FOREST FIRE DETECTION AND PREDICTION SYSTEM

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Abstract: *This paper discusses a Forest Fire Detection and Prediction System that is going to cope with one of the main problems of nowadays, namely wildfires. Huge losses and serious threats to ecosystems are common consequences of forest fires. This work describes a forest fire controller logic and decision-making methods aiming at enhancing forest fire prevention and detection systems. The environmental monitoring of several dynamic risk factors is performed with wireless sensor networks. With respect to this, meteorological variables such as humidity, temperature, etc. are measured in real-time to estimate the existence of forest fire risks in the short-term and to detect the recent occurrence of fire outbreaks over different forest areas and notify fire fighters.*

Keywords: *IoT, cloud, protocol, automation, sensor, network, notification, data analysis, microcontroller.*

1. Introduction

An IoT system is a web-enabled device that uses embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from the environment. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The IoT systems do most of the work without human intervention, although people can interact with the devices - to set up, give instructions or access the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed. The internet of things is also a natural extension of supervisory control and data acquisition (SCADA) a category of software application programs for process control, the gathering of data in real-time from remote locations to control equipment and conditions. SCADA systems include hardware and software components.

One of the problems that may be solved using IoT is related to the environment. One of the biggest of its kind is the problem of the occurrence of more and more forest fires that are out of control. This is caused by human and natural disasters. Taking into account the huge damage that it causes, some strategies should be implemented for overcoming and much better detection and prediction. The response time of emergency corps greatly affects the consequences and losses caused by them, so the enhancement of forest fire prevention and detection systems can be considered the main goal for conserving the environment. With respect to this, the real-time monitoring of certain environmental variables may make forest fire prevention, detection, and fighting more efficient.

Considering the advantages of IoT, the proposed solution is to make a “Forest Fire Detection and Prediction System”.

2. Concept of the system

As it was mentioned before, forest fires are one of the most common hazards for the environment. Different types of risk factors can be considered for estimating the existence of forest fire risks. On the one hand, there are static forest fire risk factors such as vegetation layers, topography, or the frequency of forest fire. In such zones, it can be useful to perform a long-term estimation of forest fire risks because vegetation affected by weather changes over time and several topography parameters (such as the existence of elevated slopes) may have a direct impact on the probability of fire occurrence. On the other hand, unusual changes of dynamic forest fire risks such as meteorological variables, polluting gases, or the oxygen level measured in real-time can be analysed aiming at performing a short-term estimation of forest fire risks [1].

Environmental monitoring may make the response time of emergency corps more efficient. Fire monitoring has 3 phases [2]:

- Pre-fire → take appropriate action for fire control
- During-fire → detection of fire
- Post-fire → damage assessment and mitigation planning

Basically, the most popular systems are related to pre-fire and during-fire monitoring.

The "Forest Fire Detection and Prediction System" is also based on that. The main advantage of such a system is that it helps to monitor the surroundings parameter, such as humidity, temperature, flame and smoke at real-time. All the changes are recorded and in some cases triggers actions. This is done due to sensors.

Generally speaking, a sensor is a device that is able to detect changes in an environment. It converts physical variables into electrical signals. Also, produces an electrical signal or optical output signal corresponding to the changes in the inputs. The main goal of the sensors is to detect events or changes in the environment. Taking into account that the territory of the forests is quite big, in order to implement the solution on such big distances, more sensors are required. They are situated at optimal distances from one to another such that in case of fire, the closest one will react. Below, in Figure 1 is presented the main idea of such a system.

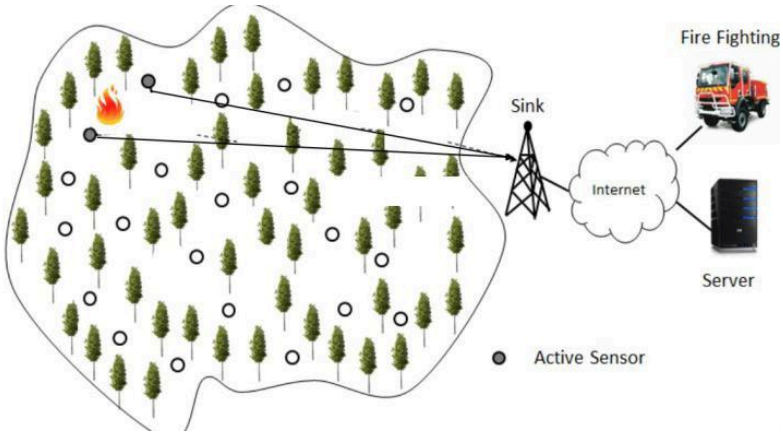

Figure 1. Forest sensor scheme

As it can be noticed, once the fire begins, the nearby sensors react and become active. Then, the data is sent to the sink. After that, using the network, the system and fire fighters are notified.

3. System architecture and functional

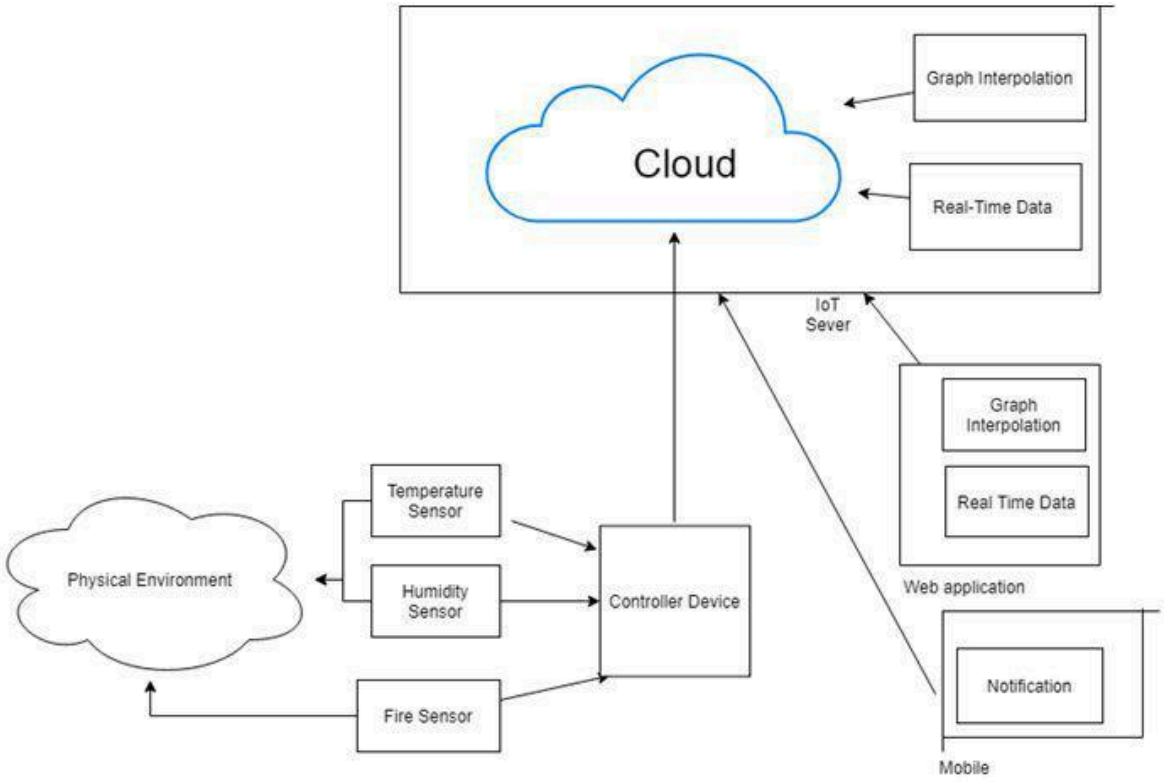

Figure 2. Architecture of "Forest fire and detection and prediction system"

The architecture of forest fire detection and prediction system in Figure 2 shows how all components of the system interact and what actions are made. Physical environment is a forest that the system will monitor and sensors like temperature sensor, humidity sensor, etc. sends values of different parameters that the system will use for detecting and preventing fire in the forest. Controller Device receives data from sensors, after this is filtering the data for more precise value and sends this to the cloud. It is done using GSM modules, which can provide internet connection anywhere where cellular networks are available. GSM modules use slow 2g connection, but it consumes little amount of power and its speed is more than capable of sending data from a few sensors once in a while [3]. This connection is based on AT commands, which are actually like HTTP requests. And to make it even better we decided to use our protocol atop this connection that is based on MQTT protocol [4]. MQTT protocol is used in IoT in cases where many publishers/devices send data to some root device, and then the root device sends it further. It basically sends open data in byte format, cutting unnecessary parts from ordinary HTTP requests to make packages lighter, and, therefore less dependent on connection speed. We analyzed how MQTT works and decided to use its principles to create our own version of it. It will be even lighter and it will fit our project the best way possible. Cloud that we want to use is called ThingSpeak. It allows you to aggregate, visualize and analyze live data streams in the cloud. To send our data there ThingSpeak provides it's api, and our device controller just needs to send ordinary REST api requests there [5]. REST api, or in some cases just HTTP requests (particular case), is one of the most popular ways to send data over the Internet. It is very flexible and can be modified for many purposes. We also want to use it to safely transfer data in our system of devices. After data has got to the cloud, it is processed and analysed. Using different interpolation methods on data that came from sensors and in this way the system predicts if a fire will occur in forest by creating the function of parameters that we receive and if the function graph is past the limit bound then there is a big chance that a fire will happen. Detecting is made by data analysing of values that came and if they are equal to values that are set in limit holders then the system notify a fire is detected in forest, when system is detecting or predicting fire in forest also

are notified local firemen. User interaction with the system is made by two components one is a web interface that is the cloud front end part and other is mobile app. Web interface shows graphs for every parameter that is sent by sensors of the system and is changing in real time in this way the user can monitor how the state is modifying. Mobile app is using the GPS module of mobile phones for creating a map with location of every system node so if something happens it can be easily found also then you press on a node one the map is showing the latest value of parameters that came from that sensor to cloud. Also our system will send automatic email and SMS notifications to firemen.

Conclusion

The intention of this paper was to show how the concepts of IoT systems helps people to monitor different parameters from a large area and process this data for detecting and preventing some events. The system that is described in this article ``Forest fire detection and prediction system" is an example of how an IoT system helps people for preventing fire in forest. This system is scalable so it can be used on different sizes of area. With this system implemented in real life people will save a big part of forests from fire and this will save nature and the animals also this will decrease the destruction made by fire and will save air from pollution from smoke that came from fire and will help to prevent fire from coming in location where people are living and prevent the situation when fire is uncontrollable.

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