The Development of Quail Eggs Smart Incubator for Hatching System based on Microcontroller and Internet of Things (IoT)

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Abstract—**For the quail farmers, hatching the eggs in a big number is a problem to producing the quail which incubate by quail parent manually. In this research describe the development of quail eggs smart incubator. The incubator system based on Arduino microcontroller can control the temperature, humidity, and reversal the quail eggs automatically. In addition, Internet of Things (IoT) system can help farmers to monitor the smart incubator from a distance. The quail eggs smart incubator be applied to hatching the quail eggs at CV Slamet Quail Farm, Sukabumi, Indonesia show the best result to hatching the quail eggs. The quail eggs has been successfully hatch normally is** 87.55%**,** 0.41% **hatch but defective,** 1.84% **hatch but dead, and** 10.20% **not hatch by 490 eggs in 17th days of incubate period.**

Keywords—**Quail eggs smart incubator, microcontroller, Arduino, Python, hatching quail eggs, IoT, automatic control.**

I. INTRODUCTION

The eggs incubator is a device which can control the temperature and humidity for hatching process. By using eggs incubator, the hen does not need to incubate the egg manually. Thus, incubator device can help farmers to hatch an egg to produce the chicken on a big number [1]. Researchers have to build the incubator for various egg, such as for Chicken [2], quail [3], Turtle [4], Partridge [5], and other. For the incubating system, researchers developed the incubator to automate the adjustment system, such as the temperature [6], humidity [2], egg reversal [7], and other [8] [9] which based on the microcontroller [10] [8], IoT [10] [11], and other [12].

In this paper describe the development of quail eggs smart incubator for eggs hatching system. The incubator can control the temperature, humidity, and reversal the quail eggs automatically based on Arduino microcontroller. In addition, the incubator based on Internet of Things (IoT) system using VNC's software can help the farmers to control and monitoring the smart incubator from a distance. Finally, the quail eggs

smart incubator be applied to hatching the quail egg at CV Slamet Quail Farm, Sukabumi, Indonesia for 17th days incubate period.

The paper is organized as follows. In section 2 described the theoretical background of quail and incubator system. In section 3 described the experimental method of the quail eggs smart incubator. In section 4 described the results and discussion of the research. Finally, the concluding remarks are given in section 5.

II. THEORETICAL BACKGROUND

Japanese quail (*Coturnix coturnix japonica*) is poultry species which found in East Asia which has a little body and spotting on the eggshell. Farmers raise the eggs and meat for consumed, because of the quail has many nutrition benefits, such as protein, fat, vitamin E, minerals and sex hormone P. Thus, by consuming the quail egg or the meat it is very good for body additional nutrients [13] [14].

Egg incubation is the process to develops the embryo of eggs until hatching by the animal's parent [1] [7]. While the eggs incubator is a device like a box which can control the temperature, humidity/moisture, and other adjustments to develop the embryo of the egg until hatch [15]. In this decade, the researcher developed a smart eggs incubator which can control the temperature, humidity, eggs reversal or the other adjustment combination based on the microcontroller [1]. Moreover, the incubator added the observer based on Internet of Things (IoT) in order the farmer can be monitoring the incubator on the distance [16].

For the quail farmers, hatching the eggs in a big number is a problem to producing the quail which incubate by quail parent manually. Moreover, the season can influence the embryo development of the quail to hatch process [17]. So, researchers

developed the technology which can be hatching the egg and a method to increase the qual production, for example, the eggs incubator [9] and prediction the quail gender on the egg [18].

To develop the eggs incubator, we must know and pay attention the temperature, humidity, and another adjustment in order to develop the embryo proper. For Japanese quails especially, the incubation period is 17 to 19 days [1] [7] [19], the temperature is $36.5^oC - 37.5 \pm 0.5^oC$ [7] [2] and the humidity range is $50\% - 65\%$ [2] [15]. In the incubating process, an egg must be rotated for 45° every 4 hours to avoid the embryo stick to the eggshell [20]. Egg quality is one of the success factors to hatch. If the egg quality is bad, the opportunity for the egg to hatch is low. Thus, before the egg going to incubation process, the farmer must check the egg quality first.

III. EXPERIMENTAL METHOD

A. Method and System Design

Fig. 1 describe the general process of the quail eggs smart incubator based on Arduino Microcontroller. When the hardware system is started, Arduino microcontroller will be active to control the temperature sensor, humidity sensor, and eggs reversal system. The control process is divided into 3 section; Section 1 is the temperature control which monitored by DHT 11 sensor. When the incubator temperature is lower than 36.5^oC the system will turn on the Lamp, and if more than 38.5^oC the system will turn off the Lamp. On section 2 is the humidity control which monitored by DHT 11 sensor. When the incubator humidity is lower than $55\%RH$ the system will turn on the heater, and if more than $65\%RH$ the heater will turn off. The final section is an egg reversal which monitored by the time module. When the system has turned on for 4 hours, the Synchronous Motor will reverse the egg for 45° to the right. For the next 4 hours, the Synchronous Motor will reverse the egg for 45° to the left, and repeatedly.

For data monitoring of smart incubator system is divided into 2 part. The first part is internal data monitoring using the personal computer (or called the source PC) shown in Fig. 2. The system displays the real-time data Graphical User Interface (GUI) of Temperature and Humidity based on Python 2.7. The data gets from microcontroller Arduino by serial communication. The data is processed becomes the graphical interface of Temperature vs Time and Humidity vs Time.

The second part is external data monitoring by various gadget using VNC's software based on IoT system shown in Fig. 3. The system divided into two processes. First, VNC Server software is installed on source PC. When the source PC is connected to the internet and access the VNC Server, automatically will get the IP Address to sharing the source PC interface for other devices. Second, the VNC Viewer software is installed on other devices/gadget. To get the data monitoring, after the gadget gets the internet connection and start the VNC Viewer with some setting, the software will display the source PC interface of Temperature and Humidity data of the quail eggs smart incubator system. In other words, the external data
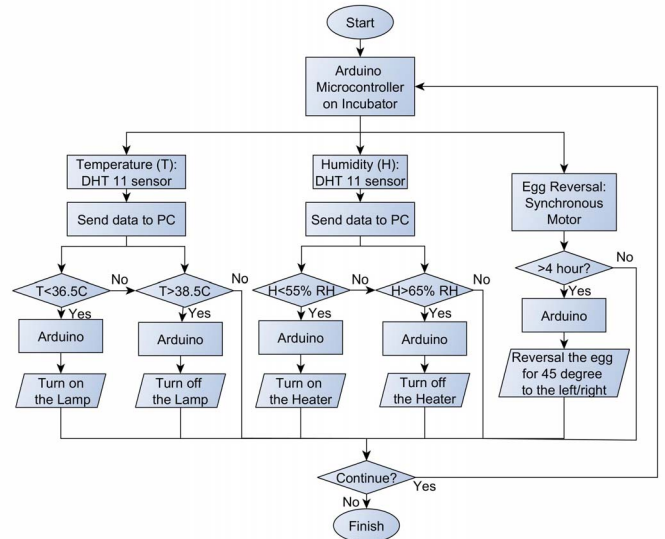

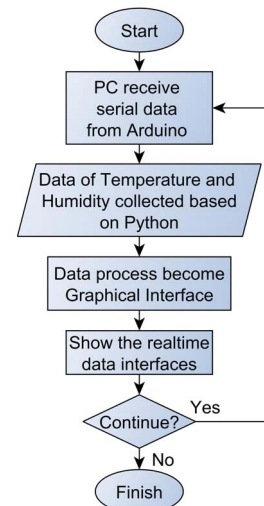Fig. 1. The general system of quail eggs smart incubator.

Fig. 2. The interface system of quail eggs smart incubator based on Python.

monitoring is access the source PC interfaces and information of the quail eggs smart incubator by other devices or gadget.

B. Hardware Design

To develop the quail eggs smart incubator hardware, the main tools/components which used such as; personal computer, Arduino Microcontroller, DHT 11 sensor (temperature and humidity sensor), power supply, Synchronous motor, blower, LCD, 5-watt lamp, relay, RTC Time module, and other. Fig. 4 is the schematic design of the quail eggs smart incubator. The schematics show that the component which connects to Arduino microcontroller board, they are; DHT sensor, lamp+relay, Synchronous Motor, LCD, blower fan, and heater.
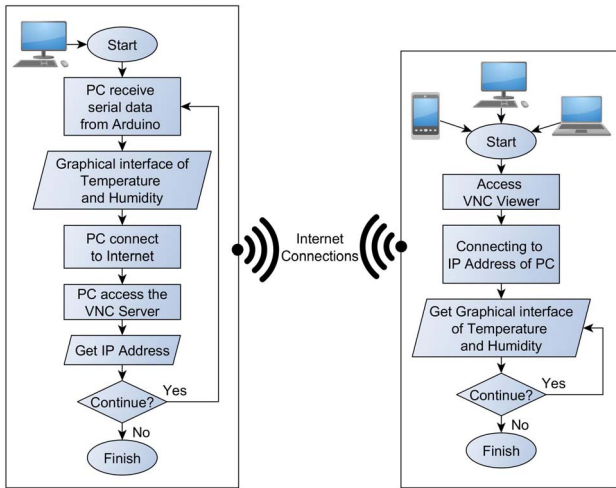
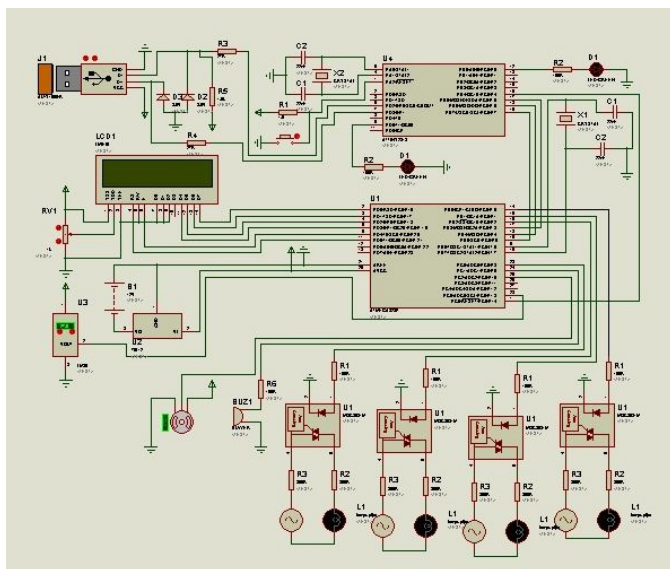Fig. 3. The IoT system scheme of quail eggs smart incubator.

Fig. 4. Circuit schematic of quail eggs smart incubator.

The dimension of the Incubator box is 100 x 70 x 43 cm. On the front side of incubator displayed the LCD to show data monitoring such as the time, temperature, and humidity. Inside the incubator displayed the egg container, 2 pcs DHT 11 sensor, 4 pcs 5-watt lamp, the heater is stored in a container of water, and 2 pcs fan blower. On the back incubator displayed the microcontroller and power supply. In the side, incubator added the ventilation for air circulation. The incubator hardware is shown in Fig.5.


(a)

(b)
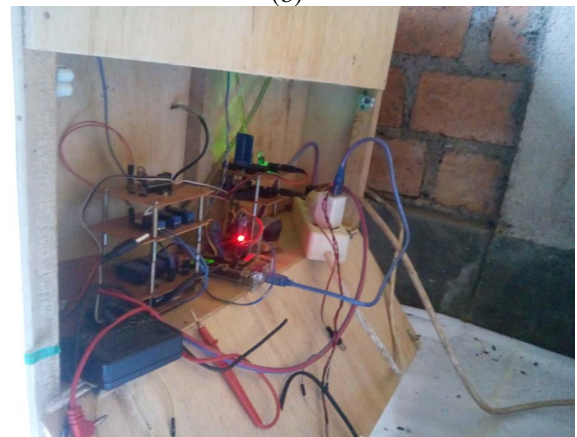
(c)

Fig. 5. The quail eggs smart incubator hardware, (a) front, (b) inner, and (c) back.

C. Interface Design

Fig.6 (a) shows the GUI of the quail eggs smart incubator based on Python 2.7. The graphical interfaces display the temperature (*Suhu*) and humidity (*Kelembaban*) against time. Thus, the data value of the temperature and humidity displayed on the Python Shell in Indonesian (Bahasa Indonesia). On the

Fig.6 (a), shows the graphical interface of Python on source pc. Fig.6 (b) the source computer be accessed by the smartphone via VNC Viewer (based IoT system) which can control the source computer on the distance. By the Fig.6 (c) shows the monitoring data displayed on LCD, which shows the time, temperature and humidity of the smart incubator system.
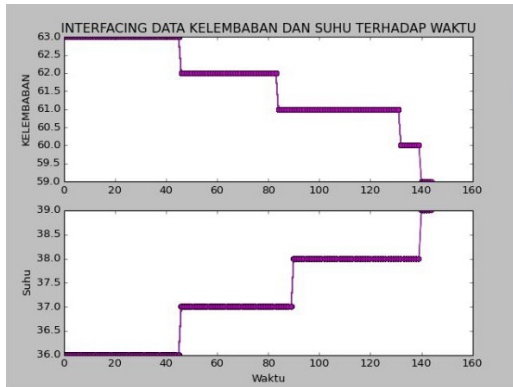
(a)
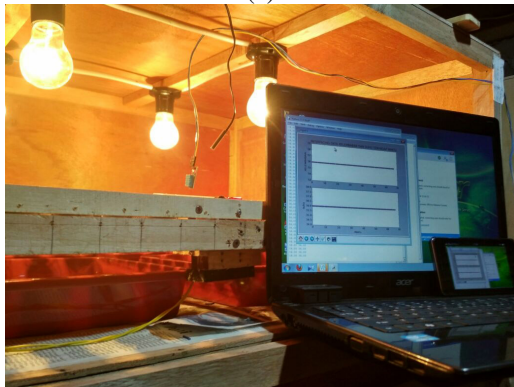
(b)

(c)

Fig. 6. GUI of quail eggs smart incubator system, (a) Python interface, (b) IoT interface, and (c) LCD interface.

IV. RESULTS AND DISCUSSION

The quail eggs smart incubator hardware has been building, and then applied to incubating the quail egg which shown in Fig. 7. In this research, the quail eggs incubate for 17th days of the period with the predefined adjustment. The 5 Watt lamp used to increase the incubator temperature. The heater on the container of water can increase the humidity of incubator. Blower fan function to spread the temperature and humidity in the incubator. To control the temperature and humidity system is controlled by Arduino controller and monitored by DHT sensor.

The position of the eggs when the incubating process, divided into 3 positions. The first position is the egg positioned upright for the adaptation on the 1st day. Second , the egg rotated automatically in the reversal for 45° to left and right every 4 hours on the 2nd day until the 14th day. Third, at the 15th day to the 17th day, the egg moved to the flat container to accommodate quail chick which hatch. Fig. 7 is the condition when the egg on the reversal container, flat container, and when the quail chick has hatched. The quail eggs smart incubator based on microcontroller has been developed and works well to control all system.

(a)   (b)

(c)

Fig. 7. The quail eggs smart incubator, (a) eggs on reversal container, (b) eggs on flat container, and (c) some eggs have hatch.

The interface system based on Python has been successfully developing to monitoring the temperature and the humidity condition on the incubator monitoring by DHT 11 sensor. VNC Viewer based IoT system can monitor the source computer very well. Finally, the incubation result for 490 eggs on 17th days period are; 429 eggs (87.55%) successfully hatch very well, 2 eggs (0.41%) are hatch but defective, 9 eggs (1.84%) are hatch but dead, and 50 eggs (10.20%) not hatching yet. The cause quail eggs which not hatching yet is because of the quail egg need more period (> 17 days) to hatch or the egg quality is not good. The advantage of this smart incubator are; easy to controlling and monitoring, saving farmer's energy, the eggs need a short time to hatch, and low cost. Therefore, this system better than other conventional eggs incubator. So, the

development of quail eggs smart incubator can be applied to quail egg farmer industries.

V. CONCLUSIONS

This research has been presented the development of quail eggs smart incubator based on Arduino microcontroller. The system can control the temperature, humidity, and reversal the quail egg automatically. For monitoring process, the interface from Python and VNC software based on Internet of Things (IoT) system has successfully can help the farmers to monitor the smart incubator from a distance. The quail eggs smart incubator has been applied to hatching the quail egg at CV Slamet Quail Farm, Sukabumi, Indonesia show the best result to hatching the quail egg, and get the result that by 490 eggs 87.55% successfully hatch normally, 0.41% hatch but defective, 1.84% hatch but dead, and 10.20% not hatch yet on 17th days incubate period.

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