DEEP LEARNING BASED APPROACH TO FIRE DETECTION SYSTEM

SUBHA CHAKRABORTY (12020002011014)
SUBROTO RAKSHIT (12020002016039)
PRATYUSH RANJAN (12020002004036)
PRABHAT KUMAR (12020002016037)
PAYEL CHATTERJEE (12020002004054)
AJAY KUMAR MANDAL(12020002016040)

Under the guidance of
Prof . Ayan Kumar Panja Sir
(Assistant Professor)

Institute of Engineering & Management

17-04-2024

PRESENTATION OUTLINE

1	2	3	4	5
INTRODUCTION	MOTIVATION BEHIND PURSUING THE PROJECT	PROPOSED METHODOLOGY	RESULTS & ANALYSIS	CONCLUSION

INTRODUCTION

In today's tech-driven era, AI and ML play pivotal roles in bolstering public safety. Our project introduces an advanced fire detection system leveraging the Inception V3 CNN model. With a 98.98% accuracy rate, it surpasses traditional methods, minimizing false alarms.

Application Domain: The deep learning based fire detection system can be applied in different places such as commercial buildings, industrial facilities, residential areas, transportation hubs, and critical infrastructure.

Aims and Objective:

1. Develop a reliable and efficient fire detection system.
2. Utilize CNN algorithm(Inception V3) for timely detection and response.
3. Minimize loss of life and property in fire-related incidents.
4. Demonstrate practical applicability of deep learning in safety and security.

MOTIVATION

Prompt detection of fires is imperative for effective fire prevention and control, considering the grave consequences they entail. Early detection facilitates swift evacuation of residents, timely deployment of firefighting resources, and containment of the fire before it escalates. This proactive approach not only reduces the likelihood of fatalities and injuries but also minimizes property damage and mitigates the adverse environmental and economic impacts of fires. Therefore, the development of advanced fire detection systems is crucial for enhancing protection, safety, and resilience in both residential and commercial settings.

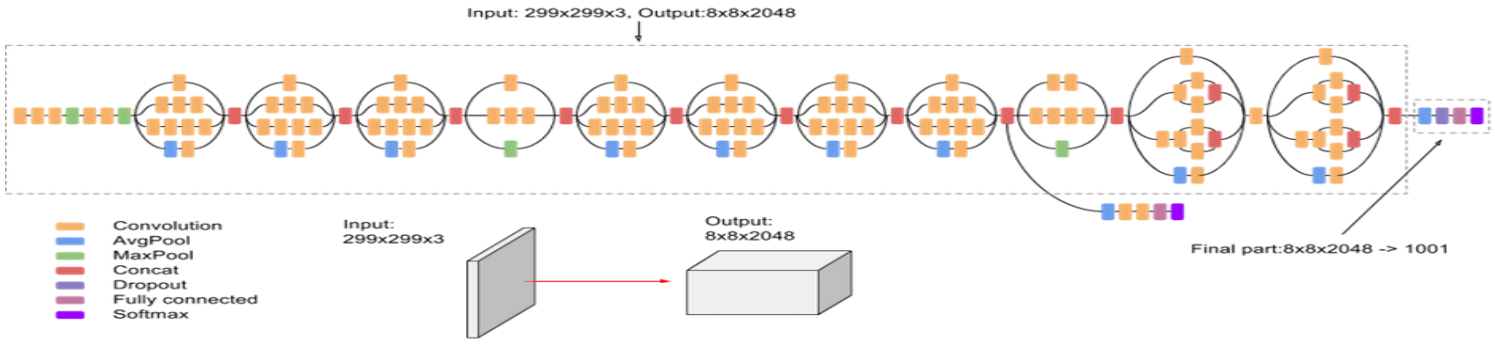
For example, in 2024, 39 people have died and 100 people have been injured fire incidents in Delhi so far. (16 people lost their life in January, 16 people lost their life in February and another 7 in March), highlighting the need of efficient fire detection system.

PROPOSED METHODOLOGY

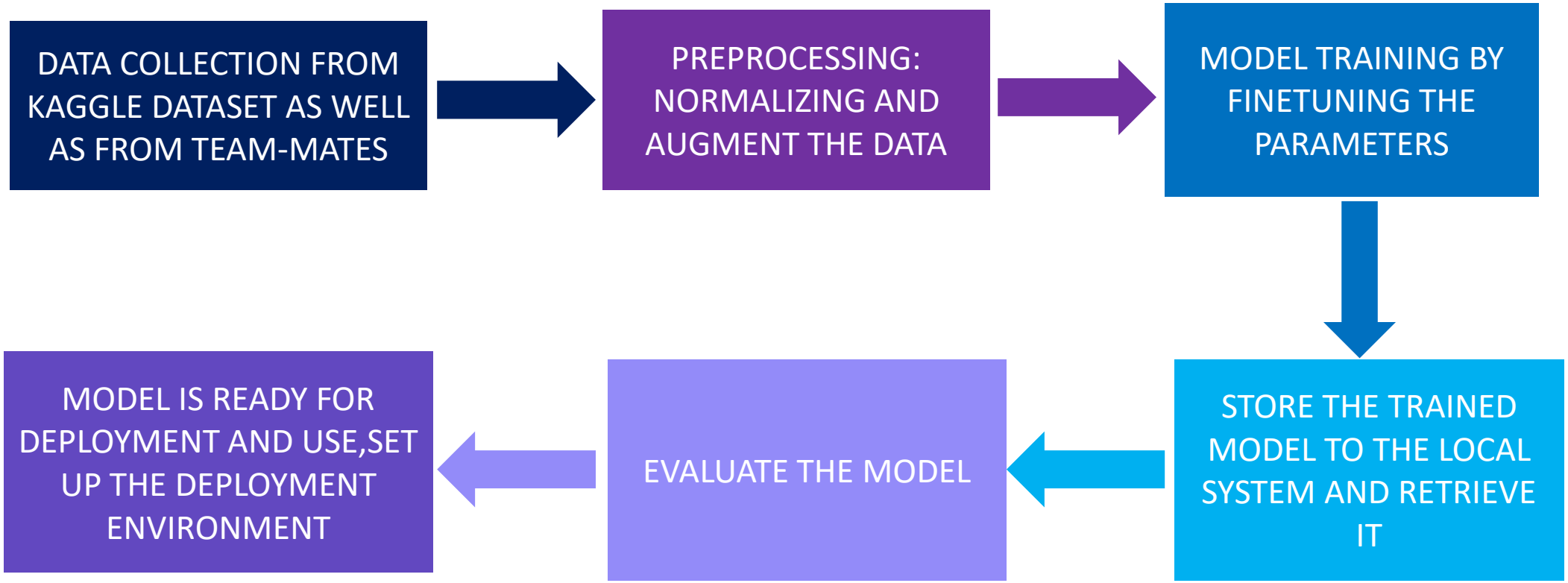
In this project, we use a CNN(Inception V3)based approach to detect fire(ex: building fire, factory fire, etc). It will help to detect fire , and early steps can be taken against the fire.

What is Inception V3?

Inception V3 is a CNN architecture by Google for image classification. It uses inception modules to capture features at various scales and employs techniques like batch normalization for faster training. Widely used in computer vision, it excels in tasks like image classification and object detection.



PROPOSED METHODOLOGY(WORKFLOW)



MODEL TRAINING AND DEPLOYMENT

PARAMETER	VALUES
Learning Rate	1.40E-04
Batch Size	32
Epochs	5
Optimizer	Adam Optimizer
Loss Function	Binary Cross Entropy
Kernel Size	3*3
Activation Function	Sigmoid
Regularization Method	Dropout
Regularization Rate	0.5

Hyperparameter and values used for the models

After preprocessing, our model is trained with defined hyperparameters, followed by tuning. Once trained, it's saved locally for future access, eliminating the need for retraining. Loading the model enables plotting of accuracy and loss curves. Predictions can be made on sample images, as well as on video frames at one frame per second, facilitating fast processing. Output is a 2x1 array, indicating fire (index 0) or no fire (index 1). For image uploads, the code prompts for an image, saving a temporary copy on the server. If fire is detected, it's boxed and confidence is provided; otherwise, no box appears with corresponding confidence for no fire. Open CV module is employed for this project to work.

Example data taken

Fire Detected

Fire detected with a confidence of 99.99%

CONTINUED.....

Video Frames on which predictions are made

we can see that, index 0 confidence value is 98% and index 1 value is 1.4%. If the confidence is higher than 97% (approx.), it can be said that fire is there, else the image needs to be processed for a more accurate result.

RESULT & ANALYSIS

EVALUATION METRICS USED

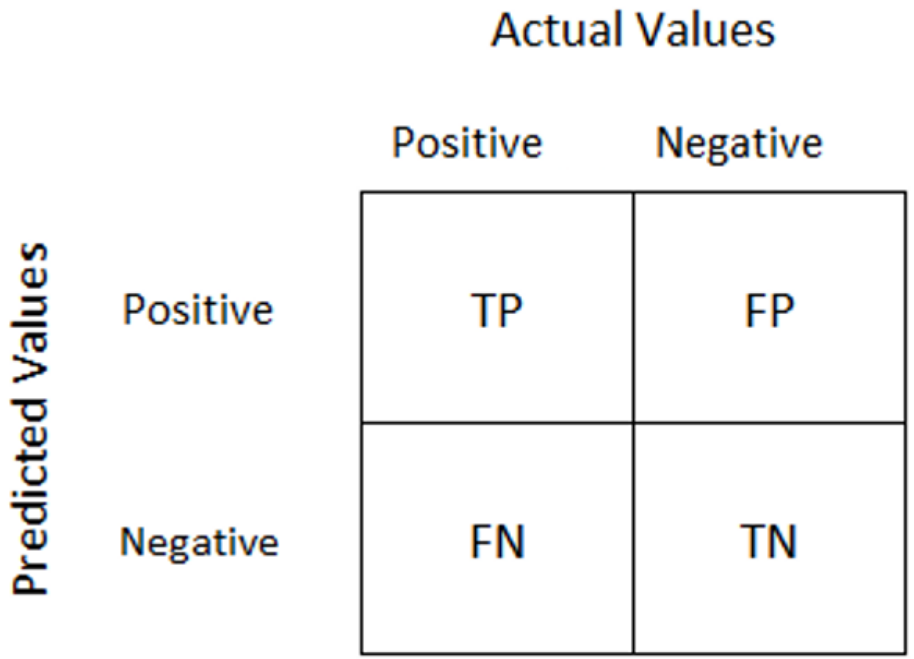
The Evaluation Metrics used for choosing the optimal model for our project involved measuring the accuracy of the model and its F1 score. Before we observe the metrics it is important to observe certain terms namely:

$$Accuracy = \frac{True\ Positive + True\ Negative}{Total\ Predictions} X100$$

$$Recall = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

$$Precision = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

$$F1\ Score = \frac{2XPrecisionXRecall}{Precision + Recall}$$



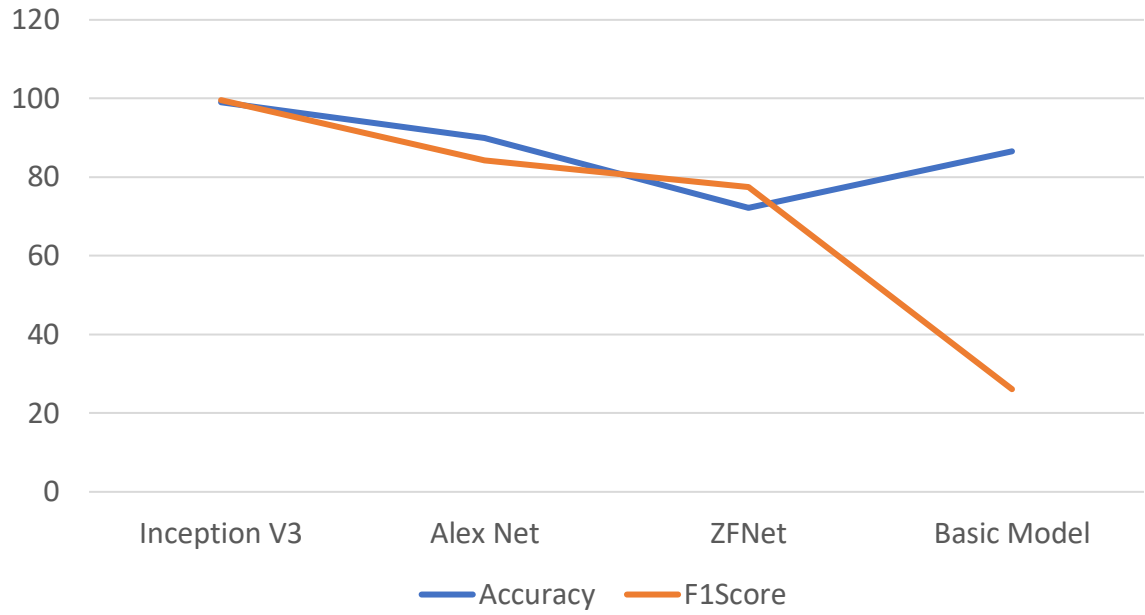
THE CONFUSION MATRIX

RESULT & ANALYSIS(CONTINUED..)

SUMMARY OF THE RESULTS

MODEL	ACCURACY	F1 SCORE
Inception V3	98.98	99.52
Alex Net	90	84.21
Basic Model	86.5	26
ZFNet	72.2	77.4

Based on these results, the Inception V3 model emerges as the optimal choice for fire detection purposes in our project. Its remarkable accuracy and F1 Score make it well-suited for reliable and efficient fire detection applications.



Graphical Representation of the Accuracy and F1 scores of the models

CONCLUSION

In conclusion, the selection of Inception V3 for fire detection represents a strategic choice informed by meticulous experimentation and performance evaluation, which is evident from its impressive accuracy rate of 98.98% and an F1 Score of 99.52%. Its remarkable attributes and exceptional performance metrics underscore its suitability for our application, promising enhanced fire detection capabilities and improved safety measures.

RESEARCH PAPER PUBLISHED

Paper Communicated: Our paper “Deep Learning Based Approach to Fire Detection System” has been communicated to the esteemed International conference on Artificial Intelligence and Sustainable Computing.

Related work to be published: Mukherjee, Amartya, et al. "A 6G-enabled Edge-assisted Internet of Drone Things Ecosystem for Fire Detection." Proceedings of the 4th International Conference on Frontiers in Computing and System, October 2023

REFERENCES

- Bin Zhang; Linkun Sun; Yingjie Song; Weiping Shao; Yan Guo; Fang Yuan; DeepFireNet: A real-time video fire detection method based on multi-feature fusion , 09 November 2020[MBE]
- Junxun Huang; Xuemei Ma; Yulong Wang; Xiao Li ; Real-time Video Fire Detection via Convolutional Neural Networks ,10 April 2023[IEEE]
- Valquíria Hüttner; Cristiano Rafael Steffens; Silvia Silva da Costa Botelho; First response fire combat: Deep learning based visible fire detection, 18 December 2017 [IEEE]
- Yaroju Raj Kumar; Vakati Surya Balaji; Vegesna Maneesh Varma; B. Ushasri; FIRE ACCIDENT DETECTION USING DEEP LEARNING, April-2022[IRJMETS]
- https://github.com/DeepQuestAI/Fire-Smoke-Dataset/releases/download/v1/FIRE-SMOKE-DATASET.zip