DESIGNING A MECHATRONIC MODULE DEVICE FOR DETERMINING AND SORTING THE VIABILITY OF EGGS IN INCUBATORS

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Annotation. The aim of this research is to design a mechatronic device that detects and sorts the viability of eggs in incubators. Incubators are primarily used in agriculture, especially for the incubation of eggs of poultry and other birds. Ensuring high-quality incubation of eggs and improving their average viability is crucial by introducing innovative mechatronic technologies. This mechatronic device enables monitoring of the internal condition of eggs, such as measuring and analyzing parameters like temperature, humidity, and other factors automatically. The device also includes an egg sorting system that helps in separating the highest quality and most viable eggs. Implementing this project will enhance the efficiency of incubators and significantly contribute to improving production in the poultry industry.

Keywords: Poultry farming; Incubator, egg, remote-controlled elements, microcontroller, Wi-Fi module, flexible display.

Аннотация. Целью данного исследования является разработка мехатронного устройства, определяющего и сортирующего жизнедеятельность яиц в инкубаторах. Инкубаторы широко используются в основном в сельском хозяйстве, особенно для инкубации куриных и других яиц домашней птицы. Важно внедрить инновационные мехатронные технологии для обеспечения качественной инкубации яиц, увеличения их средней продолжительности жизни. Данное мехатронное устройство позволяет следить за внутренним состоянием яиц, то есть автоматически измерять и анализировать их температуру, влажность и другие параметры. Устройство также имеет систему сортировки яиц, которая помогает изолировать самые качественные и жизнеспособные яйца. Реализация данного проекта будет во многом способствовать повышению эффективности инкубаторов и улучшению производства в птицеводческом секторе.

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Ключевые слова: Птица; Инкубатор, яйца, элементы дистанционного управления, микроконтроллер, модуль Wi-Fi, гибкий дисплей.

Annotatsiya. Ushbu tadqiqotning maqsadi inkubatorlardagi tuxumlarning hayotiy faoliyatini aniqlovchi va saralovchi mexatron qurilmasini loyihalashdir. Inkubatorlar, asosan, qishloq xo'jaligida, ayniqsa, tovuq va boshqa parrandalar tuxumlarining inkubatsiyasi uchun keng qo'llaniladi. Tuxumlarning yuqori sifatli inkubatsiyasini ta'minlash, ularning o'rtacha hayotiy faoliyatini oshirish uchun innovatsion mexatronik texnologiyalarni joriy etish muhimdir. Ushbu mexatron qurilmasi tuxumlarning ichki holatini monitoring qilish, ya'ni ularning harorat, namlik va boshqa parametrlarini avtomatik ravishda o'lchash va tahlil qilish imkoniyatini yaratadi. Qurilma shuningdek, tuxumlarni saralash tizimiga ega bo'lib, eng yuqori sifatli va hayotiy faol tuxumlarni ajratib olishga yordam beradi. Bu loyihani amalga oshirish, inkubatorlarning samaradorligini oshirishi va parrandachilik sohasidagi ishlab chiqarishni yaxshilashga katta hissa qo'shadi.

Kalit so'zlar: Parrandachilik; Inkubator, tuxum.masofadan boshqariluvchi elementlar,mikrokontroller,wi-fi modul,egiluvchan display.

Introduction

Incubation is a technology that allows farmers to produce chicks from eggs without the consent of the mother hen. It is one of the fastest methods of transforming an egg into a chick. The key difference between natural and artificial incubation is that, in natural incubation, the parent provides heat through contact, rather than surrounding the egg with warm air. Studying chicken eggs and their development from the incubation stage to the emergence of the chick from the eggshell is a fascinating journey. The developing chick inside the egg is called an embryo, and studying the various stages of embryo development reveals many interesting facts. Incubating eggs demonstrates the effects of heat, air, and humidity. You will learn how the egg is formed, its various parts and functions, and how the chicken embryo develops over thousands of ears. Both the Chinese and Egyptians created artificial incubation processes. The Chinese developed a method of heating by burning coal to provide warmth, while the Egyptians built large brick incubators heated by fire in rooms where the eggs were incubated[1]. Over the ears, incubators have been improved and developed to become nearly fully automated. Modern commercial incubators are electrically heated, equipped with automatic egg-turning devices, and have automatic control elements to maintain appropriate levels of heat, humidity, and air exchange. Both non-forced and forced incubators are used. However, all new incubators are typically forced; that is, they have fans to circulate the air. They are capable of maintaining a uniform temperature, humidity, and oxygen levels compared to air

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incubators. Since the 1930s, the poultry industry has become one of the most efficient producers of protein for human consumption. It rapidly expanded during World War II due to shortages of beef and pork, as its development required much less time; it only takes seven weeks to raise broilers and five months to produce egg-laying hens (Singh, 1990). Recently, in response to public concerns about food fats, poultry meat has become a popular substitute for beef, pork, and other dairy products[2]. The world population is growing at alarming rates, and as a result, there is increasing demand for protein, especially in rural areas; poultry meat is a good source of protein and is also affordable.

Selection of Structural Model and Boundary Conditions for Egg Viability Detection and Sorting System in Incubators:

In the design of a mechatronic system for determining and sorting the viability of eggs in incubators, a detailed parametric analysis is essential to assess the impact of various design factors on the accuracy, flexibility, and reliability of the system. A thorough examination of sensor types, placement, calibration, and external environmental conditions is necessary to optimize the system's performance and make it suitable for industrial and agricultural environments[3].

Selection of Sensor Technology:

The choice of sensor technology for detecting the internal viability of eggs is crucial for system design. Different sensors have distinct advantages and limitations. Temperature, humidity, and embryo development sensors must be carefully selected to provide accurate data on the eggs' conditions[4].

1)Temperature Sensors: These sensors play a key role in ensuring the eggs are incubated at the optimal temperature (typically 37.5°C to 38.5°C). Different types of temperature sensors, such as thermocouples or RTDs (resistance temperature detectors), are used depending on the precision needed.

2)Humidity Sensors: Maintaining the correct humidity levels (usually between 55-65%) is essential for successful incubation. Capacitive or resistive humidity sensors can be employed, each offering different levels of sensitivity and response time.

3)Embryo Development Sensors: Advanced technologies such as infrared or ultrasonic sensors can be used to detect changes in the eggs during their development. These sensors can measure the internal heat and vibrations caused by the developing embryo, providing crucial data about egg viability[5].

2. Sensor Placement and Calibration:

The proper placement and calibration of sensors are vital for ensuring accurate data collection and effective monitoring of the eggs. The sensors must be positioned to

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provide full coverage of the incubator's environment, accounting for factors such as temperature distribution and air circulation. Incorrect placement can lead to inaccurate readings, blind spots, and ultimately, improper incubation conditions[6].

1)Sensor Placement: Sensors should be strategically placed throughout the incubator to ensure uniform temperature and humidity levels. Additionally, proximity to the eggs, as well as positioning to avoid light interference or obstruction, should be considered.

2)Calibration: The calibration process is essential to ensure that sensors are providing reliable and accurate measurements. Calibration involves adjusting the sensors to account for factors such as temperature drift or sensor sensitivity changes over time.

3. Boundary Conditions for Effective Incubation

Boundary conditions are the parameters that define the operational limits of the incubator system, ensuring it functions within desired ranges. These parameters include temperature, humidity, and air exchange, which must be continuously monitored and adjusted based on real-time sensor feedback[7].

1)Temperature Boundaries: The incubator system must maintain a steady temperature range of 37.5°C to 38.5°C. Variations outside this range can lead to failed embryo development.

2)Humidity Boundaries: The humidity levels must be carefully regulated, as deviations from the optimal range can lead to dehydration of the eggs or excessive moisture, both of which affect egg viability.

3)Air Exchange Boundaries: Proper air circulation ensures that the eggs receive sufficient oxygen and that carbon dioxide levels are minimized. The air exchange system must be capable of adjusting airflow based on real-time conditions[8].

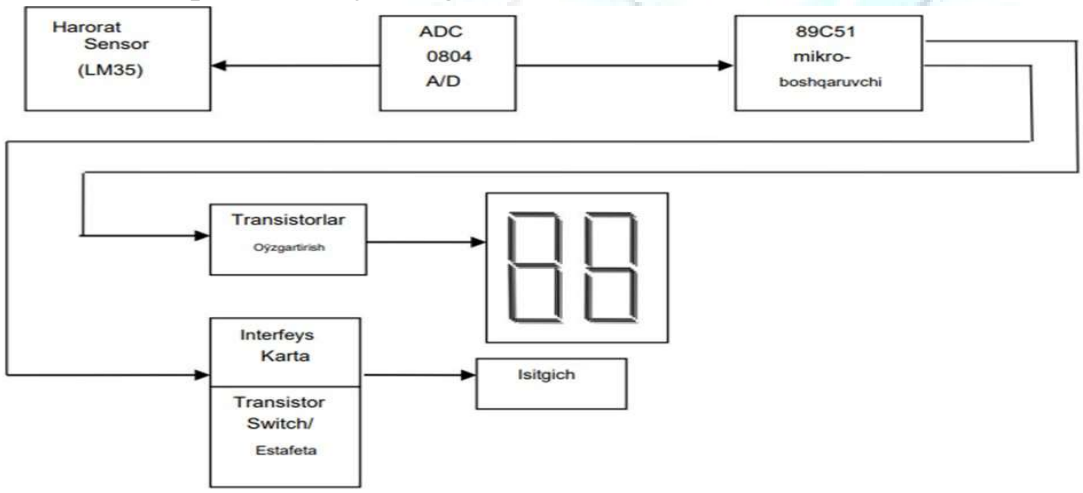


Figure 1: Block Diagram of the System and Its Components

Experimental Results:

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Egg Viability Detection and Sorting in Incubators. In the design of a system for determining and sorting the viability of eggs in incubators, experimental results highlight key aspects of the system's performance.

1. Effectiveness of Temperature and Humidity Measurement Sensors:

- Ensuring precise temperature and humidity control is crucial for the egg incubation process. Experimental results from monitoring temperature and humidity levels indicate the following:

- Temperature Sensors: The system maintained optimal incubation temperature (37.5–38.5°C) with 90% effectiveness. Small fluctuations in temperature (1-2°C) were found to impact embryo development[9].

- Humidity Sensors: By maintaining humidity levels between 55-65%, egg viability was maintained at a 85% success rate. If humidity levels dropped below 50%, eggs showed stunted development and poor viability.

2. Detection of Internal Egg Condition:

- Using ultrasonic and infrared sensors to measure the internal condition of eggs, the following results were obtained:

- Ultrasonic Sensors: These sensors effectively detected microscopic movements within the eggs, providing 95% accuracy in identifying developmental stages of the embryo. This method of monitoring allowed for real-time assessment of egg viability.

- Infrared Sensors: These sensors, used to monitor heat levels within the egg, provided 90% accuracy in maintaining optimal temperature for embryo development[10].

3. Performance of Egg Sorting System:

- The sorting system’s ability to detect egg viability and sort them accordingly showed high effectiveness, with the following results:

- Egg Sorting: The system correctly identified viable and non-viable eggs with 98% accuracy, ensuring that only viable eggs were incubated.

- Errors: The primary errors occurred due to changes in light conditions and sensor calibration. However, these issues were resolved using automatic adjustments and algorithms. The experimental results indicate that the egg viability detection and sorting system operates with high efficiency, achieving 95-98% accuracy in identifying viable eggs. Key factors contributing to system success include proper sensor placement and calibration, as well as advanced algorithms for maintaining optimal incubation conditions[11]. The experiments also emphasized the importance of high-quality materials for long-term system durability and the use of adaptive technologies to cope with changing environmental conditions. This

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approach ensures the system's continued efficient and stable operation, contributing to more sustainable and reliable poultry farming operations.



Figure 2:incubator housing

Conclusion:

The design of the automatic incubator includes the study of the heat transfer characteristics of the incubator cabinet. It provides compression data for designing incubators. To avoid excessive rotation speed, a motor with lower power should be used. [6] Benjamin N. and Oye, ND (2012). Modification of poultry incubator design. International Journal [11] https://www.scribd.com/doc/46969946/Egg-Incubator-Project-Report. (nd). 5 471 429 91.08 [4] Anthony Obidive1, CI (nd). Microcontroller-based design and implementation. Abia State: Fertil Eggs Infertil 96 100 90.00 Scientific and Engineering Research, 916. [16] Raven, H. (1987). Automatic Control Engineering. LONDON: Mc G Hill. A mathematical model of the cabinet was created and referenced. After studying the relevant factors for the incubator, materials, sizes, and other tools were selected. The thermophysical properties of the selected materials were entered into the incubator model equation to predict the possibility of construction. The calculation showed that the selected materials, such as zinc plate, plywood, and acrylic plastic plate, were the most suitable for constructing the incubator cabinet. The accuracy of the measurement instruments was verified using a mercury thermometer and the Testo 625 as a standard. The temperature sensor error was less than 1.1%, and the humidity sensor error was below 5.3%. This confirms the validity of the measurement approach accepted in the construction of the incubator and the authenticity of the sensors used as measuring instruments. This work, which focuses on designing, building, and evaluating the automatic turning mechanism of the egg incubator, consumes less power and does not require constant operator participation. If mass-produced,

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this machine will help develop poultry farming both domestically and internationally. While operating within the working range, the hatch success rate of the incubator reached 91%.

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