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Deepfake Detection Using CNN, LSTM, EfficientNet, and Xception with Multi-Dataset Training

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Abstract: ***Deepfakes pose a major threat to digital media authenticity by enabling realistic manipulation of facial videos using advanced generative models. This research proposes a hybrid deepfake detection framework integrating CNN, LSTM, EfficientNet, and Xception architectures. The system is trained on FaceForensics++ and Celeb-DF datasets to improve generalization across different manipulation techniques. Experimental results demonstrate an accuracy range of 90–96%, confirming the effectiveness of the proposed approach.***
Keywords: Deepfake Detection, CNN, LSTM, EfficientNet, Xception, FaceForensics++, Celeb-DF

I. INTRODUCTION

Deepfake technology leverages GAN-based architectures to generate manipulated facial images and videos with high realism. The rapid growth of such techniques poses serious threats in areas such as misinformation, identity fraud, and cybersecurity. Detecting deepfakes is challenging due to evolving generation methods and minimal visual artifacts. The main contribution of this paper is the design of a hybrid spatial–temporal deep learning model that effectively detects deepfake videos using multiple feature extraction networks.

II. LITERATURE REVIEW

Afchar et al. proposed MesoNet, a compact convolutional neural network designed for efficient deepfake detection. Rossler et al. introduced the FaceForensics++ dataset, which has become a benchmark for manipulated facial image detection. Li et al. demonstrated the effectiveness of XceptionNet in identifying forged images. Nguyen et al. explored capsule networks for manipulation recognition. Dolhansky et al. released the DFDC dataset to support large-scale deepfake evaluation. Mittal and Jain combined CNN and LSTM architectures to capture temporal inconsistencies in videos. Zhang et al. applied EfficientNet to achieve high detection accuracy with reduced computational cost.

III. METHODOLOGY

The proposed system follows a structured pipeline consisting of preprocessing, feature extraction, temporal analysis, and classification. Video frames are extracted and preprocessed through resizing and face alignment. CNN, EfficientNet, and Xception models extract spatial features, while an LSTM network analyzes temporal dependencies between frames. The final classification layer determines whether the input video is real or fake.

IV. DATASETS

Two benchmark datasets are used in this study. FaceForensics++ contains high-quality manipulated videos with multiple compression levels. Celeb-DF provides realistic deepfake videos with minimal visual artifacts, making detection challenging.

V. RESULTS AND DISCUSSION

The hybrid deepfake detection model achieved an accuracy ranging from 90% to 96% across both datasets. In addition to accuracy, improvements were observed in precision, recall, and F1-score compared to CNN-only baselines. EfficientNet and Xception contributed strong spatial representations, while LSTM enhanced temporal consistency analysis.

VI. CONCLUSION

This paper presents an effective hybrid deepfake detection framework combining CNN, LSTM, EfficientNet, and Xception models. The proposed approach demonstrates strong generalization and robustness across multiple datasets. Future work includes integrating Vision Transformers, multimodal learning techniques, and real-time deployment.

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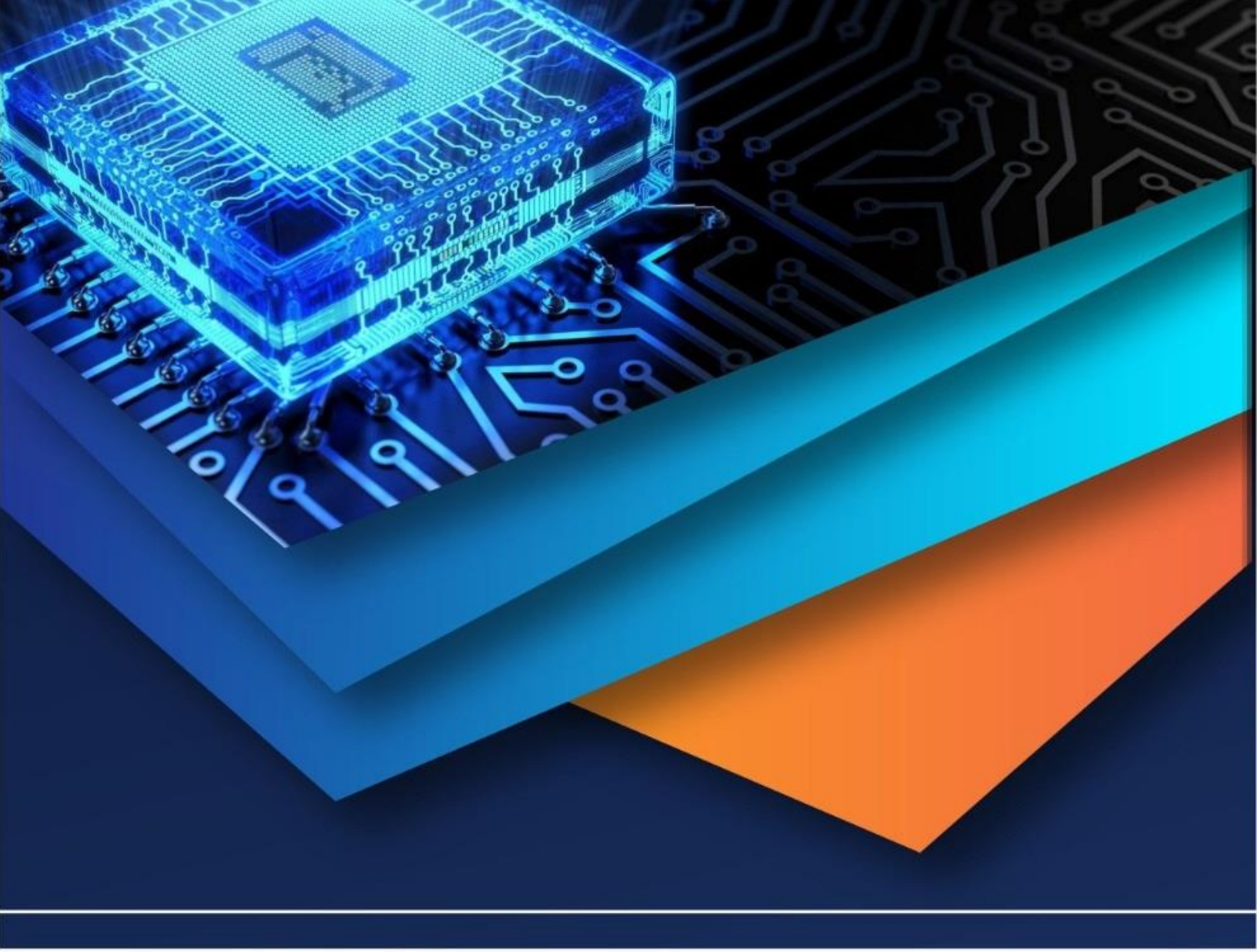

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