THE INTERNATIONAL CONFERENCE ON THE 120TH ANNIVERSARY OF THE BULNAY EARTHQUAKE: ADVANCES IN ASTRONOMY AND GEOPHYSICS

MONITORING DEVICE FOR AN EARTHQUAKE EARLY WARNING STATION BASED ON STM32 CONTROLLER

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ABSTRACT

Many countries around the world utilize seismic early warning systems to reduce risks and prevent damage caused by earthquakes. A key component of such systems is the continuously operating warning station, which includes earthquake recording instruments and related equipment. To ensure uninterrupted operation and prevent failures caused by internal or external environmental factors, it is essential to monitor these stations continuously. The objective of this study is to develop a monitoring device that enables remote observation of environmental parameters such as temperature, humidity, power supply, and the status of the station's fence and facility doors, while also supporting audible alerts and internet-based remote access. The USR-K7 internet module, which supports the UDP protocol, serves as the network communication interface, receiving data from an STM32 microcontroller and transmitting it to users via a web interface. This enables real-time remote monitoring of the station's status.

Preliminary results indicate stable power conditions and normal variations in temperature and humidity inside the facility, suggesting no abnormal or hazardous conditions have occurred. The developed monitoring device is considered applicable to other seismic stations in Mongolia.

INTRODUCTION

Early warning stations were installed near three seismically active fault zones closest to the capital city, Ulaanbaatar: Deren, Mogod, and Buren Buteel. The alarm system is triggered upon detection of the first-arriving P-waves from earthquakes with a magnitude of 7.0 or higher at these locations. The warning signal is then transmitted to the National Emergency Management Agency (NEMA) in Ulaanbaatar before the destructive S-waves reach the capital [1].


Figure 1. View of early warning station and old the FMC

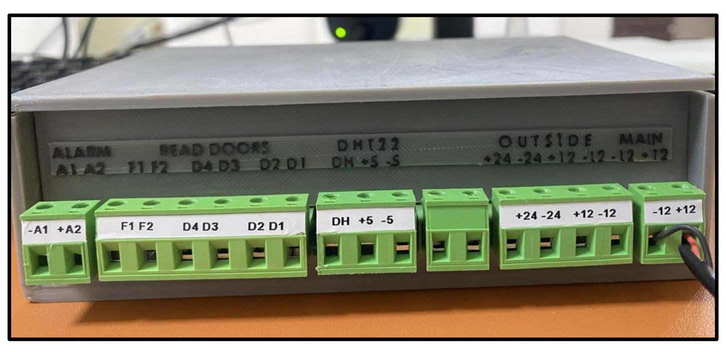
Figure 2. New Version of the FMC

The Facility Management Controller (FMC) in the early warning system is responsible for ensuring uninterrupted operation and preventing failures caused by internal or external environmental factors. However, the FMC can sometimes become damaged, and repairing it can be costly. Therefore, we designed a new monitoring device as an alternative.

METHOD

A remote monitoring device was developed to support an earthquake early warning station. The STM32F103 microcontroller managed sensors for temperature, humidity (DHT22), facility doors status, and battery voltage (via voltage divider and ADC) [2]. Data was displayed on an OLED screen, saved to an SD card, and transmitted to a server using a USR-K7 Ethernet module [3].

The PCB was designed in Altium Designer, and the enclosure was modeled in SolidWorks and printed with a 3D printer. The system was tested in both lab and field environments.

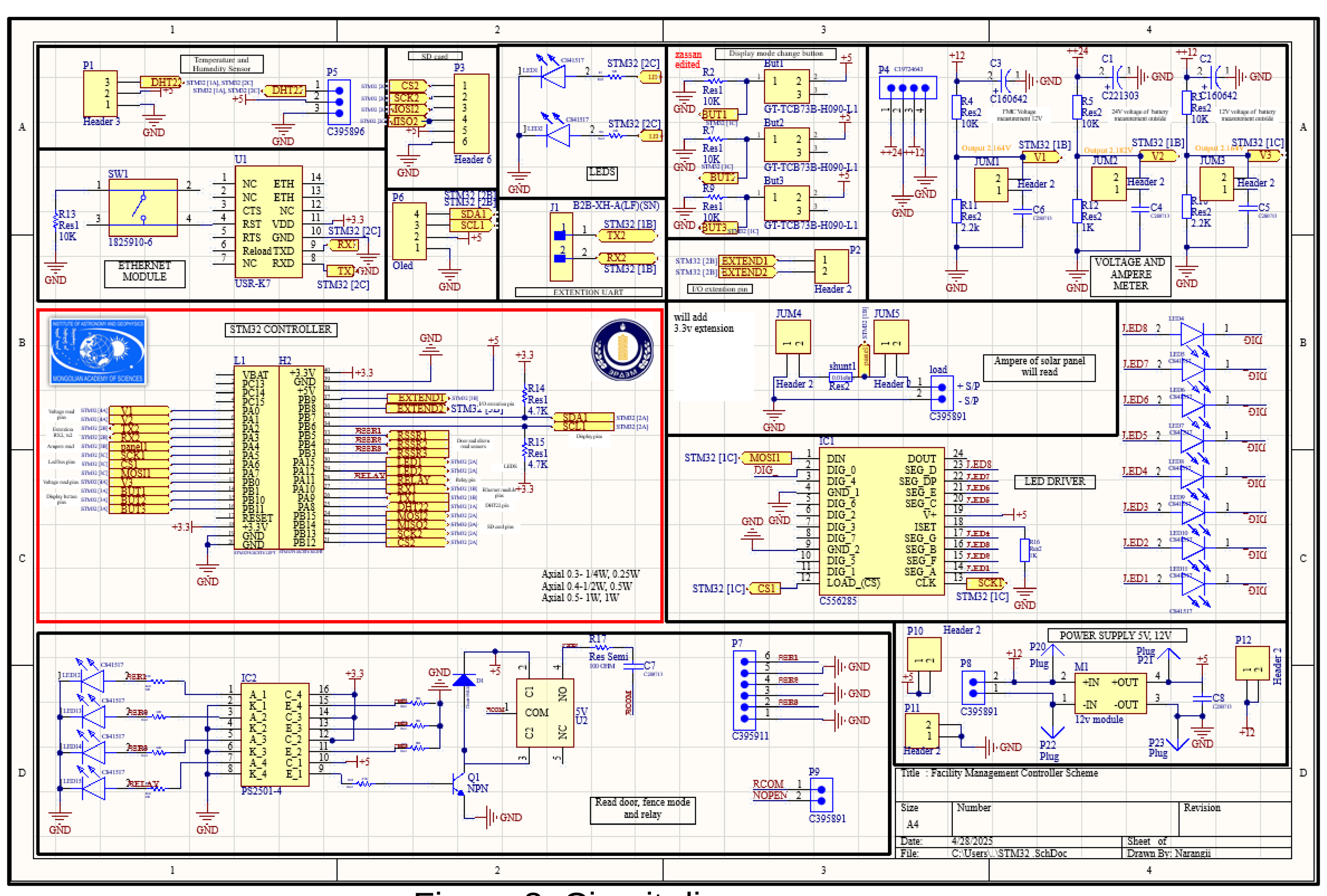
Figure 3. Circuit diagram

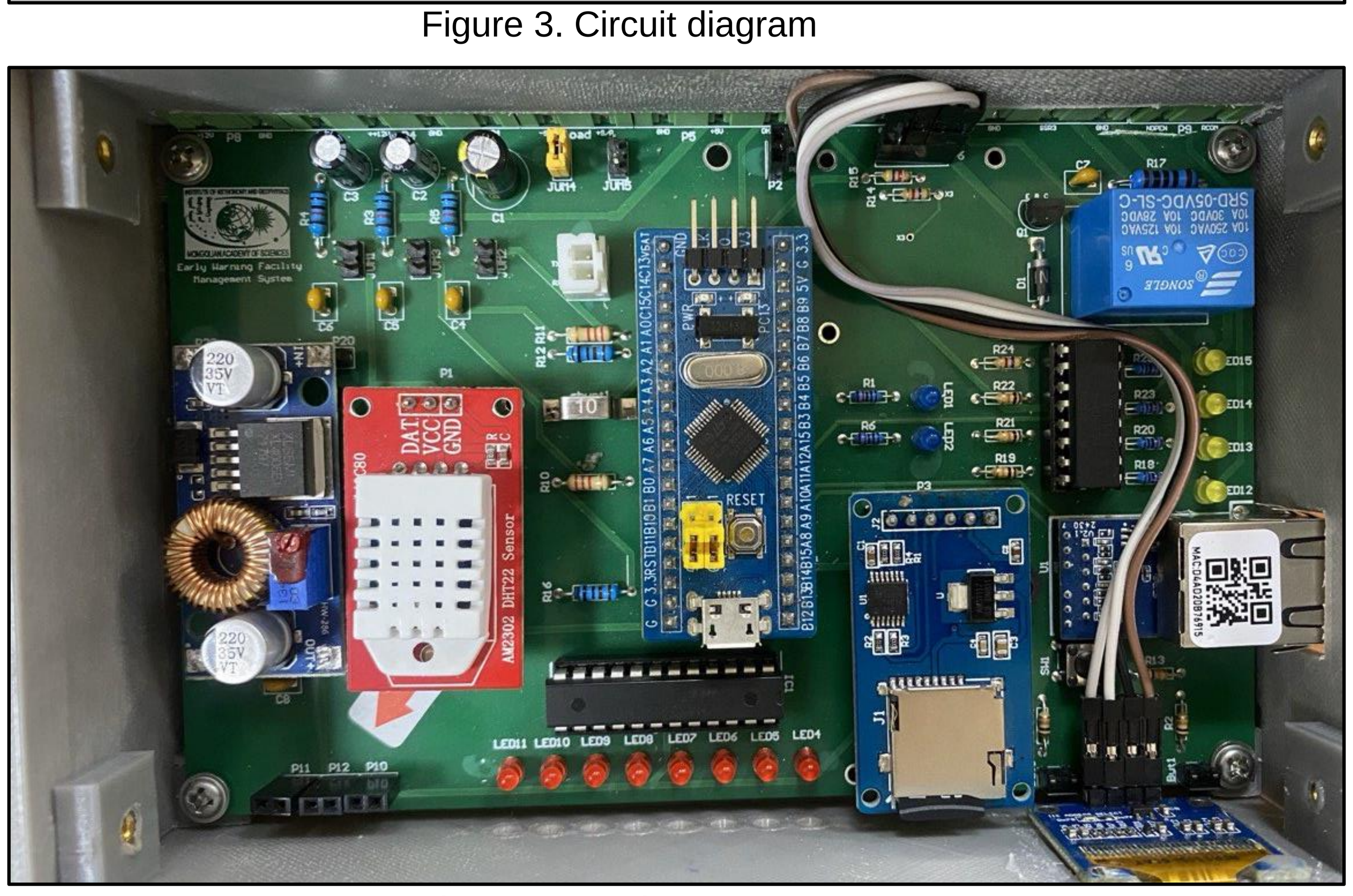
Figure 4. Hardware components

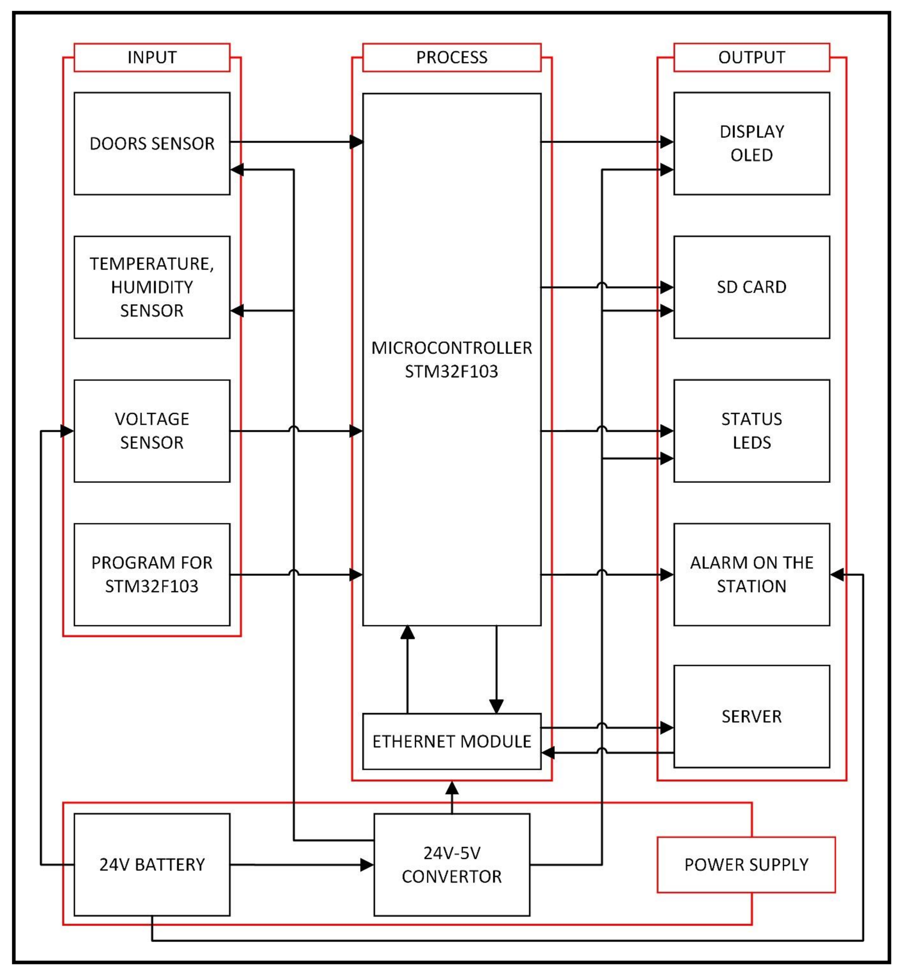

Figure 5. Block diagram

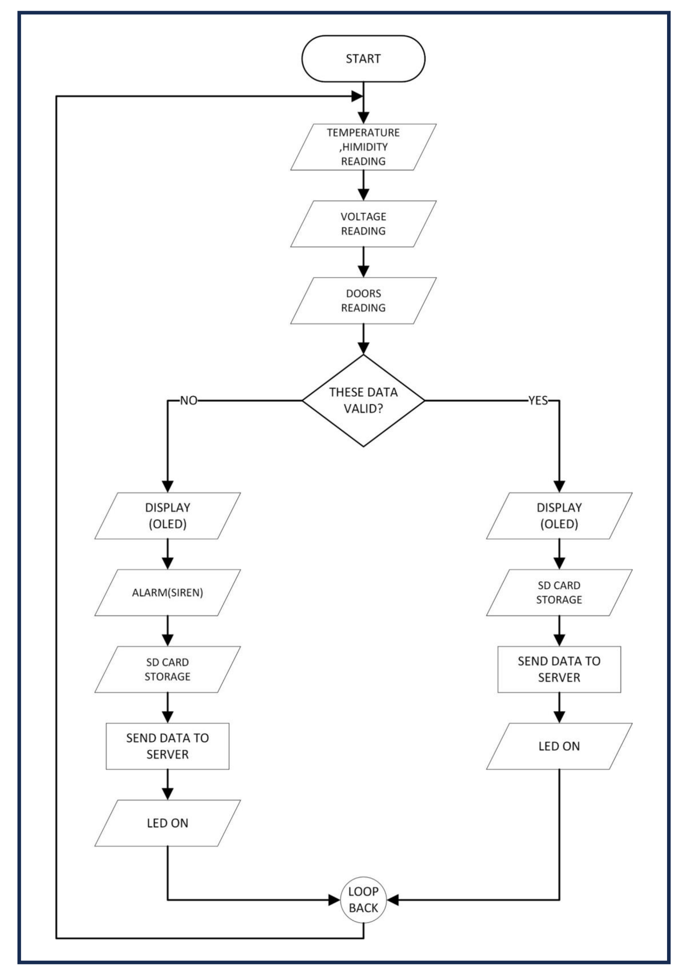

Figure 6. Algorithm

RESULT

In this study, a remote monitoring device was developed to observe key environmental and operational conditions at an early warning station, including temperature, humidity, power supply status, the condition of the fence and facility doors, and to control the audible alarm system.

The functionality of the monitoring device was tested in two phases. The first phase involved testing in a laboratory environment to verify the basic functions, sensor responses, and data transmission reliability. In the second phase, the device was deployed at an actual early warning station to evaluate its performance under real environmental conditions.

The results showed that the device was capable of reliably transmitting data to a server and effectively monitoring the station's status remotely, demonstrating its suitability for integration into operational early warning infrastructure.

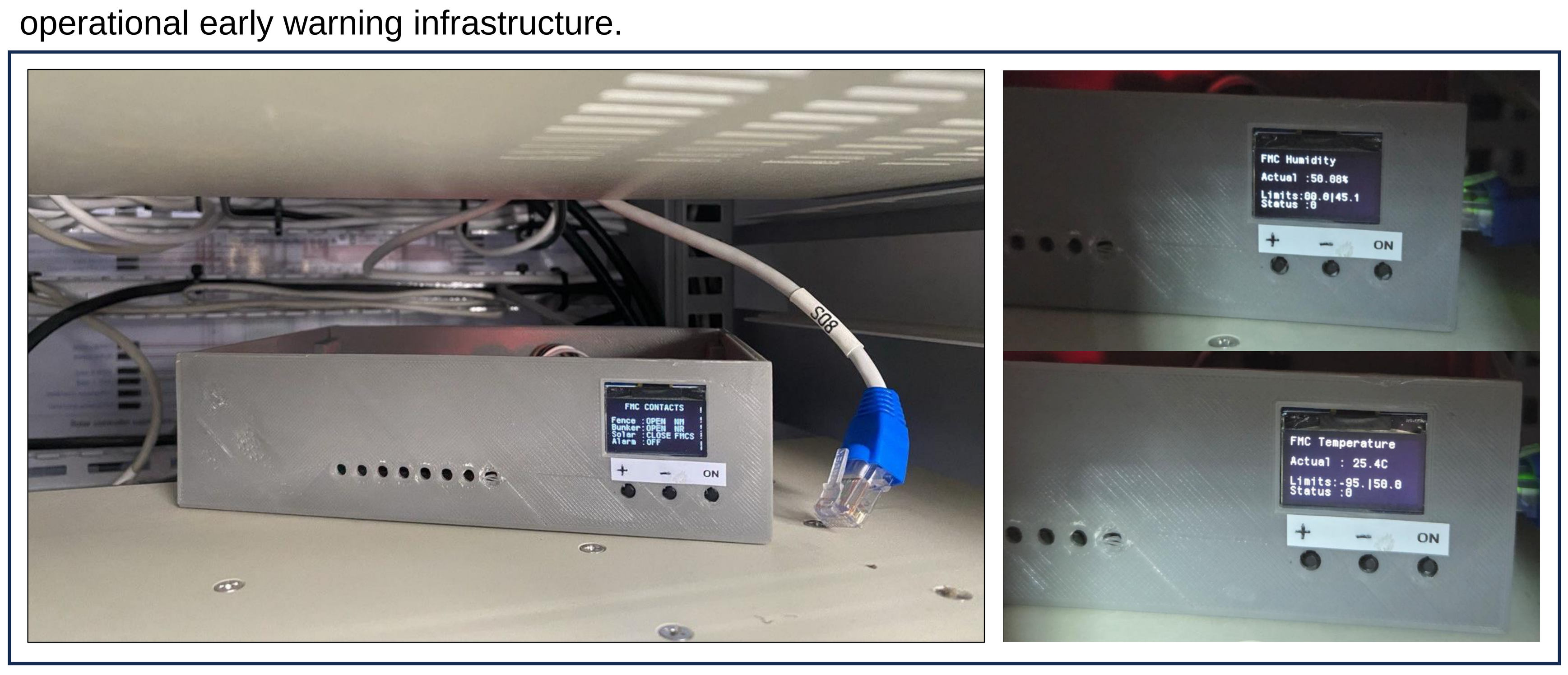
Figure 7. The OLED display in the station showed door status, temperature, and humidity

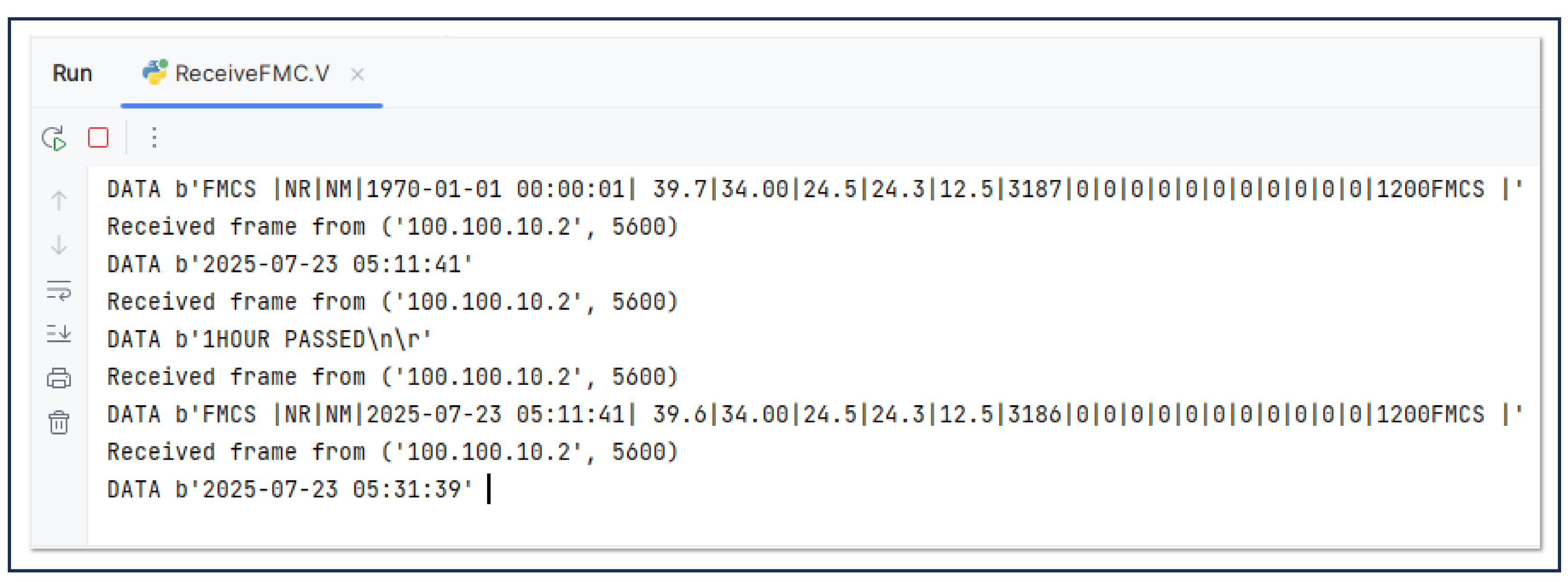

Figure 8. Data received from the monitoring device in Python

CONCLUSION

Through the development and testing process, a monitoring device for an earthquake early warning station was successfully developed to support disaster prevention efforts. The system reliably transmitted real-time data on ambient temperature, humidity, battery voltage, and the status of the facility doors to a remote server.

By enabling continuous remote monitoring of environmental and operational conditions, the device helped prevent potential equipment failures caused by adverse factors such as excessive temperature or high humidity.

Future improvements should focus on enhancing the design of the circuit board, STM32 code, and increasing the durability of the enclosure, in order to further improve the monitoring device's reliability under field conditions.

REFERENCES

1. *Seismic Network of Mongolia, April 2025*
2. *Pauzan, M., & Yanti, I. (2021). UTILIZATION OF ADC PIN ON ARDUINO NANO TO MEASURE VOLTAGE OF A BATTERY. TEKNOKOM, 4(2), 66–72. https://doi.org/10.31943/teknokom.v4i2.71*
3. *Super Port User Guide Serial to Ethernet converter (Super Port). (n.d.). www.usriot.com*