

# **EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES**

## **FUNCTIONAL REQUIREMENT DOCUMENT**

### **1. GENERAL**

#### **1.1 PROJECT DESCRIPTION**

New requirements in the ecological environment arise due to the expeditious development of society. Among the various natural disasters, fire hazard seems to own the characteristics of spreading, and also, it becomes very challenging to control, and thus, it results in heavy destruction that might be irrevocable. Over the past few years, there is a tremendous increase in the count, occurrence, and severity of wildfires across the world that has created a great impact on the economy and ecosystem of the country. There are various techniques such as watchtowers, spotter planes, infrared, aerial patrols, and automatic detection systems to detect fire events. There is no need for the exposure of humans to perilous activities when remote sensing is deployed.

##### **1.1.1 BACKGROUND**

- (i)** Contribution to the forest fire fighting strategy, providing critical data to improve their safety and efficiency.
- (ii)** Providing of valuable forest and climate parameters input to the fire propagation models. This included temperature, humidity, rainfall, wind, smoke, and solar radiation.
- (iii)** Early detection of forest fires, alarm management, and real time reporting about the fire evolution. They provide alarms by integrating information from several nodes.
- (iv)** Following of a “deploy and forget” policy. Nodes will not need any kind of maintenance or battery recharging. Energy harvesting techniques and an optimized low power consumption will ensure uninterrupted functioning.

##### **1.1.2 PURPOSE**

The aim of this work is to develop a model to detect the fire and its coverage area, and in addition, it also observes the fire in the low region.

- i)** To improve the accuracy, the Fire-like pixel detector colour model is used.
- ii)** To avoid the problem occurring in stationary videos, the new technique of motion compensation is used.
- iii)** To identify and segment the fire in video streams, the segmentation method is used.

### 1.1.3 ASSUMPTIONS

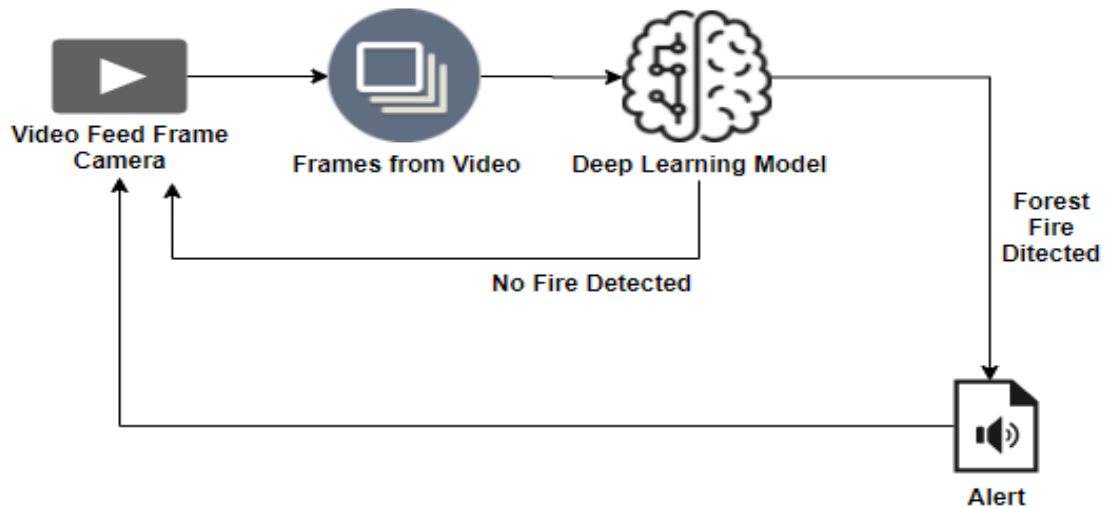
- The hardware components of the sensor-based fire detection unit, is a device meant to be installed in some premises similarly as a conventional smoke detector. At a high level, it comprises sensors and a global system for mobile communication (GSM) module connected to a microprocessor that runs the fuzzy logic fire detection program.
- The microprocessor polls the sensors at a regular interval and runs the inputs through the fuzzy logic application.
- If it concludes that a fire has been detected, a fire alert message is sent out through the web portal and the mobile app through the management information systems (MISs) to the occupants of the premises and the nearest fire station.
- If sending the message over the data connection is unsuccessful, then it sends the message out via short message service (SMS).
- The fire detection unit comprises the physical components, including the sensors and the microprocessor board, and the software that embodies the fuzzy logic fire detection algorithm and essentially drives the system.
- The software subsystem is that nonphysical part of the fire detection unit, which is concerned with reading inputs from the sensors, determining whether the readings are indicative of a fire or not, and raising alerts in cases of fires.
- The sensors used, respectively, in [28–31] were chosen based on detection range, size, and cost. By adopting a multisensory approach, the need to fuse the data arises.
- Fuzzy logic provides an easy way of dealing with uncertain data from multiple sensors by aggregating these to make a decision.
- Fuzzy logic is a type of logic that tries to mimic the human brain by incorporating the imprecision with which humans make decisions.
- As a practical example, if a human is tasked to describe the temperature of a cup of beverage, he or she would typically just say that it is hot, cold, cool, warm, not too hot, etc. rather than stating that it is 25°C or 52°C as would a computer.
- Fuzzy logic is therefore based on imprecision, and it uses linguistic variables, defined as fuzzy sets, to codify common sense and hence approximate human reasoning.
- In this regard, each of the three fire signatures (variables) three states (sets) are defined and described by membership functions.
- The output is also defined as three possible states (sets): no fire, potential fire, and fire.
- Fuzzy rules describing combinations of the various sets which indicate a fire or no fire or a potential fire are coded into the system.
- Then as the system operates, it takes the raw readings from the sensors and fuzzifies and defuzzifies them to give an output.
- Rather than saying there is x units of fire, it will say there is a fire, or there is a potential fire, or there is no fire.
- The basic configuration of the fuzzy logic unit of the fire detection system.

### **1.1.4 CONSTRAINTS**

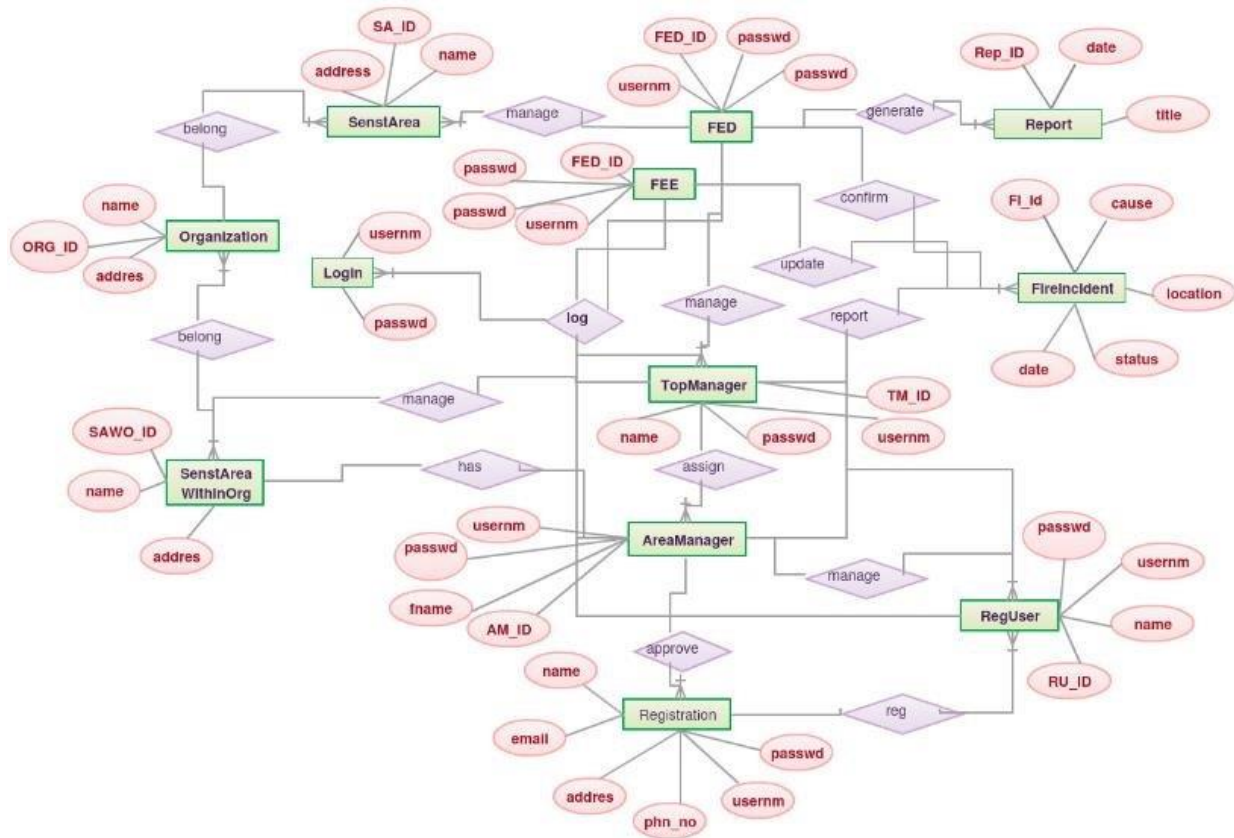
The size of the rule base of a fuzzy logic system is affected by its inputs and sets used. A reduced number of fuzzy sets results in a reduced rule base and vice versa. For each sensor input (linguistic variable), three fuzzy sets were created using grade, reverse grade, and triangular membership functions. To determine these membership functions, data collected from each sensor during tests was used to tune the membership of the various fuzzy sets. Using the centre of area (CoA) defuzzification method to obtain the system output, which gives the likelihood of a fire.

## **2. FUNCTIONAL REQUIREMENTS**

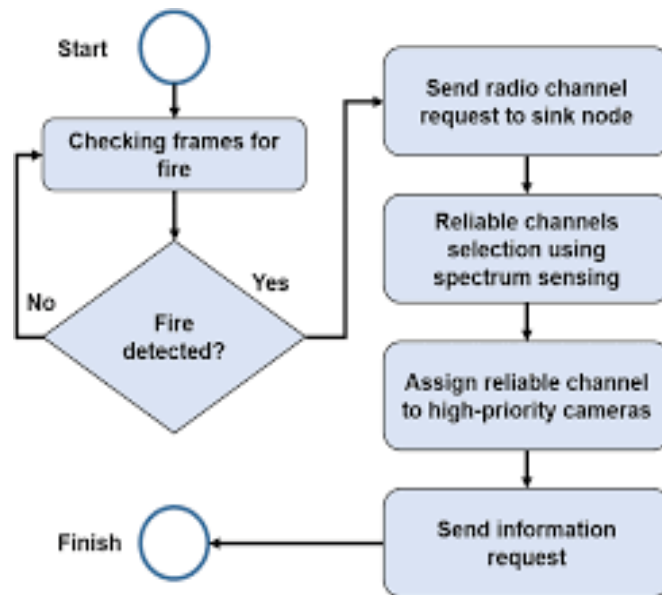
### **2.1 DATA REQUIREMENTS**



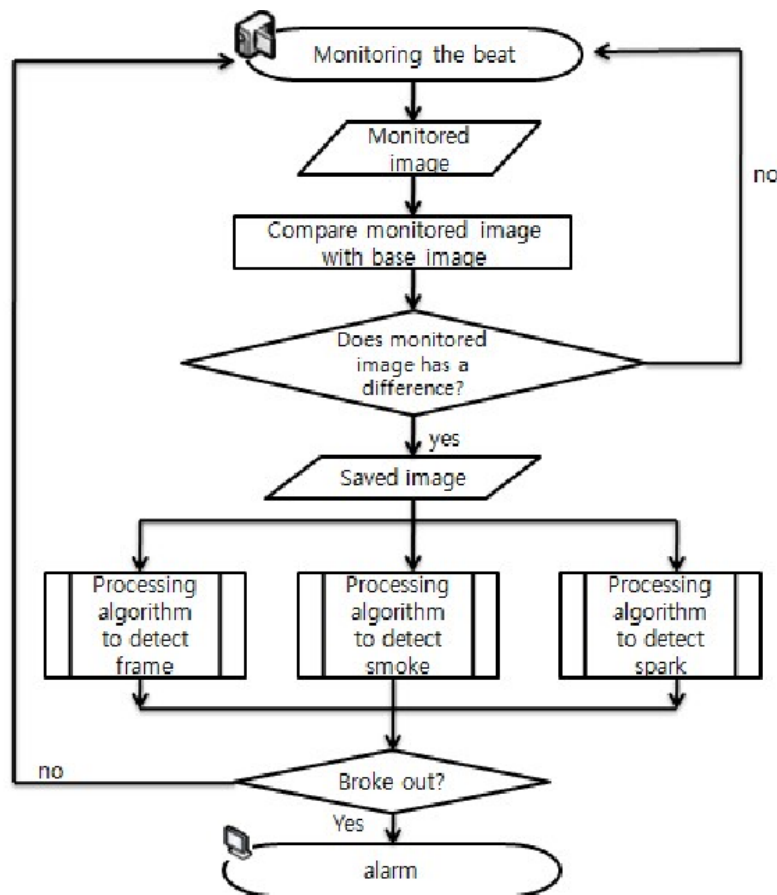
## 2.2 ENTITY DEFINITION



## 2.3 ATTRIBUTE DEFINITION



## 2.4. FUNCTIONAL REQUIREMENTS



**Figure 2.** Fire detection procedure

## 3. OPERATIONAL REQUIREMENTS

### 3.1 SECURITY

- The two hardware are responsible for sensing and preventing fire are the EFD Sensing Node and the Protective Relay Node.
- EFD sensing node is a Wi-Fi enabled device which senses the local temperature, humidity, gas (LPG, CO2 etc.) and smoke and sends the corresponding data to a remote server.



## 3.2 PERFORMANCE

