Design a mechanism to reduce the forest fire using AI

Internship Project Report

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ACKNOWLEDGMENT

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V Sem

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Abstract

Forests are important not just for animals but for humans as well as they act as a primary life support for life on this planet. Every year, huge number of forest fires across the globe cause great damage beyond description.

Forest fires or wildfires are a great threat and are one of the major reasons for their deterioration as it effects all the resources, wildlife and cause ecosystem degradation as well. Increasing forest fires can be because of human influence, earthquake etc. but availability of fuel and change in weather patterns are one of the main supporters for it.

This is the reason forest fires had been an important topic for research in terms of its prevention, detection and control. Today, various methods and techniques are developed to tackle this issue and with all this, AI (artificial intelligence) provides various new and improvised technologies with some new, safe and optimized approaches.

The demand for computer vision had risen up in past few years and it is one of the widely used technologies today in fields of surveillance, tracking, security etc. Recognition and detection technologies had always been an integral part of it which paves the way for the coming of better methods.

This project consists of various methods based on different technologies which together provides a possible mechanism for the control of wild forest fires.

Introduction: The following project is basically a possible mechanism that deals for situation like forest fires or wild fires at various level. It is based on machine learning includes technologies like OpenCV, different algorithms like linear regression, random forest etc. The basic aim to design a mechanism that can become to a possible way to control forest fires.

Motivation: The project is done with a purpose to explore the object detection field of machine, predicting capabilities of various algorithms and to explore the scope of artificial intelligence in various domains.

Aim: To design a mechanism to reduce the forest fire using AI.

Objective:

- To learn and design a system to reduce forest fire cases by preventing it, controlling and reducing its spread using AI based methods and systems.

Technical Specifications:

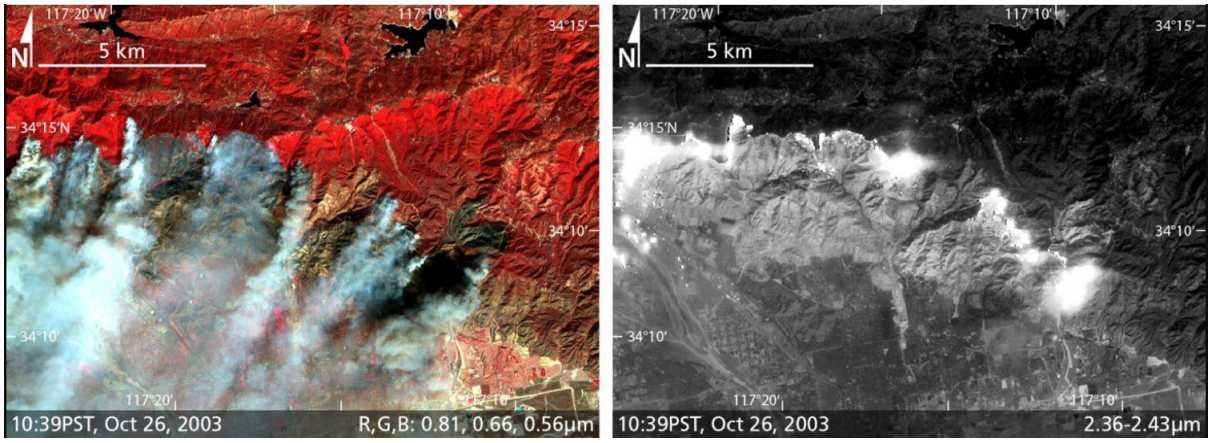
Dependencies	Versions
Operating System	Windows 10
RAM	4 GB and above.
Processor	i3 and above.
Python	3.7 and above.
Numpy	1.19.0 and above.
Open-CV	3.4.10, 4.3.0 and above.

Body: The methods we can use to prevent and control forest fires are:-

1. **Fire and smoke detecting systems in robots and UAVs.**
2. **Predicting forest damage using statistical data**

1.1 In this approach, Firefighting robots and UAVs are used which is a good way of detecting fire in a wider range using machine learning (which is a part AI) algorithms like **Haar Cascade Classifier**, **YOLO** etc.
the accuracy varies depending on the algorithm used for training the model. thermal sensor based cameras can also be used to get the images of fire and detecting it by using different methods like **IR** (Infrared), **LIDAR** (light detection and ranging), **video cameras** for detecting smoke.

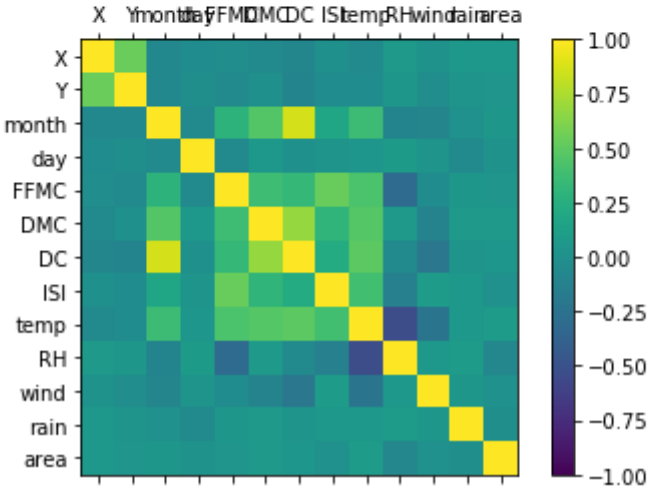
1.2 By using AI, we can build a system that can detect forest fire by detecting smoke during day time and fire during night time.
They are loaded with **fire extinguishing** mechanism and are used mostly used in indoor conditions but can be modified to use in forest as well.



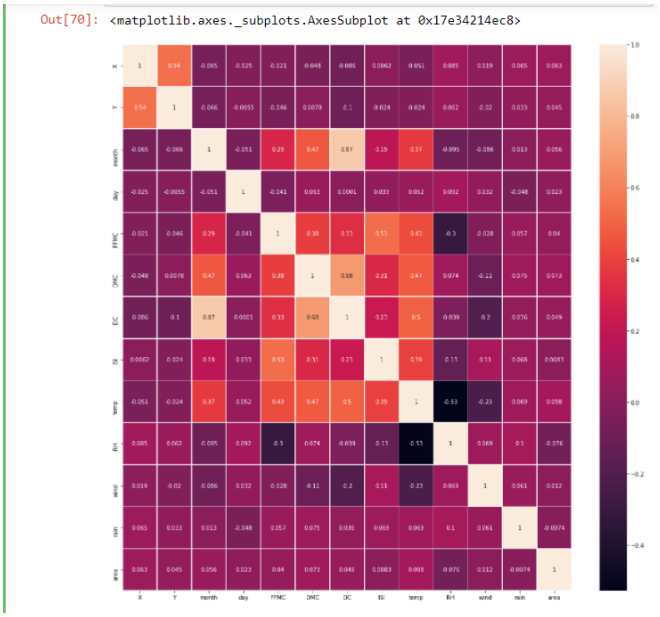
2.1 Statistical data based on historical events can be a really great resource for prediction of future events or the possible damage that can be caused by it.

2.2 This data includes factors like area, temperature etc. which describes the condition of forest.

```
[Text(0, 0, 'X'),
 Text(0, 0, 'Y'),
 Text(0, 0, 'month'),
 Text(0, 0, 'day'),
 Text(0, 0, 'FFMC'),
 Text(0, 0, 'DMC'),
 Text(0, 0, 'DC'),
 Text(0, 0, 'ISI'),
 Text(0, 0, 'temp'),
 Text(0, 0, 'RH'),
 Text(0, 0, 'wind'),
 Text(0, 0, 'rain'),
 Text(0, 0, 'area')]
```




```
Out[70]: <matplotlib.axes._subplots.AxesSubplot at 0x17e34214ec8>
```



Graphical representation on the statistics show the insights into the data.

Project:

1. **Fire and smoke detecting systems in robots and UAVs.**

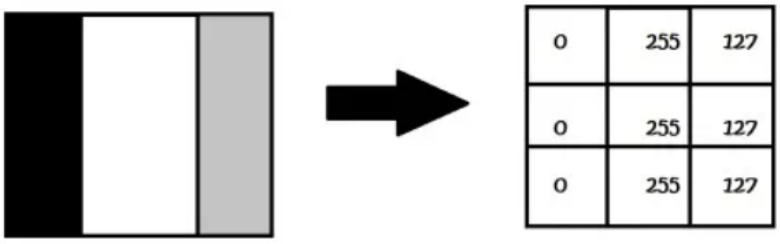
In this project, we build a live working system which detects the fire using live cam and immediately alerts the user by pop up message and playing an audio in the background.

We used OpenCV for this which is a real time computer vision library mostly used for object detection purposes. It works in BGR (blue, green, red) format by considering all small units of an image called **pixels**, then extracts value from those pixels and puts together the result in an array which then gets interpreted.

For building this, we used **haar cascades** algorithm which is basically used for object detection in an image or video. This algorithm requires a lot of positive and negative images to train the classifier.

This method basically uses **haar features** which are calculations done adjacent rectangular regions at a specific part which basically sums up the pixels intensities in different regions and calculate the difference between the sums.

We used it to create a model for detecting fire using live cameras and the software we used to create the model is called **Cascade trainer**.



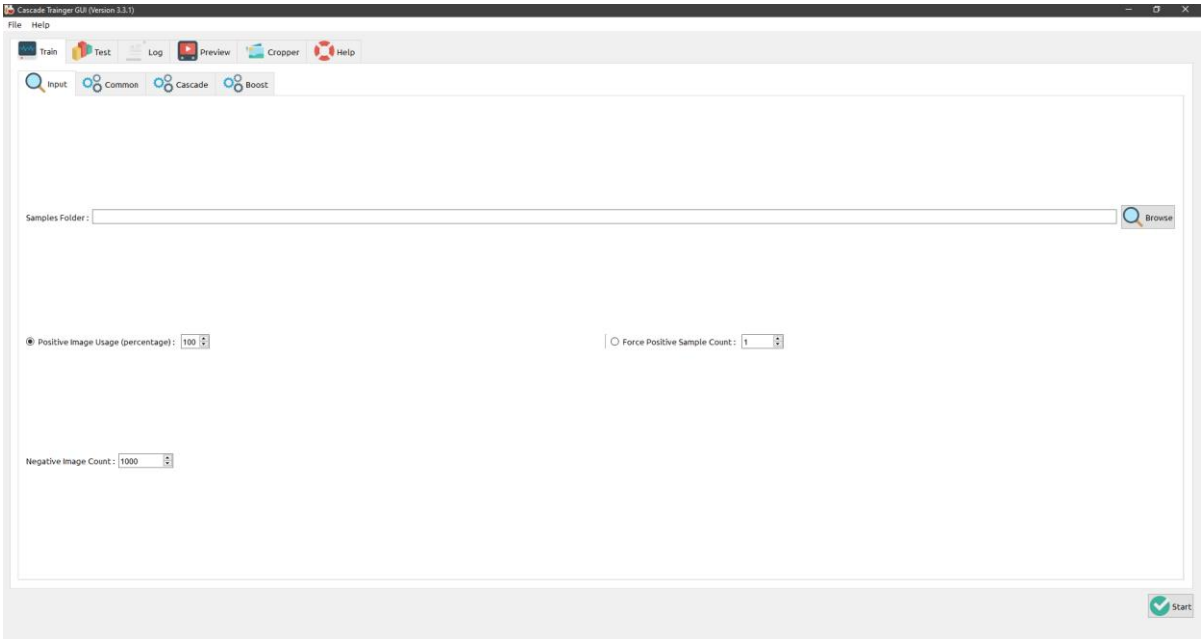


Figure 1 :- Cascade trainer : GUI

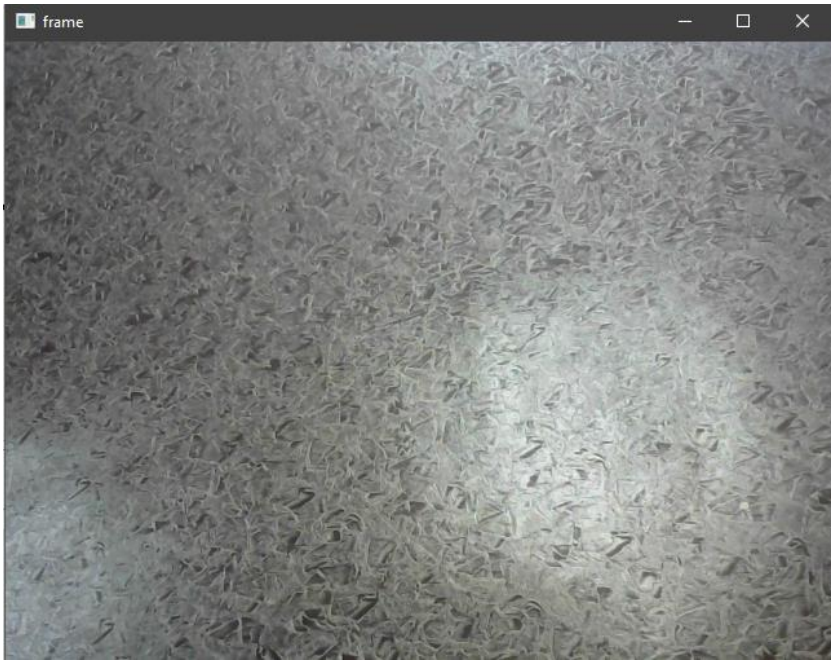


Figure 2:- Fire not Detected

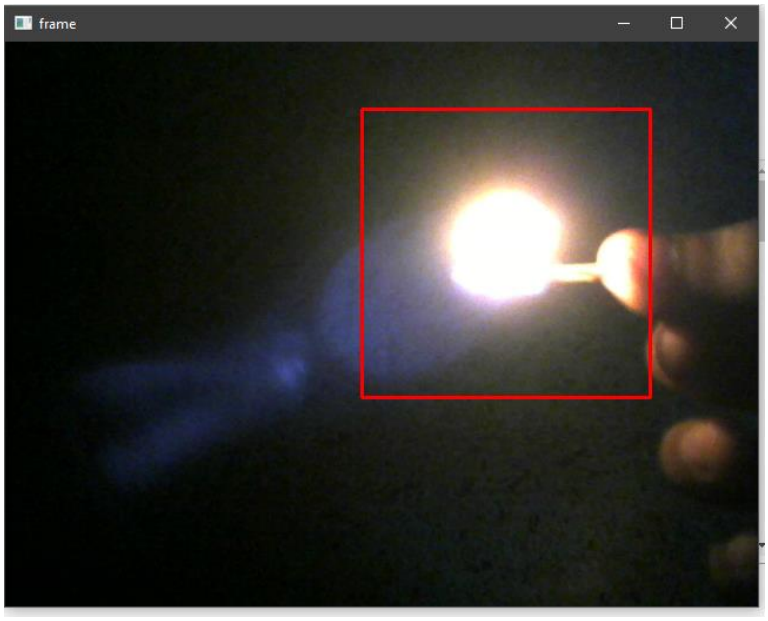


Figure 3:- Fire detected

```
    cv2.imshow('frame', frame)
    if cv2.waitKey(1) & 0xFF == ord('c'):
        break
```

```
fire is detected !!!
fire is detected !!!
fire is detected !!!
fire is detected !!!
fire is detected !!!
fire is detected !!!
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fire is detected !!!
fire is detected !!!
fire is detected !!!
```

Figure 4:- Output

2. Predicting forest damage using statistical data

In this project, we used to different supervised learning based machine learning algorithm and predicted the future damages caused by the fire by using the statistical data collected from historical incidents.

Dataset used: https://www.kaggle.com/elikplim/forest-fires-data-set

This dataset includes parameters like:

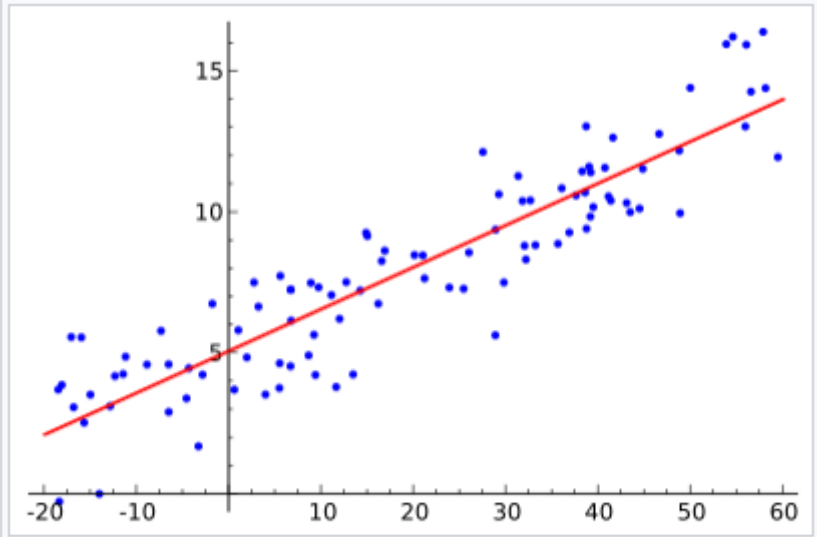
X - x-axis spatial coordinate within the Montesinho park map: 1 to 9
Y - y-axis spatial coordinate within the Montesinho park map: 2 to 9
month - month of the year: "jan" to "dec"
day - day of the week: "mon" to "sun"
FFMC - FFMC index from the FWI system: 18.7 to 96.20
DMC - DMC index from the FWI system: 1.1 to 291.3
DC - DC index from the FWI system: 7.9 to 860.6
ISI - ISI index from the FWI system: 0.0 to 56.10
temp - temperature in Celsius degrees: 2.2 to 33.30
RH - relative humidity in %: 15.0 to 100
wind - wind speed in km/h: 0.40 to 9.40
rain - outside rain in mm/m2 : 0.0 to 6.4
area - the burned area of the forest (in ha): 0.00 to 1090.84
(this output variable is very skewed towards 0.0, thus it may make sense to model with the logarithm transform).

We used two machine learning algorithm in this :

- Linear Regression

  Linear regression is basically a **linear** approach to modelling the relation between a scalar and one or more explanatory variables. This is used to predict the value of a variable

based on the value of another variable. This estimates the coefficients of the linear equation, involving independent variables that predict the value of the dependent variables. It fits a **straight line** or surface which decreases discrepancies between predicted and actual output values.

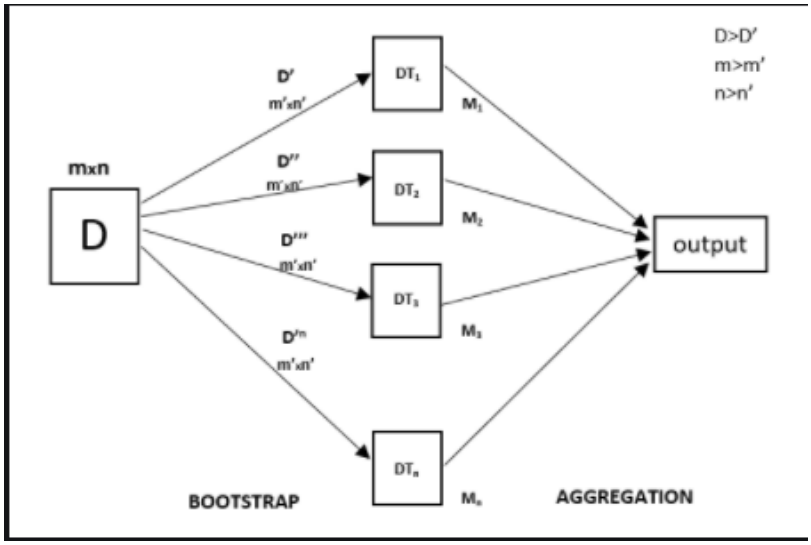


Example of simple linear regression, which has one independent variable

- Random forest Regression

Random forest regression is a an algorithm that can be used to perform both classification and regression task as it used **multiple decision trees** and a technique called **Bootstrap** and **Aggregation**.
Bootstrap means random sampling with replacement means it allows random sampling of small subsets of data from dataset. Then the output is aggregated at the end which reduces the variance.

The technique is to combine multiple decision trees in determining the final output rather relying on individual decision trees.



Result and Conclusion : various methods and approaches are discussed for reducing forest fires.

1. **Fire and smoke detecting systems in robots and UAVs.**

A live working project is build which can be used in building technologies like surveillance systems and robots to detect fire and then control it.

The system need some optimization but it can be used for the required purpose.

2. **Predicting forest damage using statistical data**

The prediction made using the statistical data can help in predicting the future damage that can be caused by the wild fires so that ample measures can be taken to counter it and reduce the chance of further damage.

It was found that random forest works better than linear regression in this case.

```
# Model Training and testing

Lreg = LinearRegression()
Lreg.fit(X,Y)
prediction = Lreg.predict(X)
score = explained_variance_score(Y, prediction)
mae = mean_absolute_error(prediction, Y)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
Score: 0.02397492990181449
Mean Absolute Error: 19.30993916466936
```

```
# Model training and testing

rfreg = RandomForestRegressor()
rfreg.fit(X,Y)
prediction_rfreg = rfreg.predict(X)
score = explained_variance_score(Y, prediction_rfreg)
mae = mean_absolute_error(prediction_rfreg, Y)

print("Score:", score)
print("Mean Absolute Error:", mae)
```

```
Score: 0.8362211063364372
Mean Absolute Error: 8.262703286359034
```

As an end result, the mechanism can be used to control and reduce forest at surface as well as core level.

Reference:

- https://www.kaggle.com
- https://github.com
- https://www.youtube.com
- https://www.geeksforgeeks.org