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Blockchain Application for Public Street Lighting in Data Sensor Recording

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ABSTRACT

Public street lighting is crucial to illuminates streets at night to reduce accidents. But one of the weaknesses of LED is their humidity and temperature. To make sure the longevity of the public street lighting, thermals need to be managed. To thermally managed the public street lighting, a way to record humidity and temperature is needed to take action. Blockchain is considered as a replacement to a conventional database due to it being more secure compared to a traditional database. This paper is designing a prototype that utilize a ESP32 microcontroller and an HTU21D as the humidity and temperature sensor. The results shows both from the serial output of the microcontroller and from etherscan.io websites show successful data recording.

INTRODUCTION

Public street lighting is one of the most important lights that illuminates the street at night, especially to reduce accidents [1]. One of the weaknesses of LED is their humidity and temperature [2]. To make an LED public street lighting last longer is to thermally manage it. One of the steps to thermally manage the humidity and temperature of the public street lighting is to acquire the data and temperature of the device especially from the housing. One of the ways to acquire the data is with the use of database [3]. But one of the downsides of using just a basic database is the security aspect [4].

This paper will be exploring the usage of Blockchain as a replacement of the usage of conventional database. Blockchain uses cryptographic encryption that creates blocks that are replicated and chained together so the data is secure [5]. Blockchain also uses consensus method, where the consensus value determined if the data can be validated [6]. This paper will be designing an implementation prototype for a humidity and temperature data recording utilizing a microcontroller and a humidity and temperature sensor that uses blockchain as its database.

THEORY

Luminaire is a tool to create, control and distribute light, which includes one or more lamp, optics, and mechanical component. LED Public Street Lighting Luminaire contains LED Chips, lens/optics, light house and electric driver Figure 1. Every process in this component, the overall efficiency decreases with every component. Optimal temperature for the best efficiency for an LED Luminaire is 20°C [7]. Sensor data recording is important to thermally manage the LED Public Street Lighting Luminaire so that manufacture could the steps necessary to achieve the optimal condition, such as active cooling or adding heatsink.

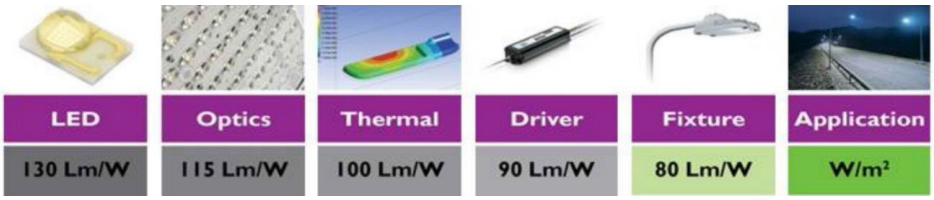


Figure 1. Luminaire Component of LED Public Street Lighting (Source: Philips)

IMPLEMENTATION PROTOTYPE

The implementation prototype built here are consisting of hardware and software design. The hardware design in this prototype consists of a Microcontroller and a Humidity and Temperature sensor. The microcontroller used in this design is an ESP-32 chosen for having a Wi-Fi built in. ESP32 is also used in this prototype because the ESP32 can withstand an operating temperature range between -40°C to 125°C making the ESP32 applicable to be implemented in the real public street lighting [8]. The temperature sensor used in this design is the HTU21D, with the specification of temperature reading between -30°C to 90°C and Relative Humidity range between 5% to 95%[9]. HTU21D can also withstand an operating temperature range between -40°C to 125°C so it is also applicable to be implemented in the real public street lighting [10]. Figure 2 shows the hardware prototype.

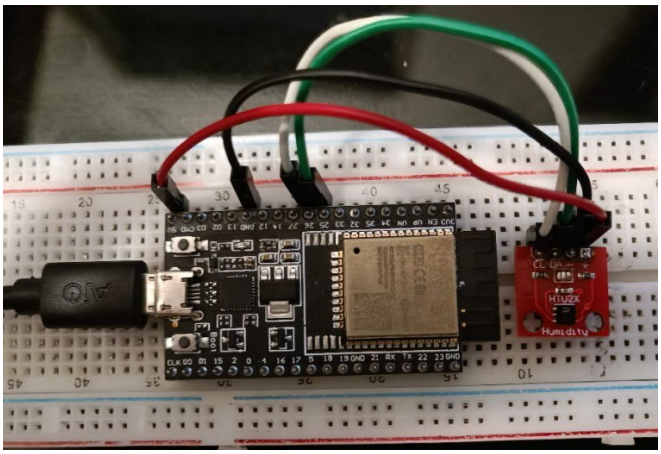
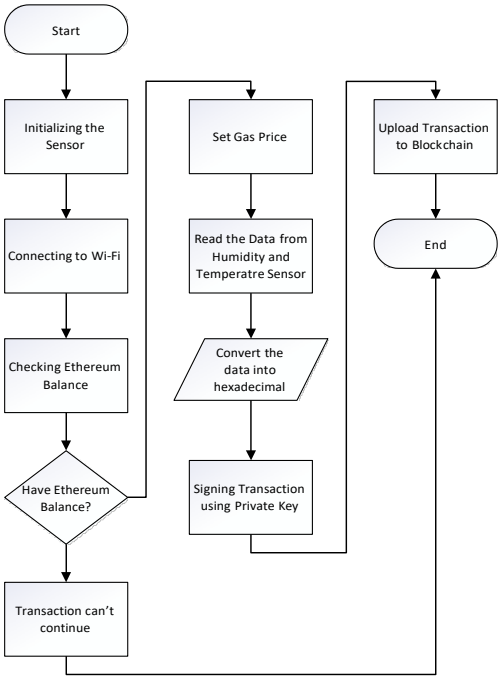


Figure 2. Prototype Hardware Design

The software design in this prototype is the program used to record the data produced by the sensors and upload it into the blockchain. The software design utilizes Ethereum as the cryptocurrency. Ethereum communicates usually using a Remote Procedure Call. This design uses a service called Infura that provides the Remote Procedure Call to communicate into the Ethereum. The software works by first initializing the humidity and temperature sensor, then it connects to wifi. The program then starts to check the user Ethereum balance. If the user Ethereum balance is not zero, the program would prepare for the transaction for Ethereum by setting up gas price. The program then reads the humidity and the temperature from the sensor. The program then convert the sensor reading into hexadecimal then sends it into the blockchain. The program block diagram can be seen in Figure 3.

Figure 3. Software Design Block Diagram



RESULTS AND DISCUSSION

The results from this prototype can be seen both in the serial output from the microcontroller and from "etherscan.io" website. The serial output can be seen in Figure 4 and the etherscan.io website can be seen in Figure 5

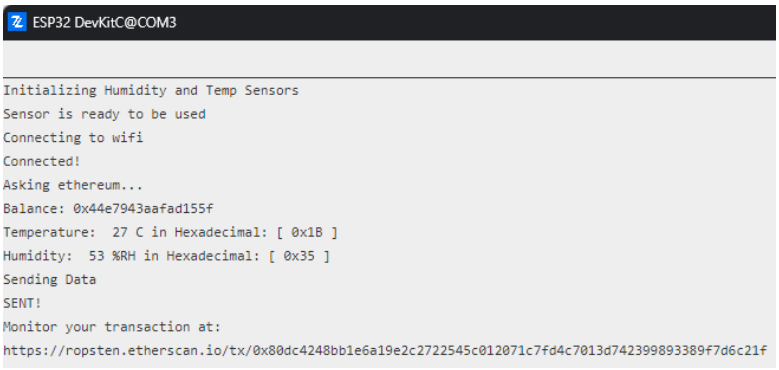


Figure 4. Serial Output from the Microcontroller

From Figure 4 and Figure 5 we can see that the transaction being sent is successful and the humidity and temperature data being sent is recorded successfully in the blockchain. This test is being done 66 times and shown by the nonce number in etherscan.io website on Figure 5.

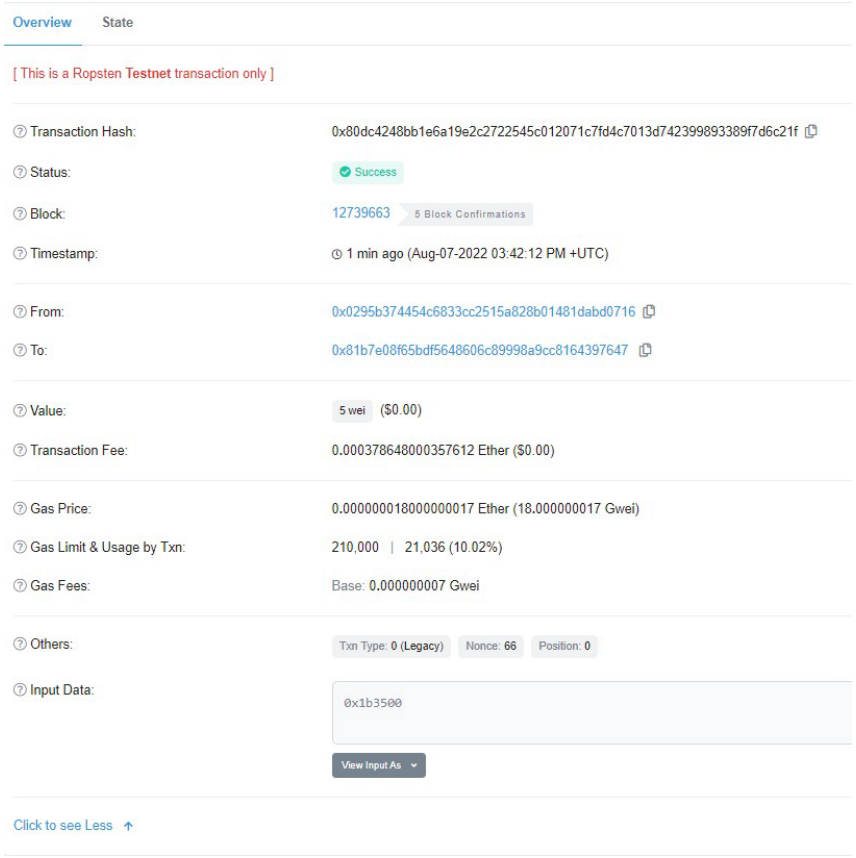


Figure 5. Successful Transaction Seen From etherscan.io Website

CONCLUSION

After 66 times of testing, the results show success in the humidity and temperature data recording using blockchain. This is shown in the results from the etherscan.io website and the serial output from the microcontroller. This prototype can also be tested to be used in the real public street lighting because the device in theory could withstand operating temperature for extreme case of ambient temperature.

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