CNG 476 System Simulation Progress Report

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Forest Protection System

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1 Objective

The purpose of this project is to simulate a forest protection system that can detect fires from a long range distance using the LoRa [4] technology. The simulation structure will be created using OMNeT++ [3] and its FLoRa [1] package. The random number generation, probability models, and stochastic processes will be implemented in C/C++ by hand to achieve a greater understanding of the topic.

2 Structure

The system will consist of several sensors such as temperature, humidity, heat, smoke, and gas, all of which can detect different stages of a fire.
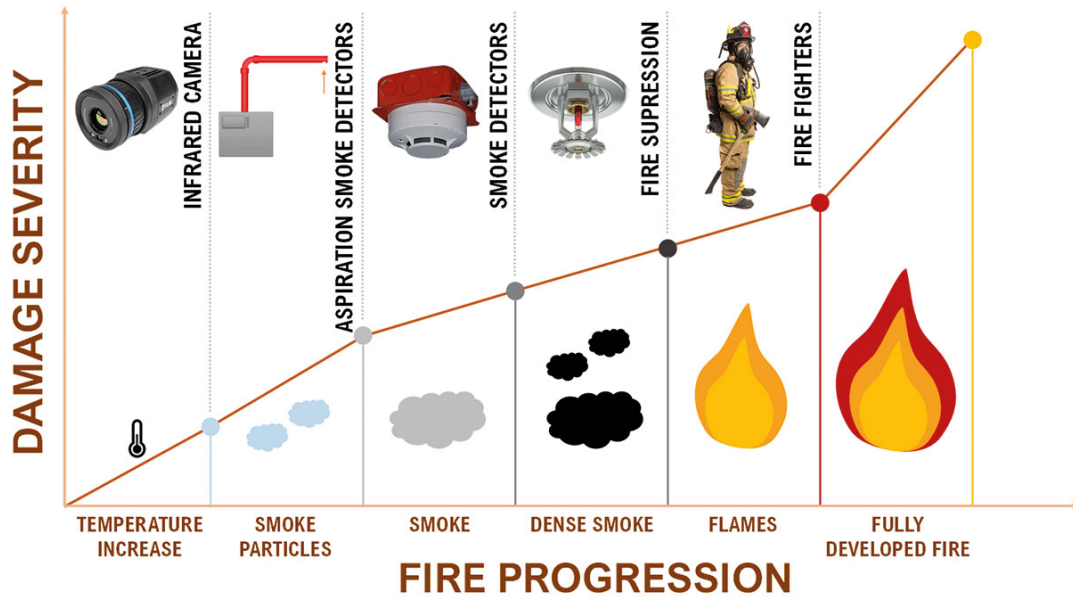

Figure 2.1: Fire progression graph [2]

These sensor nodes will be LoRa enabled, and will connect to a central LoRa gateway device to transfer the data via the Internet to a computer, where the data can be studied or analysed.
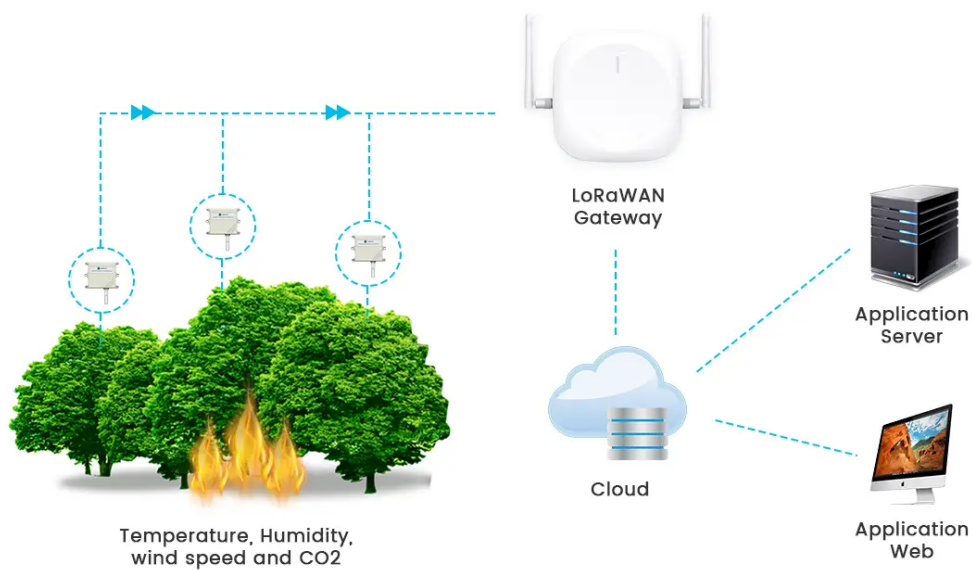

Figure 2.2: Example structure of a LoRa network [2]

3   Parameters of Simulation

Because this simulation will be concerned with the progression of fire at different stages as shown in Figure 2.1, parameters such as the temperature level, the densities of the smoke particles and CO2, CO gases will have to be tracked. These parameters and their probability of increasing or decreasing are, by their nature, going to be dependent on each other as the existence of one of them suggests the threat of another, it is a chain reaction.

Therefore, the crucial part will be designating a starting point and calculating what could happen next. What is the probability of a smoke according to the current state of the system? What is the probability of a fire if there is a probability of smoke? All the modelling and the randomness will have to be set up according to this nature of the parameters.

Temperature + Humidity + Wind Speed → Smoke + CO + CO2 → Fire

After the fire probability is calculated at a given time, it will be given as an input to the simulation along with a spread probability. The "fire" in this context means the initial ignition while the spread is how likely the fire will spread to its surroundings. With this setup, the spread probability will need to be higher than the ignition probability because it is easier for the fire to spread when it already started.

The main idea to take away from all these explanations for the purpose of the explaining the progress is, the end product should give out sensible outputs as long as the calculated ignition and spread probabilities are correct. Since we have not yet tried to implement the sensor nodes in OMNeT++, the current example program on the GitHub page [5] takes a fixed value for both probabilities.

4 Network Logic

In the example program, there is a forest 2D array with trees and empty spaces in it. In an OMNeT++ project, the trees could be considered as individual sensor nodes that can sense its surroundings. These sensors would then directly send data to a gateway node, which will carry the data to a system that can do computations with that data, such as an application on the web. See Figure 2.2.

In this case, a gateway will be responsible from a "forest" area which will have a number of nodes in it. Assuming the coordinates of each node relative to a forest is known, it should be possible to simulate the spreading of the fire as well. There could be a counter in each node that gets incremented whenever another nearby node is on fire, which will contribute to the overall fire probability.

References

[1] FLoRa. *A framework for LoRa simulations with OMNeT++*. URL: https://flora.aalto.fi/.

[2] Silvio Gerard. *Forest Fire Detection Made Better with LoRaWAN IoT Technology*. URL: https://www.mokolora.com/forest-fire-detection-made-better-with-lorawan/.

[3] OMNeT++. *What is OMNeT++?* URL: https://omnetpp.org/intro/.

[4] Semtech. *What is LoRa?* URL: https://www.semtech.com/lora/what-is-lora.

[5] udemir. *Forest Detection Simulation*. URL: https://github.com/udemir02/forest-detection.