These findings use the geodatabase to improve disaster readiness, guide mitigation efforts, and help communities become more resilient.

Understanding the Physical Structure of Communities for Improved Disaster Impact Predictions

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Introduction

Natural disasters, such as tornadoes and hurricanes, pose a real threat to all communities that highly depend on **building vulnerability** and critical infrastructure. This paper uses **CNN** for the classification of buildings into residential, commercial, and industrial land use classes, connecting these classifications to disaster impacts using the Enhanced Fujita Scale.

It is a diverse dataset, collected from different global sources, representing various building types. The study evaluates **ConvNet**, **ResNet50**, and a **custom CNN model** using key metrics such as accuracy, precision, recall, and F1-score to determine the best-performing architecture among them.

This research will predict **wind-induced damages** during disasters by integrating a geodatabase with classified building data. Hence, this will fill critical gaps in disaster assessment, improving **preparedness**, **response efficiency**, and **mitigation strategies** while strengthening community resilience against future events.

Data Description

Data source: Google Street View, Google Images and Open-source datasets (e.g. Kaggle)

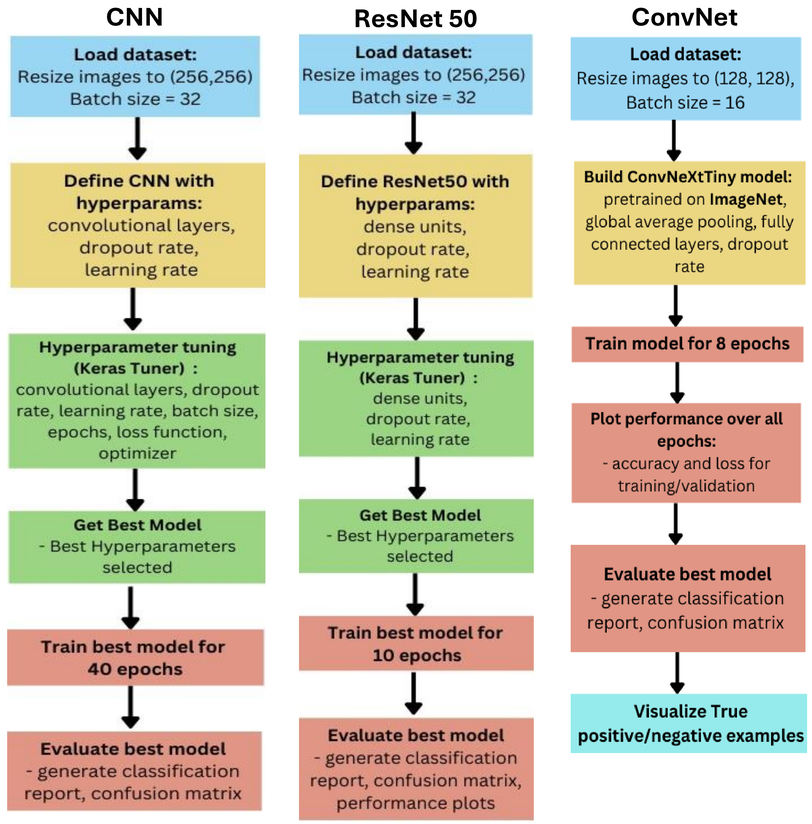
Cat	Type	# of images
1	S_ProfBldg	1258
2	StripMall	813
3	L_ShopMall	181
4	AutoService	279
5	LowRise	634
6	MidRise	1043

Cat	Type	# of images
7	HighRise	730
8	InstiBldg	762
9	MetalBldg	1187
10	Canopy	617
11	Warehouse	333

Sample images from the dataset



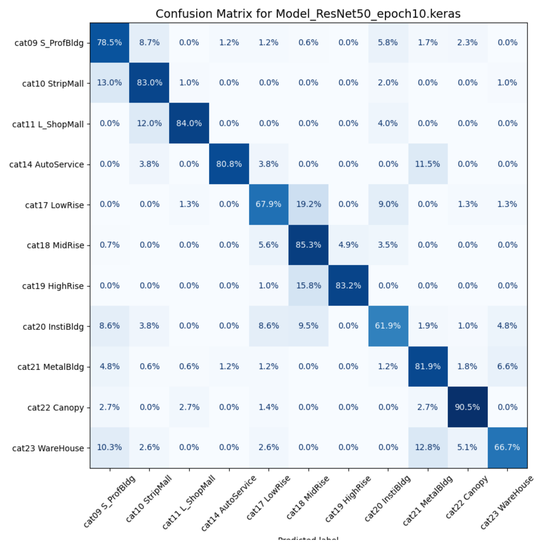
Model Structure



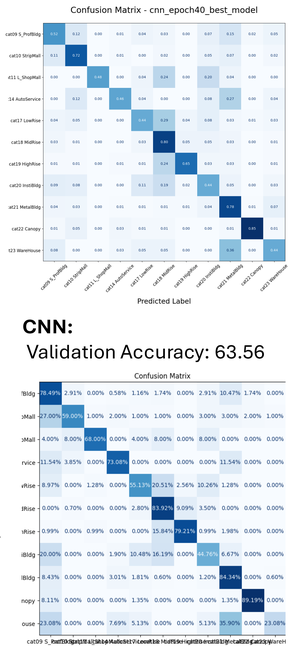
Model Changes from Base Model

1. **Modified ResNet50:** Adds GlobalAveragePooling2D, Dense, and Dropout layers for task-specific fine-tuning and flexibility. Fine-tunes pre-trained weights and uses Keras Tuner to optimize dense units, dropout rate, and learning rate.
2. **Modified ConvNeXtTiny:** Adds GlobalAveragePooling2D, Dense (512 units), and Dropout layers for enhanced classification. Fine-tunes pre-trained weights and adapts to reduced image resolution (128x128) for efficiency.
3. **Custom CNN with Hyperparameter Tuning:** Uses Keras Tuner to optimize Conv2D filters, dropout rates, and learning rate for adaptability. Designed for dataset-specific optimization, unlike fixed-layer traditional CNNs.

Results



ResNet50:-
Validation Loss: 0.74
Validation Accuracy: 79.01
Precision: 78.22 / Recall: 78.52 / F1 Score:78.23



CNN:
Validation Accuracy: 63.56

ConvNet:-
Validation Accuracy: 71.43

Conclusion

This study used CNNs for classifying buildings into residential, commercial, and industrial categories, aiding disaster impact predictions. **ResNet50** emerged as the best model, achieving **79.01% accuracy and 78.23% F1-score**. **Limitations** include dataset bias, background noise in images, and limited building categories. **Future work** will be focusing on expanding building classifications (e.g., schools, hospitals), implementing image cropping to remove irrelevant backgrounds, and diversifying datasets for better generalization. Additionally, we plan to explore advanced models and integrate classification results with geodatabases can improve disaster preparedness. This will enhance model performance and help optimize disaster mitigation strategies to strengthen community resilience effectively.

References

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