Smart Poultry Farm Based on the Real-Time Environment Monitoring System Using Internet of Things

Sittichai Choosumrong[1]*, Venkatesh Raghavan[2], and Thitisak Pothong[1]

Abstract

Nowadays, a small breeder affected by the changing of weather or the environment within the livestock farm. It is a cause various effects such as growing rates, the decrease of yield and the likelihood of disease within the farm has increases whether the dairy farm and beef cattle, pigs, broilers etc. If there are tools that help to notify the unusual environment of the henhouse it can help farmers to solve such problems. Such accidents occur due to temperature changes, relative humidity and the increasing of ammonia as the impact on animals, etc. Even though some companies had imported or built the real-time sensing controller and alert system of environment for the farm animals for to sell. But a price of up to 2-3 billion baht, which is especially unsuitable for the production of livestock for small-scale farming according to the high cost. In this paper, we have proposed and developed a real-time environment monitoring system, such as air temperature and humidity, ammonia and brightness, for poultry farm with a low-cost based on Internet of Things (IoT) technology. The data acquired from the sensor and real-time recording in to sd-card. The feasibility of the developed system was tested by deploying the proposed system at Department of Agriculture Science's research poultry farm in Naresuan University, Phitsanulok, Thailand. The most vital climatic factors for the productivity of a poultry farm are temperature and humidity and their maintenance. For instance, a day-old chicken requires 27^{o}C at a relative air humidity of 70%. If the outside temperature is 25 $^{\circ}$C and the air is headed straight into the zone occupied by the nascent birds without being heated first, then weather conditions would be too harsh. Therefore, proper heating/cooling solution should be provided along with appropriate ventilation. With advancement in IoT, it is possible to automate the monitoring and automatically regulate these climatic parameters instead of using the conventional monitoring methods.

Keywords : Environment monitoring, Sensor network, Poultry farm, Internet of things

[1]*Faculty of Agriculture Natural Resources and Environment, Department of Natural Resources and Environment, 99 Moo 9 Tambon Tha Pho, Amphoe Muang, Phitsanulok, Thailand 65000, Office: +66 55 962756,Mobile: +66 91-767-2963

[2]Graduate School of Engineering, Osaka City University,3-3-138 Sugimoto, Sumiyoshi-ku, Osaka 558-8585, Japan.

*Corresponding author email: sittichaic@nu.ac.th

Introduction

With the large- scale intensive poultry model increasingly promotion and popularization of farming, in order to improve the yield and quality, prevent poultry diseases, we need a monitoring system for the poultry house temperature, humidity, NH3 and illumination parameters. The suitable environment can give full play to the potential egg production on layers and chicken meat. Nowadays, with the rapid development of Thai breed poultry, there are a large number of laying hens specialized culturist in rural areas and small-scale farmer. Due to farmers generally lack adequate fund and appropriate field, when building the poultry farm (henhouse), they always didn’t built a new one, but reformed an old house which they had built. Most these henhouses are provided with simple facilities and automated level is low, lack of the ability of monitoring and controlling the henhouse environment which severely restricted the production of eggs or chicken meat. Therefore, enhancing the automation and specialized level of regulating equipment’s of the small henhouse were imperative (Wu *et al*., 2011, Chakchai, 2012).

Information management is becoming an increasingly challenging task for many field of works (Choosumrong *et al*., 2016) such farmers especially in terms of the amount of data and the complexity of processes in integrated poultry farms management cultivation (Sravanth Goud and Sudharson, 2015). In advanced poultry farms, various measurement spots are required to record the parameters defining the local climate at different parts of the large poultry farm to make the automation and control system work efficiently. However, due to the high cost of such a sensing and controlling system it is not suitable for the small-scale farm or the rural farmer.

Since the researcher and students at the Department of Agriculture Science’s research poultry farm in Naresuan University, generally lack of the ability to monitor the environment air and to acquire the real-time data inside the henhouse for their own research. Thus, they need a tools with not high cost to help to monitoring and recording the environmental data inside the henhouse. Moreover, to control the environment parameter which can be effect to the growth of the chicken.

In this research explores the creation of fully customized low-cost environment sensor station, based on the open design and open source software for poultry farm environmental monitoring and testing its feasibility with a simple experimental setup.

Conceptual framework and methodology

A very systematic approach was considered for the overall design of the project, in which 4 parameters were monitored. The temperature, humidity, NH3 and light sensors were used to monitor the henhouse and the measurements data had recorded into SD-card based on Arduino data logger.

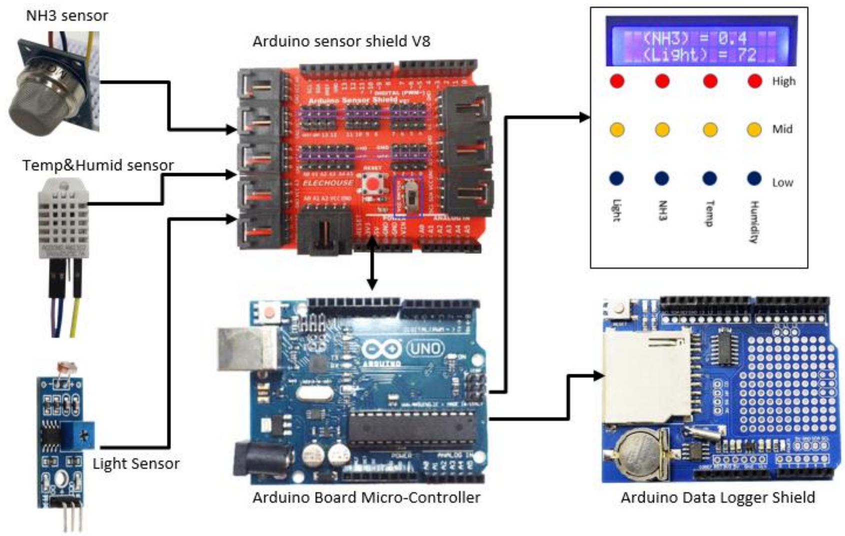


Figure 1 Generic design of a Wireless Sensor Network for poultry farm

Figure 1 is shows the required elements has brought together for an effective sensing, data display and real-time data recording of environments in henhouse. Figure 2 show the step of flow chart over all process of this works.

2.1 Hardware Description

2.1.1 Micro-Controller

Since Arduino systems are open source software programmable, it belongs to the owners to generate the actual program that will process the Arduino stack. This is a strong advantage, as it is possible to custom build a generic tool, then customize it to conditions, environments or experiment to know/control more uncertainties using open source hardware and open source software (Pearce, 2013b; Pearce, 2014). The Arduino UNO R3 board used the ATmega328, was selected as the microcontroller for this project. This was an ideal selection, as the processor is extremely strong and cost efficient. An input voltage ranging from 7-12V is required, which corresponds with the humidity sensor. An on-board 10 bit analog to digital converter (ADC), aids in the digitization of the analog signal acquired from the sensor. The Arduino has a serial port to allow communication with the computer. The USB connection from the computer goes directly onto the Arduino board, where a USB to serial converter than allows communication to occur.

2.1.2 Arduino Sensor Shield V8

Arduino sensor shield was designed to help Arduino users to connect various sensor modules easily. It saves much trouble for users to do the wiring, especially when there are so many modules connecting to Arduino.

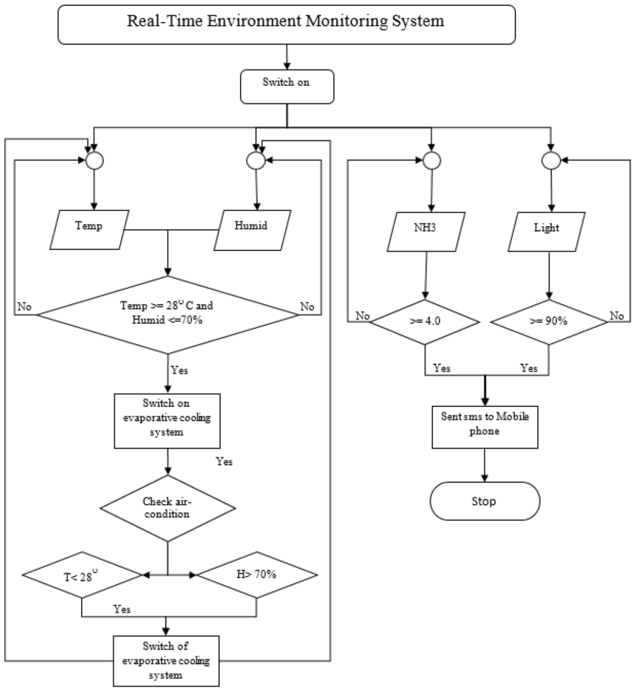


Figure 2 Flow chart over all process

2.1.3 Arduino Data Logger shield

This data logger shield provides an Arduino Uno, Leonardo or Mega with the ability to log sensor data to an SD card with the minimum of set-up. The shield includes the very popular DS1307 battery backed real time clock (RTC). This RTC will keep an accurate track of the data and time for up to several year, even when then shield isn't being powered. A very useful prototyping area consisting of a grid of pads on a stand 0.1" pitch provide an area to add to a components such as sensors to interface to the Arduino board. (http://hobbycomponents.com/shields/587-data-logger-shield).

The Arduino Data Logger Shield and Arduino Sensor Shield is an add-on board to the Arduino, and plugs directly on top of it. One the board are temperature, humidity, light and NH3 sensors. The set once soldered, and mounted, can be programmed through the Arduino board to return the data from all sensors to the session terminal, LCD and display on the LED light, which return as Red, Yellow and Blue colors. Moreover, the data is returned to the terminal in Comma Separated Values from (CSV; *.csv) (Chemin *et al.*, 2014)

System experiment

We have done our experiments in Department of Agriculture Science's research poultry farm in Naresuan University, Phitsanulok, Thailand. The size of the portly farm is 4 x 20 meters (see Figure 3). The poultry farm is mainly divided into three zones for test the system and each zone was monitored by three motes.;1 in the left side in front the evaporative cooling system zone, 2 in the middle zone of the farm and 3 in the right side of the farm in front the blower zone which provides broiler breeder. (broiler hatching eggs). Depending upon zonal chicken population and distribution, each zone has its own local climate (Mohsin et al., 2009). Figure 4 shows the deployment of each motes in poultry farm.

Figure 3 Department of Agriculture Science's research poultry farm in Naresuan University

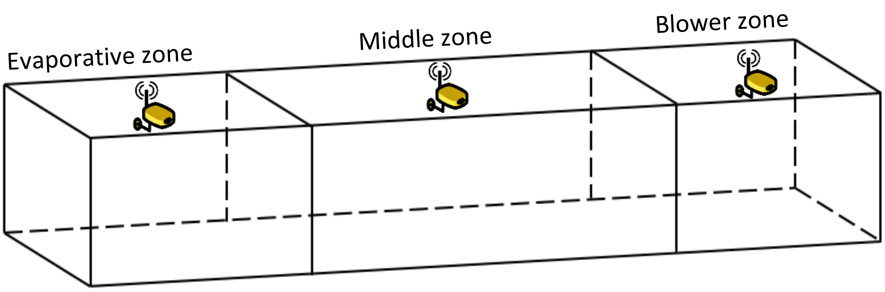


Figure 4 Deployment of each motes in poultry farm

Results

A generic and Environments Sensor Station for Poultry Farm (ESS4PF) was designed and prototyped to fit several research and monitoring requirements in Department of Agriculture Science's research poultry farm in Naresuan University, Phitsanulok, Thailand. The first prototype is shown in Figure 5. Figure 6 show a Arduino IDE software with an example of a specifically designed ESS4PF code and result. The process consist of the temperature and humidity checking for the evaporative controller. NH3 and light are checking limit to more than 4.0 for NH3 and 90% for light, otherwise the system will send SMS to farmer. Real datasets acquired by the system was tested. The system was run for 24 consecutive hours and the data has recorded into the SD-CARD every 1 hour as shown the example data in Figure 6. In our monitoring step, 3 motes were deployed in the poultry farm to acquire information about the difference in varying climate variables. In the 24 hours period, every mote measured light, NH3, temperature and relative humidity values. Figure 7 (a,b,c,d) showing the graph of acquired data every 15 minutes in 24 hours of environmental data value inside the research poultry farm. In Figure 7 at 18:02:01, one can see the relational between temperature, light and humidity. When farmer open the door to get inside the poultry farm, temperature and light is increasing in the same time due to the outside temperature and light is higher than inside. When temperature and light in increasing then, the humidity is dropping as shown in the graph.

(a) (b) (c) (d)

Figure 5 (a) the first prototype when not turn on and (b) the first prototype when it is recording and showing the result (c) and (d) is showing the system hardware inside the box

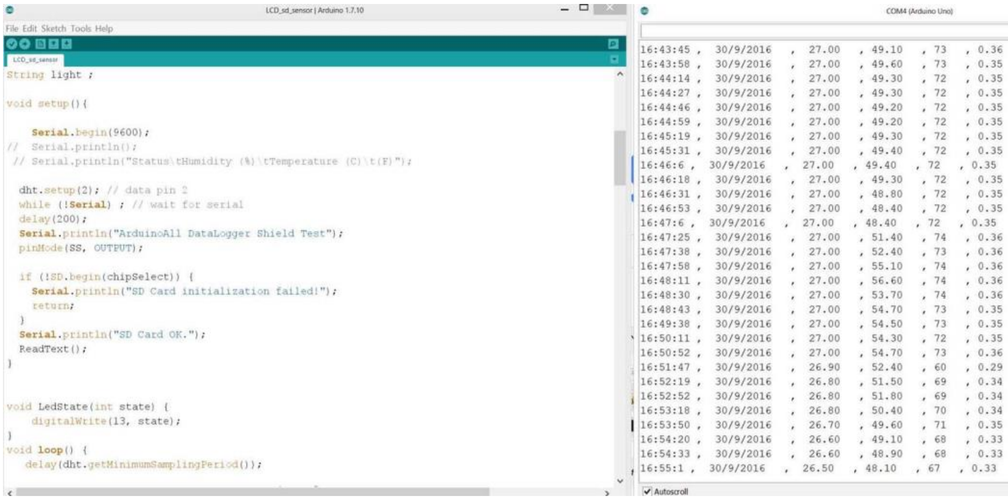
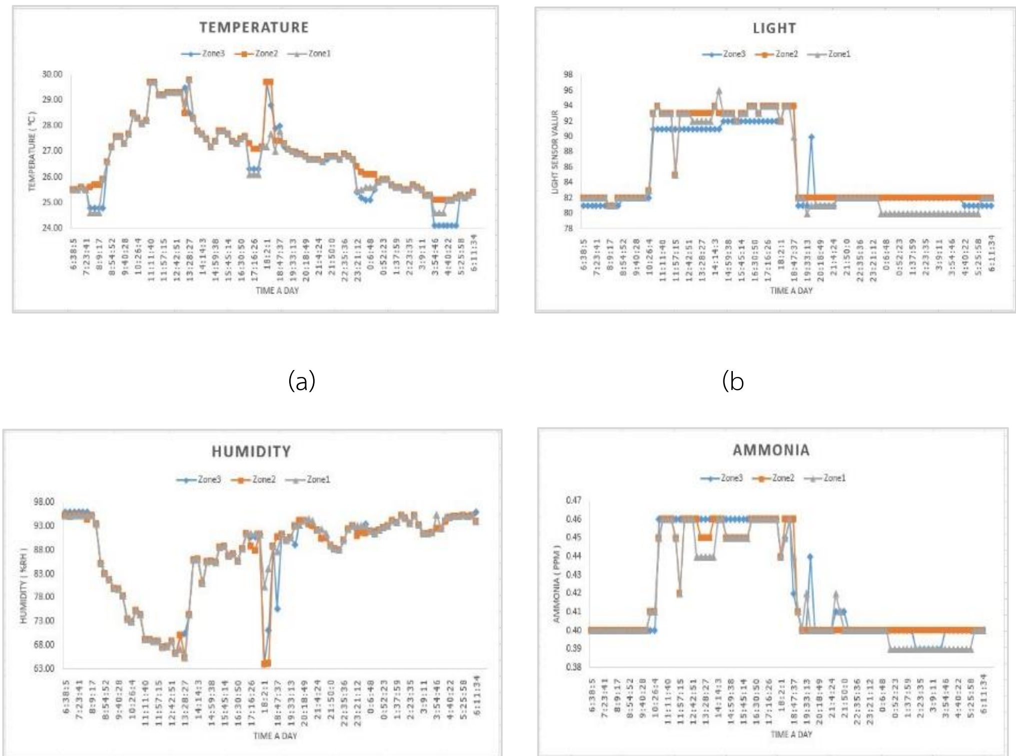


Figure 6 Example of a specifically designed ESS4PF code



(a) (b

(c) (d)

Figure 7 Environmental parameter variations within a day

Discussion

Poultry farm in Department of Agriculture Science's research poultry farm in Naresuan University, Phitsanulok, Thailand is lack of knowledge in development of hardware and ESS4PF. Due to farmers generally lack adequate fund and appropriate field, when building the henhouse. Without such an acquired data from ESS4PF, a farmer cannot predict or know that how to control the environmental air inside the henhouse. Daily data correction by human are not enough to capture the rate of individual intensity of environmental values because the data need to correct in 24 hours due to the chicken also growing up every minute in 24 hours. Thus, ESS4PF is the requirement system for the small-scale farmer.

Environment values harvesting depends upon the user and scale of the farm. Therefore detailed statistics of environment is essential in the initial stages of the ESS4PF system. The size of the ESS4PF system should be different area to area depending of the region, topography and type of the henhouse.

Conclusion

In this paper, the design based on IoT was implemented that Open Design, Open Source Hardware and Free & Open Source Software can be used to build an ESS4PF. We have proposed a methodology to acquire the environment data to control temperature, humidity, NH3 and light in a poultry farm. This work has been implemented is done with the help of Arduino UNO for controlling and monitoring.

Monitoring environmental parameters in a real-time are crucial. In this paper, various environmental parameters for effective growth of thickens have been identified and defined. With this initial studies, famer, researcher or students can corrected the environmental data inside the henhouse. The frequency of the recording is depending on how often the need to record the data. The main conclusions that can be drawn from outcome of this research are as below; (a) with low-cost (around 1,000 THB for 1 station), (b) reliable operation, (c) it records what is of interest to the user only, (d) it can improve the production and quality of poultry farms, (e) improve the degree of automation and has a certain significance, and (f) the technology in poultry production has a good promotional value.

Future Development

Some of the enhancements and improvements that need to be considered in future works were; (a) enhancing an environments sensor station by considering additional more environment sensor that might be an impedance factors of production such as CO2, rainfall values etc., (b) improve the ESS4PF by including the GNSS data for each station, ZigBee wireless sensor to sending real-time data correction to the server, and (c) enhance the remote controller system using IoT and smart phone technology to switch on either sprinkler or evaporation system based on threshold values of temperature and humidity

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