Deep Learning

SCS 3546

Forest fire monitoring using Deep Neural Network

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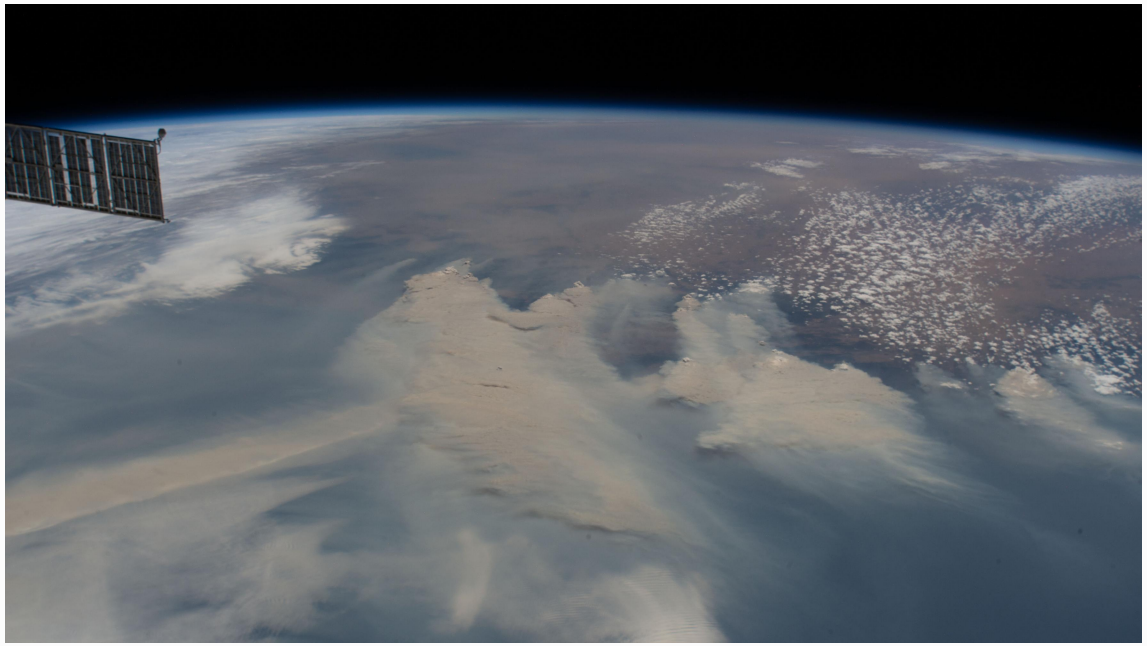
Background:

In recent years, due to climate change and other environmental factors, the frequency of forest fires has significantly increased. Timely detection of forest fires in the early stages is crucial for controlling the spread.

Currently, the use of satellite remote sensing images for forest fire detection has become a popular monitoring method. However, due to limitations in resolution and timeliness, there is still room for technological advancement in this field.

Objectives:

The goal of the project is to develop a machine learning model capable of identifying areas at risk for forest fires using satellite imagery. Focuses on using image processing and deep learning techniques to accurately and efficiently detect forest fires.



Note: Adapted from "NASA's SAGE III Instrument Observes Aerosol Spike from Australian Fires"

Extreme fire activity was seen above Australia from the International Space Station in January 2020

Data Source:

The original data set comes from the Government of Canada-"Forest fires" and was compiled by ABDELGHANI AABA and uploaded to Kaggle.

Each image is extracted from satellite imagery of forest fire sites using longitude and latitude coordinates, and the image resolution is 350x350 pixels.

Data Preprocessing:

1. Corrupted images are identified and deleted.

2. Balance the data set.

- Train: #14000=70%
- Test: #3000=15%
- Validation: #3000=15%

3. Apply data enhancement techniques such as: random rotations, shifts, zooms, and flips to enhance the generalization ability of the model.

Model Architecture and Training

01

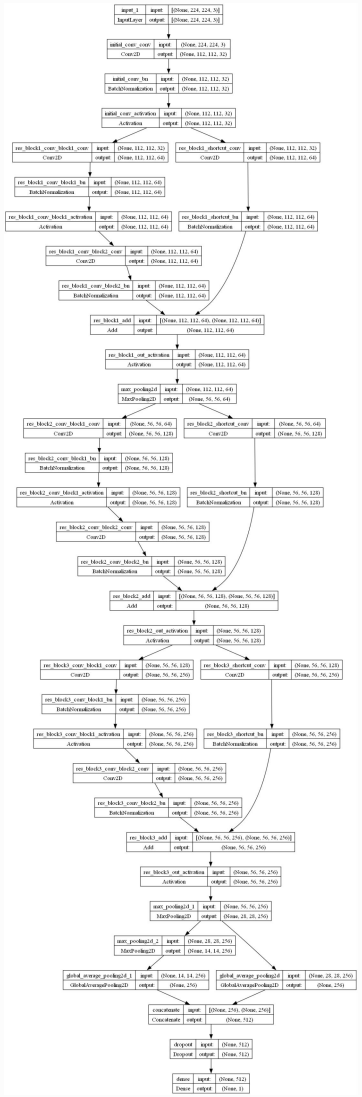
Key Features

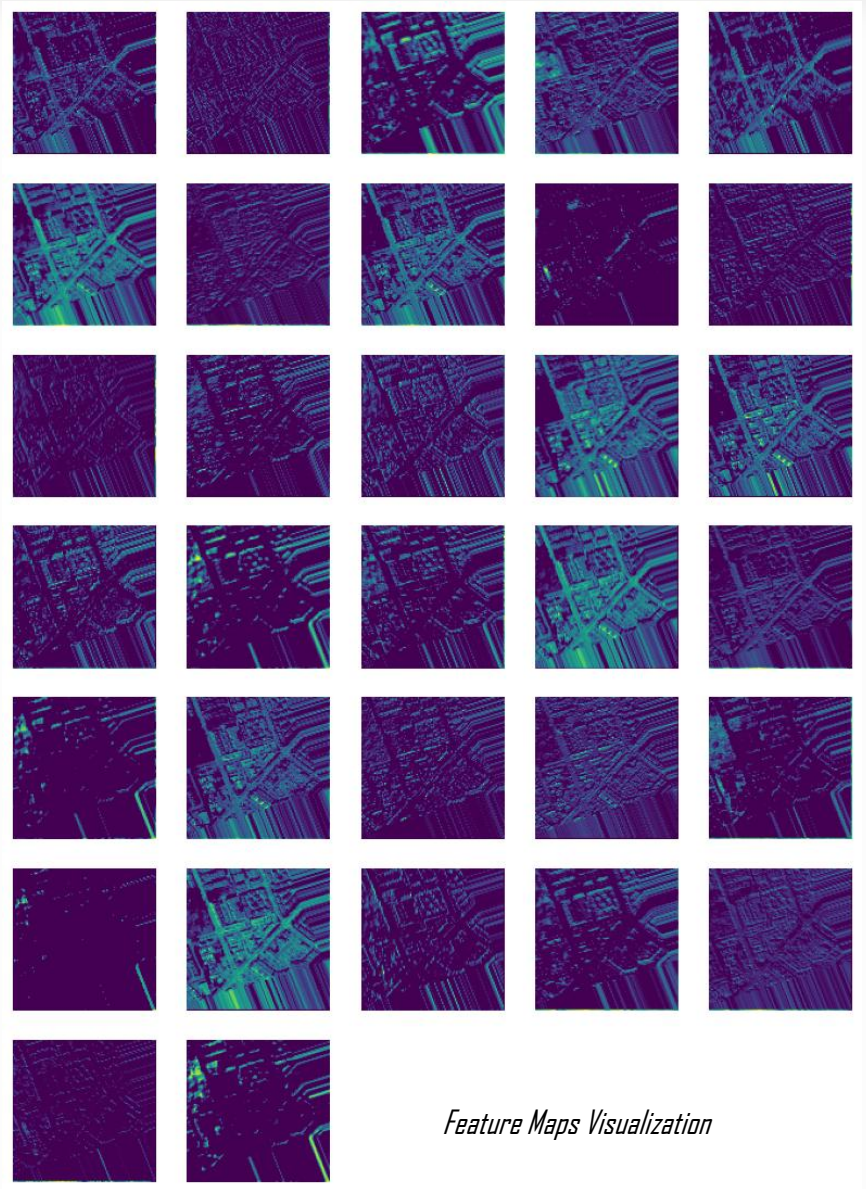
- Convolutional Neural Network (CNN)
- Residual Block (3)
- MaxPooling
- Batch Normalization
- Dropout Layers (0.5)

02

Training Process

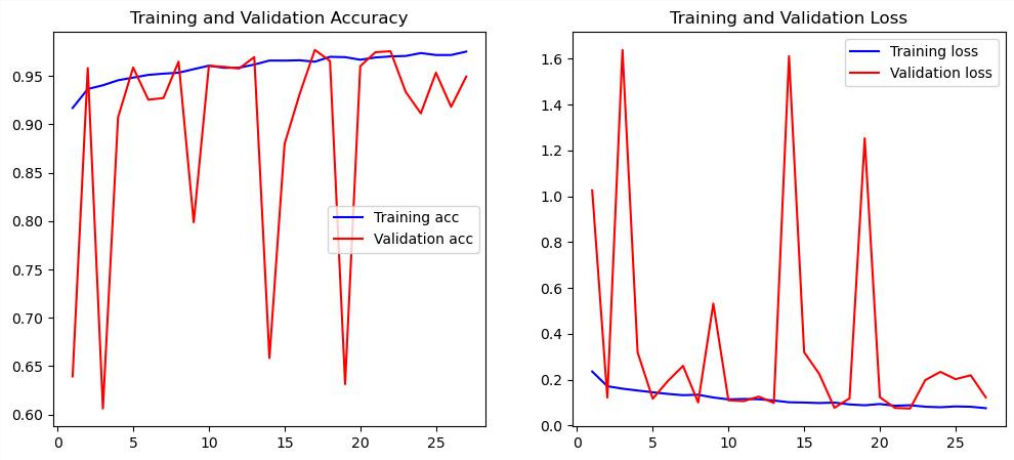
- Binary cross-entropy loss function
- Adam optimizer
- 30 epochs & 32 batch size
- Early Stopping (5 epochs)





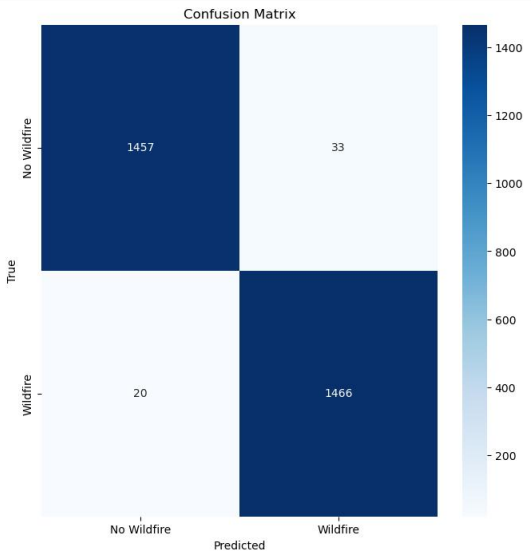
Feature Maps Visualization

Results and Performance Evaluation



The model achieved an accuracy of 97.51% on the train set and 94.93% on the validation set.

Upon evaluation on unseen test data, the model demonstrated a high accuracy of 98.25% and a loss of 0.0582.



	precision	recall	f1-score	support
No Wildfire	0.99	0.98	0.98	1490
Wildfire	0.98	0.99	0.98	1486
accuracy			0.98	2976
macro avg	0.98	0.98	0.98	2976
weighted avg	0.98	0.98	0.98	2976

Conclusions:

This project develops a convolutional neural network model capable of detecting forest fires from satellite imagery. The model demonstrates robustness, showing high accuracy and low loss on validation and test data.

This work contributes to the field of environmental monitoring and demonstrates the potential of artificial intelligence in aiding disaster management and response initiatives.

Future Work:

The integration of other data sources, such as combining temperature, wind pattern or radar image data, can be explored in the future to further improve the accuracy of the model.

Further research may involve exploring other deep learning methods such as Transformers, or trying to use unsupervised learning techniques for feature extraction.

THANKS

FOR WATCHING

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