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Monitoring and controlling the incubation process using the Internet of Things system

*1- Hossein Roshan Ghiyasi. 2- Ali Haji Ahmad 3- Soleiman Hosseinpour 4-Ali Jafari 5-Hossein Mousazadeh 6-Amir Hossein Asadollahzadeh

1. PhD Student, Department of Biosystems Engineering, Faculty of Agriculture, University of Tehran, Karaj, Iran (Hossein.roshan.g@ut.ac.ir)
2. Assistant Professor, Department of Biosystems Engineering, Faculty of Agriculture, University of Tehran, Karaj, Iran (hajiahmad@ut.ac.ir)
3. Associate Professor, Department of Biosystems Engineering, Faculty of Agriculture, University of Tehran, Karaj, Iran (shosseinpour@ut.ac.ir)
4. Professor, Department of Biosystems Engineering, Faculty of Agriculture, University of Tehran, Karaj, Iran (jafarya@ut.ac.ir)
5. Associate Professor, Department of Biosystems Engineering, Faculty of Agriculture, University of Tehran, Karaj, Iran (hmousazade@ut.ac.ir)
6. Master student of Automotive Engineering, Faculty of Engineering, University of Science and Technology (amir.asadzadeh@ut.ac.ir)

abstract

Today, poultry and its products constitute an important part of humanity's food basket. The first step in order to get the most out of the poultry production process is to produce chickens. In small-scale incubators for domestic use, one of the barriers to production is a sudden power outage, so the production is severely overshadowed by the embryos being sensitive to temperature and humidity stresses. The aim of this study is to develop an Internet of Things (IoT) system to monitor and control the conditions inside the incubator due to the sensitivity of eggs to temperature, humidity and ventilation inside the incubator due to the impossibility of line monitoring. In this study, using the Arduino-at-Mega 2560 board, which is the core of the control system, by the IoT interface module of the sim800, the temperature and humidity sensor data read by SHT75 based on the MQTT protocol on the AdaFriut IoT cloud platform, a system IoT was developed, with this system the user can view the temperature and humidity data and the ventilation system online every 30 seconds without having to go to the location of the incubator on his mobile phone, if the water level inside the humidifier tank of the system is low. It can issue the necessary warnings to the user, in case of emergency, the system sends a warning text message to the user so that the operator can immediately refer to the developed software to apply control commands, also in case of power outage from 24V DC battery as car power supply. Incubator use.

Keyword: Arduino, Incubator, IoT, Remote control.

*Corresponding author
E-mail: Hossein.roshan.g@ut.ac.ir

1-Introduction

Today, poultry and its products play an important role in the human food chain. The first step in poultry production is the incubation process, which requires an incubator. The incubation process requires a lot of money and energy. In order to achieve higher efficiency in the incubation process, several factors are influential, including the fertility, the freshness of the eggs placed in the incubator, and the way the eggs circulate in the incubator. Setter pointed out in order to prevent the embryo from sticking to the eggshell and also to control the temperature and humidity conditions in the incubator in the incubation process [1]. In the embryo mortality curve of broiler chickens, more losses are observed in three stages, the first stage: from the second to the fourth day, which occurs due to the inability of the fetus to face physiological and biochemical changes in the early stages of development. The second stage is from the eleventh to the fourteenth day, which is due to the lack of nutrients such as pantothenic acid, and finally the seventeenth to the twenty-first day, which occurs due to temperature and humidity fluctuations in the car [2].

If the humidity is high, the air-containing chamber in the egg shrinks and the oxygen supply to the fetus is disrupted. If the relative humidity of the environment is less than the desired level, the moisture of the egg is lost and increases the volume of the air chamber and the fetus sticks to the shell and causes the loss of the fetus [3].

Due to the sensitivity of the incubation process, this process requires online monitoring of the internal conditions of the incubator, which is time consuming and costly. There are a lot of costs on the incubation process. In this research, we have tried to provide the ability to continuously monitor the incubation process by using the Internet of Things system.

Today, the use of the Internet of Things (IoT) is expanding rapidly in all areas of agriculture, with most of the spread of IoT in agriculture taking place in greenhouses, has found.

Iot in the chicken production process:

A study using IoT technology on the use of infant incubators to reduce the risk of using medical equipment and online management has been introduced to improve management and efficiency. It has been used in combination with IoT technology and temperature sensors to control online management [4].

In order to control the internal conditions of the incubator in a study, using the Internet of Things, which has three main systems, including the independent IoT system, web applications and the Telegram robot. Web application software in intelligent egg incubator was created using Object Oriented Analysis and Design (OOAD). Web-based applications can be used to monitor the condition of the incubator based on sensor data sent during the hatching process. While in the Telegram robot, temperature, humidity, egg transfer, and inversion of the inside of the incubator can be controlled online, short-term notifications can also be made if there are conditions in the incubator that change too much. Was also informed [5].

In one study, the proposed system is equipped with a DHT11 sensor that monitors the temperature and humidity of the incubator and is constantly updated via Wi-Fi. The user remotely monitors the temperature and humidity values and controls the light intensity of the lamp through an Android application on his mobile phone. The servo motor is connected to the egg spinner that is kept inside the incubator and is rotated according to the specified schedule to prevent the yolk from sticking to the eggshell and also to create a uniform temperature of the eggs. From the experimental results, it is inferred that better hatching can be done by controlling the machine conditions remotely [6].

In another study, the protection and monitoring of the poultry environment by the Internet of Things is presented. The software-based hardware provided is able to monitor environmental components such as air temperature, humidity, oxygen level O_2, carbon dioxide concentration, CO_2 concentration and ammonia NH_3 concentration. Wireless sensors are responsible for collecting the desired data, and send the data to the monitoring and control center. Hardware runs successfully on various poultry sites. Very effective and accurate experimental settings were obtained [7].

In a study by Provence *et al*., They created a remote monitoring system using a Raspberry Pi-3 board, which was able to control the incubator on-line with a camera and temperature sensor. In Provence system, in case of power outage, the system is automatically sourced. Electricity replaces the battery [8].

In automation and monitoring of the desired level of internal conditions of a poultry farm, Thomas et al. Using sensors and microcontrollers to monitor and monitor the line on the environmental conditions inside the poultry farm [9].

Sebastian et al. In the development of a control system in an incubator using the Arduino-uno board and the Lab-view programming environment and with the help of MET-Inverto were able to control the temperature, humidity and rotation of the eggs inside the incubator [10].

Due to the impossibility of online monitoring of the incubator in order to control the internal conditions of the incubator, in order to prevent damage to the incubator, in this study, an attempt was made to monitor the conditions inside the incubator by providing a remote monitoring and control system.

2-materials & method

An incubator with a capacity of 108 eggs was built on one level inside the incubator with the ability to place eggs in separate cells for research on the Campus of Agriculture and Natural Resources, University of Tehran (Figure 1).

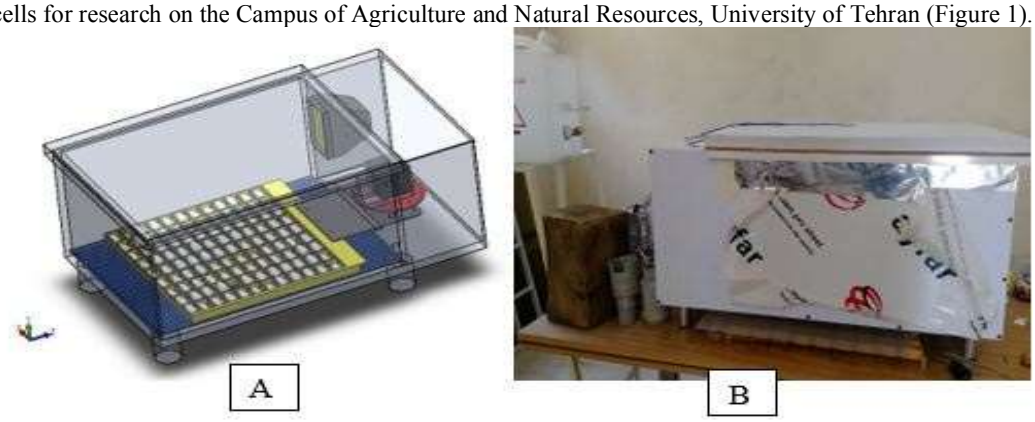

Figure 1. A) Incubator simulated in SolidWorks software B) Developed incubator.

After building the incubator, the machine control system was simulated and launched in Proteus software (Figure 2). In the developed control system, the Arduino Mega 2560 board was used as the central controller, the temperature and humidity were measured by the SHT75 module. The water level inside the humidifier module is monitored by an electric

float. Using a four-channel relay operator, the temperature, humidity, water level in the tank as well as the circulation of eggs are controlled. LCD4 * 16 and KeyPad 4 * 4 modules were used to communicate with the central controller. In order to solve the problem of power outage and shock to the fetuses in case of power outage, the required power of the incubator was provided by $24V_{DC}$ voltage converters so that if necessary, the energy required for the incubator could be supplied from the $24V_{DC}$ battery provide.

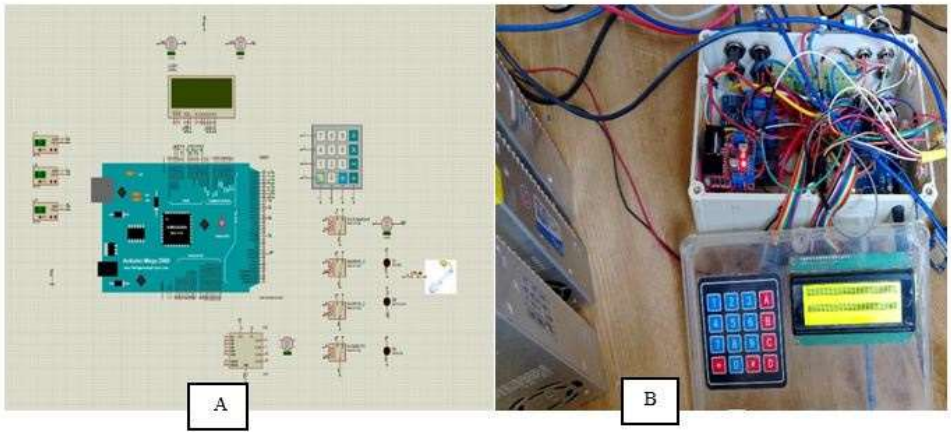

Figure 2. A) Simulated control system in Proteus software B) Developed control system.

In order to use the IoT system inside the incubator, the sim800 module (Figure 3) with the ability to install a SIM card was used. This module sends the temperature and humidity read by the SHT75 module, the water level inside the humidifier module and the spin time of the eggs to the IoT server on the Adafruit site by connecting to the Internet through the MQTT process. The user can visit the site to make the desired decisions. Next, an alarm system was developed by which, in necessary cases, according to the flowchart of Figure (4), an emergency text message was sent to the user to inform the user of the conditions inside the incubator. The order of H_{set} and T_{set} inside the incubator and H_{in} and T_{in} are the humidity and temperature measured by the sensor, respectively. The SIM card number stored in the program is sent to warn the user to prevent possible damage to the incubator and eggs by visiting the IoT server and executing the desired commands or by visiting the location of the incubator in person.

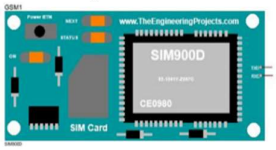

Figure 3. SIM800 module

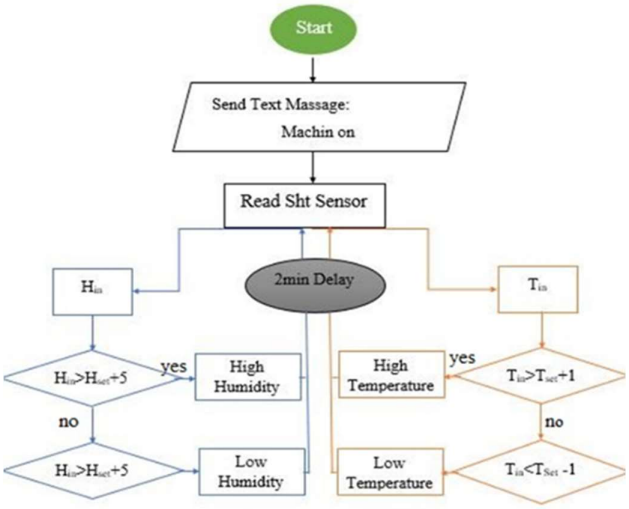

Figure 4. Flowchart of emergency SMS system in incubator.

By applying the command to turn off the machine through the user, the relay used in the power path is cut off for a short time (Figure 5) and the incubator, after turning off and on in standby mode, waits for the control commands to be applied and the user must Presence at the location of the incubator to apply the control conditions.

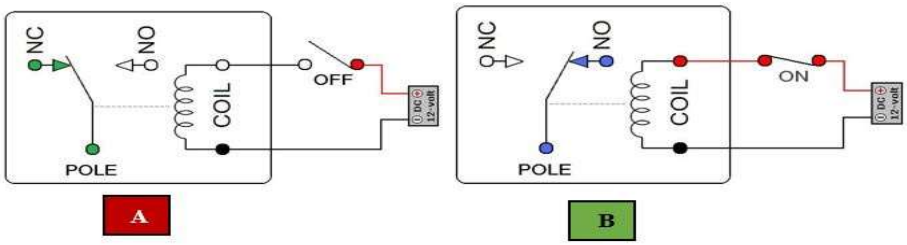

Figure 5. A) Normal mode of the incubator B) Receiving the command to turn off the incubator.

3-Results & Discussion

In this study, measurement and monitoring of all parameters including temperature, humidity, egg circulation and water level inside the humidifier module were successfully monitored and controlled. Also, in the developed program, remote control of the device (Figure 5) was successfully performed. Figure (6) is a page created in the Internet of Things cloud. Figure (5) shows the instantaneous data on temperature and humidity as well as the water level inside the humidifier chamber in the incubator.

Figure 5. IoT page created in the incubator developed.

The control system test was successfully evaluated in order to cut off the power in the circuit, by touching the power button on the Internet, the developed objects of the incubator were put into standby mode after turning off and on. The SMS system was also successfully evaluated, Figure (6).

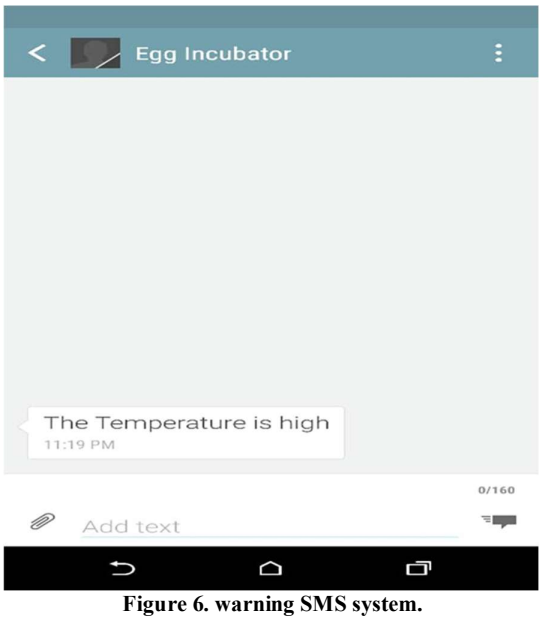

Figure 6. warning SMS system.

In this study, in comparison with the researches done by Sebastian, *et.al*, and Purwanti, *et.al*, from the Ardino board, which is a cheap board, all the factors inside the incubator were monitored. Turns off the cache, also sends a short text message to inform the user of the necessary conditions of the car. This feature is an important application, especially for rural areas where the Internet speed is low. Also, due to monitoring the duration of the method and turning off the water flow valve, the amount of water used in the incubation process can be measured.

4-Conclusion

This study describes the implementation of a prototype of a remote monitoring and control system on a low capacity incubator. In this project, using the Internet of Things, the ability to monitor and control the operating conditions online on the incubator has been provided in order to increase the incubator efficiency without continuous presence in the incubator environment. Using this system, the user can view and control the conditions inside the incubator on a smartphone, tablet or laptop by connecting to the Internet, so that the user can be informed about the operating conditions of the incubator online for a small fee.

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