Decision Tree Model for Automatic Sterilizied Water Feeding System in Poultry Farm Based on Internet of Things

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***Abstract*— The automatic sterilized drinking water supply system for chickens is designed to facilitate the activities of farmers in the process of providing drinking water to chickens and to facilitate the process of sterilizing the water. The process of sterilizing water with UV light must be done properly in order to get good results. In this study, there were five HC-SR04 ultrasonic sensors connected to the ESP8266 microcontroller. The ESP8266 microcontroller is embedded with the decision tree method as an output decision maker based on the calculation of the C4.5 algorithm. There are three processes, namely the process of determining the dataset, forming a decision tree and forming a rule. From the results of several tests that have been carried out, it is known that the reading error values of each ultrasonic sensor are 3.63%, 2.09%, 1.54%, 3.39% and 3.38%, respectively. Then in testing the rules that have been generated from the decision tree method with a total of 10 test data, an accuracy of 100% is obtained. Average system execution time is 0.98 seconds.**

Keywords— Decision tree, water sterilization, UV light, C4.5 algorithm, ultrasonic sensor.

I. INTRODUCTION

The demand for livestock products in Indonesia is always increasing every year. Based on data obtained from the Indonesian Central Statistics Agency, in 2019 the production of broiler or broiler meat in Indonesia reached 3.4 million tons, while the production of laying hens reached 4.7 million tons [1]. This shows that the livestock sector plays an important role in economic growth in Indonesia. One of the factors that can improve the quality of the livestock sector, especially chickens, is the provision of drinking water [2]. In broilers, where the characteristics of this type of chicken have the nature of drinking water, so that if there is no water supply within a few hours, the chicken can die [3]. The use of drinking water for chickens also needs special attention to avoid bacterial contamination. One of the diseases caused by drinking water, namely salmonellosis, comes from the salmonella bacteria [4].

Ultraviolet light has been shown to effectively kill bacteria by damaging DNA which causes bacteria to be unable to reproduce and die without contact with chemicals, so ultraviolet light can be used for water sterilization [4]. The sterilization process of drinking water for chickens with ultraviolet light must be carried out properly in order to get good results. In addition, the provision of drinking water to chickens must also be done regularly and on time [5]. The sterilization and drinking water supply system for chickens can be automated using a microcontroller based on the Internet of Things [6]. In order for the system to function as needed, it is necessary to create a rule to determine the conditions for providing drinking water to chickens and the sterilization process. The decision tree method is one method for making rules that can be used to determine decisions [7].

Previously, Abijheet Ashok Paidalwar and Isha P Kheidar had conducted research on the process of water sterilization (disinfection). Which discusses the best types of UV waves and the dosage required to provide effective UV radiation [8]. Then research on the use of the decision tree method which is implemented in an automatic plant watering system to control the condition of the water pump. The research was conducted by Firman Al Islami, which stated that the decision tree method can be used in the classification of conditions determination [9]. Akbar Riansyah et al in their research proved that the feeding system for fish can be automated and monitored based on IoT [10]. Then, Rina Yuhasari et al in their research explained that the Electrical Conductivity Control System in Aquaponics Cultivation can run well using the fuzzy-logic method [11]. Muhammad Daffa Fadillah et al in his research also explained that the Fuzzy Logic method can be implemented in a Control System to Maintain pH in Aquaponic [13]. And also a humidity control system in cactus plants which has been described by Rachma Dianty et al in their research [14]. Dzulfikri Hanafi et al in their research also explained that internet of things technology can be implemented in the Automatic Growth Monitoring and Watering System for Chili Plants [12].

II. DETERMINATION OF UV IRRADIATION TIME FOR WATER STERILIZATION FROM SALMONELLA

The water sterilization process can use the UV irradiation method. In order for the UV irradiation process to run effectively, it must pay attention to several parameters such as the required UV dose, the intensity of the UV lamp light and the duration of the irradiation time [8]. By following the equation:

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$$D = I \cdot t \quad (1)$$

with

D : UV dose (mWsec/cm^2),

I : Intensity (mW/cm^2),

t : Exposure time (sec).

TABLE I. UV DOSE FOR SALMONELLA.

No.	Bacteria	Dose (mWsec/cm^2)
1	Salmonella Thypimurium	15.2
2	Salmonella Enteriditis	7.6
3	Salmonella Parathypi	6.1
4	Salmonella Thyposa	4.1

Based on TABLE I, Salmonella thypimurium had the highest dose of 15.2 mWsec/cm^2, so it could be used to cover other types of salmonella under it. By using a UV lamp with an intensity of 0.0136 mW/cm^2, UV irradiation duration can be determined using (1) which is 18.627 minutes.

III. MODELING DRINKING WATER SYSTEM USING DECISION TREE

A. Block Diagram System

The design of a water sterilization system with a decision tree in determining its conditions can be divided into three stages of the system, namely input, process, and output. In the input process, five HC-SR04 ultrasonic sensors are used which are mounted on two tank caps and three container lids. Fig. 1 shows a block diagram of an automatic sterilized drinking water supply system for chickens.

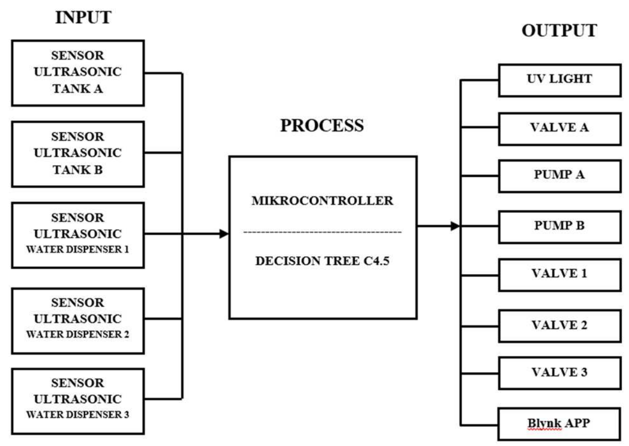

Fig. 1. The block diagram of this control system.

In general, all these parts are interconnected with each other, so that an automatic water sterilization system can be created.

1. At the input stage there are five ultrasonic sensors HC-SR04. The sensor is used to read the water level.
2. The processing section is the most important part in making this system, namely the sensor reading in the form of the water level will be processed by the NodeMCU ESP8266 microcontroller using the decision tree method.
3. The output section is the result of classification in the form of ON and OFF conditions on UV Light, Valve A, Pump A, Pump B, Valve 1, Valve 2, Valve 3.

B. Hardware Design

In designing the sterilization system and automatic drinking water supply using the decision tree method, several electronic and non-electronic supporting components are used. The names and number of components needed to design the system can be seen in TABLE II.

TABLE II. COMPONENT.

NO	COMPONENT`	LOTS
1	CONTAINER BOX	2
2	NODE MCU ESP8266	1
3	PCF8574	2
4	UVC LAMP	1
5	SELENOID VALVE	3
6	POWER SUPPLY 12V	1
7	ULTRASONIC SENSOR HC-SR04	5
8	RELAY	7
9	WATER PUMP 12V	2
10	CHICKEN WATER DISPENSER	3

Fig. 2 illustrates the overall schematic of an automatic sterilized drinking water supply system using an ultrasonic sensor, UV lamp and ESP8266.

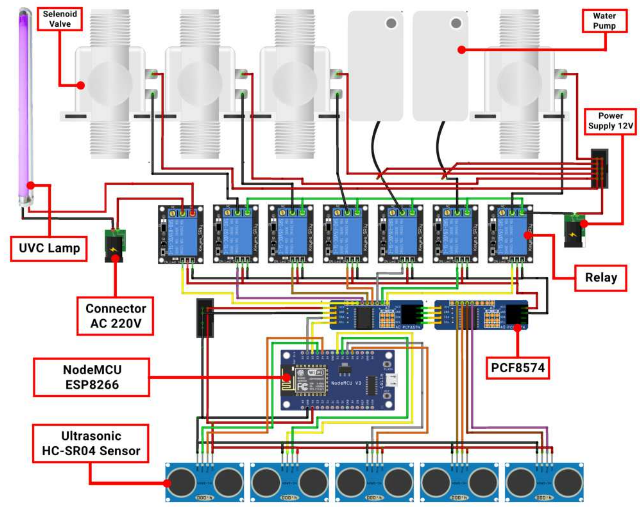

Fig. 2. Schematic system.

C. Software Design

The system design using the decision tree method and applying the C4.5 algorithm consists of several processes needed. The process is determining the dataset, manual calculations, making decision trees and making rules. The classification process using the Decision Tree method by applying the C4.5 algorithm consists of several stages according to Fig. 3, an explanation of converting a dataset into a tree is shown and discussed according to the following flow chart.

To carry out the classification process using a decision tree, it consists of several stages, these stages are in accordance with the flow chart in Fig. 3. Dataset is data that will be used to make a decision tree to determine the condition of the automatic sterilized drinking water supply system for chickens.

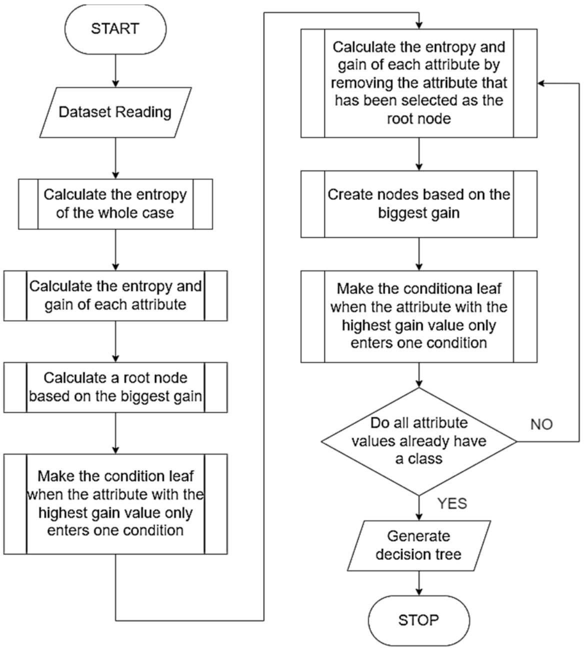

Fig. 3. Decision tree classification design flowchart.

The first stage carried out in classifying the condition of automatic sterilized drinking water supply system for chickens using the decision tree method and the C4.5 algorithm consists of several stages, namely:

1. Prepare training data. This training data will later be used as a dataset to make a decision tree.
2. Create a decision tree. To make a decision tree, it is necessary to calculate the root nodes, internal nodes and leaf nodes. This root node will be taken from the attribute that has the highest gain value, by calculating the entropy value in all cases and calculating the entropy value along with the gain in each attribute. These internal nodes will be taken from the attribute that has the highest gain value by eliminating the attribute that has been selected as the root node. These leaf nodes will be taken from the attribute with the highest gain value whose attribute value only falls into one condition.

To find the entropy value, the following formula is used:

$$Entropy\ (S) = \sum_{i=0}^{k} -p_i \times log2\ p_i \qquad (2)$$

with

S : Case Set,

k : Number of partitions S,

p_i : Proportion of S_i to S.

To calculate the gain value, the following formula is used:

$$Gain\ (A) = Entropy\ (S) - \sum_{i=1}^{k} \frac{|S_i|}{|S|} \times \sum_{j=0}^{k} -p_i \times log2p_i \qquad (3)$$

with

S : Case Set,

A : Attributes,

n : Number of attribute partitions A,

$|S_i|$: Number of cases on partition I,

$|S|$: Number of cases in S.

In TABLE III is a dataset table to determine the conditions of sterilization and provision of drinking water for chickens. Each value is the result of testing without a method.

TABLE III. DATASET.

No	Tank		Water Dispenser			UV Light	Water Pump		Selenoid Valve				Desc
	A	B	1	2	3		A	B	A	1	2	3	
1	Full	Full	Full	Full	Full	Off	Off	Off	Off	Off	Off	Off	Condition 1
2	Full	Full	Full	Full	Empty	Off	Off	On	Off	Off	Off	On	Condition 2
3	Full	Full	Full	Empty	Full	Off	Off	On	Off	Off	On	Off	Condition 3
4	Full	Full	Full	Empty	Empty	Off	Off	On	Off	Off	On	On	Condition 4
5	Full	Full	Empty	Full	Full	Off	Off	On	Off	On	Off	Off	Condition 5
6	Full	Full	Empty	Full	Empty	Off	Off	On	Off	On	Off	On	Condition 6
7	Full	Full	Empty	Empty	Full	Off	Off	On	Off	On	On	Off	Condition 7
8	Full	Full	Empty	Empty	Empty	Off	Off	On	Off	On	On	On	Condition 8
9	Full	Empty	Full	Full	Full	Off	On	Off	Off	Off	Off	Off	Condition 9
10	Full	Empty	Full	Full	Empty	Off	On	Off	Off	Off	Off	Off	Condition 9
11	Full	Empty	Full	Empty	Full	Off	On	Off	Off	Off	Off	Off	Condition 9
12	Full	Empty	Full	Empty	Empty	Off	On	Off	Off	Off	Off	Off	Condition 9
13	Full	Empty	Empty	Full	Full	Off	On	Off	Off	Off	Off	Off	Condition 9
14	Full	Empty	Empty	Full	Empty	Off	On	Off	Off	Off	Off	Off	Condition 9
15	Full	Empty	Empty	Empty	Full	Off	On	Off	Off	Off	Off	Off	Condition 9
16	Full	Empty	Empty	Empty	Empty	Off	On	Off	Off	Off	Off	Off	Condition 9
17	Empty	Full	Full	Full	Full	On	Off	Off	On	Off	Off	Off	Condition 10
18	Empty	Full	Full	Full	Empty	On	Off	Off	On	Off	Off	Off	Condition 10
19	Empty	Full	Full	Empty	Full	On	Off	Off	On	Off	Off	Off	Condition 10
20	Empty	Full	Full	Empty	Empty	On	Off	Off	On	Off	Off	Off	Condition 10
21	Empty	Full	Empty	Full	Full	On	Off	Off	On	Off	Off	Off	Condition 10
22	Empty	Full	Empty	Full	Empty	On	Off	Off	On	Off	Off	Off	Condition 10
23	Empty	Full	Empty	Empty	Full	On	Off	Off	On	Off	Off	Off	Condition 10
24	Empty	Full	Empty	Empty	Empty	On	Off	Off	On	Off	Off	Off	Condition 10
25	Empty	Empty	Full	Full	Full	On	Off	Off	On	Off	Off	Off	Condition 10
26	Empty	Empty	Full	Full	Empty	On	Off	Off	On	Off	Off	Off	Condition 10
27	Empty	Empty	Full	Empty	Full	On	Off	Off	On	Off	Off	Off	Condition 10
28	Empty	Empty	Full	Empty	Empty	On	Off	Off	On	Off	Off	Off	Condition 10
29	Empty	Empty	Empty	Full	Full	On	Off	Off	On	Off	Off	Off	Condition 10
30	Empty	Empty	Empty	Full	Empty	On	Off	Off	On	Off	Off	Off	Condition 10
31	Empty	Empty	Empty	Empty	Full	On	Off	Off	On	Off	Off	Off	Condition 10
32	Empty	Empty	Empty	Empty	Empty	On	Off	Off	On	Off	Off	Off	Condition 10

So the entropy of the data set is 2.25. The entropy value is obtained based on (2). After obtaining the entropy of all cases, the next step is to calculate the entropy and gain values for each attribute and analyze the results of the calculations to determine the highest gain value. TABLE IV shows the attribute data for node 1.

TABLE IV. ATTRIBUTE NODE 1.

Attribute	Value	Condition										Sum
		1	2	3	4	5	6	7	8	9	10	
Tank A	Full	1	1	1	1	1	1	1	1	8	0	16
	Empty	0	0	0	0	0	0	0	0	0	16	16
Tank B	Full	1	1	1	1	1	1	1	1	0	8	16
	Empty	0	0	0	0	0	0	0	0	8	8	16
Water Dispenser 1	Full	1	1	1	1	0	0	0	0	4	8	16
	Empty	0	0	0	0	1	1	1	1	4	8	16
Water Dispenser 2	Full	1	1	0	0	1	1	0	0	4	8	16
	Empty	0	0	1	1	0	0	1	1	4	8	16
Water Dispenser 3	Full	1	0	1	0	1	0	1	0	4	8	16
	Empty	0	1	0	1	0	1	0	1	4	8	16

TABLE V. ENTROPY AND GAIN ATTRIBUTE NODE 1.

Attribute	Value	Sum	Sum Condition										Entropy
			1	2	3	4	5	6	7	8	9	10	
Tank A	Full	16	1	1	1	1	1	1	1	1	8	0	2,5
	Empty	16	0	0	0	0	0	0	0	0	0	16	0
Gain Tank A		1											
Tank B	Full	16	1	1	1	1	1	1	1	1	0	8	2,5
	Empty	16	0	0	0	0	0	0	0	0	8	8	1
Gain Tank B		0,5											
Water Dispenser 1	Full	16	1	1	1	1	0	0	0	0	4	8	2
	Empty	16	0	0	0	0	1	1	1	1	4	8	2
Gain Water Dispenser 1		0,25											
Water Dispenser 2	Full	16	1	1	0	0	1	1	0	0	4	8	2
	Empty	16	0	0	1	1	0	0	1	1	4	8	2

Gain Water Dispenser 2		0,25											
Water Dispenser 3	Full	16	1	0	1	0	1	0	1	0	4	8	2
	Empty	16	0	1	0	1	0	1	0	1	4	8	2
Gain Water Dispenser 3		0,25											

It can be seen that in TABLE V, the largest gain value is the gain of Tank A. So Tank A becomes the root node. Then on Tank A "empty" everything shows "Condition 10", so Tank A "empty" becomes a leaf as shown in Fig. 4. Then the "full" Tank A shows the difference in the conditions given, so it needs to be recalculated to determine the next internal node. To make it easier, TABLE IV is filtered by only taking data that has a Tank A value of "Full" so that it becomes TABLE VI.

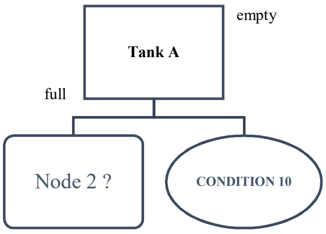

Fig. 4. Decision tree design node 1.

TABLE VI. ATTRIBUTE NODE 2.

Attribute	Value	Condition									Sum
		1	2	3	4	5	6	7	8	9	
Tank B	Full	1	1	1	1	1	1	1	1	0	8
	Empty	0	0	0	0	0	0	0	0	8	8
Water Dispenser 1	Full	1	1	1	1	0	0	0	0	4	8
	Empty	0	0	0	0	1	1	1	1	4	8
Water Dispenser 2	Full	1	1	0	0	1	1	0	0	4	8
	Empty	0	0	1	1	0	0	1	1	4	8
Water Dispenser 3	Full	1	0	1	0	1	0	1	0	4	8
	Empty	0	1	0	1	0	1	0	1	4	8

TABLE VII . ENTROPY AND GAIN ATTRIBUTE NODE 2.

Attribute	Value	Sum	Sum Condition										Entropy
			1	2	3	4	5	6	7	8	9	10	
Tank B	Full	8	1	1	1	1	1	1	1	1	1	-	3
	Empty	8	0	0	0	0	0	0	0	0	0	-	0
Gain Tank B		0,75											
Water Dispenser 1	Full	8	1	1	1	1	0	0	0	0	4	-	2
	Empty	8	0	0	0	0	1	1	1	1	4	-	2
Gain Water Dispenser 1		0,25											
Water Dispenser 2	Full	8	1	1	0	0	1	1	0	0	4	-	2
	Empty	8	0	0	1	1	0	0	1	1	4	-	2
Gain Water Dispenser 2		0,25											
Water Dispenser 3	Full	8	1	0	1	0	1	0	1	0	4	-	2
	Empty	8	0	1	0	1	0	1	0	1	4	-	2
Gain Water Dispenser 3		0,25											

Based on TABLE VII, the largest gain value is the gain of Tank B. So that Tank B becomes an internal node. Then on Tank B "empty" everything shows "Condition 9", thus Tank B "empty" becomes a leaf as shown in Fig. 5. Then the "full" Tank B shows the difference in the conditions given, so it needs to be recalculated to determine the next internal node. To make it easier, TABLE V is filtered by only taking data that has a Tank B value "Full" so that it becomes TABLE VI.

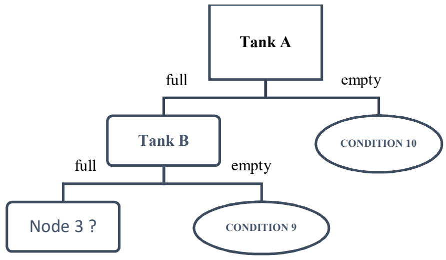

Fig. 5. Decision tree design node 2.

TABLE VI. ATTRIBUTE NODE 3.

Attribute	Value	Condition								Sum
		1	2	3	4	5	6	7	8	
Water Dispenser 1	Full	1	1	1	1	0	0	0	0	4
	Empty	0	0	0	0	1	1	1	1	4
Water Dispenser 2	Full	1	1	0	0	1	1	0	0	4
	Empty	0	0	1	1	0	0	1	1	4
Water Dispenser 3	Full	1	0	1	0	1	0	1	0	4
	Empty	0	1	0	1	0	1	0	1	4

TABLE VIII. ENTROPY AND GAIN ATTRIBUTE NODE 3.

Attribute	Value	Sum	Sum Condition										Entropy
			1	2	3	4	5	6	7	8	9	10	
Water Dispenser 1	Full	4	1	1	1	1	0	0	0	0	-	-	2
	Empty	4	0	0	0	0	1	1	1	1	-	-	2
Gain Water Dispenser 1		0,25											
Water Dispenser 2	Full	4	1	1	0	0	1	1	0	0	-	-	2
	Empty	4	0	0	1	1	0	0	1	1	-	-	2
Gain Water Dispenser 2		0,25											
Water Dispenser 3	Full	4	1	0	1	0	1	0	1	0	-	-	2
	Empty	4	0	1	0	1	0	1	0	1	-	-	2
Gain Water Dispenser 3		0,25											

The results of the calculation to determine the internal note 3 are shown in the TABLE VII, each attribute has the same gain value. So that Water Dispenser 1 is chosen to be an internal node 3 as shown in Fig 6. Then Water Dispenser 1 is "full" or "empty" shows the difference in the conditions given, so it needs to be recalculated to determine the next internal node. To make it easier, TABLE VI is filtered by only taking data that has a Water Dispenser 1 value of "full" first so that it becomes TABLE IX.

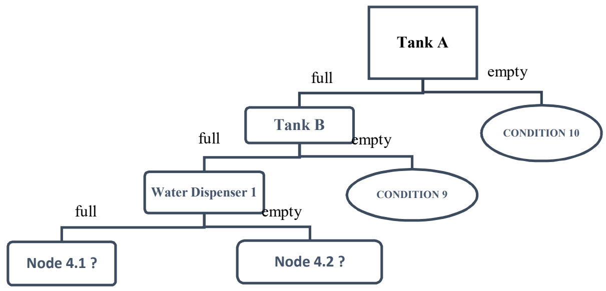

Fig. 6. Decision tree design node 3.

TABLE IX. ATTRIBUTE NODE 4.1.

Attribute	Value	Condition								Sum Value
		1	2	3	4	5	6	7	8	
Water Dispenser 2	Full	1	1	0	0	1	1	0	0	4
	Empty	0	0	1	1	0	0	1	1	4
Water Dispenser 3	Full	1	0	1	0	1	0	1	0	4
	Empty	0	1	0	1	0	1	0	1	4

TABLE X . ENTROPY AND GAIN ATTRIBUTE NODE 4.1.

ATTRIBUTE	VALUE	SUM	SUM CONDITION										ENTROPY
			1	2	3	4	5	6	7	8	9	10	
WATER DISPENSER 2	FULL	4	1	1	0	0	1	1	0	0	-	-	2
	EMPTY	4	0	0	1	1	0	0	1	1	-	-	2
GAIN WATER DISPENSER 2	0,25												
WATER DISPENSER 3	FULL	4	1	0	1	0	1	0	1	0	-	-	2
	EMPTY	4	0	1	0	1	0	1	0	1	-	-	2
GAIN WATER DISPENSER 3	0,25												

The results of the calculation to determine the internal node 4.1 on the Water Dispenser 1 condition "full" shown in the TABLE X, each attribute has the same gain value. So that Water Dispenser 2 is selected to be an internal node 4.1 as shown in Fig. 7. Then to determine the internal node in Dispenser 1 is "empty" then TABLE VI is filtered by only taking data that has a value of Water Dispenser 1 "empty" first so that it becomes TABLE XI.

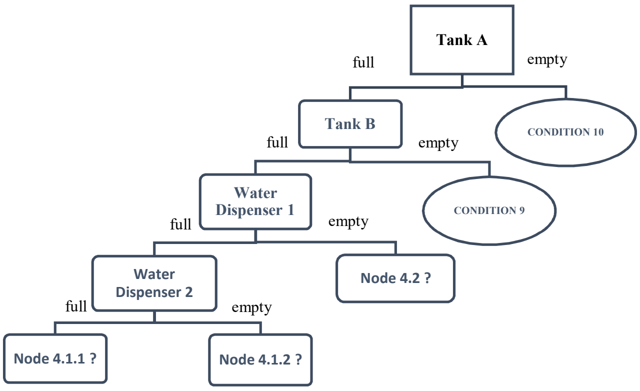

Fig. 7. Decision tree design node 4.1

TABLE XI. ATTRIBUTE NODE 4.2.

ATTRIBUTE	VALUE	CONDITION								SUM
		1	2	3	4	5	6	7	8	
WATER DISPENSER 2	FULL	1	1	0	0	1	1	0	0	4
	EMPTY	0	0	1	1	0	0	1	1	4
WATER DISPENSER 3	FULL	1	0	1	0	1	0	1	0	4
	EMPTY	0	1	0	1	0	1	0	1	4

TABLE XII. ENTROPY AND GAIN ATTRIBUTE NODE 4.2.

ATTRIBUTE	VALUE	SUM	SUM CONDITION										ENTROPY
			1	2	3	4	5	6	7	8	9	10	
WATER DISPENSER 2	FULL	4	1	1	0	0	1	1	0	0	-	-	2
	EMPTY	4	0	0	1	1	0	0	1	1	-	-	2
GAIN WATER DISPENSER 2	0,25												
WATER DISPENSER 3	FULL	4	1	0	1	0	1	0	1	0	-	-	2
	EMPTY	4	0	1	0	1	0	1	0	1	-	-	2
GAIN WATER DISPENSER 3	0,25												

The results of the calculation to determine the internal node 4.2 on the water dispenser 1 condition "empty" shown in the TABLE XII, each attribute has the same gain value. So that Water Dispenser 2 is chosen to be the internal node 4.2 as shown in Fig. 8. Then the next node will be determined 5.1 and 5.2 as in TABLE XIII.

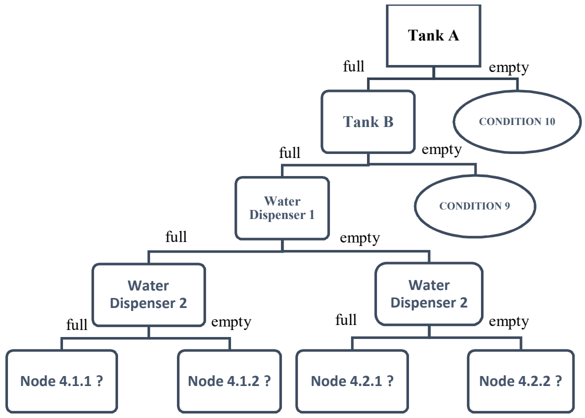

Fig. 8. Decision tree design node 4.2

TABLE XIII. ATTRIBUTE NODE 4.1.1.

ATTRIBUTE	VALUE	CONDITION								SUM
		1	2	3	4	5	6	7	8	
WATER DISPENSER 3	FULL	1	0	1	0	1	0	1	0	4
	EMPTY	0	1	0	1	0	1	0	1	4

TABLE XIV. ENTROPY AND GAIN ATTRIBUTE NODE 4.1.1.

ATTRIBUTE	VALUE	SUM	SUM CONDITION										ENTROPY
			1	2	3	4	5	6	7	8	9	10	
WATER DISPENSER 3	FULL	4	1	0	1	0	1	0	1	0	-	-	2
	EMPTY	4	0	1	0	1	0	1	0	1	-	-	2
GAIN WATER DISPENSER 3	0,25												

Based on the calculation results in determining the 4.1.1 internal node shown in TABLE XIV, water dispenser 3 was chosen to be the internal node 4.1.1 and 4.1.2, 4.2.1 and 4.2.2. So that water dispenser 3 is chosen to be a leaf on the decision tree as shown in Fig. 9.

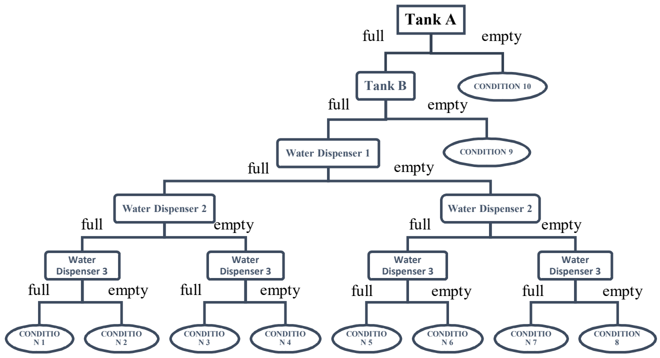

Fig. 9. Decision tree final design.

After obtaining the final decision tree, the rule is formed. The established rule is used to determine the status of sterilization conditions and provision of drinking water for chickens. The results of the rule are shown as follows:

1. If tank a is full, tank b is full, water dispenser 1 is full, water dispenser 2 is full and water dispenser 3 is full, then "condition 1".
2. If tank a is full, tank b is full, water dispenser 1 is full, water dispenser 2 is full and water dispenser 3 is empty then "condition 2".
3. If tank a is full, tank b is full, water dispenser 1 is full, water dispenser 2 is empty and water dispenser 3 is full, then "condition 3".
4. If tank a is full, tank b is full, water dispenser 1 is full, water dispenser 2 is empty and water dispenser 3 is empty then "condition 4".

5. If tank a is full, tank b is full, water dispenser 1 is empty, water dispenser 2 is full and water dispenser 3 is full, then “condition 5”.
6. If tank a is full, tank b is full, water dispenser 1 is empty, water dispenser 2 is full and water dispenser 3 is empty then “condition 6”.
7. If tank a is full, tank b is full, water dispenser 1 is empty, water dispenser 2 is empty and water dispenser 3 is full then “condition 7”.
8. If tank a is full, tank b is full, water dispenser 1 is empty, water dispenser 2 is empty and water dispenser 3 is empty then “condition 8”.
9. If tank a is full and tank b empty then “condition 9”.
10. If tank a is empty then “condition 10”.

Based on observations of the hardware used, the water level for the container box and water dispenser used is determined, the conditions are as follows:

a) Container Box “Tank A”
   - Full -+ 15 cm.
   - Empty -+ 5 cm.
b) Conatiner Box “Tank B”
   - Full -+ 15 cm.
   - Empty -+ 5 cm.
c) Water Dispenser 1
   - Full -+ 15 cm.
   - Empty -+ 5 cm.
d) Water Dispenser 2
   - Full -+ 15 cm.
   - Empty -+ 5 cm.
e) Water Dispenser 3
   - Full -+ 15 cm.
   - Empty -+ 5 cm.

IV. Software Testing

After the In the system testing section there are four kinds of tests. The tests carried out included testing of the HC-SR04 ultrasonic sensor reading, testing the accuracy of UV light irradiation duration, testing the decision tree, testing the system execution time, and testing the data sending time.

In the first test, the HC-SR04 ultrasonic sensor reading was tested in detecting water levels. The sensor is mounted on the top of the container box and water dispenser. The output value from the HC-SR04 ultrasonic sensor reading is the distance between the sensor and the water, so it can be converted into water level. The output value is displayed on the serial monitor in cm (centimeter). The results of the sensor tests that have been carried out can be seen in the following TABLE XV, TABLE XVI, TABLE XVII, XVIII and TABLE XIX.

TABLE XV. Sensor Testing Tank A.

NO	SENSOR TO WATER (cm)		Error (%)
	Ruler	Ultrasonic Sensor	
1	2	1.73	13.50
2	4	3.67	8.25
3	6	5.47	8.83
4	8	8.12	1.50
5	10	9.97	0.30
6	12	12.04	0.33
7	14	14.1	0.71
8	16	16.2	1.25
9	18	18.2	1.11
10	20	20.1	0.50
Average			**3.63**

TABLE XVI. Sensor Testing Tank B.

NO	SENSOR TO WATER (cm)		Error (%)
	Ruler	Ultrasonic Sensor	
1	2	1.97	1.50
2	4	4.30	7.50
3	6	5.87	2.17
4	8	8.00	0.00
5	10	10.05	0.50
6	12	11.51	4.08
7	14	14.14	1.00
8	16	16.00	0.00
9	18	17.52	2.67
10	20	19.70	1.50
Average			**2.09**

TABLE XVII. Sensor Testing Water Dispenser 1.

NO	SENSOR TO WATER (cm)		Error (%)
	Ruler	Ultrasonic Sensor	
1	1	0.97	3.00
2	2	2.01	0.50
3	3	2.97	1.00
4	4	3.88	3.00
5	5	5.02	0.40
6	6	5.93	1.17
7	7	7.08	1.14
8	8	7.98	0.25
9	9	9.11	1.22
10	10	9.73	2.70
11	11	10.80	1.82
12	12	11.75	2.08
13	13	13.27	2.08
14	14	13.86	1.00
15	15	14.75	1.67
Average			**1.54**

TABLE XVIII. Sensor Testing Water Dispenser 2.

NO	SENSOR TO WATER (cm)		Error (%)
	Ruler	Ultrasonic Sensor	
1	1	0.98	2.00
2	2	1.61	19.50
3	3	2.91	3.00
4	4	3.72	7.00
5	5	5.01	0.20
6	6	5.89	1.83
7	7	7.07	1.00
8	8	7.90	1.25

9	9	9.32	3.56
10	10	9.71	2.90
11	11	10.80	1.82
12	12	11.75	2.08
13	13	13.27	2.08
14	14	13.86	2.00
15	15	14.75	1.67
Average			**3.39**

TABLE XIX. SENSOR TESTING WATER DISPENSER 3.

NO	**SENSOR TO WATER (cm)**		**Error (%)**
	Ruler	**Ultrasonic Sensor**	
1	1	0.97	3.00
2	2	1.62	19.00
3	3	2.89	3.67
4	4	3.71	7.25
5	5	5.02	0.40
6	6	5.88	2.00
7	7	7.08	1.14
8	8	7.94	0.75
9	9	9.31	3.44
10	10	9.73	2.70
11	11	10.90	0.91
12	12	11.79	1.75
13	13	13.27	2.08
14	14	13.87	0.93
15	15	14.74	1.73
Average			**3.38**

In the second test, the timeliness of UV lamp irradiation was tested. The test was carried out by comparing the time of UV irradiation on the system with a stopwatch. The test results can be seen in TABLE XX.

TABLE XX. UV LIGHT IRRADIATION DURATION.

NO	**Reference (minute)**	**Stopwatch (minute)**	**Error (%)**
1	18.6	18.6	0.00
2	18.6	18.6	0.00
3	18.6	18.6	0.00
4	18.6	18.9	1.61
5	18.6	18.6	0.00
6	18.6	18.6	0.00
7	18.6	18.9	1.61
8	18.6	18.6	0.00
9	18.6	18.9	1.61
10	18.6	18.6	0.00
Average			**0.48**

The third test is to do a decision tree test on the system in determining the conditions of sterilization and providing drinking water for chickens in order to know the level of classification accuracy by using the decision tree method which is applied to the system according to the design. The output value of the sensor reading and its status will be displayed on the serial monitor. From the results of the tests that have been carried out, the results of these tests can be seen in TABLE XXI.

TABLE XXI. DECISION TREE TEST.

No	**Tank**		**Water Dispenser**			**Classification**	**System Results**	**Check**
	A	**B**	**1**	**2**	**3**			
1	Full	Full	Full	Full	Full	Condition 1	Condition 1	Correct
2	Full	Full	Full	Full	Empty	Condition 2	Condition 2	Correct
3	Full	Full	Full	Empty	Full	Condition 3	Condition 3	Correct
4	Full	Full	Full	Empty	Empty	Condition 4	Condition 4	Correct
5	Full	Full	Empty	Full	Full	Condition 5	Condition 5	Correct
6	Full	Full	Empty	Full	Empty	Condition 6	Condition 6	Correct
7	Full	Full	Empty	Empty	Full	Condition 7	Condition 7	Correct
8	Full	Full	Empty	Empty	Empty	Condition 8	Condition 8	Correct
9	Full	Empty	Full	Full	Full	Condition 9	Condition 9	Correct
10	Empty	Full	Full	Full	Full	Condition 10	Condition 10	Correct

Based on the results of the decision tree test contained in TABLE XVI, it can be seen that the accuracy rate is 100%. From the results of the test analysis, it can be concluded that the decision tree method applied for the classification of the sterilization system and automatic drinking water for chickens based on the ultrasonic sensor readings on the system is correct and in accordance with the design.

The fourth test is to test the execution time of the system in order to know the level of execution speed of input data into output by using the decision tree method in the classification process. In the process of testing the execution time of the system, a stopwatch is used to measure the time. From the results of the tests that have been carried out, so that the results are obtained as in TABLE XXII.

TABLE XXII. SYSTEM EXECUTION TIME.

Attempt	**Processing Speed (second)**
1	0.91
2	0.51
3	0.58
4	0.88
5	0.69
6	1.51
7	1.46
8	1.39
9	0.91
10	0.91
Average	**0.98**

Based on the results of tests that have been carried out 10 times, the computational time of the system required in making decisions to determine the conditions of sterilization and provision of drinking water for chickens takes an average of 0.98 seconds. Based on the average value, it can be concluded that the decision tree method has a fairly good level of performance.

The fifth test is to test the data transmission time to determine the speed of data transmission from the ESP8266 to the Blynk server. This test depends on the internet network connection used. In this testing process, Telkomsel internet service is used and a stopwatch is used to measure time. From the results of the tests that have been carried out, so that the results are obtained as in TABLE XXIII.

TABLE XXIII. DATA SENDING TIME.

Attempt	Data Sending Speed (second)
1	1.03
2	0.96
3	0.89
4	0.97
5	0.92
6	0.88
7	0.74
8	0.99
9	0.78
10	0.59
Average	**0.88**

The results of the tests that have been carried out 10 times, the data sending time from the ESP8266 to the Blynk server takes an average of 0.88 seconds.

V. CONCLUSION

In this study, the implementation of the decision tree method on the sterilization system and the water feeder for chickens can run as desired, both from the decision tree method applied and all the sensor components used. From the results of testing and analysis of the system for determining conditions for sterilization and providing drinking water for chickens using the decision tree method, the accuracy of the resulting rule is 100% from ten tests, with an average system processing speed of 0.98 seconds.

REFERENCES

[1] "Badan Pusat Statistik - Statistik Indonesia Tahun 2019)".

[2] N. Istiqamah, D. Suherman and B. Zain, "Tingkat Kepuasan Aspek Sosial Ekoomi dan Lingkungan Perusahaan Peternakan Ayam Broiler di Kecamatan Sukaraja Kabupaten Seluma," NATURALIS, vol. 8, 2019.

[3] A. T. Wahyudi, Y. W. Hutama, M. Bakri and S. D. Rizkiono, "Sistem Otomatis Pemberian Air Minum Pada Ayam Pedaging Menggunakan Mikrokontroller Arduino dan RTC DS1302," JTIKOM, vol. 1, 2020.

[4] A. Calle, M. Fernandez, B. Montoya, M. Schmidt and J. Thompson, "UV-C LED Irradiation Reduces Salmonella on Chickens and Food Contact Surface," Foods, 2021.

[5] M. Yohanna and D. T. N. L. Toruan, "Rancang Bangun Sistem Pemberian Pakan dan Minum Ayam Secara Otomatis," JuTISI, vol. 4, 2018.

[6] A. A. Masriwilaga, T. A. Jabar, A. Subagja and S. Septiana, "Sistem Monitoring Peternakan Ayam Broiler Berbasis Internet of Things," TELEKONTRAN, vol. 7, 2019.

[7] V. S. Moertini, "Toward The Use Of C4.5 Algorthm For Classifying Banking Dataset," Universitas Katolik Parahyangan, 2003.

[8] A. A. Paidalwar and I. P. Khedikar, "Overview of Water Disinfection by UV Technology A Review," International Journal of Science Technology and Engineering, 2016.

[9] F. Al Islami, "Algoritma Decision tree Pada sistem penyiraman tanaman otomatis berbasis internet of things," Jurnal Ilmiah Teknologi dan Rekayasa, vol. 23, p. 66–77, 2018.

[10] A. Riansyah, R. Mardiati, M. R. Effendi, N. Ismail, "Fish Feeding Automation and Aquaponics Monitoring System Base on IoT", International Conference on Wireless and Telematics (ICWT), IEEE, p. 1-4, 2020.

[11] R. Yuhasari, R. Mardiati, N. Ismail, S. Gumilar, "Fuzzy Logic-Based Electrical Conductivity Control System in Aquaponic Cultivation", International Conference on Wireless and Telematics (ICWT), IEEE, p. 1-4, 2021.

[12] D. Hanafi, R. Mardiati, T. Prabowo, C. Hidayat, "Growth Monitoring System and Automatic Watering for Chili Plants Based on Internet of Things", International Conference on Wireless and Telematics (ICWT), IEEE, p. 1-4, 2021.

[13] M. D. Fadillah, N. Ismail, R. Mardiati, A. Kusdiana, "Fuzzy Logic-Based Control System to Maintain pH in Aquaponic", International Conference on Wireless and Telematics (ICWT), IEEE, p. 1-4, 2021.

[14] R. Dianty, R. Mardiati, E. Mulyana, D. Supriadi, "Design of Humidity Control with Automatic Drip Irrigation System Based on Fuzzy Logic Using Node-RED and MQTT on Cactus Plants", International Conference on Wireless and Telematics (ICWT), IEEE, p. 1-4, 2021.