INTERNSHIP REPORT

ON

Fire Detection using Deep Learning (CNN)

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
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IN
ELECTRONICS AND TELECOMMUNICATION

BY

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CERTIFICATE

This is to certify that the internship report entitled,

"Fire Detection using Deep Learning (CNN)"

submitted by

Daware Atharv PRN No. 72293984B

Is a bonafide work carried out by him under the supervision of Mr. Milind Ankleshwar and Mr. A. N. Kshirsagar is approved for the partial fulfillment of the requirement of Internship Course under Third Year of the Degree of Bachelor of Engineering (Electronics and Telecommunication Engineering). This report has not been earlier submitted to any other Institute or University for the award of any degree or diploma.

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ABSTRACT

One of the most significant and essential resources is the forest , because it features a variety of plant life, including herbs, trees, andbushes, as well as several animal species. These renewable resources arecrucial to humanity in some way.

Forest fires, the most common hazard toforests, severely devastate the ecology, and local ecosystem. Topreserve forests from fires, early detection and preventive measures arerequired. The two most common existing approaches for human surveillanceto accomplish early detection are Direct human monitoring and remotevideo surveillance.

This study proposes a forest fire imageidentification approach using convolutional neural networks to detectfires automatically. Employing this technique decreases false alarms andprovides accurate fire detection results. The contour approach can beused to test its capability to monitor both interior and outdoorapplications utilizing computer vision.

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1. INTRODUCTION

1.1 BACKGROUND

Our project focuses on leveraging convolutional neural networks (CNNs) for fire detection, utilizing advanced computer vision techniques.

By harnessing the power of CNNs, we aim to create an automated system capable of accurately identifying fire incidents in various environments.

The integration of CNNs allows for efficient analysis of image data, enabling real-time detection of fires with high precision.

Our approach includes employing contour analysis methods, which enhance the system's ability to detect fire patterns in both indoor and outdoor settings.

Through extensive training, our CNN model learns to distinguish between normal environmental features and the distinctive characteristics of fire.

The system's robustness is further enhanced by considering factors such as varying lighting conditions and different types of fire sources.

We envision our project making significant contributions to early fire detection, thereby minimizing potential damage and saving lives.

Continuous refinement and optimization of the CNN architecture are integral parts of our research, ensuring superior performance and reliability.

Validation of our system involves rigorous testing across diverse datasets, validating its effectiveness across different scenarios and environments.

Ultimately, our goal is to deploy a reliable and scalable fire detection solution that can be integrated into various surveillance systems for enhanced safety and security.

1.2 PROJECT UNDERTAKEN

The development process of our automatic forest fire detection system encompassed several crucial phases, each pivotal for achieving our objectives. From initial ideation to implementation, precise planning and execution were fundamental to realizing our vision of enhancing fire safety through advanced technology.

Utilizing deep learning (DL) techniques for Fire detection:
Employing Deep Learning algorithms to analyze and interpret complex datasets, aiming to improve the detection of Fire.

Addressing limitations of traditional diagnostic methods through computational approaches:
Seeking to overcome the subjectivity and potential inaccuracies inherent in conventional diagnostic techniques by leveraging computational intelligence and data-driven methodologies.

Integrating varied datasets comprising fire indicators and environmental data linked with fire:
Utilizing multiple data streams, such as image captures, thermal readings, and geographical data, to construct comprehensive models for fire detection.

Datasets include photos, handwriting samples, and demographic information:
Utilizing rich and diverse datasets encompassing various modalities of information to capture the multifaceted nature of fire detection and enhance the diagnostic capabilities of ML models.

Training and assessing CNN models to differentiate between fire instances and non-fire:
Utilizing stringent training and evaluation methods to create CNN models adept at precisely discerning fire occurrences from non-fire situations, enabling prompt intervention and prevention.

Striving to create a dependable and resilient fire detection CNN tool for early intervention and prevention measures :
Ensuring the CNN tool's adaptability to diverse environmental conditions and its scalability for widespread implementation. Additionally, prioritizing continual refinement and optimization to enhance its effectiveness and reliability over time.

Leveraging interdisciplinary approaches to enhance detection capabilities:

Harnessing interdisciplinary methodologies to enrich fire detection capabilities:Pooling expertise from fields like computer science, meteorology, and environmental engineering to foster innovation in fire detection systems.

Contributing to advancements in fire safety:

Striving to introduce novel techniques, approaches, and technologies that elevate the current standards in fire detection, ultimately safeguarding communities from the devastating impacts of fire incidents.

1.3 SUMMARY

The undertaken project endeavors to innovate fire detection through the application of advanced convolutional neural network (CNN) techniques. By addressing the limitations of traditional fire detection methods, we aim to enhance accuracy and efficiency. This involves integrating diverse datasets, including image captures, thermal readings, geographical data, and environmental factors.

Through rigorous CNN model training and evaluation, our goal is to develop a reliable fire detection tool capable of accurately distinguishing fire instances from non-fire scenarios. Drawing upon interdisciplinary expertise from fields such as computer science, meteorology, environmental engineering, and firefighting techniques, we seek to foster innovation in fire safety.

Additionally, we aspire to contribute to advancements in the field by introducing novel techniques and technologies. The ultimate objective is to create a dependable fire detection CNN tool that enables timely interventions and enhances safety measures. Through collaborative efforts, we aim to alleviate the impact of fire incidents on communities worldwide, ensuring a safer environment for all.

The project also emphasizes the importance of continuous refinement and optimization of the CNN architecture to ensure its adaptability to diverse environmental conditions and its scalability for widespread implementation. By staying abreast of the latest advancements in machine learning and fire detection technology, we aim to maintain the effectiveness and reliability of our diagnostic tool over time. Furthermore, our commitment to excellence extends to the validation of our system through rigorous testing across various datasets and real-world scenarios, ensuring its robust performance in different environments. Through these concerted efforts, we strive to make a lasting impact on fire safety, ultimately saving lives and mitigating the devastating effects of fire incidents.

2. LITERATURE SURVEY

2.1 PREVIOUS WORK UNDERTAKEN

A literature review serves as a fundamental aspect of project development, offering an exhaustive examination of prior research, studies, and advancements pertinent to fire detection CNNs. In our pursuit of creating a fire detection model, conducting a literature review entailed investigating previous work in fields like computer vision, image processing, neural network architectures, and real-time data analysis.

This involved scrutinizing existing methodologies, algorithms, and datasets utilized in fire detection research to identify trends, challenges, and opportunities for innovation. Additionally, exploring literature related to fire incidents, environmental monitoring, and sensor technologies provided valuable insights into the complexities of fire detection and prevention.

Through this comprehensive literature survey, we gained a deeper understanding of the state-of-the-art techniques and best practices in fire detection CNN development, laying a solid foundation for our project's advancement.

1 . Deep Learning Models:

In our project, we focused on employing CNNs for fire detection and explored ResNet-50's effectiveness inenhancing accuracy.

- ResNet-50:

  Known for its depth and skip connections, ResNet-50 captures intricate spatial features in fire patterns, improving detection accuracy.

- VGG:

  We experimented with VGG architecture for its simplicity and effectiveness in image classification tasks.

- DenseNet:

  DenseNet, with its densely connected layers, promotes feature reuse and gradient flow, enhancing detection capabilities.

Through these models, including CNN, ResNet-50, VGG, and DenseNet, we aimed to develop a robust fire detection system.

2. Dataset Selection:

Researchers have curated diverse datasets containing annotated fire and non-fire images, facilitating the training and evaluation of CNN models for fire detection tasks. These datasets include publicly available repositories as well as custom collections tailored to specific scenarios and requirements.

3. Image Selection and Augmentation:

Studies have investigated techniques for image selection and augmentation to enhance the diversity and representativeness of the dataset. Augmentation methods such as rotation, scaling, flipping, and adding noise have been employed to simulate real-world variations and improve the generalization ability of CNN models.

4. Model Selection:

The choice of CNN architecture plays a crucial role in fire detection performance. Researchers have explored various architectures, including ResNet-50, for their effectiveness in capturing spatial features and learning complex patterns from fire images. Comparative studies have evaluated the performance of different models and identified the most suitable architecture for specific fire detection scenarios.

5. Performance Evaluation Metrics:

Evaluation methodologies for assessing the performance of CNN models in fire detection tasks have been extensively discussed. Common metrics such as accuracy, precision, recall, F1-score, and ROC curve analysis are used to measure the model's effectiveness in distinguishing between fire and non-fire instances.

2.1 SUMMARY

The literature survey reveals a growing body of research focused on leveraging deep learning techniques, specifically convolutional neural networks (CNNs), for fire detection, aiming to enhance accuracy and enable early intervention. Previous studies have explored CNN architectures like ResNet-50 and Sequential models, demonstrating their effectiveness in accurately distinguishing fire incidents from non-fire scenarios. These models have been applied to diverse data modalities, such as image captures and thermal readings, highlighting the multidimensional nature of fire detection.

In addition to CNN models, researchers have employed feature selection techniques to optimize performance, including methods such as Principal Component Analysis (PCA) and Recursive Feature Elimination (RFE). Image analysis has emerged as a prominent area of investigation, with features like spatial patterns and temperature gradients showing promise in detecting subtle fire cues. Similarly, data integration from various sensors has provided valuable insights into environmental conditions and fire behavior.

Furthermore, the literature survey underscores the importance of interdisciplinary collaboration, with researchers drawing upon expertise from fields such as computer science, meteorology, and environmental engineering to drive innovation in fire detection. Integrating insights from diverse disciplines has enabled the development of more robust and scalable fire detection systems, with the potential to improve safety measures and mitigate the impact of fire incidents.

Looking ahead, future research in CNN-based fire detection is poised to explore novel approaches for model optimization, data augmentation, and real-time monitoring. Advances in sensor technology, remote sensing, and cloud computing offer exciting opportunities for enhancing fire detection capabilities and enabling proactive interventions. By embracing interdisciplinary collaboration and leveraging cutting-edge technologies, researchers can continue to advance the field of fire detection and safeguard communities from the devastating effects of fire.

3. DESIGN AND DRAWING

3.1 Algorithm:

Algorithm used: ResNet-50 and Sequential Models

Our project integrates ResNet-50 and Sequential models for fire detection, delving into deep learning techniques. ResNet-50's depth and skip connections, coupled with Sequential models' simplicity and flexibility, make them ideal for capturing intricate spatial and sequential features in fire patterns.
While ResNet-50 serves as a robust base for extracting dense spatial features, Sequential models complement the process by efficiently handling sequential data.
This combination enhances our fire detection system's accuracy and efficiency, leveraging ResNet-50's capabilities alongside Sequential models' adaptability.
By integrating these deep learning algorithms, we aim to develop a comprehensive fire detection tool capable of effectively identifying fire incidents and improving safety measures. Through continual refinement and optimization, we seek to enhance the reliability and scalability of our fire detection system, ensuring its effectiveness across various environments and scenarios.

There are several types of Convolutional Neural Network (CNN) models commonly used for fire detection tasks. Some of the popular ones include:

1. LeNet-5: One of the earliest CNN architectures proposed by Yann LeCun et al. in 1998. It consists of several convolutional and pooling layers.
2. AlexNet: Introduced by Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton in 2012, AlexNet was a breakthrough in deep learning for image recognition, winning the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) in 2012.
3. VGGNet: Developed by the Visual Geometry Group at the University of Oxford, VGGNet is known for its simplicity and depth. It comes in variations with 16 or 19 weight layers.
4. GoogLeNet (Inception): Introduced by Google researchers in 2014, GoogLeNet features the Inception module, which allows for efficient use of computational resources by performing parallel convolutions at different scales.

5. ResNet: Residual Networks, introduced by Kaiming He et al. in 2015, introduced the concept of residual learning, where residual blocks with skip connections are used to ease the training of very deep networks.
6. MobileNet: Designed for mobile and embedded vision applications, MobileNet uses depthwise separable convolutions to reduce the computational cost while maintaining performance.
7. DenseNet: Dense Convolutional Networks, proposed by Gao Huang et al. in 2016, connect each layer to every other layer in a feed-forward fashion. This connectivity pattern enhances feature propagation and encourages feature reuse.
8. EfficientNet: EfficientNet, proposed by Mingxing Tan and Quoc V. Le in 2019, uses a compound scaling method to scale up CNNs in a more efficient manner, achieving state-of-the-art performance with fewer parameters.

These are just a few examples of CNN architectures used for fire detection. Each architecture has its strengths and weaknesses, and the choice of model depends on factors such as the size of the dataset, computational resources available, and the specific requirements of the task at hand.

3.1 SUMMARY

Our project harnesses the power of ResNet-50 and Sequential models to revolutionize fire detection through deep learning techniques. By seamlessly integrating ResNet-50's depth and skip connections with the simplicity and flexibility of Sequential models, we unlock a potent synergy for capturing intricate spatial and sequential features inherent in fire patterns. ResNet-50 acts as a robust foundation for extracting dense spatial features, while Sequential models adeptly handle sequential data, enhancing the accuracy and efficiency of our fire detection system. This strategic fusion of algorithms not only elevates the reliability of fire incident identification but also empowers safety measures with improved efficacy.

In the realm of Convolutional Neural Network (CNN) models tailored for fire detection, an array of options exists, each with its distinct characteristics and applications. Among these, ResNet stands out for its groundbreaking introduction of residual learning, mitigating training challenges in very deep networks through residual blocks and skip connections. Moreover, MobileNet offers a compelling solution for resource-constrained environments, utilizing depthwise separable convolutions to balance performance and computational cost effectively. These examples underscore the diverse landscape of CNN architectures available for addressing fire detection tasks, each catering to unique considerations such as dataset size, computational constraints, and task specificity.

The quest for optimal fire detection solutions extends beyond mere model selection, necessitating continual refinement and optimization to ensure efficacy across diverse environments and scenarios. By leveraging the strengths of ResNet-50 and Sequential models, we endeavor to develop a comprehensive fire detection tool capable of meeting the evolving demands of safety and security. Through iterative enhancements and adaptation, our system aims to bolster reliability and scalability, fostering a safer future through advanced deep learning technologies tailored for fire detection.

4. IMPLEMENTATION AND RESULTS

4.1 SOFTWARE DETAILS

Visual Studio Code:
Utilized as the primary integrated development environment (IDE) for writing and managing code files, providing features such as syntax highlighting, code completion, and version control integration.

Python:
Employed as the primary programming language for implementing machine learning algorithms and data preprocessing tasks, offering extensive libraries and frameworks for data analysis and model development.

Python Libraries:

- Pandas:

Used for data manipulation and analysis, facilitating tasks such as data cleaning, transformation, and aggregation.

- Matplotlib:

Utilized for data visualization, enabling the creation of plots, charts, and graphs to visualize patterns and relationships in the data.

- Seaborn:

Employed for statistical data visualization, offering high-level functions for creating informative and visually appealing plots.

- Scikit-learn:

A comprehensive machine learning library in Python, utilized for model training, evaluation, and deployment.

- ResNet:

Introduced in 2015 by Kaiming He et al., transformed deep learning by tackling the vanishing gradient issue. Traditional deep networks suffer from degraded training error as depth increases, but ResNet's skip connections facilitate gradient flow, enabling effective training of very deep networks with hundreds or thousands of layers. These connections add identity mappings to layer outputs, aiding in preserving gradient information. ResNet architectures like ResNet-18, ResNet-34, ResNet-50, ResNet-101, and ResNet-152 vary in depth, with the number denoting the total layers.

- HTML:

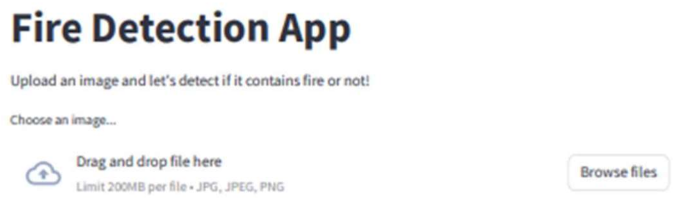
Employed for building the user interface (UI) for the application, providing structure and layout for web-based interfaces.

- Streamlit :

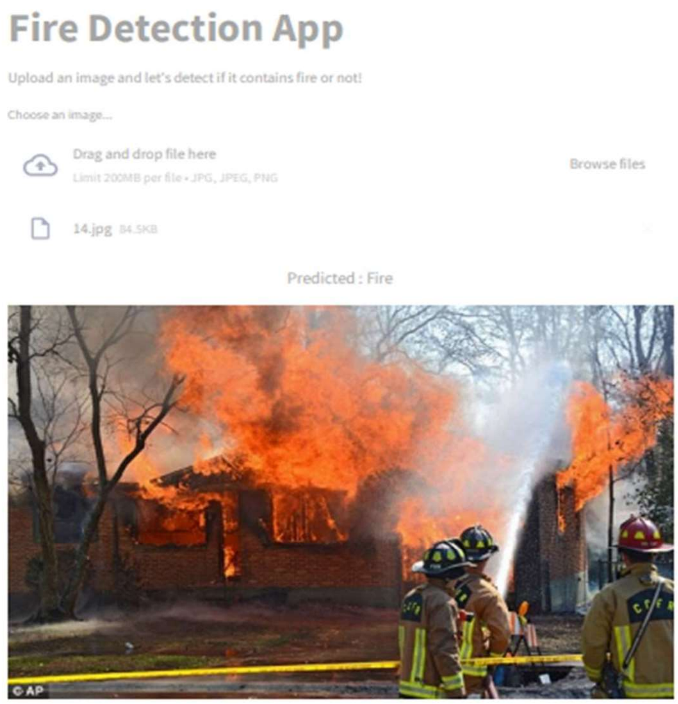
Streamlit is a Python library that simplifies the creation of interactive web applications for machine learning and data science projects. It enables users to quickly build and deploy apps without needing expertise in web development. With Streamlit, developers can easily showcase their machine learning models, visualizations, and data analysis in a user-friendly interface.

By integrating these software tools and libraries, we were able to develop a comprehensive deep learning application for Fire detection, encompassing data preprocessing, model training, interface development, and deployment.

INTERFACE


Fire Detection App
Upload an image and let's detect if it contains fire or not!
Choose an image...
Drag and drop file here
Limit 200MB per file • JPG, JPEG, PNG
Browse files

OUTPUT


Fire Detection App
Upload an image and let's detect if it contains fire or not!
Choose an image...
Drag and drop file here
Limit 200MB per file • JPG, JPEG, PNG
Browse files
14.jpg 84.5KB
Predicted : Fire
© AP

CONCLUSION

Our project, Fire Detection Using CNN, aims to utilize Convolutional Neural Networks (CNNs) to swiftly and accurately identify fire outbreaks. Leveraging the ResNet-50 model and popular Python libraries like TensorFlow, Keras, and Streamlit, we've developed a versatile tool capable of analyzing environmental data to pinpoint fires with remarkable precision and speed.

At the core of our system lies the ResNet-50 architecture, a powerful deep learning model. With the assistance of TensorFlow and Keras, we've harnessed the capabilities of ResNet-50 to effectively examine images and environmental variables. Through rigorous training, evaluation, and extensive testing, we've ensured the reliability and robustness of our fire detection system.

By analyzing environmental data in real-time, our system can detect fires early on, providing crucial time for intervention and mitigation efforts. This proactive approach enhances fire safety measures and helps prevent the spread of fires, particularly in vulnerable areas. The ResNet-50 model, combined with TensorFlow and Keras, enables us to handle large volumes of data efficiently, ensuring timely and accurate detection.

The success of our project underscores the effectiveness of deep learning techniques in addressing critical societal challenges. Through collaboration and innovation, we've developed a tool that can make a tangible difference in fire prevention and management. Moving forward, we remain committed to further refining and optimizing our fire detection system to better serve communities and protect lives.

Through careful training, evaluation, and extensive testing, we've ensured that our fire detection system is reliable and robust, reflecting our commitment to leveraging advanced technology to address critical fire safety challenges and protect lives and property from the devastating effects of fire outbreaks.

By employing the ResNet-50 model alongside popular Python libraries like TensorFlow, Keras, and Streamlit, we've built a strong system capable of analyzing environmental data to identify fires with impressive precision and speed.

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INTERNSHIP LOG BOOK

Sr. No.	Date	Time IN	Time OUT	Brief Description of Activity	Student Sign
1	21/12/2023	2:15 pm	5:15 pm	Teaching of Basics of Python Language	
2	22/12/2023	2:15 pm	5:15 pm	Teaching of Basics of Python Language	
3	26/12/2023	2:15 pm	5:15 pm	Teaching of Basics of Python Language	
4	27/12/2023	2:15 pm	5:15 pm	Teaching of Arrays and Dictionaries	
5	28/12/2023	2:15 pm	5:15 pm	Teaching of Arrays and Dictionaries	
6	29/12/2023	2:15 pm	5:15 pm	Teaching of Arrays and Dictionaries	
7	1/1/2024	2:15 pm	5:15 pm	Teaching of Numpy and Pandas	
8	2/1/2024	2:15 pm	5:15 pm	Teaching of Numpy and Pandas	
9	3/1/2024	2:15 pm	5:15 pm	Teaching of Numpy and Pandas	
10	4/1/2024	2:15 pm	5:15 pm	Teaching of Numpy and Pandas	
11	8/1/2024	2:15 pm	5:15 pm	Teaching of Data Preparation	
12	9/1/2024	2:15 pm	5:15 pm	Teaching of Data Preparation	
13	10/1/2024	2:15 pm	5:15 pm	Teaching of Data Preparation	
14	11/1/2024	2:15 pm	5:15 pm	Teaching of Data Visualization	
15	12/1/2024	2:15 pm	5:15 pm	Teaching of Data Visualization	
16	15/1/2024	2:15 pm	5:15 pm	Teaching of Matplotlib	
17	16/1/2024	2:15 pm	5:15 pm	Teaching of Matplotlib	
18	17/1/2024	2:15 pm	5:15 pm	Teaching of Seaborn	
19	18/1/2024	2:15 pm	5:15 pm	Teaching of Seaborn	

20	19/1/2024	2:15 pm	5:15 pm	Learning of various machine learning algorithms	
21	22/1/2024	2:15 pm	5:15 pm	Learning of various machine learning algorithms	
22	23/1/2024	2:15 pm	5:15 pm	Learning of various machine learning algorithms	
23	24/1/2024	2:15 pm	5:15 pm	Applying machine learning algorithms on datasets and obtaining outputs	
24	25/1/2024	2:15 pm	5:15 pm	Applying machine learning algorithms on datasets and obtaining outputs	
25	26/1/2024	2:15 pm	5:15 pm	More miscellaneous concepts related to machine learning	
26	27/1/2024	2:15 pm	5:15 pm	Allotment of individual projects	
27	29/1/2024	2:15 pm	5:15 pm	Reading Research Papers based on the topic allotted	
28	3/2/2024	2:15 pm	5:15 pm	Project Review	
29	20/2/2024	2:15 pm	5:15 pm	Applying machine learning models to get the desired outputs	
30	12/3/2024	2:15 pm	5:15 pm	Project Submission	

Supervisor’s Signature