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Early Forest Fire Detection using LoRaWAN Technology

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Abstract – **Advanced fire detection systems like LoRaWAN play a crucial role in fighting forest fires, which have damaging effects on climate and its change. This paper demonstrates a successful technical implementation of a smart LoRaWAN based system for forest fire detection. This early detection capability helps prevent fires from spreading and getting out of control.**

Keywords – **LoRaWAN sensors, Milesight Gateway, Milesight Cloud, forest fire detection.**

I. Introduction

Forest fires pose serious environmental risks and often escalate into emergencies before they are detected. Often, by the time a fire is noticed, it has already spread. Hence, enhancing detection systems with CO_2 monitoring can help address this issue. Tracking key environmental variables can improve the efficiency of forest fire prevention, detection, and response.

Placing sensors in optimal locations is essential for effective forest fire detection. A network of EM500-CO_2 sensors can be distributed throughout forest areas to identify fire outbreaks. In addition to CO_2 levels, these sensors track changes in other key indicators of fire as well, such as temperature, humidity, and pressure. Early detection enables faster firefighter response and allows remote monitoring centers to quickly assess the fire's start and spread.

The Republic of North Macedonia and Greece jointly initiated the "Cross Border Complex Floods and Forest Fires Prevention and Management" project with the acronym SOLVE [1, 2] to improve flood and fire management, showing how cross-border cooperation enhances crisis response. Within the project, modern IT equipment and software for training, modelling and data analysis for prevention, protection and dealing with floods and forest fires were obtained.

LoRaWAN® technology has been selected due to its reliable, long-range communication capabilities between sensors and monitoring centers in remote forest regions [3, 4, 5]. The effectiveness of LoRaWAN technology for real-time environmental monitoring, in particular for monitoring environmental parameters such as temperature, air pressure and humidity has also been widely acknowledged in recent studies [6, 7, 8, 9]. Specialized equipment for analysing fire consists of one aerial vehicle – drone (DJI Mavic 3) and 2 pieces of UG67 Outdoor LoRa gateway and ten pieces of Carbone Dioxide Sensor (4 in 1) EM500-CO_2. This paper outlines the setup of our LoRaWAN gateway and sensors, along with the configuration of smart alert mechanisms using Milesight IoT Cloud's monitoring platform, as part of the SOLVE project.

II. System Architecture

The smart LoRaWAN® based forest fire detection system for CO_2 monitoring and forest fire detection with an effective alert mechanism configured within the SOLVE project is composed of the following devices [10].

- EM500-CO_2 Carbon Dioxide Level LoRaWAN® Sensor
- Milesight Gateway
- Milesight Cloud

The EM500-CO_2 sensor enables real-time monitoring of CO_2 levels, detecting significant concentration changes. Placing sensors strategically at optimal locations in forests improves the CO_2 rate accuracy. It is powered by a 19000mAh battery and LoRa technology and hence offers low power consumption and up to 10 years of operation. It integrates CO_2, temperature, humidity, and pressure sensors, making it ideal for outdoor monitoring. The device detects early signs of fire, sensing CO_2 from 400 to 5000 ppm and collecting data in intervals of 2 to 30 minutes.

When data exceeds preset tolerance limits defined in the alarm threshold, the sensor promptly reports to the Milesight UG67 LoRaWAN® Gateway. The Milesight IoT Cloud then processes the data and sends alerts, enabling quick action to help prevent major losses.This framework is visualized in Fig. 1 [11].

Fig. 1. Early Forest Fire Detection with Milesight EM500-CO_2 Carbon Dioxide Sensor [11]

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