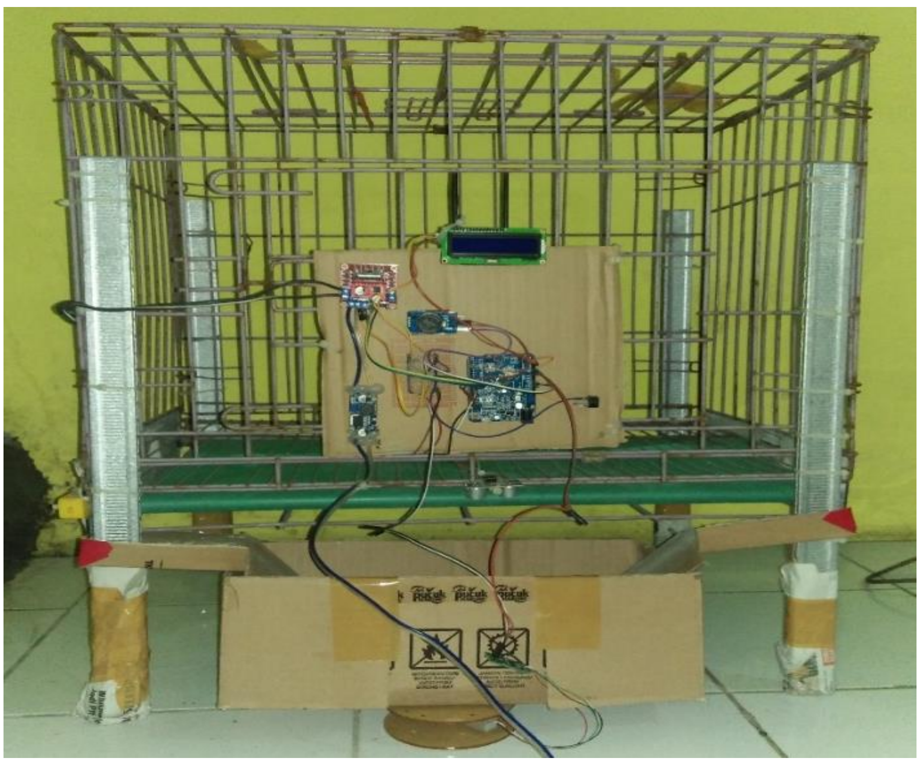

Fig. 4. Prototype Of A Rabbit Cage With An Automated System For The Disposal Of Feces And Urine

In the rabbit cage prototype, there is an RTC module that serves as a timer for the DC motor driving the conveyor belt, an ultrasonic sensor that serves as a detector of the height of feces and urine collected in the disposal container, and a load cell weight sensor installed in the middle of the cross-sectional base that detects the weight of feces and urine collected in the disposal container. LCD 16x2 as a display of weight and height information of feces and urine. Arduino Uno board as the main control system. The supporting components of the system are I2C as a two-way serial communication interface between the LCD 16x2 and the Arduino board. This I2C Module functions to reduce the number of Arduino pins when connected to an LCD 16x2. Another supporting component is the motor driver module which makes it easier to control dc motors such as ON/OFF, adjust speed, and change motor rotation.

Initial testing was carried out on a load cell using a comparison tool in a 30 kg digital scale and a set of manual weights of 50, 100, 200, 500, 1000, and 2000 grams as a load. The test is carried out using a load cell, and digital scales are given each type of load and its combination, then the values on the load cell and digital scales are matched with the given weights. Table I displays the data obtained from the tests conducted with load cells and digital scales.

DOI: 10.25139/ijair.v3i2.3347

TABLE I
TEST RESULTS BETWEEN LOAD CELLS AND DIGITAL SCALES.

Load (gram)	Load cell	Digital Scale
50	50	50
100	100	100
150	150	150
200	200	200
250	250	250
300	300	300
350	350	350
500	500	500
600	600	600
700	700	700
800	800	800
1000	1000	1000

Ultrasonic sensor testing is done by connecting the ultrasonic sensor to the Arduino minimum system. The testing technique is by giving an object in front of the ultrasonic sensor, then the results of the ultrasonic sensor reading are compared with a 30 cm ruler. Table II contains information about the test findings.

TABLE II
TEST RESULTS BETWEEN ULTRASONIC SENSOR AND RULER.

Ruler (cm)	Ultrasonic sensor	Deviation
3	3	0
5	5.3	0.3
7	7	0
10	10	0
13	12.7	0.3
15	15.3	0.3
20	20	0
23	23	0
25	25	0
27	27	0
30	29.7	0.3

The dc motor test aims to determine whether the dc motor can rotate or not. The method used in this test is to provide a combination of outputs on the Arduino digital pins 8 and 9 connected to the dc motor driver module. In this system, the dc motor simply rotates clockwise. As a result, this dc motor test is sufficient in only two situations, namely when the motor is turning clockwise and stopping. The results of the tests performed on this dc motor are reported in Table III.

TABLE III
RESULTS OF THE EXPERIMENT DC MOTOR

Digital pin		Test results	Result should be	Description
Pin 8	Pin 9			
High	High	Not rotating	Not rotating	Valid
High	Low	Rotate clockwise	Rotate clockwise	Valid

The buzzer is generally used in alarm systems. This system uses a 5-volt active buzzer. So that it can be directly connected to Arduino via digital pins without an amplifier circuit, this buzzer test is intended to find out whether the buzzer can make a sound or not. Buzzer testing technique by providing high/low output on pin 2. The results of this buzzer test are shown in Table IV.

TABLE IV
TEST RESULTS BUZZER

Pin 2	Test results	Result should be	Description
Low	No sound	No sound	Valid
High	Sounds	Sounds	Valid

The RTC module in this system is used to run the time function in real-time by using the battery as a power supply. This RTC module test is intended to determine whether the RTC module can provide information on the time required by the system. This

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RTC testing technique is done by displaying date and time data through the Arduino serial monitor. The results of this RTC test are as shown in Fig. 5. Based on the test results, the RTC is still in normal condition.

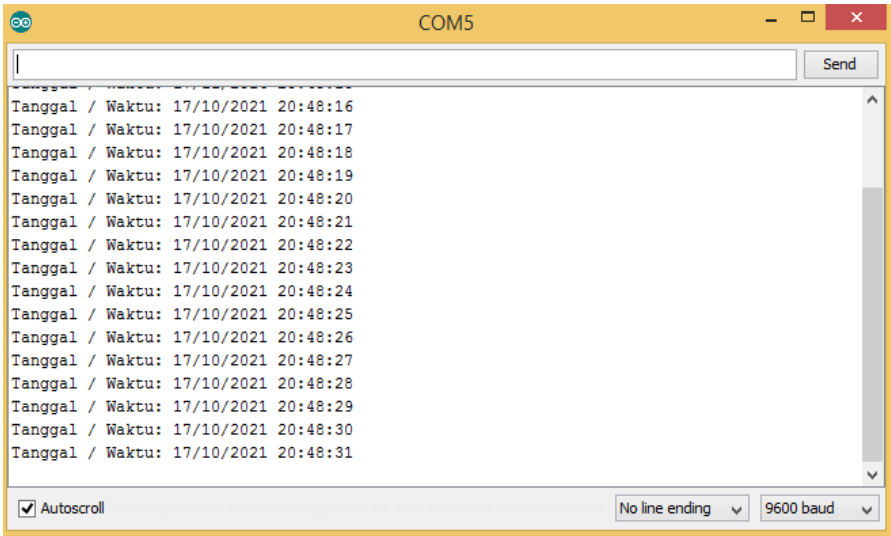

Fig. 4. Test results RTC.

After completing the testing of the input and output devices, they tested the whole system. Overall testing is performed to ensure that the system's functional capabilities are consistent with the standards that have been established. The instruments are the Arduino microcontroller, a real-time clock, a load cell, an ultrasonic sensor, an LCD 16x2, a rabbit cage, a feces and urine container, a power supply, water, and gravel utilized in the overall system test. The steps are included in the entire system testing procedure:

- Power up the Arduino microcontroller by connecting it to the power supply.
- Place the gravel on the conveyor belt and alternatively spray it with water.
- Adjust the alternating time to coincide with the cleaning period or occur outside of the dirt.
- The movement of the conveyor belt and the change in the LCD indication is to be observed in step
- Inspect the excrement and urine container to see if the ultrasonic sensor signals the Arduino microcontroller, causing a buzzer to sound when the container is overflowing.
- Pay close attention to the excrement and urine container. If the load cell detects a load of 1 kg, the Arduino microcontroller will sound a buzzer to alert the user.

After testing according to the above procedure, the following results were obtained. As shown in Table V, the test for cleaning dirt shows the conveyer belt can work according to the specified time, namely at 6 or 18. Testing the weight of feces and urine in the container, as shown in Table VI, shows the system can detect the weight limit of feces and urine according to the specified function, which is 1 kg. Testing the height of feces and urine in the container, as shown in Table VII, shows the system can detect the height limit of feces and urine in the container according to the specified function, which is 15 cm from the ultrasonic sensor.

TABLE V
TESTING FOR CLEANING FECES

RTC	Belt conveyor	Test result
the hour is equal to 6 or 18	on	Succeed
the hour is not equal to 6 or 18	off	Succeed

TABLE VI
FECES AND URINE LOAD TESTING

Weight Of Feces And Urine On Load Cell Sensor	Buzzer	Test result
weight under 1 kg	off	Succeed
weight 1 kg and above	on	Succeed

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TABLE VII
TESTING THE HEIGHT OF FECES AND URINE IN THE CONTAINER.

Surface Level From The Ultrasonic Sensor		Buzzer	Test result
Feces	Urine		
greater than 15 cm	greater than 15 cm	off	Succeed
greater than 15 cm	less than or equal to 15 cm	on	Succeed
less than or equal to 15 cm	greater than 15 cm	on	Succeed
less than or equal to 15 cm	less than or equal to 15 cm	on	Succeed

Based on the test results, assess the overall test findings in terms of whether or not they satisfy the system's functional requirements, as seen in Table VIII.

TABLE VIII
OVERALL TESTING

Parameter	Test result
The system is capable of turning the conveyor belt with a dc motor during cleaning	Succeed
The system can provide timely information with the RTC module.	Succeed
The system is capable of monitoring the weight through the load cell module.	Succeed
The system can detect the distance through the ultrasonic sensor HC-SR04.	Succeed
The system can display the results of distance and weight readings to an LCD 16x2.	Succeed
The system can provide notification via buzzer sound if the storage container is full	Succeed

The system can move the belt conveyor with a dc motor following the specified time. The timing of the system is determined by the clock information provided by the RTC. This device can measure the weight of the feces and urine; however, it can also measure the height of the feces and urine using an ultrasonic sensor. The LCD is used to monitor the weight of the load cell and the height of the dirt from the ultrasonic sensor, which are both being continuously monitored. A notification alarm will sound if at least one of the conditions of the stool load or the height of the feces has reached the stated limit, and the system will activate a buzzer to sound the alarm.

IV. CONCLUSION

This research has resulted in an automation system disposal of feces and urine in the rabbit cage and implementing it in a prototype form. The system is capable of removing feces using a conveyer belt based on the timing of the RTC. The system can also monitor the weight and height of the dirt at any time and will activate an alarm if one of the conditions, both the weight and height of the dirt, has reached the specified limit. Some work could be implemented in the future, such as developing to control more rabbit cages more efficiently.

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