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PREDICTING BURNED AREAS OF FOREST FIRES: AN ARTIFICIAL INTELLIGENCE APPROACH

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***Abstract*—"Predicting Burned Areas Of Forest Fires: An Artificial Intelligence Approach" is a software application for predicting the propagation of forest fire to identify the burned area during the event of fire.**

Forest fires are a major environmental issue, creating economical and ecological damage while endangering human lives. It importantly influences our environment and lives. Predicting forest fire propagation is a crucial issue when fighting these hazards as efficiently as possible. Fast detection is a key element for controlling such phenomenon. Powerful computational tools are needed to predict the amount of area that will be burned during a forest fire. There is a need of a system for predicting the area that may be affected in a forest fire event. Different techniques are available in literature to solve such crucial issue including Mathematical model, FWI calculator. Such models require a set of input parameters and that should be precise and the calculations are based on mathematical formulas which require more time and unable to provide accurate result.

We proposed an intelligent system based on genetic programming for the prediction of burned areas, using data like relative humidity, temperature, wind, speed, slope, drought factor etc parameters which are possibly easily known and collectable to any forest officer.

***Index Terms*— forest fires, style, an intelligent system based on genetic programming.**

I. INTRODUCTION

A Forest fire is defined as being an uncontrolled fire that occurs in the wilderness. They can be massive in size and have the ability to spread across vast distances, jumping rivers, roads and fire breaks in the process.Forest fires are generally occurs during summer [4]. Forest fires, regularly experienced in regions with hot, dry, or Mediterranean climates, represent a risk to life and extant infrastructure.

Fires can cause extensive economic damage, environment, endangering human lives and physical, chemical, biological soil properties can be affected.

Three elements are needed for a fire to start and continue to burn are fuel, oxygen, ignition sources.

If any one of these three elements will be missing, there would be no chances of fire. The basic principle of wildland firefighting is to remove one or more of these elements in the quickest and most effective way.

The primary factors that influence the spread of fires are:

- Fuels
- Weather
- Topography.

II. BACKGROUND HISTORY

A wild-land fire is a fire in an area of combustible vegetation that occurs in the countryside and rural area. Depending on the type of vegetation where it occurs, a wildfire can also be classified more specifically as a brush fire, bush conflagration, desert under fire, forest fire, grass fire, hill fire, peat fire, vegetation fire.

The most common cause of wildfires varies throughout the world. In Canada, Southern Europe, and northwest China, for example, lightning is the major source of ignition. In other parts of the world, human involvement is a major cause for the fire ignition. In Africa, New Zealand, South America, and Southeast Asia, wildfires can be attributed to human activities such as agriculture, animal husbandry, and land-conversion burning. In coal sustain china and in the Mediterranean Basin, human carelessness is a major cause of wildfires. In the United States and Australia, the source of wildfires can be traced both to lightning strikes and to human activities.

III. PROBLEM DEFINITION:

In recent years, many efforts have been taken towards enhancing both the quality of simulation tools and the feasibility of putting them into operational environments [1].

However, the presence of complete and reliable fire spread prediction frameworks is still scarce, and they rarely include a real-time computational simulation module. The main reasons for this lack of confidence in computational simulations at the time of making decisions during a forest fire are the uncertainty involved in two key aspects: the accuracy of the input data with respect to the actual scenario and the execution time of the simulation tool.

Regarding the first aspect and the accuracy of the input data, it is well known that describing the forest fire scenario is a complex task because it involves data coming from very different sources such as satellites, weather stations, databases, and so on, and it also requires data computed by complementary models.

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The Genetic algorithm has many advantages like it produce “closer” to optima results in a “reasonable” amount of time, suitable for parallel processing, so proposed system is based on Genetic Algorithm to predict the burned areas of forest in the event of fire.

IV.METHODOLOGY:

- Genetic Programming is a technique where computer programs are encoded as a set of genes that are then modified using an evolutionary algorithm known as Genetic algorithm [3],[5].
- Genetic programming is able to produce results significantly better than traditional methods.
- GAs constitute a technique that works in an iterative way that is, the quality of its results directly depends on the times it is iterated as well as its specific configuration settings.
- It starts with an initial population of individuals which will be evolved over several iterations in order to guide them to better search space areas.
- Proposed inputs such as wind speed and wind direction, moisture content of the live fuel, moisture content of the dead fuel and type of vegetation.

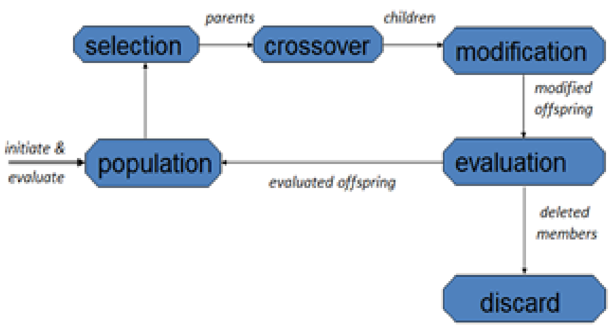

Fig.1. Genetic Algorithm

Here we propose the Genetic Programming method on fire frequent region. We are using Forest Fires dataset.

PARAMETERS:
1: Drought factor:
Drought factor is a measure of fuel availability or a condition of dryness in the duff and upper soil layers that progress from total moisture saturation to an absence of available moisture (fuel dryness). Drought factor value range from 0 – 10, with zero value of DF the potential of fire is very low due to the fuel is fully of moisture as the value of DF increases the potential of fire increase. With DF value of 10 it indicate that the fuel is very dry and has no moisture and the potential of fire is very high.

2: Temperature:
A temperature is a numerical measure of hot or cold. It’s measured in degrees and is the heat of the air mass. High temperature is responsible to increase the temperature of grass and forest fuels to their ignition points. In addition temperature affects the atmospheric stability and wind speed.
3: Relative Humidity:
Relative humidity is the amount of water vapor in the air and it is measured as a percentage. The amount of the moisture in the atmosphere will affect the amount of moisture in the grass and forest fuel. When humidity is high bushfires will not spread because the grass and forest fuel contain have a high amount of moisture.
4: Wind:
Wind speed is the rate of the movement of wind in distance per unit of time. It can be affected by terrain and obstacles such as buildings or trees. Cup-anemometer has been used to sense wind speed.
5: Rainfall:
Rain has a direct effect on humidity and fuel moisture, when rain fall temperature drops down and wind become calm. Rainfall will dampen the surface of the grass and forest fuel to the stage that fires can’t ignite the fuel. The amount of the rainfall has direct effect on the drought factor value.

Temperature & Wind Categorization:
[2]In this author explains relation between temperature and wind as shown in the table 1, Temperature (T) is considered with different categories. They are Moderate, high, very high and is measure in Celsius. Temperature T is in between 20 to 30 is considered as moderate temperature, T is in between 31 to 40 Celsius is high and T more than 40 Celsius is considered as very high temperature.

TABLE I
TEMPERATURE

Temperature(T)Celsius	Description
20<T<=30	Moderate
31<T<=40	High
T>40	Very High

In table 2, wind speed give the description of the wind speed considered. Wind speed till 29 km/hr is considered as fresh wind. Wind speed between 30 to 75km/hr is strong wind, and between 75 to 115 km/hr is storm and more than 115km/hr is hurricane.

TABLE II
THE WIND SPEED

Wind Speed (WS) Km/Hr	Description
30<=WS<75	Strong Wind
75<=WS<115	Storm
WS>=115	Hurricane

Fitness Function:

The McArthur Forest Fire Danger Indices (FFDI) [6] have been used in Australia since was developed in 1960s and used by fire authority to measure the level of fire danger. Its value depend on the drought factor which is based on dryness of the fuel and other weather variable factors such as temperature, relative humidity, rainfall, wind speed and wind directions. The accuracy measurement of FFDI output depends on the accuracy of the input variables, inaccuracy and uncertainty of these inputs may result in incorrect of the FFDI value. The value of FFDI increased from the inaccuracy of the wind speed, temperature and humidity. Bushfires prediction systems sensitivity depends on the instruments accuracy used to measure the input data.

Formula:

Where:
-FFDI: forest fire danger index
-DF: drought factor
-RH: relative humidity
-U: wind speed
-T: Temperature

The FFDI is forest fire danger index, where fire danger level are classified as low, moderate, high,
Very high, severe, extreme or catastrophic according to the value of the FFDI as shown in table 3.

TABLE III
CLASSIFICATION OF FIRE DANGER LEVEL

Category	Forest fire danger index(FFDI)
Catastrophic	100+
Extreme	75-99
Severe	50-74
Very high	25-49
High	12-24
Low to moderate	0-11

Example:
Input Data:
RH= 60 30 70
WN= 20 50 60
TM= 30 20 34
Initial Population:
1: 60 20 30
2: 30 50 20
3: 70 60 34
Fitness:
1: 60 20 30 = 4
2: 30 50 20 = 5
3: 70 60 34 = 9

Crossover:	Result:	Fitness:
1: 30 | 50 20	1: 30 60 34	34
2: 70 | 60 34	2: 70 50 20	4

Optimum Solution:
RH=30 WN=60 TM=34
Fire intensity: 34 VERY HIGH
Rate of Spread: 1.15 km/hr

CONCLUSION:

As we had mentioned earlier that forest fires have damaging effect on the environment as well as on the human lives. Different techniques are available in literature to solve such crucial issue including Mathematical model, FWI calculator.
Here, we have proposed an intelligent system based on genetic programming. Genetic algorithm have many advantages such as it search parallel form of population of points. Therefore it has ability to avoid being trapped in local optima solution. It probabilistic selection rules instead of deterministic ones..

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