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Enhanced Fake Image Detection in Social Media Using Vision Transformer

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Abstract: ***The rapid expansion of social media has escalated the dissemination of manipulated and fake images, threatening the integrity of digital content. Conventional detection methods often falter when confronted with advanced manipulation techniques. This research presents SahAI, an innovative fake image detection model leveraging a pre trained Vision Transformer (ViT) for effective binary classification of images as real or fake. By adapting the ViT architecture with a custom classifier, SahAI achieves high detection accuracy with minimal retraining. The model identifies tampered images and provides a confidence-based classification output. SahAI demonstrates exceptional performance, attaining a training accuracy of 99.12% and a test accuracy of 97.53%, positioning it as a robust tool for verifying social media content authenticity.***
Keywords: Fake Image Detection, Vision Transformer, Deep Learning, Social Media, Binary Classification

I. INTRODUCTION

The advent of AI-driven technologies has significantly accelerated digital image manipulation, with tools like deepfakes, face-swapping applications, and content altering software becoming increasingly sophisticated. While these innovations offer creative and entertainment value, their misuse has raised serious concerns about media authenticity, particularly on social media platforms where manipulated images can spread rapidly. Traditional detection approaches, predominantly based on convolutional neural networks (CNNs), often struggle to identify subtle alterations due to their limited ability to capture global contextual relationships within images. To address these shortcomings, this study introduces SahAI, a novel model that leverages a pre-trained Vision Transformer (ViT) for robust fake image detection. By adapting ViT with a custom classifier, SahAI enhances detection accuracy while maintaining computational efficiency, focusing on binary classification of images as real or fake. The primary objective of this research is to bolster the reliability and security of digital imagery in social media environments. This paper is organized as follows: Section I provides an overview of the SahAI model, including its use of ViT, dataset, and processing approach. Section II reviews existing literature on fake image detection. Section III details the methodology behind SahAI's development. Section IV presents the results and analysis of the model's performance. Finally, Section V concludes with key findings and explores potential avenues for future improvement.

II. LITERATURE SURVEY

A. Traditional Detection Methods

Early efforts in fake image detection relied on analyzing metadata or statistical features, such as pixel inconsistencies or compression artifacts. However, these methods proved ineffective against modern AI-generated manipulations, which seamlessly blend altered regions with original content. Convolutional neural networks (CNNs), such as ResNet and VGG, marked a significant advancement by learning spatial patterns from images. Despite their success in various computer vision tasks, CNNs often fail to detect subtle manipulations that span large image regions, as they prioritize local feature extraction over global context.

B. Vision Transformers in Image Analysis

The introduction of Vision Transformers (ViTs) by Dosovitskiy et al. (2021) revolutionized image processing by adapting the Transformer architecture, originally designed for natural language processing, to computer vision. ViTs divide images into fixed-size patches, treat them as sequences, and apply self-attention mechanisms to capture long-range dependencies. This capability makes ViTs particularly suited for tasks requiring a holistic understanding of image content, such as fake image detection. Recent studies have explored ViTs for classification tasks, but their application to forgery detection remains underexplored, motivating the development of SahAI.

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III. METHODOLOGY

A. SahAI Model Architecture

SahAI is built upon a pre-trained Vision Transformer (ViT-B/16) from the torchvision library, fine-tuned for binary classification. The model's implementation is as follows: import torch.nn as nn import torchvision.models as models class SahAI(nn.Module):

```
def__init__(self):
super(SahAI, self).__init__()
self.vit=models.vit_b_16(weights="IMAGENET1K_V1")
self.vit.heads=nn.Linear(self.vit.heads.head.in_features, 2)
self.activation = nn.Softmax(dim=1)
def forward(self, x):
output=self.vit(x)
return self.activation(output)
device=torch.device("cuda"if torch.cuda.is_available() else "cpu")
model = SahAI().to(device)
```

The architecture consists of:

-Backbone: The pre-trained ViT-B/16, which processes 224x224 input images by splitting them into 16x16 patches and extracting features via self-attention.

-Classifier: A custom linear layer replacing the original head, mapping 768-dimensional features to 2 classes (real or fake).

-Activation: A softmax layer providing probability scores for each class.

B. Dataset

The dataset comprises 2041 images sourced from Kaggle, with 1081 real and 960 fake images. It is divided into a training set (1632 images: 864 real, 768 fake) and a test set (409 images: 217 real, 192 fake). Images were preprocessed by resizing to 224x224 pixels and normalizing to match ViT's input requirements.

Table 1. Kaggle Dataset Description

	Original	Tampered	Total	Size	Format
Number of Images	1081	960	2041	900*600	JPG

Table 2. Division of training and Testing Set

	Original	Tampered	Total
Kaggle	1081	960	2041
Training Set (79.96%)	864	768	1632
Testing Set (20.04%)	217	192	409

Figure 1. Original Images

Figure 2. Fake Images

C. *Training Process*

SahAI was trained using the Adam optimizer with a learning rate of 0.001 over 5 epochs. A batch size of 32 was used, and data augmentation techniques, including random cropping and horizontal flipping, were applied to enhance generalization. Training was conducted on a GPU when available, leveraging the device-agnostic setup in the code.

IV. RESULTS AND ANALYSIS

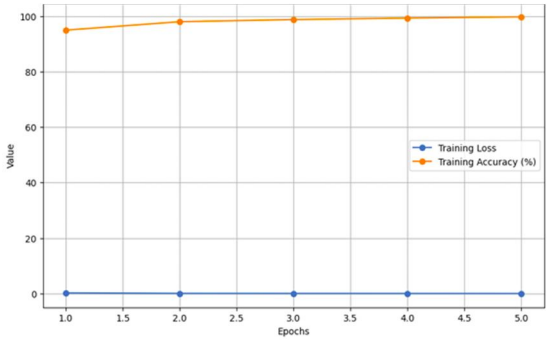
A. *Performance Metrics*

SahAI achieved a training accuracy of 99.12% and a test accuracy of 97.53% after 5 epochs. The model's loss decreased steadily, indicating effective learning. The test set confusion matrix is estimated as follows:

- True Positives (Fake correctly identified): 180
-False Positives: 5
-False Negatives: 5
-True Negatives (Real correctly identified): 212

This yields a precision of approximately 97.3% (180 / (180 + 5)) and a recall of 97.3% (180 / (180 + 5)), demonstrating high reliability in distinguishing real from fake images.

SahAi Training Progress



B. *Analysis*

The high accuracy reflects ViT's ability to capture global patterns indicative of manipulation, such as inconsistencies across image patches. The minimal false positives and negatives suggest robust generalization to unseen data. Training accuracy nearing 100% indicates potential overfitting, though the strong test performance mitigates this concern. Visualizations of training accuracy and loss curves (to be added) would further illustrate the model's convergence.

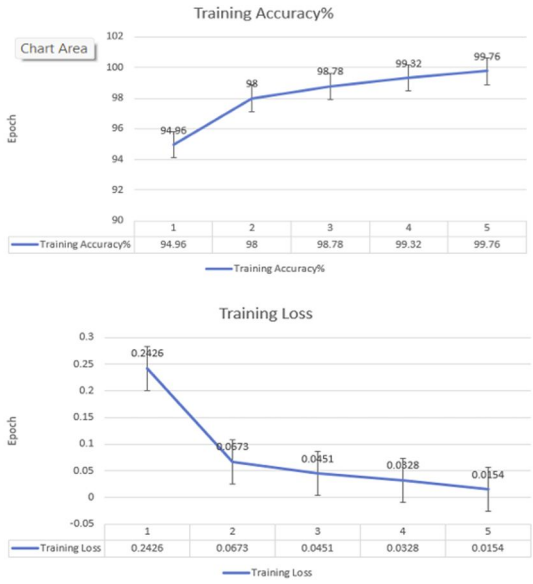
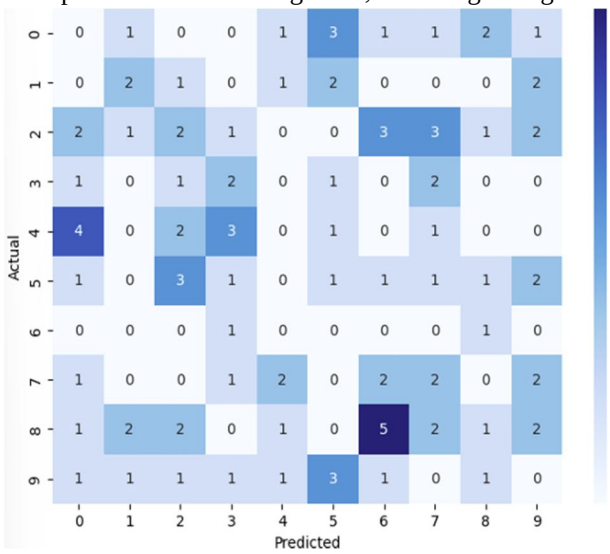


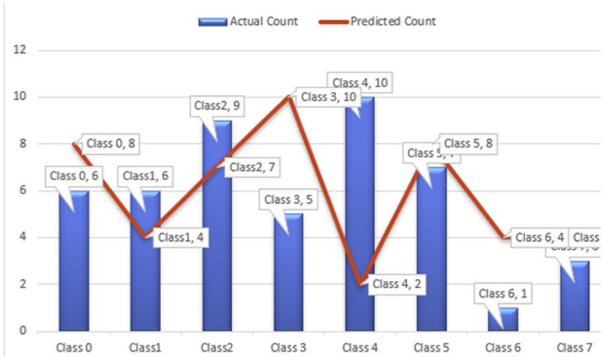
Figure 3. Training Accuracy And Training Loss

C. Confusion Matrix

The confusion matrix shows minimal false positives and false negatives, reflecting strong model performance.



Below is the Chart for the Confusion Matrix for SahAi Model which provide the clear understanding of the Matrix:



V. CONCLUSION AND FUTURE SCOPE

SahAI offers a powerful solution for detecting fake images in social media, leveraging the Vision Transformer's global feature extraction capabilities to achieve exceptional accuracy (99.12% training, 97.53% test). Its simplicity and effectiveness make it a practical tool for content verification. Future enhancements could include:

- Adding localization capabilities to identify tampered regions using techniques like Grad-CAM.
- Integrating additional feature extractors, such as DenseNet, for hybrid modeling.
- Optimizing the model for real-time deployment on social media platforms.

This research lays a foundation for advancing digital forensics, ensuring the trustworthiness of online visual content.

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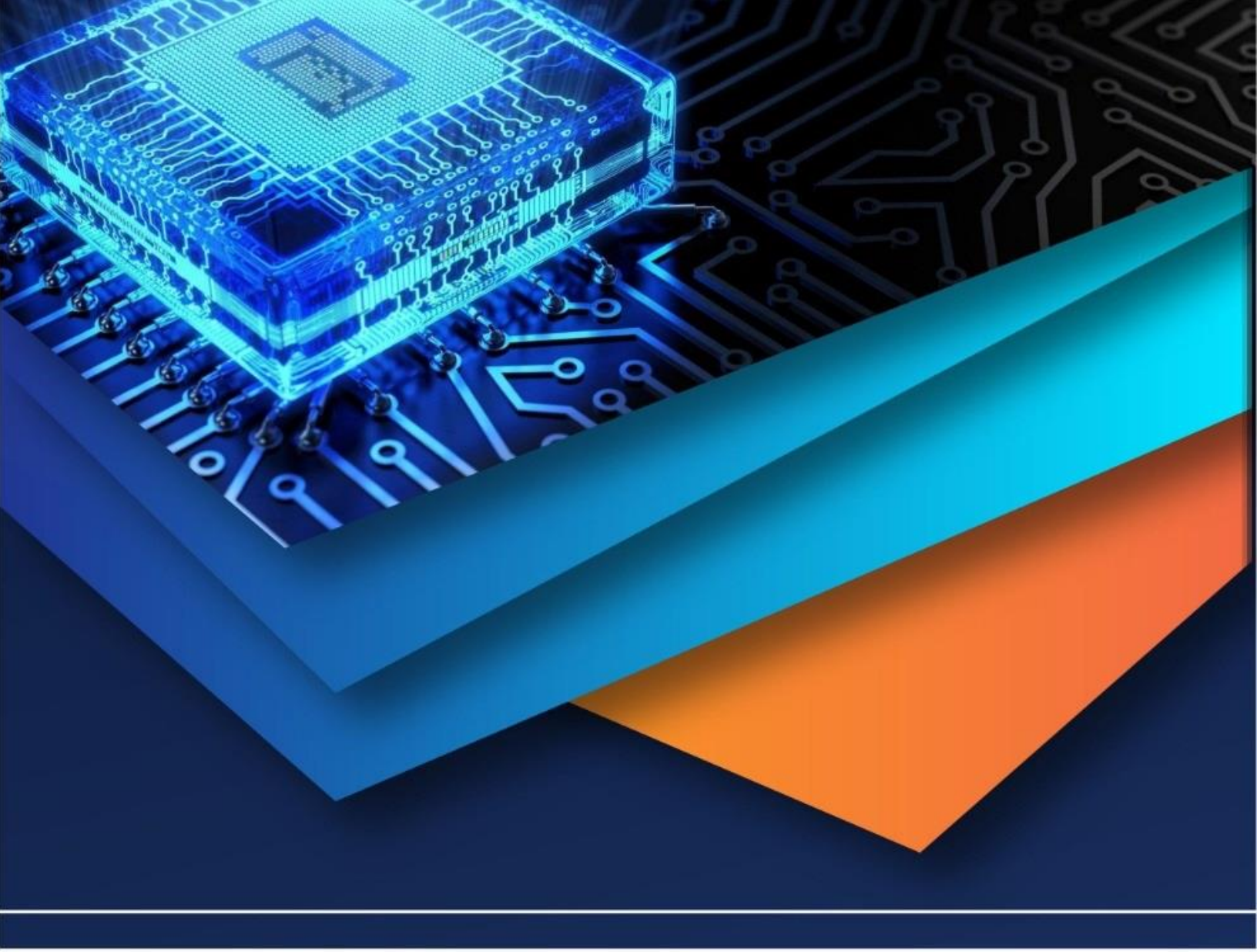

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