Army Institute of Technology, Pune

Forest Fire Detection using Satellite Imagery

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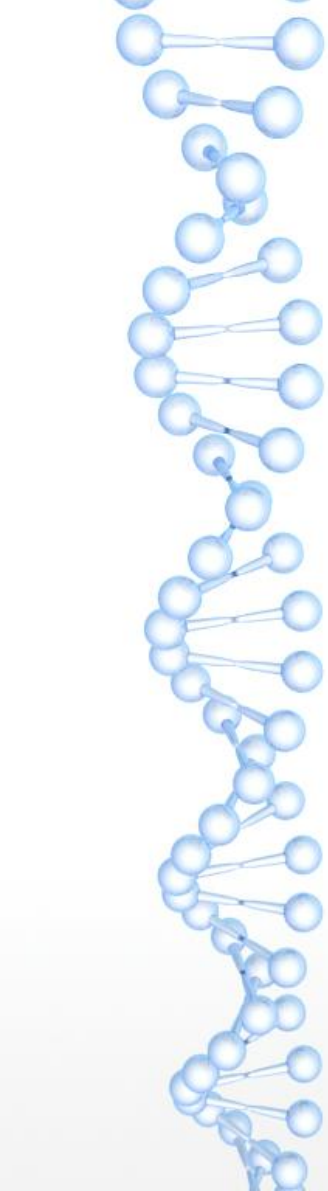
Aim & Objectives

- Forest Fires are not a sudden incidents they occur in steps and the focus is to detect it in latest possible stage.
- Detecting features directly from a raw image is not so efficient as compared to doing same after applying image processing over it.
- The colour quantized image give us best extracted features from any raw image which leads to a better model performance.
- Detecting nearby local areas to find the sensitivity of incident.
- Providing an optimal solution recover the fire.

Project Introduction

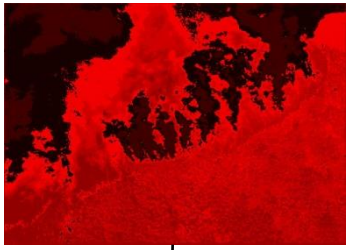
- Forest fire is a major concern as it causes huge damage to environment. Forest fire detection and coming up with optimal solution is a challenge.
- Technique that proved to be best for forest fire detection is pseudo-color processing for infrared forest-fire image.
- Imagery of the entire land surface of earth at 3-5 meter resolution are available and a coarse-resolution imagery from Landsat(30 meter pixels) or MODIS (250 meter pixels).

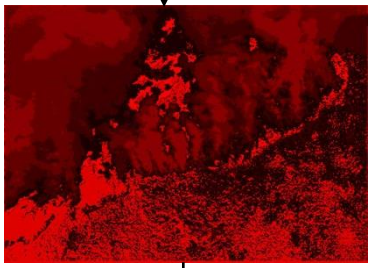


Project Workflow

input_image(224x224)

Image_Processing





Mask-RCNN

GoogleNet

ResNet-50

Fire Detection and Optimal Solution

Pseudo Color Image Processing

- It deals with **different grey-scale transforms of the grey image into different colours with different linear or nonlinear mapping functions.**

- The wild-fire image typically includes flame, some fire, smoke coverage area, the background.

- Flame can be divided into three parts: outer flame, inner flame, and centre of the flame.

- The temperature of outer flame is the highest, followed with in flame, then the centre of the flame, resulting in the gray level of flame image distributes in a certain form.

Principles of Forest-Fire Image Coloring

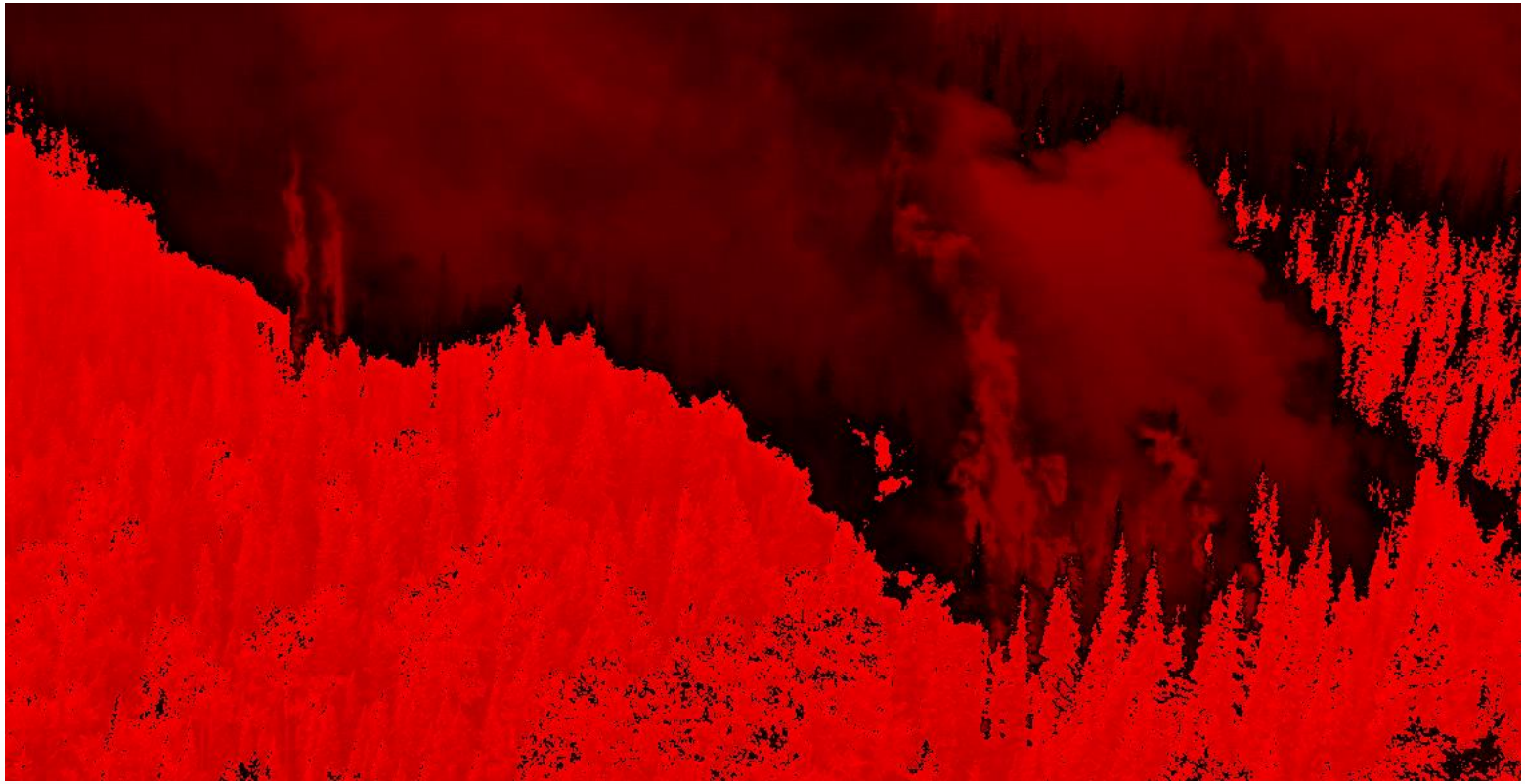
- We divide the image into two regions: the foreground of the image, areas covered by smoke, and the background.

- The gray values of the foreground concentrate between 0 and 128, according to gray value, we change the gray value of pixels into the values between white and yellow.

- The smaller of the grey value, the more light-coloured, the greater of the grey value, the more darken-coloured.

- The greater of the gray value the deeper of the red colour, the smaller of gray colour, the lighter of the red colour.

Fig 1 : R component of Normal image



Img 2 : Pseudo colour based filtered image

Histogram partial equalization

•The background or burning parts of the forest - fire infrared images occupy most of the gray-scale. Flame, some fire, smoke parts occupy less.

• When the contrast is weak, and the histogram distribution concentrates in the low gray level, background of the coded image is blur, and its details are loss seriously.

• The **gray levels of the area covered by smoke is in the middle gray-scale**, due to the impact of light and other factors, they may become higher.

• The area covered by smoke may mistake for part of the flame.

- For the above factors, **it proposes the partial histogram equalization to reduce the error** and increase the effect of pseudo-colour processing.

Histogram partial equalization

- Histogram statistical analysis is carried out, and based on the gray value distribution, we divide it into different local histograms.

- We analyze the rates of local histogram of the gray changing and its corresponding gray-scale, do **partial equilibrium to the histogram the gray value of which is at around 128.**

- **Using this algorithms for infrared image processing smoke, background and flames can be clearly distinguished.**

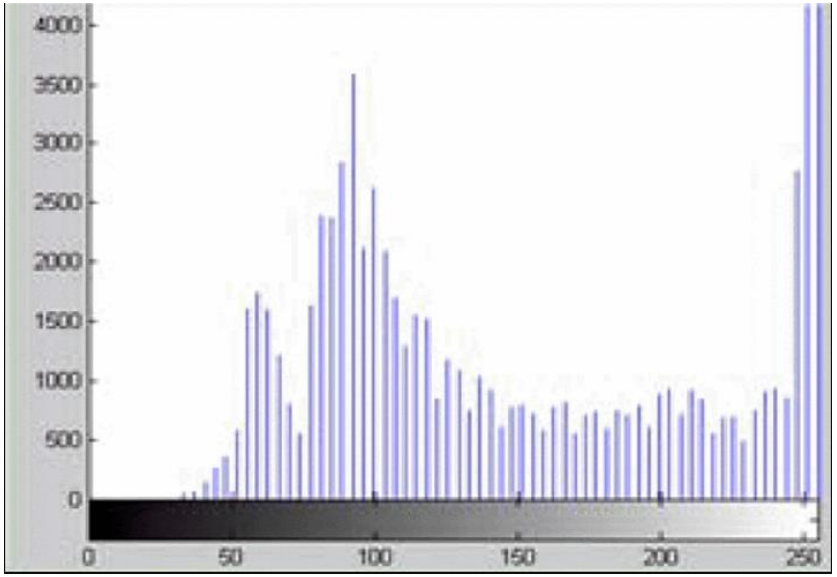
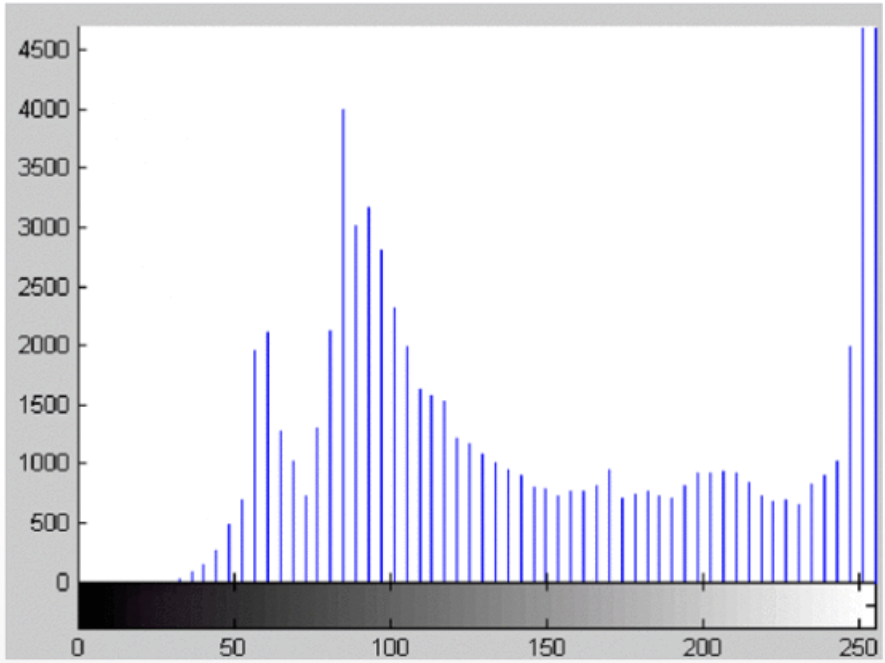


Fig 3 : Histogram distribution of Red colour after pseudo colour image processing

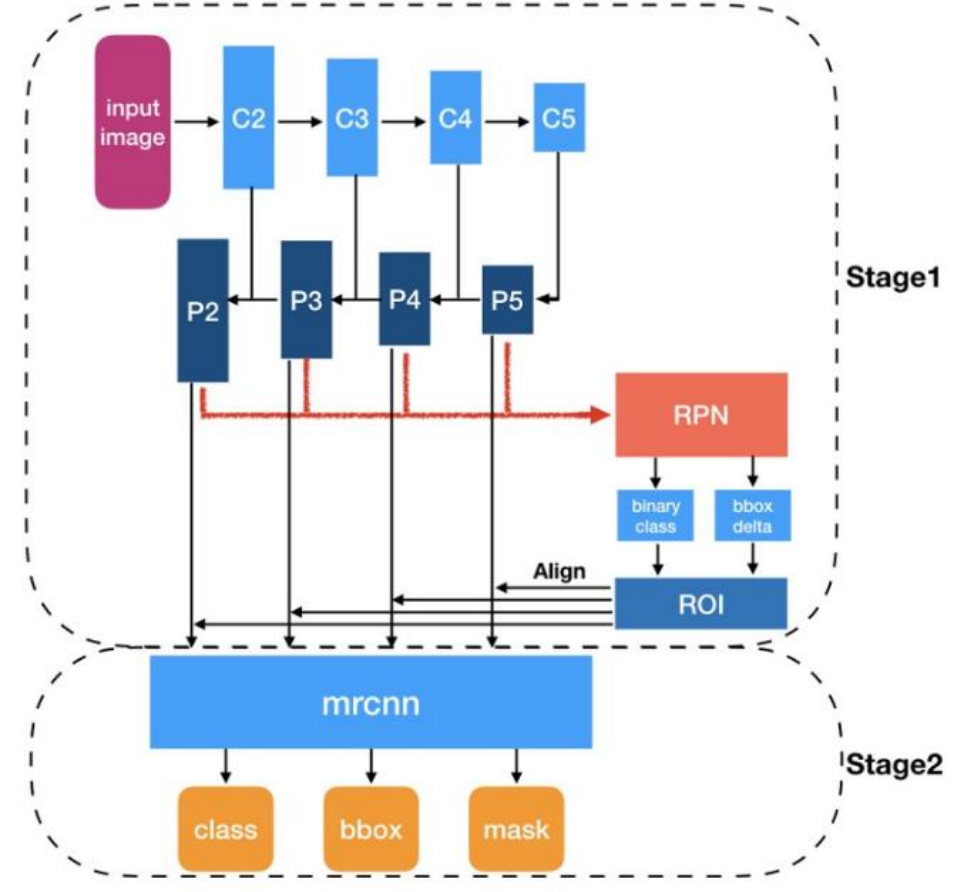
Fig 4 : Histogram equalized b/w 120 to 150 of red colour



MASK R-CNN

- Mask R-CNN extends Faster R-CNN to pixel-level image segmentation.
- Based on the framework of Faster R-CNN, it added a third branch for predicting an object mask in parallel with the existing branches for classification and localization.
- The mask branch is a small fully-connected network applied to each RoI , predicting a segmentation mask in a pixel-to-pixel manner.

MASK R-CNN NETWORK ARCHITECTURE



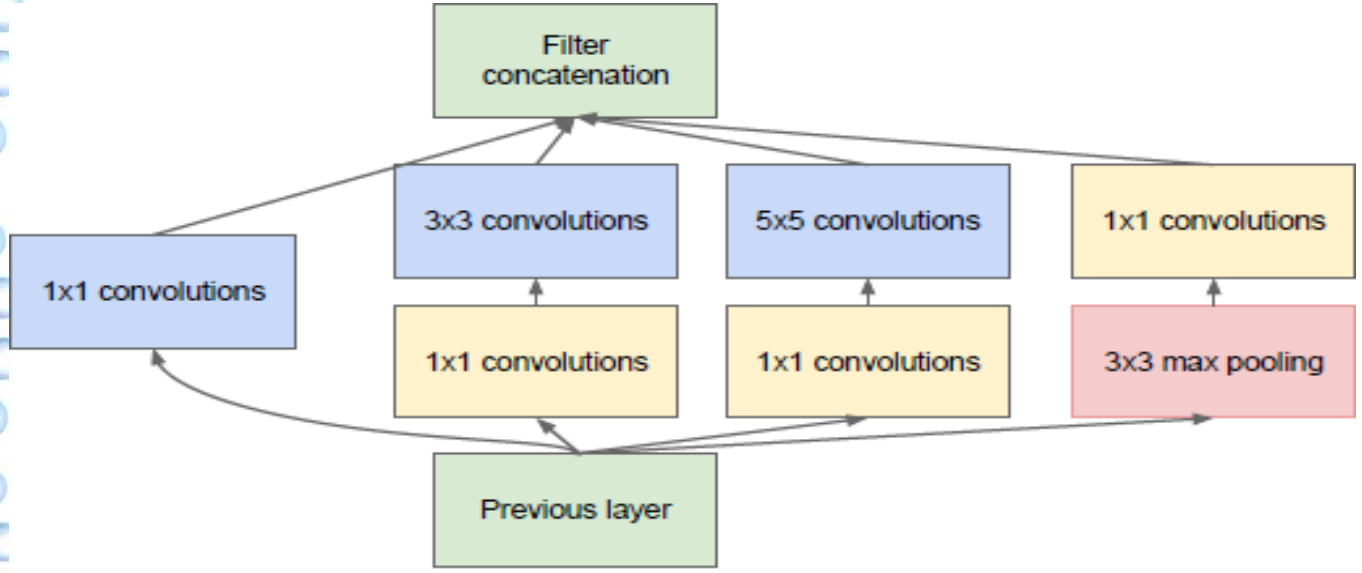
MASK R-CNN RESULT

Fig 6: Masked Result [2]

GoogLeNet

- Main goal of using GoogLeNet is to detect the fire from satellite imagery.
- For faster and real time detection of fire on satellite imagery , GoogleNet ensures efficiency of computation.
- 12 times lesser parameters than AlexNet and significantly more accurate than AlexNet.
- Lower memory-use and lower power-use acutely important for mobile devices.
- Computational cost less than 2X compared to AlexNet.

Working of GoogLeNet



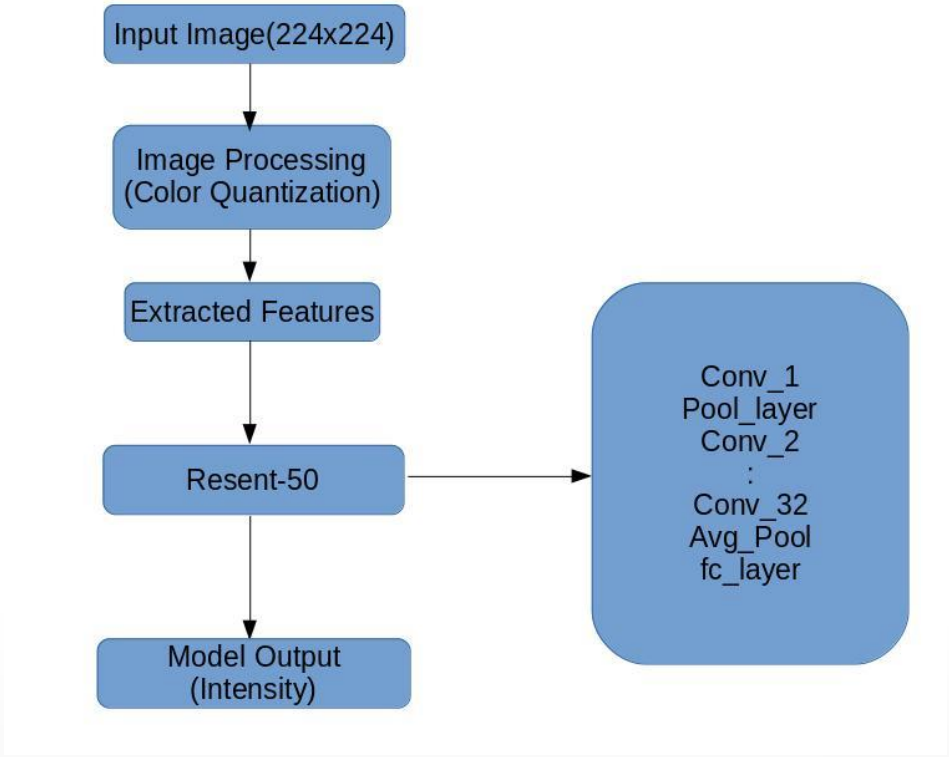
(b) Inception module with dimensionality reduction

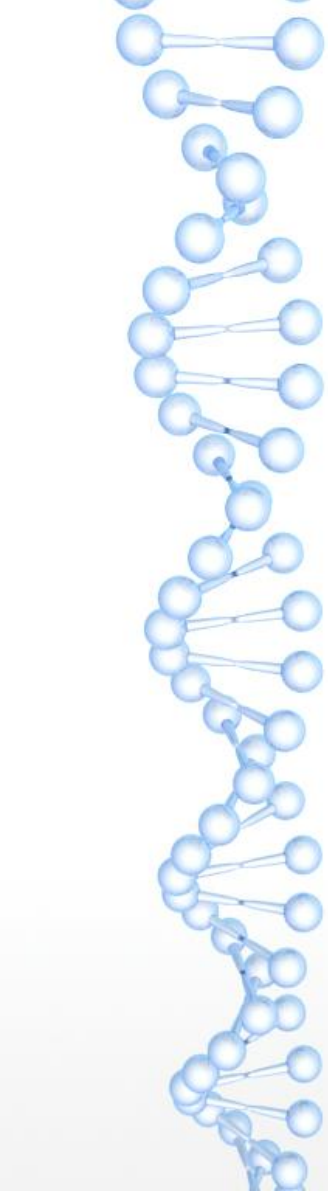
Fig 7. Inception module in GoogLeNet

Resnet-50

- Instead of learning a direct mapping of x to y with a function H(x) (A few stacked non-linear layers). Let us define the residual function using F(x) = H(x)-x, which can be re-framed into H(x) = F(x)+x, where F(x) and x represents the stacked non-linear layers and the identity function(input=output) respectively.
- Deeper neural networks are more difficult to train. We present a residual learning framework to ease the training of networks that are substantially deeper than those used previously.
- We explicitly reformulate the layers as learning residual functions with reference to the layer inputs, instead of learning unreferenced functions.

Resnet-50 Model Architecture





Implementation

Satellites
KEEP CLAM
AND
CLICK IMAGES,
RESNET
is on
WORK.

Hyperparameter Tunning

- Learning rate
- No.of epochs
- Batch Size
- Activation Function
- No. of Hidden Layers
- Weight Initialization
- Feature extraction

Applications of Satellite Imagery

- There are currently over 4500 satellites orbiting the Earth. Over 600 of them are regularly taking pictures of the Earth’s surface.
- Object Detection over earth’s surface is an interesting task to keep an eye over activities.
- Traffic Monitoring, Intrusion Surveillance, Ship Detection on Oceans, Advancing Agriculture is huge field of study which enriches farmers activity.