

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

Khomchan Promneewat¹, Tadsuda Taksavasut^{2*}

¹ *Thoranee Krasib Co., Ltd., Chiang Mai, Thailand*

² *Department of Mining and Petroleum Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai, Thailand*

* *Correspondence email: tadsuda.t@cmu.ac.th*

Abstract

Nowadays, many high-level technologies occur that give humans opportunities to be able to access, explore, or even work wherever they wish. One of those places is a confined space area, for example, tourism-to-undiscovered caves, tunnelling construction, and underground storage on any scale. However, these limited-of-space areas pose challenges in which there are limited numbers of entrances and air circulation. Monitoring systems that can automatically report the weather situation and provide an emergency signal at a particular time are necessary tools despite their costly prices and unfamiliarity.

This study proposes a cost-effective automatic system to detect the weather in a confined space named the Muang-On Cave located in Chiang Mai, Thailand. The system also provides an emergency alerting signal in this cave. A three-dimensional model of the cave has been produced for a monitoring point reference. We applied and integrated a technology of the low-cost microcontroller called the Internet of Things (IoT). The system consists of four ground wireless stations with 11, 31, and 43 meters of spacing. The distance of the final station from the cave entrance is approximately 85 meters. Each station has responsibility for (1) weather monitoring, in terms of temperatures (°C), humidity (%), carbon dioxide content (ppm), and total organic volatile content (ppm) and (2) emergency detection, which will work only when required. After 17 days of the system working, the weather data from the monitoring session has been uploaded into the cloud system through a chain-like data transferring pattern. The emergency session has been set on the cloud system through the registration of cave visitors as they can hit the virtual emergency button on their mobile device screen. The total cost of this system is below 200 USD. The findings suggest that this system appears to be suitable for environmental-to-hazard monitoring and may need further development.

Keywords: confined space, monitoring, emergency assessment, speleology, low-cost