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Smart Farm Monitoring Using Raspberry Pi and Arduino

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Abstract—**This study aimed to investigate an establishment using an Intelligent System which employed an Embedded System and Smart Phone for chicken farming management and problem solving using Raspberry Pi and Arduino Uno. An experiment and comparative analysis of the intelligent system was applied in a sample chicken farm in this study. The findings of this study found that the system could monitor surrounding weather conditions including humidity, temperature, climate quality, and also the filter fan switch control in the chicken farm. The system was found to be comfortable for farmers to use as they could effectively control the farm anywhere at anytime, resulting in cost reduction, asset saving, and productive management in chicken farming.**

Keywords—Embedded System; Raspberry Pi; Arduino; Android; Smart Phone;

I. INTRODUCTION

Thailand was considered as an agricultural wealthy country in terms of food and environmental resources. Nevertheless, such prosperity was gradually regressed directly contributing to a low agricultural productivity and farmer incomes. The farmers additionally lacked insights in agricultural marketing strategies and high quality production planning. [1]

According to world's agricultural produce, chicken is the most favored produce, since it is a nutrient-rich food providing high protein, low fat and cholesterol, and lower energy than other kinds of poultries. Also, it is quite easy to look after and propagate its species. [2] For 5 years, the chicken production in Thailand has been increasing on an average of 4.63% yearly because of standardized farming management and good manufacturing practices, leading to more chicken consumption and an increased export number of both domestic and international destinations. On the other hand, a lacking of labor in chicken production processes has affected fresh chicken export, which is found to be the principal problem. [3] Another significant obstacle can be wrong knowledge sharing and folk wisdom in chicken farming which effects efficiency.

This study aims to set up a new model by using a modern technology applied to chicken farming known as a "Smart Farm" or "Intelligent Farm", which is expected to clear up the farming problems. Smart Farm could perceive any changed information derived from a semi-automatic microprocessor, alarming all notification to a connected personal computer. The farm monitoring could be conducted via application programs on smart phones for convenience use, time saving, and increasing labor reduces.

II. RELATED WORK

This research has focused on the use of modern technology to help manage animal farming, which means farm management automation in various ways. Manakant Intarakamhaeng and et al [4] studied the model of farm management automation technology with RFID, Result; the adoption of RFID, or radio-frequency identification of objects and animals including 5 kinds of animal: cattle, buffalo, sheep, pigs and rabbits were successfully individually identified and recorded automatically.

Md Saifudaullah Bin Bahrudin and Rosni Abu Kassim [5] presented a fire alarm system in a real-time monitoring system that detected the presence of smoke in the air due to fire and captured images via a camera installed inside a room when a fire occurs. The embedded systems used to develop this fire alarm system were Raspberry Pi and Arduino Uno. The key feature of the system is the ability to remotely send an alert when a fire is detected. When the presence of smoke is detected, the system will display an image of the room state in a web page. The system will need the user confirmation to report the event to the Firefighter using a Short Message Service (SMS). The advantage of using this system is that it will reduce the possibility of false alert reported to the Firefighter. The camera will only capture an image, so this system will consume only a little storage and power.

Kumar and Hancke [6] presented an animal health monitoring system (AHMS) for monitoring the physiological parameters such as rumination, body temperature, and heart rate with surrounding temperature and humidity. The developed system could also analyze the stress level corresponding to thermal humidity index (THI). The IEEE802.15.4 and IEEE1451.2 standards based sensor module was also developed successfully. The zigbee device and PIC18F455 microcontroller were used in the implementation of sensor module. The graphical user interface (GUI) is implemented in LabVIEW 9.0 according to the IEEE1451.1 standard. The real

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time monitoring of physiological and behavioural parameters can be present on the GUI PC. The device is very helpful and a inexpensive health care of livestock. A prototype model was developed and tested with high accuracy results.

From the above.There are many new technologies that can be used in a more efficient management of farms. The authors study has focused on the importance of modern technology of Raspberry Pi, Arduino and Smart Phone combined with chicken farming.

III. Concept Diagram

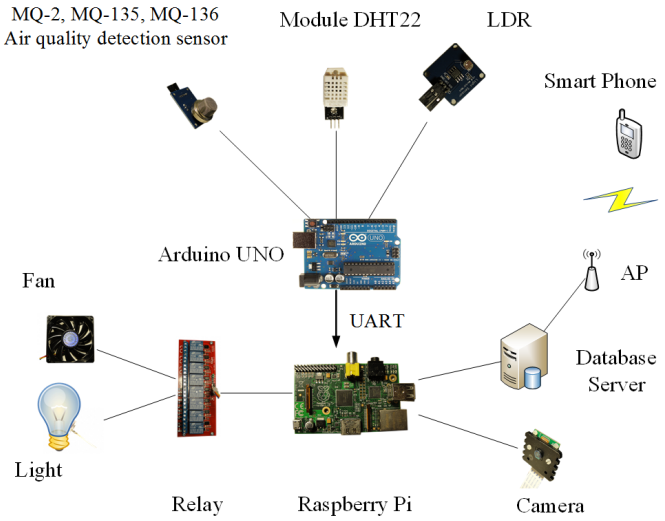

Fig. 1: Full Block diagram of the system.

IV. System Overview

Shown in figure 1, components of the automatic farming system on Raspberry Pi Model-B and Arduino Uno are demonstrated. The system can notify using a real-time alarming system to smart phones reporting such as the current and daily highest/lowest temperature, humidity, and weather quality of the farm surroundings. Users can also control the filter fan switches and customize the notification system to the smart phone.

V. Methodology

A. *Raspberry Pi*

Raspberry Pi [7] is a small computer board working on the Linux operating system which connects to a computer monitor, keyboard, and mouse. Raspberry Pi can be applied to a electronic structure and programming network work, it can also served as a personal computer and Apache Webserver, MySQL could be installed in the board.

A GPIO [10] pin can be used as either a digital input or a digital output, and both operate at 3.3V. Unlike the Arduino, the Raspberry Pi which does not have any analog inputs. For that you must use an external analog-to-digital converter (ADC) or connect the Pi to an interface board must be used.

B. *Arduino*

Arduino is an open-source microcontroller compatible with developed platforms. The controller appears not to be expensive and uses low electrical power, 5.5 volts. C and C++ were employed for this development. Arduino can connect to a computer via the Universal Serial Bus (USB) and perform with compatible connected accessories in both analog signal and digital signal.

The Arduino [9] is a microcontroller platform, mounted on a board that plugs easily into most computers. It allows the user to program the onboard Atmega chip to do various things with programming language, in programs called sketches.

C. *Humidity Sensor module*

Environmental conditions directly affect animal livelihood contributing to some chronic epidemics such as Bird Flu and Hand Foot and Mouth Disease. Therefore, DHT22 is use as a censor for measuring temperature (for both Fahrenheit and Celsius value) and humidity. The measurement unit will be demonstrated in a digital signal form.

D. *Gas Sensor module*

The module works as a Air Quality Detection Gas Sensor, this is sensitive to gas dangerous to human, applied to measure NH3, NOx, Alchohol, Benzene, CO, and CO2. The module is also used for controlling weather conditions and air cleaners in buildings. The measurement unit is presented in a analog signal.

In this research, three censor forms were used, consisting of MQ-2, MQ-135, and MQ-136 because of its gas measurement differences.

E. *Photosensitive sensor module (LDR)*

A light sensor was used for measurement of light intensity especially for naked eye light, its unit is called Lux [8].

Light Dependent Resistor (LDR) is a light sensitive resistance changing electronic resistance when there is a light incidence, called Photo Resistor or Photo Conductor. The resistor was made from Semiconductor, Cadmium Sulfide (Cds) or Cadmium Selenide (CdSe). These two substances are semiconductors coated in a ceramic sheet as a base.

F. *Hardware connection*

The Raspberry Pi and Arduino were connected via UART. The connection was a serial communication as Full Duplex since there was two-ways that data could be transmitted via pin TX and RX.

A direct connection between the Raspberry Pi and Arduino was prohibited, because of its electrical potential differences, which is 3.3 volts for the Raspberry Pi and 5 volts for the Arduino. Bi-directional Logic Level Converter should be used to separate them.

Fig.2: Bi-directional Logic Level Converter.

A connection between a camera and Raspberry Pi by applying Common System Interface (CSI) serves as a point-to-point connection, providing a fast data transmission and low energy consumption.

MJPG-Streamer is a basic program command copying data from a single input to multiple outputs. A photo could be presented in a network system accessing from a web browser on a computer. In this study, a photo from a camera would be taken to demonstrate on a smart phone.

All sensors would be connected via Board Arduino and the data would be transmitted from UART to Board Raspberry Pi. Raspberry Pi works as a controller of a ventilator, notifying a working condition to the smart phone and served as a data sender to store in a server computer.

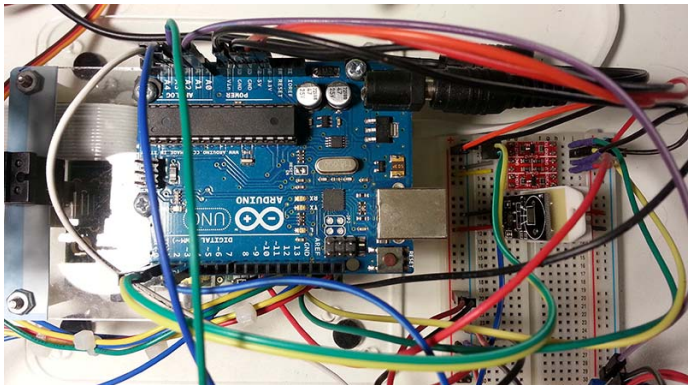

Fig. 3: Shows the connection of the circuit.

G. Software

A connection between Raspberry Pi and smart phones was investigated in this study. Programming of a communication between a server and a client consisted of two perspectives. The Raspberry Pi would check whether there was any connected clients, if so, a mutual data transmission would be done. By doing this, an application would send the data via Socket referring to IP Address and Port in Transport Layer using TCP protocol.

Linux was the main operating system used for Raspberry IP. In this research, Raspbian Wheezy, an efficient operating system confirmed by the producer, was installed on a SD Card via Application Win32 Disk Manager. After the installation, IP Address configuration, camera configuration, UART connection, and Apache Webserver installation would be conducted.

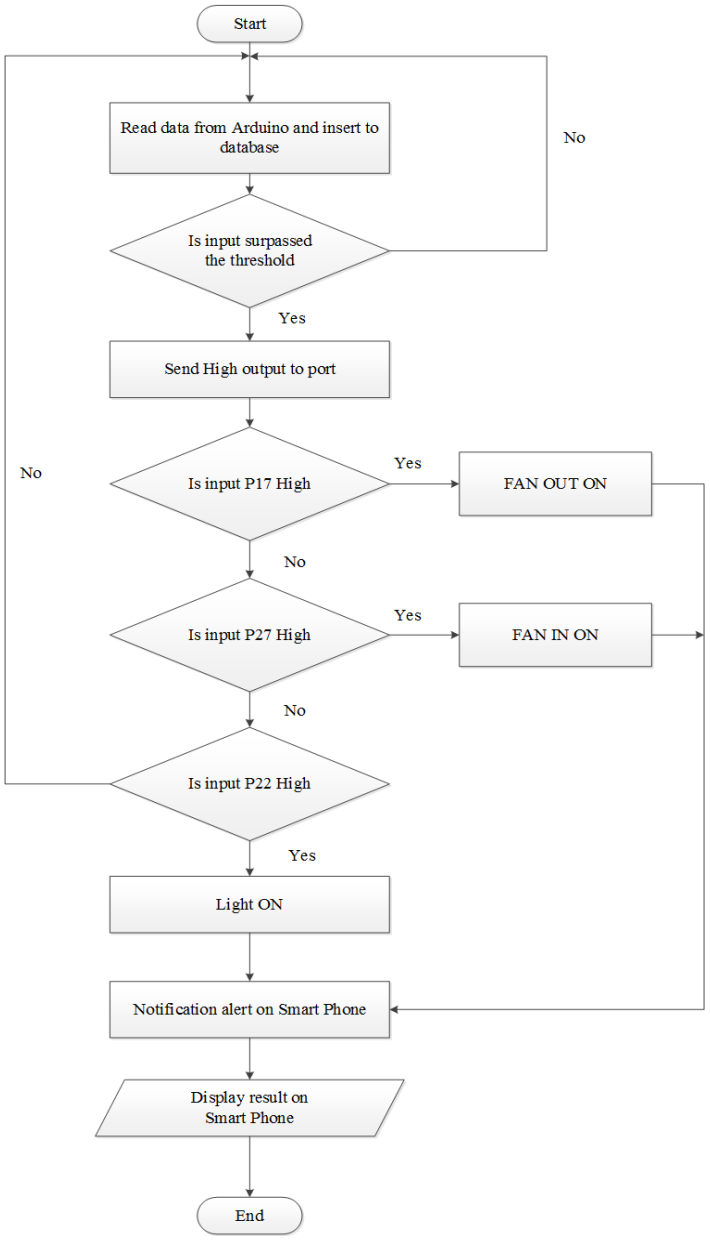

Fig.4: Flowchart of the Python programming in Raspberry Pi.

Python programming is applied for the development of Raspberry Pi. Python would read the Arduino signal value via UART and then collect the obtained signal to the database for processing. If the value surpassed threshold, the over signal would be sent to GPIO pins to aware the analog signal. In case of high quality data, a “High” signal would be sent to GPIO pin 17 and the ventilator would erase the internal air (Fan out on). In case of high temperature, a “High” signal would be sent to GPIO pin 27 and the ventilator would work automatically (Fan in on). In the event of luminescence change, the data would be sent to GPIO pin 22 and electric lamps would be opened. Conveniently, working of

accessories could be customized by the user as mentioned in Fig. 4 expressing the flowchart of the Python programming in Raspberry Pi.

Another important thing is that this Smart Phone works with the Android OS. Developed applications are on the Android operating system using the Java language and interacted with the Raspberry Pi through the wireless network. This will take the value from the Arduino to read displays such as temperature, humidity, light, toxic gases, etc. It's able to control fans and lights, and can be tracked via the internet at any time.

VI. EXPERIMENTAL AND RESULTS

In this paper, the model developed has led to a trial in the environment and climate of a chicken farm, using the default configuration notifications via Smart Phones.Shown in table 1 below.

TABLE 1.The default configuration notifications via Smart Phones.

List	Up to the Alert
CH4	50%
H2S	30%
NH3	50%
Maximum temperatures	30°C
Minimum temperature	25°C
Lighting	50%

According to figure 5: The display of the program first allows the users to choose from 4 menus consisting of status, camera control, work yourself, and set up alerts.

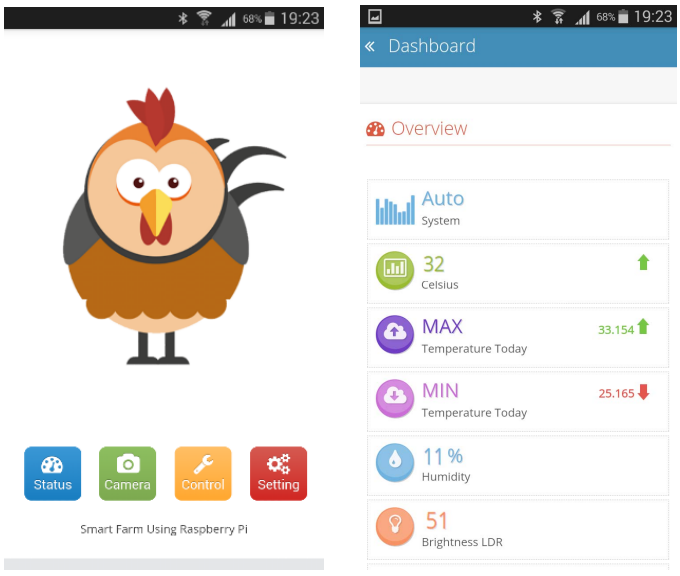

Fig. 5: Shows the main screen and the system status screen on the Smart Phone.

Screen: Dashboard presents the value of the farm environment Spanning; current temperature, maximum-minimum temperature, moisture in the air, light, amount of methane, ammonia gas, and hydrogen sulfide gas.

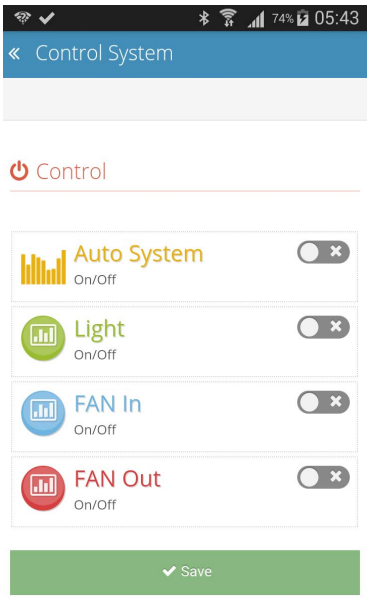

Fig. 6: Screen control system.

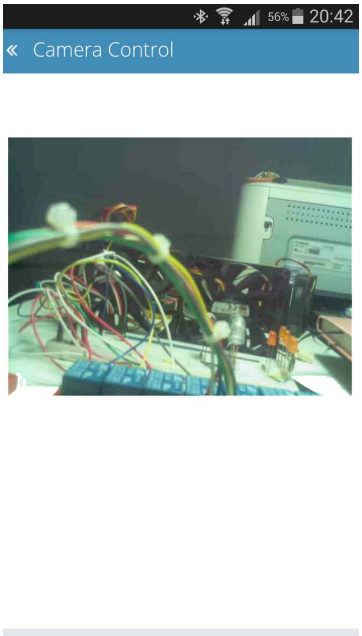

Fig.7: Screen self- image through the camera.

Shown in figure 6, the control system displays the controls of lights and fans. By selecting Shutdown, the system will be automatic and turn control the device by itself.

The camera control screen will show the Farm in real time.

Fig.8: Screen when the alert system malfunction occurs.

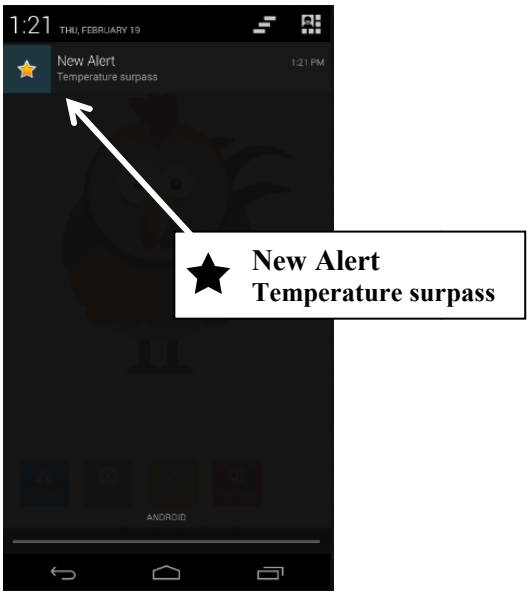

Fig.9: Display notification when a fault occurs.

Shown in figure 7 and 8, a notification from will be sent by the system when a problem occurs at the farm, such as temperature higher than a predetermined value, excessive amounts of hydrogen sulfide, the humidity is too high, etc.

VI. CONCLUSIONS

The embedded system is innovative for chicken farming, which changes a traditional farm to a "Smart Farm" or "Intelligent Farm". In addition, the system could work on applications of smart phones helping the farmers to control and monitor real time environmental contexts such as temperature, weather condition and quality, humidity, light and filter fan switches. The intelligent system can reduce cost, time, and labor and is highly user friendly for farmers.

In the coming future, Raspberry Pi Model B should be changed into Raspberry Pi 2 because of its more effectiveness and server working reduction. All collected farming information should be sent from the server and stored in a new system. Moreover, a livestock feeding system should be also developed to make this a more complete system.

Acknowledgment

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