ECP 2024 Conference

The 3rd International Electronic Conference on Processes

29–31 May 2024 | Online

An Affordable IoT System for Weather Monitoring and Emergency Assessment in a Confined Space: A Case Study of Muang-On Cave, northern Thailand

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INTRODUCTION

This study presents a development of an IoT-based weather monitoring and emergency rescue request detecting system for working in a confined space environment. The system has been devised from low-cost electrical and non-electrical materials functioning with an open-source software and data management system. To monitor the weather conditions and emergency request detections, this IoT system was tested in the Muang-On Cave, a representative natural confined space located in Chiang Mai, the north of Thailand, for 17 days during the wet-to-dry seasonal transition period. The collected data includes temperature, relative humidity, CO_2, total VOC, and emergency codes.

METHODS

Three operating components of the system includes: (i) four weather monitoring and emergency rescue request detecting stations, (ii) a data transfer command, and (iii) a data display and cloud database shown in *Figure 1*. The four working stations were installed in the cave exhibiting the setting locations as presented in *Figure 2*. An internal and external aspect of each station is also provided in *Figure 2*.

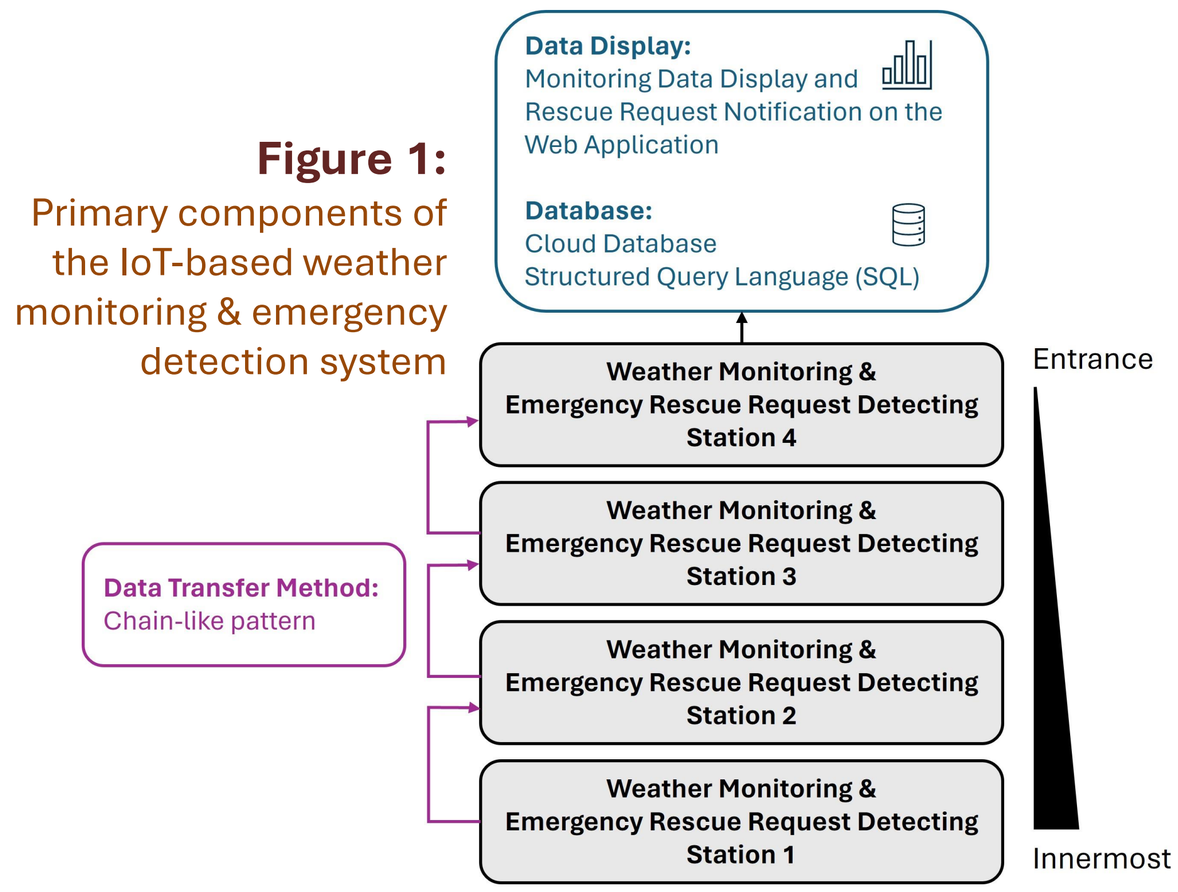

Figure 1: Primary components of the IoT-based weather monitoring & emergency detection system

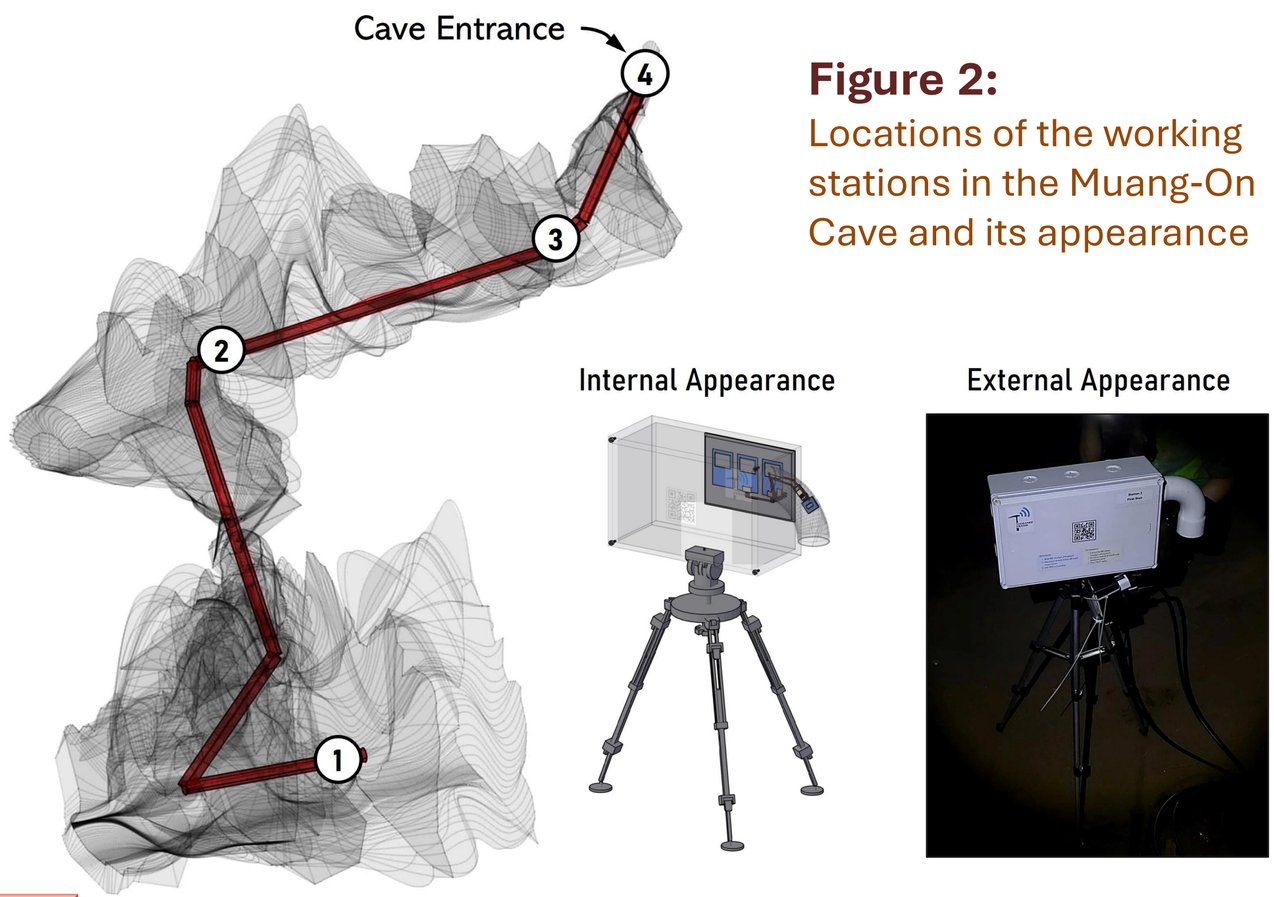

Figure 2: Locations of the working stations in the Muang-On Cave and its appearance

RESULTS

In-cave weather data and emergency detection are displayed via web application *(Fig. 3)*, which are updated every 80-110 seconds. Totally 6,073 datasets were stored into the database. For example, the relative humidity data reported by all station in the cave are presented in *Figure 4*.

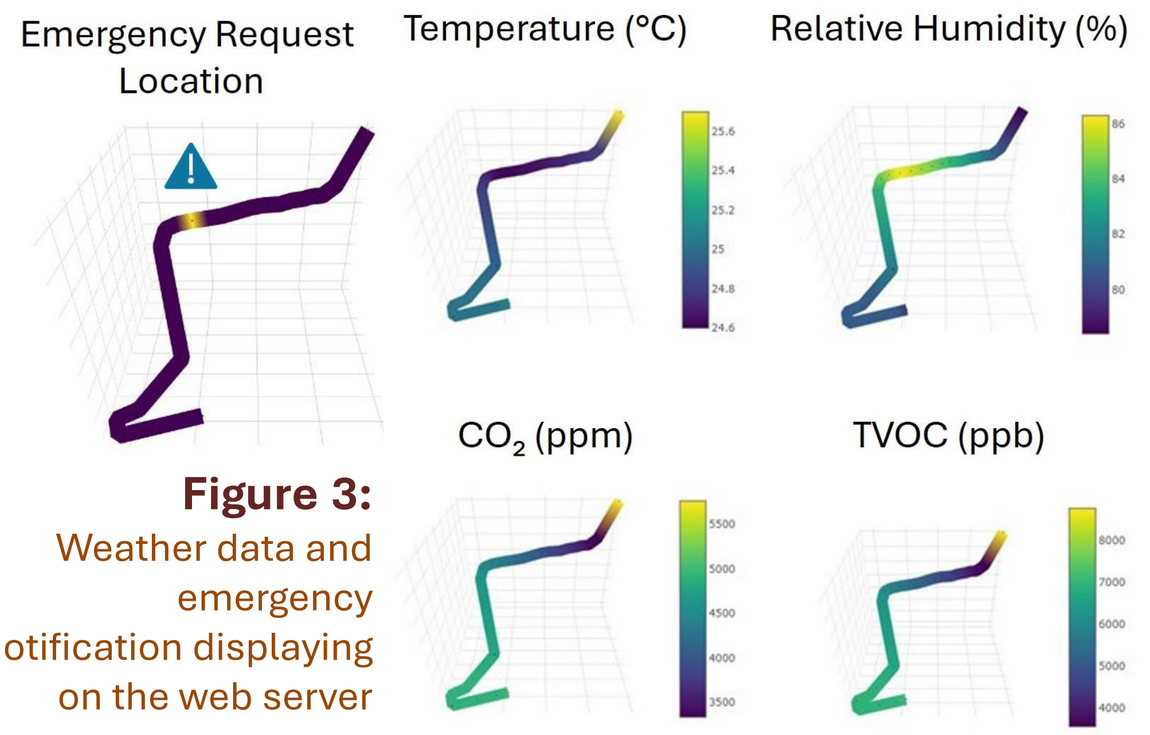

Figure 3: Weather data and emergency notification displaying on the web server

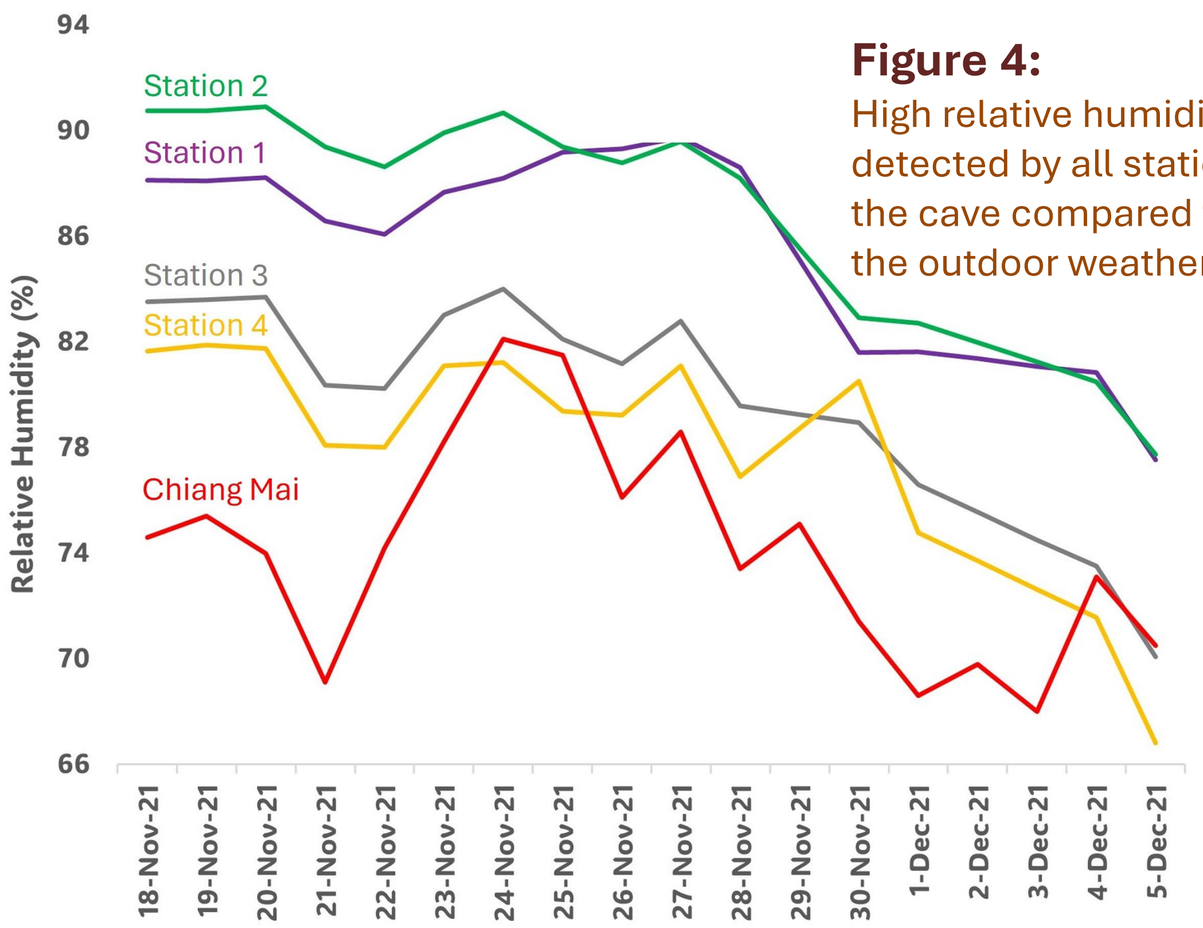

Figure 4: High relative humidity detected by all station in the cave compared to the outdoor weather

CONCLUSION

The system testing provides positive results for weather monitoring and emergency detection activities conducted in relevant confined-space environment. However, extremely humid conditions may cause inaccurate readings of the CO_2 and total VOC sensors. Despite the errors, this IoT system appears to be affordable as it is estimated to cost nearly $200. Further improvement, in terms of sensor selection or timing intervals for data processing, and the stability assessment of the system are highly recommended.