"Design and implementation of chicken egg incubator for hatching using IoT"

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UNDER THE GUIDANCE OF

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INTRODUCTION

In incubation system the fertile eggs should be kept warm for the proper embryo development in the chicken egg. The incubation process can be of two types: one is natural incubation and the other one is artificial incubation. In the natural incubation the hen sits on the egg to give warmness to hatch. In artificial incubation system the entire environment such as temperature, humidity and ventilation are monitored and controlled by the controller which is the crucial task in the incubation process. The advantages of the artificial incubation are that the hatched eggs are relatively larger throughout the year.

Egg embryos are delicate, hence the change in the temperature, humidity, ventilation and egg rotation system will affect the growth and hatching time. Hence creating a low cost and efficient incubator is difficult. Most of the people in the country are fond of using mini-incubation system, the major problem is the lack of adequate financial and technical support. Due to this technology and adequate knowledge, the proper temperature, humidity and ventilation could not be maintained in the incubation system, hence during eggs incubation period up to 17 days 50% of the eggs will be dead. In winter season the temperature drops below, which effects the incubation system majorly. The hatching unit is controlled by using Arduino Nano and the sensors used here are the LM35 and DHT11 for temperature and humidity in the incubator.

As per the observation the semiconductor type sensors have linear response but also have lowest accuracy that is 10 to 50 in change and the response time varies from 5 seconds to 60 seconds. The interaction with the web server were in the information from the device to the web server is through the Wi-Fi, without the internet the user cannot control the unit remotely, and the information such as bulb on or off and fan on or off is monitored in the web server.

During mini hatcheries, late or early hatching, sometime chicks got piped but deceased, blood ring are formed and deceased embryos are seen at the primary stage are the usual problems. The egg incubators existing in the market have inappropriate temperature, humidity and ventilation control due to lower cost control equipment and sensors which are not robust to handle. The systems which are available are not user friendly to maintain, smaller in size and expensive which in turn means that smaller villages cannot afford the system. The first and foremost step is to build an incubator with good housing, good thermal insulation to keep the eggs warmer throughout the incubation period. Here the incubator has both hatchery and brooder in a single unit which saves the space and the money.

OBJECTIVES

For the following below objectives of our project of design and implementation of chicken egg incubator using IOT

Design an IoT-based chicken egg incubator to automate and optimize the hatching process.

Enable remote monitoring and control of temperature, humidity, and other vital parameters.

Implement real-time data collection and analysis for efficient hatch management.

Ensure precise environmental conditions for successful egg incubation.

Enable automatic alerts and notifications for temperature or humidity fluctuations.

Provide a user-friendly interface for remote configuration and monitoring.

Optimize energy consumption through automated power management.

Facilitate remote troubleshooting and diagnostics for prompt issue resolution.

Integrate with other IoT devices for seamless poultry farm automation.

Improve hatch success rates and overall efficiency of the incubation process through IoT-enabled optimization.

METHODOLOGY

The main criteria in incubation system are to maintain the temperature and humidity level stable. To do this a continuous monitoring and a closed loop system should be maintained. The data coming from the sensor may not be correct due to noise from the environment, to overcome this problem Kalman filter is proposed (Lim et al., 2016). By using the Kalman filter algorithm it can screen out the unwanted signals resulting which the data with respect to humidity and temperature to be more precise

The Kalman filter model at time (k) derives from state (k – 1) of the state-space model.

$$X_k = AX_{k-1} + Bu_k + W_{k-1} \tag{1}$$

where A is the state transition model form the previous state X_{k-1} and B is the control input model that controls the Uk and W_{k-1}.

$$Z_k = Hx_k + V_k \tag{2}$$

where H is the measurement model and Vk is the measurement noise.

The Kalman filter equation has two parts. The time update equation used to update estimation from the current time step to next time step. This equation is also known as predict equation. The other part is measurement update equation which is responsible for feedback. It is also known as correct equation.

$$\hat{X}_k = A\hat{X}_{k-1} + Bu_k \tag{3}$$

$$P_{\bar{k}} = AP_{k-1}A^T + Q \tag{4}$$

where $P_{\bar{k}}$ is error covariance and Q is the process noise covariance.

The measurement equations are illustrated by:

$$K_k = P_{\bar{k}}H^T\,(HP_{\bar{k}}H^T + R^{-1}) \tag{5}$$

$$\hat{X}_k = \hat{X}_k + K_K\,(Z_k - H\hat{X}_{\bar{k}}) \tag{6}$$

$$P_k = (I - K_kH)\,P_{\bar{k}} \tag{7}$$

where K is the Kalman gain, H is observation model and R is observation noise covariance. In the proposed method totally 300 fertile eggs were used for incubation. Totally three tests were carried out, at T1 36.5°C, T2 37.5°C and T3 38°C

Among these the 37.5°C is proposed best for incubation with 0.2°C variations in the incubation system. Blynk app is used to control and the monitor incubator remotely, this helps the user to continuously monitor the system. The incubation system with the IoT technology is an add-on to the user to monitor and control anywhere in the world. This helps a lot for the user to continuously check the status of the system. the temperature (36.5°C) with respect to humidity is plotted for totally 21 days. The results show there is a variation in the humidity with respect to temperature.

1. Block Diagram:

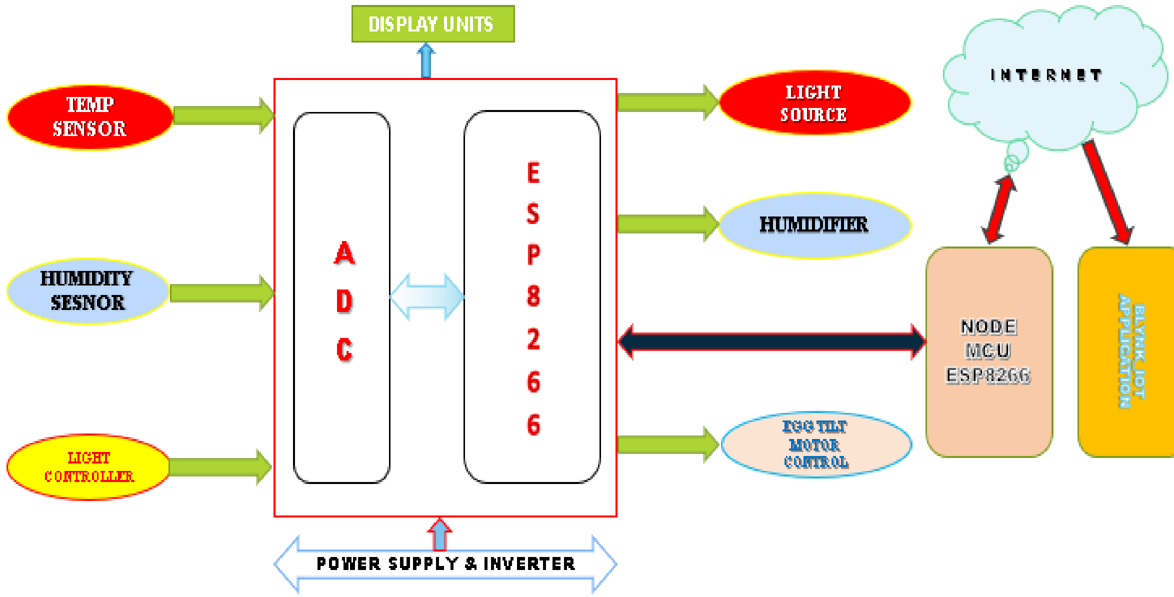

Figure 1: -BLOCK DIAGRAM CHICKEN EGG INCUBATOR

INPUT Components: - temperature sensor, humidity sensor, light sensor, egg tilt sensor, power supply, keypad.

OUTPUT components: bulb controller, humidifier, light source, egg tilt motor control, LCD.

INOUT component: Node MCU ESP 8266.

In the block diagram:

The IoT device serves as the main control unit for the incubator, integrating various components and enabling connectivity to the internet. Temperature and humidity sensors measure and provide data on the incubator's internal environment.

A motor is employed for egg turning, ensuring consistent embryo development. IoT connectivity allows the device to communicate with external systems, such as a cloud platform.

ABSTRACT

In this project, the egg fertilization is one of the major factors to be considered in the poultry farms. The smart incubation system is designed to combine the IoT technology with the smart phone in order to make the system more convenient to the user in monitoring and operation of the incubation system.

The incubator is designed first with both setter and the hatcher in one unit and incorporating both still air incubation and forced air incubation which is a controller and monitored by the controller keeping in mind the four factors: temperature, humidity, ventilation and egg turning system.

Here we are setting with three different temperatures for the experimental purpose at T1 = 36.5°C, T2 = 37.5°C and T3 = 38°C. The environment is maintained same in all the three cases and which is the best temperature for the incubation of the chicken eggs is noted

WORKING PRINCIPLE

The nucleus of the female cell is a small white or light-coloured speck about the size of a pinhead that is located on the top side of the yolk. Here the microscopic male sperm cell finds lodgement and the cells are united to form the embryo. A fertilised egg is characterised by a white ring 3-4 millimetres in size on the yolk surface (germ cell), whereas an infertile egg is characterised by a single white speck of about 2-3 mm diameter.

Fertile Egg Storage:

Fertile eggs should be clean and dry and stored between 12-15°C at a relative humidity of 75% with the small end down.

Eggs should be turned by 90 degrees at least once to twice daily. Optimal hatchability is achieved in fresh eggs less than 10 days old, but reasonable hatchability can be obtained in eggs up to 14 days of age. Fertile eggs should maintain a relatively constant weight with minimal weight loss during storage. Temperatures above 25°C can initiate cellular replication of the germ cell on the yolk of the fertile egg and will increase embryonic mortality and reduce hatchability. Temperatures below 10°C can inactivate the germ cell.

Principles of Artificial Incubation of Fertile Eggs

The four main essentials of incubation of good quality fertile eggs are:

- Correct and even temperature controlled by a thermometer or thermocouple
- Correct humidity controlled by ventilation rate and water application
- Correct oxygen and carbon dioxide concentrations controlled by ventilation
- Turning of the fertile eggs by approximately 90 degrees several times per day by manual or automatic means.

These parameters can be easily achieved and maintained if the incubator manufacturer's operating instructions are carefully adhered to.

Figure 2: Fertile eggs should be stored point down

Incubation Temperature Range and Variation The temperature requirements for incubation and most incubators have a temperature variation of 0.2-0.4°C for effective incubation and subsequently a high hatchability rate.

Embryo tolerance to temperatures more than 1°C above or below the recommended temperature is low, and temperatures outside this range will result is significant embryonic mortality. Embryos are much more susceptible to temperature variation in the early and late phases of incubation.

Incubation Relative Humidity Range and Variation

The maintenance of consistent relative humidity is more difficult during incubation and can only be constantly maintained by ventilation rate, using adjustable ventilation apertures and by surface water and water sprays during incubation. The tolerance of the embryo to different ranges of humidity are greater than temperature, but there are negative consequences observed with humidity below 40% and above 90%. Good hatchability is achieved when relative humidity is maintained at approximately 50-65% until the last 3 days of incubation, at which point it should be increased to between 70-90%.

Incubator working principle:

The thermo-electricity theory, which states that heat or thermal energy can be converted into electrical energy, is the foundational idea behind an incubator. Every incubator operates under the fundamental element that microorganisms need the ideal environment to live and grow. The perfect temperature, humidity, oxygen, and carbon dioxide are all present in an incubator, allowing the microorganisms to grow and increase in population. An incubator's thermostat controls the temperature within the incubator. We can use the thermometer to check this temperature outside.

We keep the temperature within the incubator constant by heating and no heating cycles. In the heating cycle, the incubator's temperature is raised by the thermostat, but in the non-heating process, the incubator is cooled by radiating heat outward. The cabinet has a system of insulation that keeps it isolated from the outside and promotes efficient microbial growth. Similarly, the incubator also

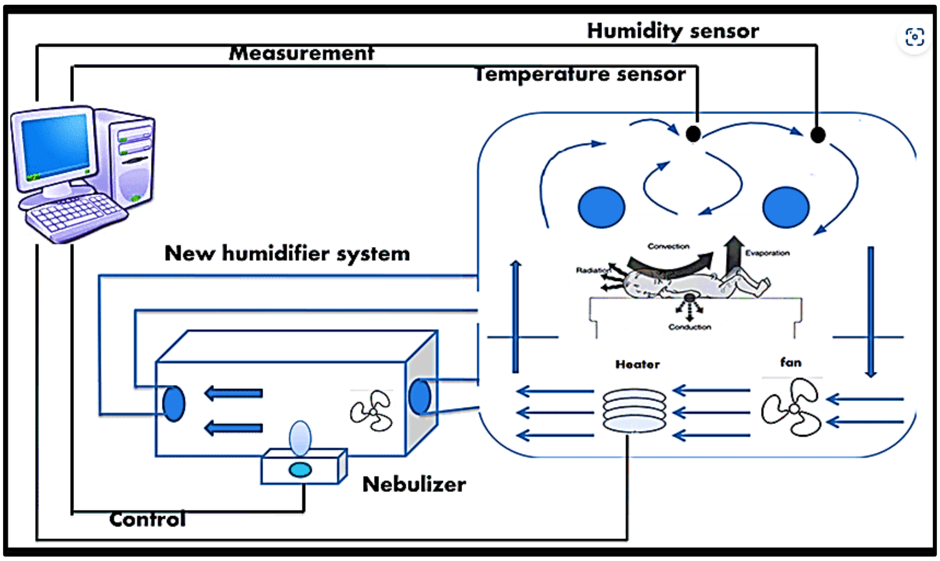

Figure 3: working principle of Incubation System

maintains other conditions necessary for the development of the organisms, such as humidity, ventilation, CO2 concentration, and pH, using various processes. A shaking incubator variation of the incubator enables the constant shaking of the culture needed for investigations on cell aeration and solubility.

An incubation system is a device that provides a controlled environment for the growth and development of living organisms, such as eggs or bacteria. The working principle of an incubation system involves the maintenance of specific environmental conditions, such as temperature, humidity, and oxygen levels, that are necessary for the growth and development of the organism.

The basic components of an incubation system include a chamber or enclosure to hold the eggs or other biological material, a heating element or temperature control system to regulate the temperature inside the chamber, a humidity control system to maintain appropriate levels of moisture, and a ventilation system to regulate the oxygen and carbon dioxide levels.

In general, the incubation process involves placing the biological material inside the incubator and setting the desired environmental conditions. The incubation system will then monitor and maintain the conditions inside the chamber to ensure optimal growth and development of the organism.

For example, in the case of egg incubation, the temperature must be maintained at a constant level within a certain range, usually around 37-38 degrees Celsius (98-100 degrees Fahrenheit), while the humidity must be maintained at a certain level to prevent the eggs from drying out or becoming too wet. The ventilation system ensures that there is an adequate supply of oxygen and removal of carbon dioxide, which is essential for the developing embryo.

Overall, the working principle of an incubation system involves the creation and maintenance of a specific environment that supports the growth and development of living organisms under controlled conditions.

When working with fertile eggs in an incubator, the basic principle is to provide the appropriate environmental conditions that allow the eggs to develop and hatch successfully. Here are the steps involved in incubating fertile eggs:

Selecting fertile eggs: Ensure that the eggs you are using are from healthy, disease-free birds and are less than 10 days old. Check that they are clean and free of cracks.

Preparing the incubator: Clean and disinfect the incubator thoroughly before use. Set the temperature and humidity according to the specifications of the species you are hatching.

Setting the eggs: Place the eggs in the incubator with the pointed end facing downwards. Use an egg turner or turn the eggs by hand at least three times a day to prevent the embryo from sticking to the shell.

Monitoring the conditions: Check the temperature and humidity levels regularly to ensure they are within the recommended range. Make adjustments as needed.

Candling the eggs: After about 7-10 days of incubation, use a bright light to "candle" the eggs to check if they are fertile and developing. Discard any infertile or non-developing eggs.

Hatching the eggs: Depending on the species, eggs can take anywhere from 18 to 28 days to hatch. When the eggs start to pip (crack open), stop turning them and increase the humidity levels to help soften the shell. Allow the chicks to hatch naturally.

How to Incubate & Hatch Chicken Eggs - Just 21 Days from Egg to Chicken:

Incubating and hatching eggs is one of the most enjoyable (and addictive) aspects of chicken keeping and breeding. Nothing beats watching those little ones fight their way out of the eggs, after the 3 weeks of fretting and fussing and watching the incubator, wondering what is going on in there. To get you started on this wonderful journey, here is a quick rundown on.

Incubating Eggs 89 Numbers:

First things first chicken eggs should hatch in 21 days, though some may hatch a day or two early and some a day or two late after the incubation period began. A "day" is counted as a full 24 hours, so day one would be the first 24 hours after setting the egg. Day two the next 24 hours, etc. If you set eggs on a Monday, it's usually a safe bet that they will hatch on a Monday, three weeks later.

Select clean, even shaped, undamaged eggs for incubating. You should also avoid eggs that are too large or small, or that are misshapen. Large eggs tend to hatch poorly, and small eggs often produce smaller chicks. It's best not to wash the eggs prior to setting, as washing can remove the protective "bloom" on the shell and make the eggs more susceptible to absorbing bacteria and other nasties, which could compromise your hatch.

If possible, do not store them too long pre-incubation. Ideally eggs should be set within a week after being laid (especially if they are stored at room temperature). After 10 days the hatchability of the eggs drops significantly. Store the eggs in a cool place (NOT the fridge) and turn them once a day to keep the yolks centered. If you place cold eggs in a warm and humid incubator, they will crack and the embryos will die.

A note on shipped eggs: shipped eggs should be allowed to rest for 24 hours prior to setting, to allow the contents of the eggs to settle. Place shipped eggs upright, with the fat end of the egg up, in an egg carton, or something similar. Shipped eggs often have loose or damaged air cells and should ideally be incubated upright, with the fat end up. For more information and tips on managing these see here.

Before putting your eggs into an incubator, plug it in and make sure the temperature is steady. In a forced-air incubator (with a fan) the temperature should be 99.5–100*F. In a still-air incubator the temperature should be slightly higher, 101–102*F measured at the top of the eggs. To ensure that you get fresh air and oxygen in a still air incubator, you'll need to open it at least four times a day. Eggshells are porous so oxygen can enter and carbon dioxide can exit. I use a thermometer and a hygrometer (which measures humidity levels) in my incubator. Hygrometers can be purchased quite cheaply at a cigar shop; Radio Shack and I believe even Walmart. You want 28–50% relative humidity for day 1–18, depending on air cell size, then 65% to 75% for the last few days.

During the first 18 days of incubation, the eggs should be turned a minimum of 3 times a day. Use a non-toxic marker and mark eggs with an X on one side and an O on the other so when you are turning them you can make sure they all got turned. More about turning later...

Incubators:

There are many makes and models of incubators for sale and they vary greatly in price, quality, and user-friendliness. It's recommended that you read our Egg Incubator Reviews and get some opinions before you choose one! If you are the DIY type, building your own incubator is fairly easy too. Our members have shared designs with instructions, plans, and ideas on their homemade incubators.

Natural fertility may vary from 55% to 95% with season, depending on condition and age of your birds. You might be safe to expect that 50% to 75% of the fertile eggs will hatch, though 90%-100% hatches can and does happen. With shipped eggs the hatch rate is approximately 50% overall. After 5–7 days of incubation, white-shelled eggs can be candled to see if embryos are developing. Candling is done by going into a dark room/area and shining a bright light (usually a flashlight) into the egg to see what is going on inside.

Fertility and embryo development is usually apparent by day 5–6, when infertile, developing eggs, some veins and a small embryo can be seen inside the egg. If there is no sign of development by day 10, you may discard any "clears". However, sometimes embryos are hard to spot, so some hatchers wait until around day 14 or so, before discarding any undeveloped eggs. When candling, also check for blood rings showing as a dark ring around the inside of the egg, along the shell, usually roughly in the middle of the egg, and other signs of problems.

The Air Bubble (Sac) in the Egg:

Soon after an egg is laid, a small air bubble starts forming in the large end under the shell. This air sac serves as a "breathing space" for the hatching chick to pip into in order to breathe, during the hatching process. This is known as an "internal pip". The drier the outside air is, the more fluid is depleted from the egg contents and the faster the bubble grows. Correct humidity in the incubator ensures that the bubble does not grow too big, depleting essential fluids, or deny the chick enough air by remaining too small.

The importance of correct humidity is more apparent at the end of incubation. The normal condition is that the air cell has enlarged to the point where the chick can reach its beak through the membrane wall, allowing it to breathe, before it pips through the shell, after which it will "zip" around the shell. If humidity has been excessive, the chick may pip internally into the air cell and drown in excess fluid. On the other hand, if humidity has been too low, the air cell will be oversized and the chick may be unable to hatch.

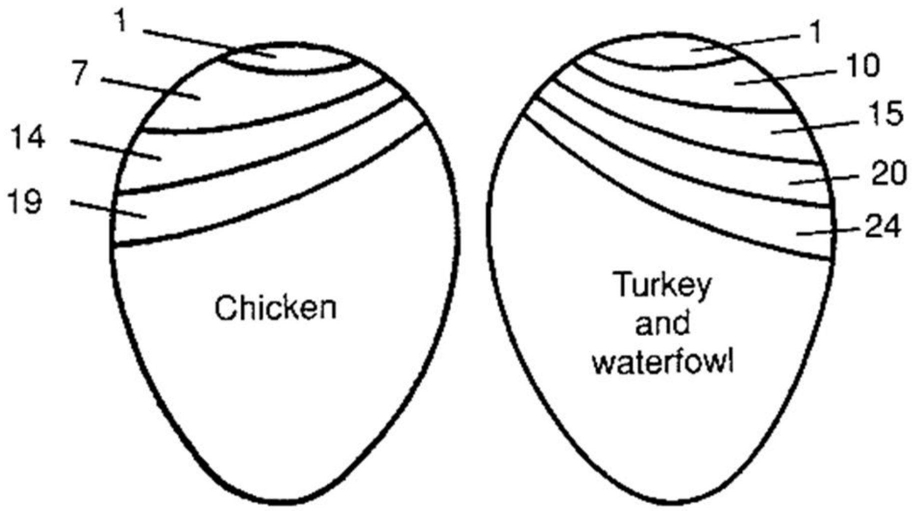

Figure 4: A rough guide showing the development of the air cell on different days of incubation

The air bubble or sac in an egg is a crucial component of incubation as it allows the chick to breathe as it develops inside the egg. The air sac forms naturally as the egg cools after being laid, and its size increases as the egg ages.

During incubation, the air sac becomes larger as the chick consumes oxygen and produces carbon dioxide. It is important to monitor the size of the air sac throughout the incubation process, as it can provide information about the health and development of the embryo.

To check the size of the air sac, candling can be used. Candling is a process of shining a bright light through the egg to observe the contents inside. When candling, the air sac appears as a dark area at the blunt end of the egg.

The size of the air sac can be affected by the humidity level in the incubator. If the humidity is too low, the air sac can become too large, which can cause problems during hatching. If the humidity is too high, the air sac can become too small, which can also cause problems during hatching.

Therefore, it is important to maintain the appropriate humidity level throughout incubation to ensure the proper development of the air sac and the chick inside the egg. Generally, the humidity level should be around 40-50% for the first 18 days of incubation and then increased to 60-70% during the last few days of incubation to facilitate hatching.

Positioning of the Eggs:

An incubating egg could set in a normal position as it would on a flat surface; that is with the large end slightly higher than the point, or upright in egg cartons/turners, with the fat end of the egg always up. An egg that persistently has the small end elevated may cause the embryo to be misoriented with the head toward the small end. In the misoriented position, the chick is likely to drown on pipping. Therefore, it is quite important that in general, the large end of eggs should be slightly higher than the small ends; or as they would lie naturally on a flat surface.

Figure 5: Egg Tilt Tray

The positioning of eggs in an incubator is important for proper development of the embryos inside the eggs. Here are some guidelines for proper egg positioning:

Place the eggs with the pointed end down: When you place the eggs in the incubator, make sure to position them with the pointed end down. This helps the air sac to be in the correct position and allows the embryo to develop properly.

Use an egg turner: An egg turner is a device that turns the eggs automatically, ensuring that the embryos develop uniformly. If you use an egg turner, it's important to place the eggs with the pointed end down, so that they rotate properly.

Hand-turn the eggs: If you don't have an egg turner, you can turn the eggs by hand. It's important to turn the eggs at least three times a day to prevent the embryo from sticking to the inside of the shell.

Avoid stacking the eggs: Stacking the eggs can lead to uneven heating and cooling, which can result in uneven development of the embryos. It's best to use a single layer of eggs in the incubator.

Leave space between the eggs: Leave a small space between the eggs to ensure that they are not touching each other. This allows for proper air circulation around the eggs.

Turning:

Turning is essential during the first 14 days of incubation, but most people continue it to day 18. Turning is stopped during the last 3 days. If you're hand turning and not using an automatic egg turner, always turn the eggs an uneven number of (minimum 3) times a day, so the eggs do not spend two nights in a row in the same position. If not turned to a fresh position frequently during the early stages, the developing embryo touches the shell membrane and sticks to it causing abnormal growth. Turning the egg aids these movements within the egg, and mimics what a mother hen would do naturally.

Turning the eggs in an incubator is important for the healthy development of the embryos inside the eggs. Turning helps prevent the embryo from sticking to the inside of the shell and promotes the development of the circulatory and skeletal systems.

Here are some guidelines for turning eggs in an incubator:

Turn the eggs at least three times a day: Turning the eggs three to five times a day is recommended to prevent the embryo from sticking to the inside of the shell.

Turn the eggs for the first 18 days: Turning the eggs during the first 18 days of incubation is important for the development of the embryos. After day 18, stop turning the eggs to prepare for hatching.

Use an egg turner: An egg turner is a device that can be placed in the incubator to automatically turn the eggs. Egg turners are usually sold separately from the incubator, but they can be very convenient and can ensure that the eggs are turned consistently.

If turning by hand, mark the eggs: If you are turning the eggs by hand, it's a good idea to mark the eggs with an "X" on one side and an "O" on the other side to keep track of which eggs have been turned. Turn the eggs 180 degrees each time to ensure uniform development.

Wash your hands before handling the eggs: It's important to wash your hands before handling the eggs to prevent contamination.

Lockdown:

The last few days of incubation, days 18–21, are known as "lockdown". When lockdown day comes, switch OFF/remove turners (if present), increase the humidity in the incubator to around 70% and maintain it. Do not open the incubator unless necessary and do not turn the eggs during this period.

Lockdown in an incubator refers to the period of time near the end of the incubation process when the eggs are no longer turned and the environment inside the incubator is adjusted to facilitate hatching. Here are some guidelines for lockdown in an incubator:

Stop turning the eggs: At around day 18 of incubation, stop turning the eggs to prepare for hatching.

Increase the humidity: About three days before the expected hatch date, increase the humidity level in the incubator to around 60-70% to facilitate hatching.

Do not open the incubator: During lockdown, avoid opening the incubator as much as possible. Opening the incubator can cause a drop in temperature and humidity, which can be harmful to the developing embryos.

Wait for the hatch: After the eggs have been in lockdown for several days, the chicks should begin to hatch. Do not disturb the chicks while they are hatching, as they need time to absorb the remaining yolk sac and adjust to the outside environment.

Remove the hatched chicks: Once the chicks have hatched, remove them from the incubator and place them in a brooder to provide warmth and food.

What to do When the Chicks Have Hatched:

After the chick hatches allow it to dry off and fluff up in the incubator before removing it to a brooder. Newly hatched chicks can survive for up to 3 days on the yolk they absorb during the hatching process, but once you put them in the brooder make sure there is at least water available and offer them food after a day or 2. For more on raising chicks.

If your chicks have hatched in an incubator system, here are some important steps to follow:

Leave the chicks in the incubator for at least 24 hours: Chicks will absorb the remaining yolk sac, which provides them with nutrients and energy for the first few days of their life. So, it's important to leave them in the incubator for at least 24 hours after hatching to allow the yolk sac to be fully absorbed.

Move the chicks to a brooder: Once the chicks are ready to leave the incubator, move them to a brooder that is equipped with a heat lamp or a heating pad to provide warmth, a feeder, and a waterer.

Figure 6: chicks have hatched it self

Monitor the temperature: Chicks need to be kept in a warm environment, ideally around 95-100°F for the first week, and then you can decrease the temperature by 5°F per week until they are fully feathered. Use a thermometer to monitor the temperature in the brooder and adjust the heat source accordingly.

Provide food and water: Your chicks will need access to fresh water and food as soon as they are moved to the brooder. Make sure the water is clean and shallow enough for them to drink without drowning. A chick starter feed is best for their first few weeks of life.

Keep their environment clean: Clean the brooder regularly to prevent any build-up of waste or bacteria.

Monitor their health: Keep an eye on your chicks for any signs of illness or injury. Common issues include pasty butt, which is when faces gets stuck to their vent and can be deadly if not treated, and splayed legs, which is when the legs splay out to the sides instead of being underneath the body.

Provide socialization: Chicks are social creatures and need to be around other chickens. You can consider introducing them to other chickens or providing them with toys to keep them occupied.

LITERATURE SURVEY

A Design of IoT-Based Egg Incubator System for Brooding in a Poultry Farm by Olanrewaju et al. (2020).

This research proposes a design of an IoT-based egg incubator system for brooding in a poultry farm. The system utilizes sensors to monitor temperature, humidity, and carbon dioxide levels inside the incubator. The data from the sensors is transmitted to a cloud-based platform for real-time monitoring and analysis. The system is designed to provide remote control of the incubator parameters through a mobile application.

Design and Construction of an Automatic Egg Incubator Using IoT Technology by Ogundipe et al. (2020).

This research presents the design and construction of an automatic egg incubator using IoT technology. The system uses a microcontroller-based control system that monitors and regulates the temperature, humidity, and egg turning mechanisms. The system is connected to the internet via a Wi-Fi module and can be remotely controlled using a mobile application.

Design and Implementation of an Automatic Egg Incubator System Using IoT Technology by Aliyu et al. (2020)

This research presents the design and implementation of an automatic egg incubator system using IoT technology. The system uses a microcontroller-based control system that monitors and regulates the temperature, humidity, and egg turning mechanisms. The system is connected to the internet via a Wi-Fi module and can be remotely controlled using a mobile application. The system also utilizes a camera module to monitor the eggs and provide real-time images to the user.

An IoT Based Smart Egg Incubator for Efficient Poultry Farming by Srinivasan et al. (2021)

This research proposes an IoT-based smart egg incubator system for efficient poultry farming. The system uses sensors to monitor temperature, humidity, and carbon dioxide levels inside the incubator. The data from the sensors is transmitted to a cloud-based platform for real-time monitoring and analysis. The system is designed to provide remote control of the incubator parameters through a mobile application. The system also includes an automated egg turning mechanism and an alarm system to alert the user in case of any anomalies.

RESULTS AND CONCLUSION

1.RESULTS:

The primary resultant of a chicken egg incubator is the successful hatching of chicks from fertilized eggs. This is achieved by providing optimal incubation conditions such as temperature, humidity, and egg turning, which promote embryo development and hatching.

In addition to hatching chicks, an egg incubator can also result in other benefits, such as increased efficiency and control over the incubation process. With an incubator, hatchery operators can hatch a large number of eggs simultaneously, which can save time and labour compared to hatching eggs naturally using broody hens. Additionally, an incubator allows for more precise control over incubation conditions, such as temperature and humidity, which can result in higher hatch rates and healthier chicks.

Moreover, egg incubators can provide an opportunity for small-scale poultry farmers or backyard chicken keepers to hatch their own eggs rather than relying on purchasing chicks from hatcheries. This can result in cost savings and the ability to raise specific breeds or strains of chickens.

Overall, the primary resultant of a chicken egg incubator is successful hatching of chicks, but it can also result in increased efficiency, more precise control over the incubation process, and cost savings for small-scale poultry farmers.

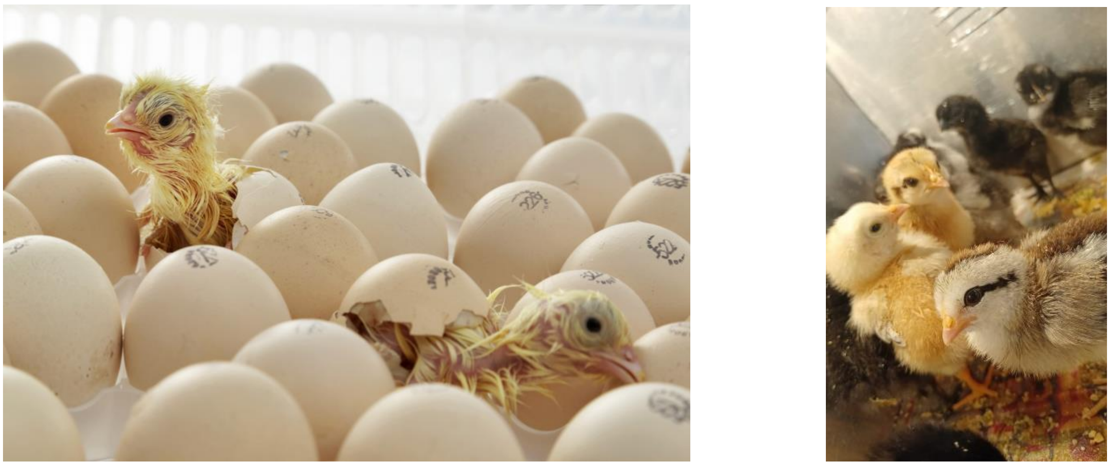

Figure 8.1: Experiment Resultant of Chicken egg incubator

The output of a chicken egg incubator is a hatched chick from the fertilized egg. The incubator provides a controlled environment for the egg to develop and hatch, typically maintaining a temperature between 99 and 103 degrees Fahrenheit and a humidity level between 50 and 55 percent.

Once the eggs are placed in the incubator, they will typically take around 21 days to hatch. During this time, the incubator will need to be monitored regularly to ensure that the temperature and humidity levels are properly maintained.

Once the chicks hatch, they will need to be carefully removed from the incubator and placed in a brooder to keep them warm and healthy. The brooder should be set up with a heat lamp, food and water, and a safe space for the chicks to move around and grow.

Proper maintenance of a chicken egg incubator is essential to ensure successful hatching of eggs. Here are some of the requirements for maintaining a chicken egg incubator:

Regular Cleaning: The incubator should be cleaned regularly to maintain proper hygiene. The incubator should be cleaned and disinfected thoroughly before every use. After use, it should be cleaned again to remove any remaining debris, eggshells, and waste.

Temperature and Humidity Control: The temperature and humidity levels in the incubator should be checked regularly to ensure that they are within the recommended range. It is also important to monitor the temperature and humidity levels during the hatching process and adjust them as needed.

Egg Rotation: Eggs should be rotated at least three times a day during the incubation period to prevent the embryos from sticking to the inside of the shell. An automatic egg turner can be used to simplify this process.

Calibration: The incubator's thermometer and hygrometer should be calibrated regularly to ensure that they are providing accurate readings. It is recommended to use a separate thermometer and hygrometer to cross-check the readings.

Electrical Components: Check all electrical components, such as the thermostat, heating element, and fan, regularly to ensure they are working correctly. Replace any damaged or faulty parts.

Check the Water Level: Water should be added to the incubator's water reservoir as needed to maintain the proper humidity level.

2. CONCLUSION:

The ESP8266 microcontroller based low cost forced air incubator has been designed. The materials used in the incubator are locally available materials at a very low cost. The incubator hatching test was conducted for three temperature values T1, T2 and T3. The test confirmed that temperature T2 is the best temperature to get better yield. The incubator combines both hatcher and brooder in the same chamber. The incubator at the start takes around 10 minutes to achieve the set temperature, i.e., T2 (from 29°C to 37.5°C).

The power consumption at the time was around 50 watts and running time after attaining the set temperature was around 37.5 watts. The entire unit can be controlled anywhere with the help of Blynk app from the smartphone. The incubator is designed to be adopted by villages for small scale poultry farming and can be used for egg embryo investigation and laboratory works. Total 30 eggs were used for incubation, among 30 eggs 3 eggs were non-fertile and was found by candling the eggs on 7th day of incubation. Out of 27 eggs 24 eggs were hatched successfully. Remaining 3 eggs were in mortality and waited for 25 days and couldn’t find any life in those eggs.

WHAT IS THE INNOVATION IN THE PROJECT

The innovation in designing and implementing a chicken egg incubator for hatching using IoT lies in the integration of IoT technologies and capabilities to enhance the efficiency, precision, and monitoring of the incubation process. Here are some key innovations that arise from incorporating IoT into the design of a chicken egg incubator for hatching:

Remote Monitoring and Control: IoT enables real-time monitoring of crucial parameters such as temperature, humidity, and egg turning status from anywhere using a mobile or web application. This allows users to remotely monitor and control the incubator, making adjustments as needed without physical presence.

Data-driven Decision Making: IoT integration facilitates continuous data collection from sensors within the incubator. This data can be analyzed to gain insights into the incubation process, detect patterns, and make informed decisions to optimize hatching success rates.

Automated Environment Control: IoT-enabled incubators can automate the regulation of temperature, humidity, and ventilation based on preset parameters and desired profiles. This ensures consistent and precise control of the incubation environment, creating optimal conditions for successful hatching.

Alerts and Notifications: IoT-enabled incubators can detect deviations from desired temperature or humidity levels and send automated alerts or notifications to users. This allows for timely intervention and corrective actions to maintain optimal incubation conditions.

Remote Diagnostics and Troubleshooting: IoT connectivity enables remote diagnostics of the incubator's performance. Users or technicians can remotely identify and troubleshoot issues, reducing downtime and improving maintenance efficiency.

Energy Optimization: IoT-based incubators can incorporate energy-saving features such as intelligent scheduling and power management. This helps optimize energy consumption, reducing operational costs and environmental impact.

Integration with Smart Systems: IoT integration allows for seamless integration with other smart systems or agricultural automation platforms. This enables holistic farm management, synchronized data sharing, and coordinated control of various farming processes.

Data Analytics and Predictive Insights: IoT-enabled incubators can leverage cloud platforms for data storage, analysis, and predictive modeling.

SCOPE FOR FUTURE WORK

The future scope of chicken egg incubator projects is vast, with potential applications in various fields such as agriculture, food production, and research. Here are a few potential areas for future development:

Small-scale incubators for backyard poultry farmers: As interest in backyard poultry farming grows, there is a need for small-scale, affordable, and easy-to-use incubators for hatching eggs. Future projects could focus on designing such incubators that are user-friendly and accessible to novice poultry farmers.

Large-scale commercial incubators: Commercial poultry production relies heavily on incubators for hatching chicks. Future projects could focus on developing larger and more efficient commercial incubators that can handle higher egg capacities while maintaining optimal environmental conditions.

Remote monitoring and control: The use of remote monitoring and control technologies could enable farmers and researchers to track incubator performance and adjust environmental conditions from a distance. This could be particularly useful for remote or inaccessible locations.

Integration with renewable energy sources: The integration of renewable energy sources such as solar power could make incubators more sustainable and cost-effective in the long run.