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RESEARCH ARTICLE

DESIGN AND CONSTRUCTION OF AN INTELLIGENT INCUBATOR BY A COMPUTER PROGRAM UNDER ARDUINO

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ABSTRACT

The incubator makes it possible to deal with many problems of poultry farming in a country like Burkina Faso. Indeed, the incubator allows good visibility of the eggs, a remarkable hatching rate. A computer program carried out using programming tools such as Arduino, provides built-in automatic temperature and humidity control and a programmable automatic rotation system who optimizes the performance of incubators. Beyond its many advantages there are shortcomings in which one can enumerate late and early hatching, chick malformations, infertile eggs and chick death during hatching.

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INTRODUCTION

For the needs of survival, the human being is called upon to feed. This diet must be completeto ensure the growth and shape of men. Among the many foods contributing to this balance arethe proteins. One of the sources of these proteins comes from eggs. Our society is driven to develop the industrial sector in order to satisfy the primary needs of its population, such as the food industry. Yet the development of the poultry industry in recent years is absolutely remarkable and the evolution of automatic incubators is more competitive in order to face a market that has become increasingly competitive and conditioned by quality standards. severe. Local poultry farmers use electric artificial incubators which mainly come from other countries and are made with plastic materials to minimize the import cost due to the weight of the device. In the event of a power outagesure oflong hours, breeders easily lose eggs that are incubating as a result of hypothermia. The chicken egg incubator is where eggs are incubated and hatched through the use of new technology or artificial equipment (Kelebaone Tsamaase, 2019). Broadly speaking, a smart egg incubator is any incubator with a temperature and humidity control system; and an automatic egg turning system. It is able to acquire data from its sensors, process it and then communicate it to humans through a graphical interface. A hen hatches an average of 8 to 14 eggs andHatching occurs after 21 days of incubation (Gregory, 2014). This is the reasonable time for egg hatching (Leksrisompong, 2009). This situation is a limit to the productivity of the hen and the smart incubator could be a solution to consider to increase the yield of production. In order to offer breeders incubators with better hatching rates and in which innovations are made each year, we chose to carry out a study on the Modeling and optimization of an intelligent incubator with automatic humidification system.

Background and rationale for the study: In 2021, local poultry production in Burkina Faso is estimated at 46 million heads and 40 million in 2018 (Ministry of Animal and Fisheries Resources). Daily consumption of poultry in the two major cities of Burkina Faso in (2018) is estimated at 80 thousand and 50 thousand chickens. This high demand has forced poultry farmers to modernize their activities and to take an interest in poultry incubators commonly known as "incubators". Several types of incubators exist on the market depending on the energy used. All have the same operating principle, that is to say that they convert the energy received into heatto have a temperature between 36.5°C and 37.8°C.

Figure 1. Incubator working with the 220V electrical network

Figure 2. Incubator operating with a petrol lamp

Figure 3. Incubator operating with a 12 or 24V photovoltaic system

Figure 4. Incubator operating with butane gas

Figure 5. Built-in incubator with heating resistors

Figure 6. Incubator incorporated with incandescent lamps

Is it possible to create an incubator capable of operating 24 hours a day, under well-monitored temperature and humidity. It is in this context that you have written a computer program to control the temperature and humidity of the incubator in order to optimize its operation.

Materials and modeling

Materials

This work aims to use a system that will allow us to achieve the smart incubator. For this work we can use several models of printed circuit like:

- The Arduino system, a platform for prototyping interactive objects for creative use consisting of an electronic board based around a microcontroller to write, compile and transfer the program to the microcontroller board in order to allow the various equipment to 'incubator to perform their functions automatically without human presence.
- The Raspberry Pi system, capable of running a large number of programs from the Linux world quite correctly, is a nano computer the size of a credit card that can be plugging into a monitor is used like a standard computer. Its small size, and its attractive price makes the Raspberry PI an ideal product to test different things, and in particular the creation of a Web server at home, to control a small Robot, or home automation (camera, portal, lights). Obviously, for its size you should not expect incredible performance, but to upload projects to show the client.
- The banana Pi system is asingle madein China. Hesupportsandroid, Ubuntu, Arch Linux, Fedora, Debian and Gentoo-Linux. The Banana Pi can be used as an open-source software development platform as well as many other applications.
- Also, we have the Asus Tinker Broad, Orange Pi, ODROID-C2, Adafruit Metro system to perform the same tasks as the others.

Among all these different systems, our choice is turned to the Arduino system. First of all, it has a standard and easily accessible circuit board in the market at an affordable price. Then, easy to learn and with a clear and simple program environment. In addition, the Arduino system has a cross-platform that runs on Windows, Macintosh and Linux and it has a large community of users and in the end, we had to study Arduino in class with some practice as well.

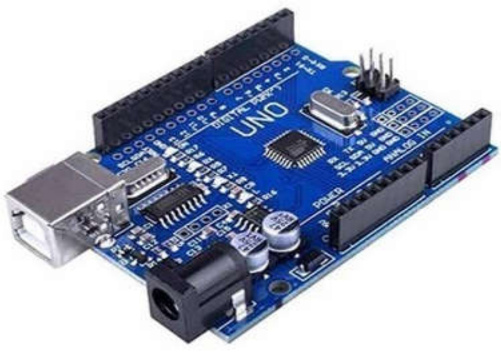

Figure 7. ATmega 328 microcontroller

- Microcontroller: ATmega328
- Internalsupply voltage = 5V.
- Supply voltage (external)= 7 to 12V, limits =6 to 20 V.
- Digital inputs/outputs: 14 including 6 PWM outputs.
- Analog inputs = 6.
- Max current per I/O pins = 40 mA.
- Max current on 3.3V output = 50mA.
- 32 KB flash memory.
- 2 KB SRAM memory.
- 1 KB EEPROM memory.
- Clockfrequency = 16 MHz.
- PC manufacturing via USB port.
- Dimensions = 68.6mm x 53.3mm

Figure 8. Built-in incubator with incandescent lamps and a humidification tank

Humiditysensor: The humidity sensor we used is the DHT11. The latter includes a complex of temperature and humidity sensors with a calibrated digital signal output. Using the exclusive digital signal acquisition technique and temperature and humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and a NTC (Negative Temperature Coefficient) temperature measurement component, and connects with a high-performance 8-bit microcontroller, providing excellent quality, fast response, interference suppression and high profitability. Each DHT11 element is strictly calibrated in the laboratory, which is extremely accurate when calibrating the humidity. Calibration coefficients are stored as programs in OTP (One-Time Programmable) memory, which are used by the sensor's internal signal detection process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and transmission of signals up to 20 meters make it the best choice for various applications, including the most demanding. The component is a 4-pin single row pin package as shown in the figure below. Its small size, low power consumption and transmission of signals up to 20 meters make it the best choice for various applications, including the most demanding. The component is a 4-pin single row pin package as shown in the figure below. Its small size, low power consumption and transmission of signals up to 20 meters make it the best choice for various applications, including the most demanding. The component is a 4-pin single row pin package as shown in the figure below.

Modelization

Electronic circuit of the incubator: It includes the power supply, microcontroller, communication interfaces, heating and humidification, ventilation, temperature and humidity sensor, air humidifier, resistance, float. Each block receives a supply voltage adapted to the electronic components of the block.

Microcontroller: The Arduino UNO microcontroller we used is an ATMega328. It is an 8-bit AVR family ATMEL microcontroller.The main characteristics are:

- FLASH = 32 K program memoryB
- SRAM = 2 KB (volatile) data
- EEPROM = data (non-volatile) 1 KB,

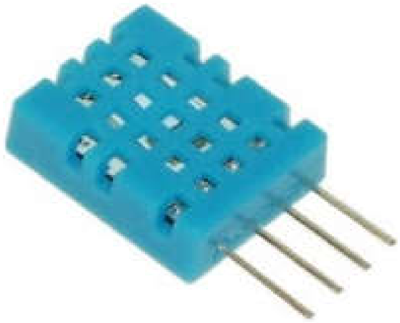

Figure 9. DTH11 humidity sensor

Figure 10. Ultrasonic humidifier

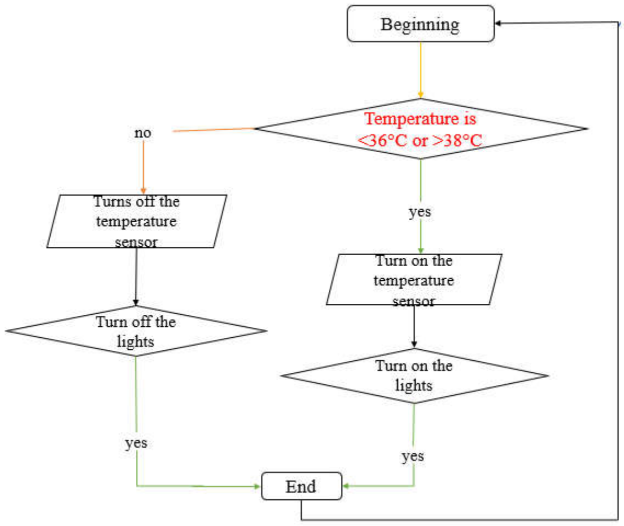

Figure 11. Temperature control flow chart

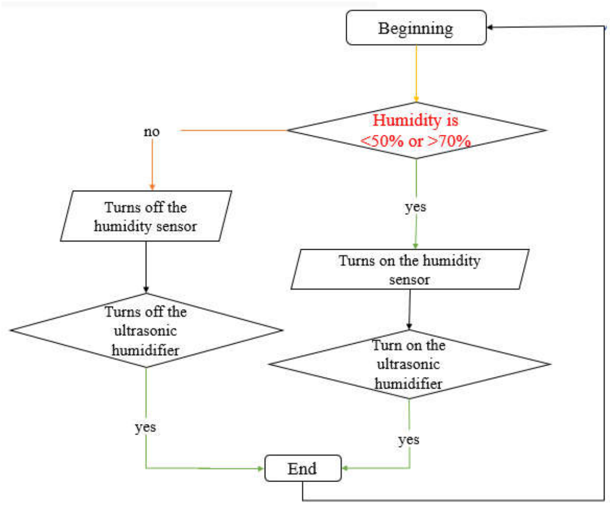

Figure 12. Humidity control flowchart

A program that contains all the necessary instructions related to the incubation of chicken eggs that will allow the microcontroller to give the pulses necessary for controlling the heating, ventilation, humidification, egg turning, temperature and humidity control circuit. At power-on, the microcontroller is reset and sends instructions to the LCD screen which displays the owner's name and other writings to be displayed that are in the source code. After a few seconds, the control pulses are supplied to the motor control circuit, the first reversal takes place then the screen displays the value of the temperature, the humidity rate, the incubation clock as well as a few messages alarm when the temperature and humidity are outside the setpoints. After seven days, the screen displays a candling message and the twentieth day is scheduled for hatching.

RESULTS

Temperature control: For heating, we used incandescent lamps, these lamps are powered by 220V network voltage. The latter transform 95% of the energy they receive into heat and transform only 5% into light. You can also use resistance heaters as a heat source and place them in such a way as to have a harmonious distribution of the heat. The recommended temperature for egg incubators is 37°C to 38°C ((4), (5), (6), (7)). As soon as the temperature in the incubator is lower than the setpoint set at 37.7°C, the microcontroller sends a pulse to the control circuit of the lamps which will be powered to heat the incubator, When the temperature exceeds the threshold of 38 degrees centigrade,

Humidity control: The control of the humidity is carried out practically in the same way as the temperature but except that this time as soon as the humidity is lower than 50%, the microcontroller supplies a signal for the control of the humidification tank, which is equipped with automatic float and automatic ultrasonic humidifier. The float will be responsible for filling or stopping the water at the recommended level and the ultrasonic humidifier will spray the water in the form of a water molecule which will be conducted inside the incubator through an aeration installed in the 'incubator to humidify the warm incubator air up to 70% and stop. To restart again when the humidity is lower than the low threshold.

System working principle: The source code is entered under the Arduino environment to make temperature and humidity functional. The recommended value of temperature and humidity is adjusted by means of the keys of the digital controller. When the adjustments are complete, save the desired values. High and low temperature alarms are triggered below 36°C and above 38°C. As soon as the temperature alarm starts, the microcontroller sends the pulse to the control circuit of the lamps that will be powered and stops when the temperature is reached. High and low humidity alarm will be triggered under 40% and above 80% and if the humidity alarm is triggered, the microcontroller will send the pulse to the ultrasonic humidifier to humidify the humidity. hot air from the incubator and stops when humidity is reached.

CONCLUSION

The modeling and optimization of intelligent incubator with automatic humidification system in the production of chicken eggs has many advantages includingsocio-economically, to have higher yield compared to traditional egg incubators, it can allow any userlucid to flourish in his activity and able to participate in the development of his country and in which innovations are made every year. This mechanism makes it possible to automatically humidify the eggs while taking into account the humidity level and the temperature required for incubation thanks to the Arduino programming tool. The modeling and production of a completely autonomous incubation system equipped with an automatic humidification system has brought us real multidisciplinary added value.

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