Early Detection and Quick Response to Extreme Weather Conditions: A Case Study for Forest Fires with a Tree-Friendly Application, ORSIS

Group GRIFFIN

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November 2019

1 Which solution do you offer?

A tree-friendly software system which is newly called ORSIS (Orman Sistemleri - Forest Systems), is proposed. The main purpose of the system is early detection and quick response to forest fires under extreme weather conditions of the cities.

2 Solution Context

Nowadays, the forest fires are detected by an observer on the observation towers. In the case of the fire, the observer is responsible for informing the necessary departments to extinguish the fire. However; this conventional system depends on human-centric decisions where the false alarm may be high. This causes extra costs in a city while informing emergency departments unnecessarily. On the other hand; this system has a huge delay (at least 5 minutes) to trigger the emergency departments. This time spent may cause vital problems because the fire is likely to grow even more under extreme weather conditions. In light of

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these challenges, we propose to ORSIS which automatically detects a fire before it starts and quick response to its spread. Here, thanks to the isolation of human-centric decisions, we propose a reliable system where the risk of fire can be estimated with an acceptable accuracy rate perhaps even before the start of the fire. Thanks to ORSIS, the total cost that spent on the fire system in a city will be under a level that is almost 50% less than a conventional system and more forest areas will also survive with its living creatures. The real purpose of the ORSIS is to ensure that the forests are not destroyed worldwide. As a future work, the system can be used for the farming areas thanks to the scalable architectural design. It may also offer cost-effective solutions to farmers such as more efficient harvesting of land according to measured data.

3 Solution Description

The fire cannot be detected by the observation towers within the first 5 minutes, which causes the destruction of many forest areas. For this reason, hectares of land turn into arid land worldwide every year. Therefore, we isolate the human-centric detection and propose ORSIS that takes automatic fire detection even before it starts. The technical details of the ORSIS can be found below:

3.1 Proposed System Architecture of ORSIS

The ORSIS is built on a Service Oriented Architecture (SOA) that enables each software service to communicate with each-others via Application Programming Interface (API). Thanks to that it isolates software language-specific challenges from others and makes the system more robust. In this architecture, ORSIS has the following components named Detection service, Fire Sensor service, Machine Learning service, Database service, and Mobile service.

3.1.1 Detection Service:

This is the main service that orchestrates the other service components via global view. It periodically takes statistics from Fire Sensor Service that communicates with sensor nodes placed in the predetermined area of the city. Here; the sensor data is processed instantaneously according to Machine Learning based built model taken from Machine Learning service. In the case of exceeding the predicted level for this region, this service provides a faster response to fire and triggers Mobile service used by emergency departments. This software service is planned to be coded in a C# based .NET platform.

3.1.2 Fire Sensor Service:

ORSIS is designed to be capable of scanning an area of 24 square kilometers. The built-in sensors enable data such as Temperature, Humidity, Relative Humidity, Carbon Dioxide, etc. to be measured quickly. These sensor nodes communicate with each other on a Wireless Sensor Network (WSN). Thanks to the system, the measurement devices allow instant tracking of data.

3.1.3 Machine Learning Service:

This service trains a model for fire detection by running on previously collected data such as Temperature, Humidity, Relative Humidity, Carbon Dioxide etc. The model is planned to train by using scikit learn library in Python. With the help of this library, previously collected data is processed and the areas with a high probability of fire are determined in a model. Here, the city-region is determined according to the risk level of the fire under extreme weather conditions. Such specific areas are tracked by the measurement devices and they are compared with the data of the previous years. When they are determined as the critical point according to their risk prediction, they are involved in our system. Then, the Machine Learning Service re-builds a model for fire detection with newly added areas. The period for retraining a model is determined by city managers and this does not impose extra costs on the municipal budget.

3.1.4 Database Service:

This service manages the database transactions on MS-SQL based database where the instant and previously collected data are stored.

3.1.5 Mobile Service:

This service totally orchestrates the employees over mobile devices and routes them to the fire region when the fire detection service of ORSIS triggers the emergency services. It is planned to be coded by using Java-based Mobile Android and SWIFT based IOS platform.