

Sensor Placement Strategy to Maximize Coverage and Early Detection of Forest Fires

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Abstract

Forest fires represent a significant threat to ecosystems, causing extensive damage to vegetation, fauna, and local communities. In this context, wireless sensor networks (WSNs) constitute a promising solution for the early detection of fires through the continuous monitoring of environmental parameters such as temperature, humidity, smoke presence, and sound spectrum. However, the implementation of these systems in large forest areas present challenges related to network coverage, connectivity, and energy efficiency. This work proposes an optimization methodology for planning a wireless sensor network applied to the early detection of fires in the Serra de São Mamede Natural Park, as it presents topographic and ecological characteristics that significantly increase its vulnerability to forest fires. The methodology includes the generation of a risk map and a numerical risk map of the study area, the determination of the number and optimal positioning of sensors, as well as the evaluation of network connectivity considering the presence of natural obstacles. Additionally, clusters and Cluster Heads (CHs) are defined in strategic locations in the forest, with the aim of improving communication efficiency and energy management of the network. Finally, a comparative analysis of energy consumption and WSN coverage performance was carried out for different Cluster Head configurations. It is expected that the results will contribute to the development of more robust, energy-efficient monitoring systems capable of ensuring adequate coverage of areas with the highest fire risk.

Keywords: Forest fires, wireless sensor networks (WSN), wildfire detection systems, sensor location, Geographic Information System (GIS), cluster head configurations.

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