A Preliminary Study on Poultry Farm Environmental Monitoring using Internet of Things and Blockchain Technology

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Abstract— **This paper presents the application of Internet of Things (IoT) and blockchain technology in poultry industry. Production of poultry is highly depending on the environment parameter like temperature, humidity, air and lighting to maintain and to boost the production of poultry. Monitoring all the environmental parameters is crucial for a large poultry farm, especially in traditional way. Recently, the adoption of IoT and Blockchain is used for monitoring and controlling the farm automatically. It is proven that it can reduce cost and the poultry farm well-managed. At first, the data of temperature are monitored using IoT-based temperature and humidity sensor and recorded in JSON format. From the results, the data is successfully transmitted to IOTA blockchain. Blockchain will ensure the data is secured and transparent to consumers.**

Keywords— poultry, IoT, blockchain, IOTA, environmental monitoring

I. INTRODUCTION

Production of poultry is influenced by environmental of poultry farm. Environmental parameters like temperature, humidity and air are important to monitor and to control in order to boost the poultry production. In addition, the production of poultry is also influenced by proper nutrition. Malnutrition may cause by improper feeding; which organised manually by manpower. Hence, feeding and watering system should be designed automatically in order to feed the poultry properly as well as to avoid wastage.

The operational of poultry farm is tremendous and limited when using manpower, especially in a large farm. As the environment of poultry farm has to monitor regularly, farmers need to inspect all the environmental parameters manually. Therefore, with the implementation of IoT in poultry farm, it could reduce cost, manpower and manageable. Blockchain is a digital ledger in which transactions made are recorded chronologically and publicly in chain of blocks produced cryptographic algorithms. Commonly blockchain is the engine behind the cryptocurrency that ensure the integrity of the data decentralized and secured. There are many blockchain technologies such as Ethereum, Hyperledger, NEM and NEO. Since IOTA is the blockchain technology [1] that was designed for IoT, then we will be using IOTA in this study. IOTA allows computer computers in IOTA network to transfer immutable data and value among each other. IOTA aims to improve efficiency, increase production and ensure data integrity in machine-to-machine economy.

II. FRAMEWORK OF SMART POULTRY FARM SYSTEM

Smart poultry system can be defined as an automatic poultry farm, where the farm can be monitored and controlled without the presence of farmers in the farm. Most previous studies monitor and control environmental of poultry through smartphone or webpage. Environmental parameters like temperature, humidity, lighting and ventilation are measured by sensors and integrated with microcontroller. The sensors data then is transmitted to webpage or smartphone. In addition, some studies also included automatic feeder and watering system in their proposed systems.

In [2], monitoring and controlling of poultry farm using wireless sensor network has been performed. In this study, the combination of wireless sensors and mobile system network is implemented in order to remotely manage and monitor environmental parameters in poultry farm. Environmental parameters such as temperature, air and light are monitored and controlled. All sensors are integrated by microcontroller R5F100LE.

A review study that performed in [3], has suggested poultry farm could be monitored and controlled by the used of Raspberry Pi3. Environmental parameters like temperature, humidity and air are measured by four sensors (smoke, temperature, humidity and gas sensor), while watering system is controlled by float sensor. All the sensors are integrated with Raspberry Pi3 which can control and monitor data.

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Progress of IoT application in poultry industry further enhanced by providing database of environmental parameters for further analysis. Study of [4] proposed a system for monitoring condition of poultry farm via data that stored in the cloud. Farmers could freely access the data in real-time using computer or smartphone. In this study, temperature, humidity and air are measured by different sensors. Farmers could control the environmental parameters automatically once threshold value of the sensors is exceeded. In the case of air, ventilation fan is ON when amount of ammonia gas and carbon monoxide exceeded the threshold value. While cooling fan and exhaust fan are used to control temperature and humidity of poultry farm, respectively. Furthermore, the proposed system has implemented watering system, in order to control level of water. All the sensors are connected to Arduino board (MEGA 2560) and all the sensed data are sent to the cloud by ESP8266 Wi-Fi module.

Another smart poultry system is developed in [5]. Environmental parameters of poultry farm like temperature, humidity, air and light are monitored and controlled through smartphone. In addition, the data of environmental parameters that integrated by Arduino UNO are stored in remote server through Raspberry Pi2. In this study, fan is used for controlling humidity and temperature. The fan is ON when humidity and temperature level are exceeded threshold value.

In [6], farmers able to access condition of poultry farm in Google spreadsheet, either via smartphone or webpage. Farmers could control the poultry environment through smartphone once they obtain an alert message from the sensors. In this system, temperature, humidity and water level are measured using LM35, HIH4030 and HC-SR04 sensors, and integrated with CC3200 ARM cortex and M4 microcontroller for remote monitoring.

Furthermore, in the study of [7], researchers developed an automated Environment Controlled Poultry Management System (ECPMS) using Raspberry Pi as a Linux embedded system board and Arduino UNO board as for interfacing with different sensors. For web application setting, this study has implemented LAMP architecture on a single-board computer (RPI) which consists of database server and web server. In this system, poultry environment is monitored through temperature, humidity, light and air sensors. As a consequence, this system reduces complexity of integration, deployment and management since the database server, web server and services are integrated on a single board computer (RPI). The study also compared the average computation time elapsed in the communication between RPI and user device (Wi-Fi and cellular data networks). Result has shown that shorter delivery time attained for Wi-Fi network, as compared to cellular data.

Study in [8] also implemented LAMP server and web page and mobile application for monitoring and controlling environment of poultry farm and greenhouse. Temperature, soil moisture, air, light intensity and humidity are parameters used to measure environmental of green house and poultry farm. In this study, Node-MCU (ESP8266) controller is used for node monitoring, where it collects data from different sensors. This node is connected to Raspberry Pi, which is configured as a LAMP server. Like other studies, the farmers could control the environment of green house and poultry farm by mobile or webpage. Furthermore, the data is stored into MySQL database on webserver through Wi-Fi.

From the preliminary studies, the operational of poultry farm can be managed automatically, through webpage or smartphone with the implementation of IoT. Then, recent studies have implemented database service, where the environmental parameters can be stored in cloud storage. The purpose of storing data is claimed anonymously for further analysis [4]-[6], [8]-[9]. In IoT-based food industry, the stored data is used for managing supply chain, with the application of blockchain technology. The blockchain technology has been proven as a promising technology towards a transparent food supply chain as well as to secure digital records [9], especially in agriculture sector [10]–[12]. However, the implementation of blockchain in the poultry industry is still infant. To our best knowledge there is no study performed for blockchain technology in poultry industry. Due to good performance that has shown in agriculture sector, it is suggested that the technology can be implemented in poultry industry, so that poultry supply can be sustained and secured. Therefore, in this study, a smart poultry farm system based on blockchain technology is proposed. The system implemented IoT for monitoring temperature and humidity of poultry farm, and blockchain technology for securing poultry supply.

III. Proposed Methodology

In this study, a smart poultry system, based on IoT and blockchain technology is proposed for monitoring environment of poultry farm as well as for storing data securely. Fig. 1 shows the proposed system. For preliminary study, temperature and humidity are measured where correct temperature and humidity are critical to the success of the poultry operation [13]. Therefore, DHT22 sensor and Raspberry Pi 3 B+ board as shown in Fig. 2 are used for measuring the temperature and humidity. The measured data then is transmitted and stored to IOTA blockchain, in JavaScript Object Notation (JSON) format. The data can be viewed by using IOTA Tangle Explorer [14]. For software installation, Adafruit Python DHT is installed for interfacing between the sensor and the board and IOTA Python for IOTA blockchain programming.

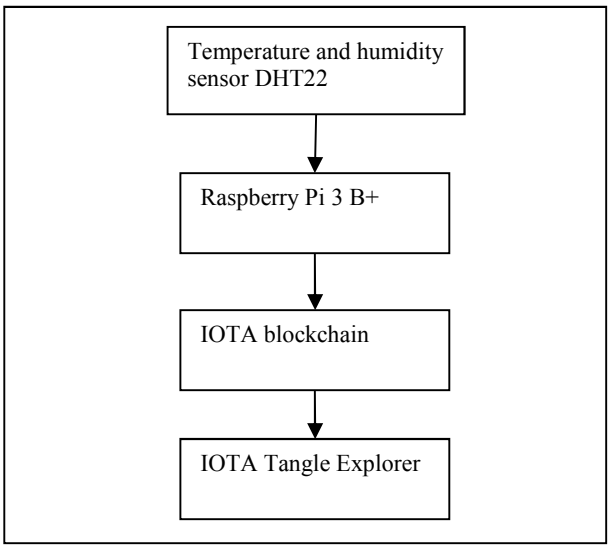
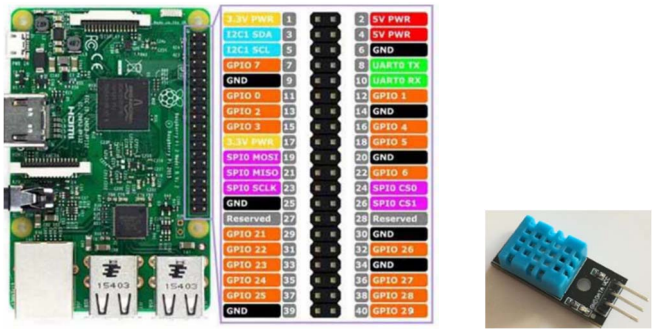


Fig. 1. The proposed smart poultry farm based on IoT and blockchain technology



(a) (b)

Fig. 2. IoT sensor (a) Raspberry PI3 model B v1.2 (b) DHT11 sensor

The dht11-raspi3 project has 4 JavaScript files:

- mam_publish.js: Publishes randomly generated numbers to the IOTA Tangle using Masked Authenticated Messaging (MAM).
- mam_receive.js: Extract the stored data from the IOTA Tangle using MAM and display the data.
- sensor.js: The DHT11 sensor data (temperature and humidity) is read and displayed.
- mam_sensor.js: The DHT11 sensor data is read and published to the IOTA Tangle using MAM.

The mam_publish.js is initially executed to check if we can store data (randomly generated numbers) on the Tangle (see Fig. 3). Copy the root as shown in Fig. 3.

Fig. 3. Terminal for *mam publish.js*

When we open another terminal and type: *node mam_receive.js your root*, the stored data is displayed as shown in Fig. 4.

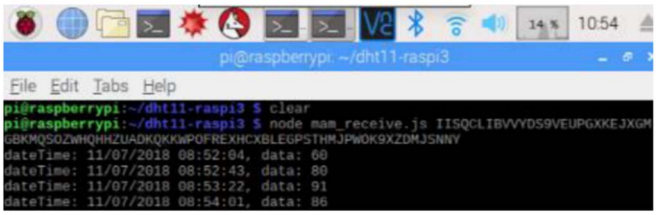


Fig. 4. Stored data is displayed

Next, execute sensor.js to check if the Raspberry Pi can read temperature and humidity data from the DHT11 sensor module.

In the final step execute mam_sensor.js. On fig.5, this script will store the temperature and humidity data from the DHT11 sensor module to the Tangle.

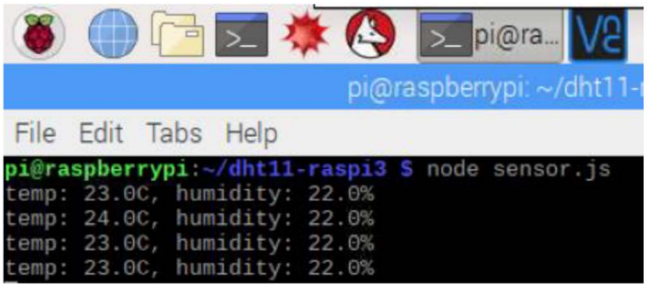


Fig. 5. The DHT11 sensor data is displayed

IV. Results and Discussions

Open a terminal and type: *node mam_sensor.js* as shown in Fig. 6. This script will automatically read the temperature and humidity data from the DHT11 sensor module and sent to the Tangle. Tangle can tolerate conflicting transactions that popped up asynchronously. It believes that any incorrect transaction would be automatically orphaned, or erased, as Tangle keeps on growing. Security wise, Tangle is much more robust in security compared to block chain. The reason is Tangle is built to have a network wide resistance with safeguard.

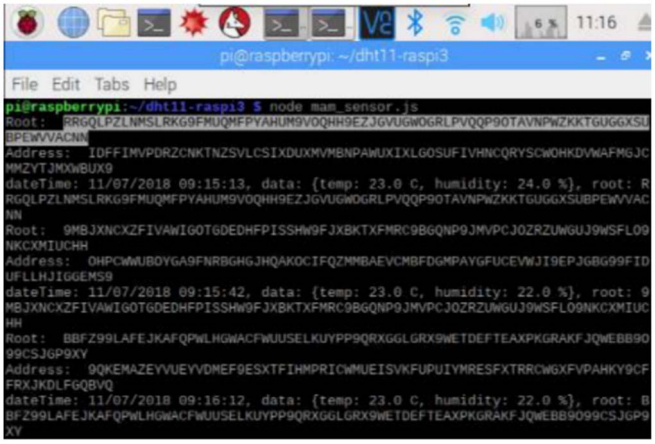


Fig. 6. Terminal for *mam sensor.js*

Each stored sensor data has a separate root. Copy a root which will be used in the next step. Then open another terminal and type: *node mam_receive.js your root,* as shown in Fig, 7.

Fig. 7. The stored data is displayed

The data can also be viewed by using IOTA Masked Authentication Messaging Demo as shown in Fig. 8. This means that the data is successfully stored in the IOTA blockchain.

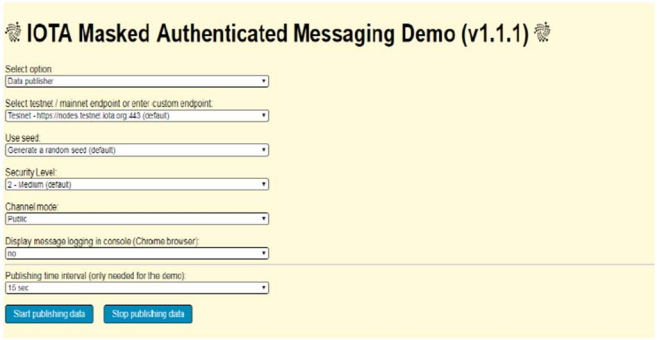


Fig. 8. The stored data on graphical user interface

The temperature and humidity data collected as shown in Table1. Each dataset is collected with its timestamp with average differences of 30 milliseconds. This data was successfully stored in and collected from the IOTA blockchain.

Table. 1. Temperature and Humidity Data Collected from DHT11

Timestamp	Temperature (C)	Humidity (%)
11/07/2018 09:15:13	23.0	24.0
11/07/2018 09:15:42	23.0	22.0
11/07/2018 09:16:12	23.0	22.0
11/07/2018 09:16:42	24.0	22.0

V. CONCLUSION

In conclusion, the proposed system based on the combination of IoT and blockchain technology is successfully developed. At first, the data of temperature are monitored using IoT-based temperature and humidity sensor and recorded in JSON format. From the results, the data is successfully transmitted to IOTA blockchain.

The benefit is that the farmer does not need to record temperature as IoT sensors can automate the environmental reading. This data will then transfer to the IOTA blockchain. This will ensure the data is secured and transparent to consumers.

For future work, it is recommended to implement other sensors in determining more accurate environment of poultry farm with other blockchain technology. Other than that, we hope to improve the security aspects for this technology to reduce the vulnerability towards cyber-attacks and data intrusions.

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