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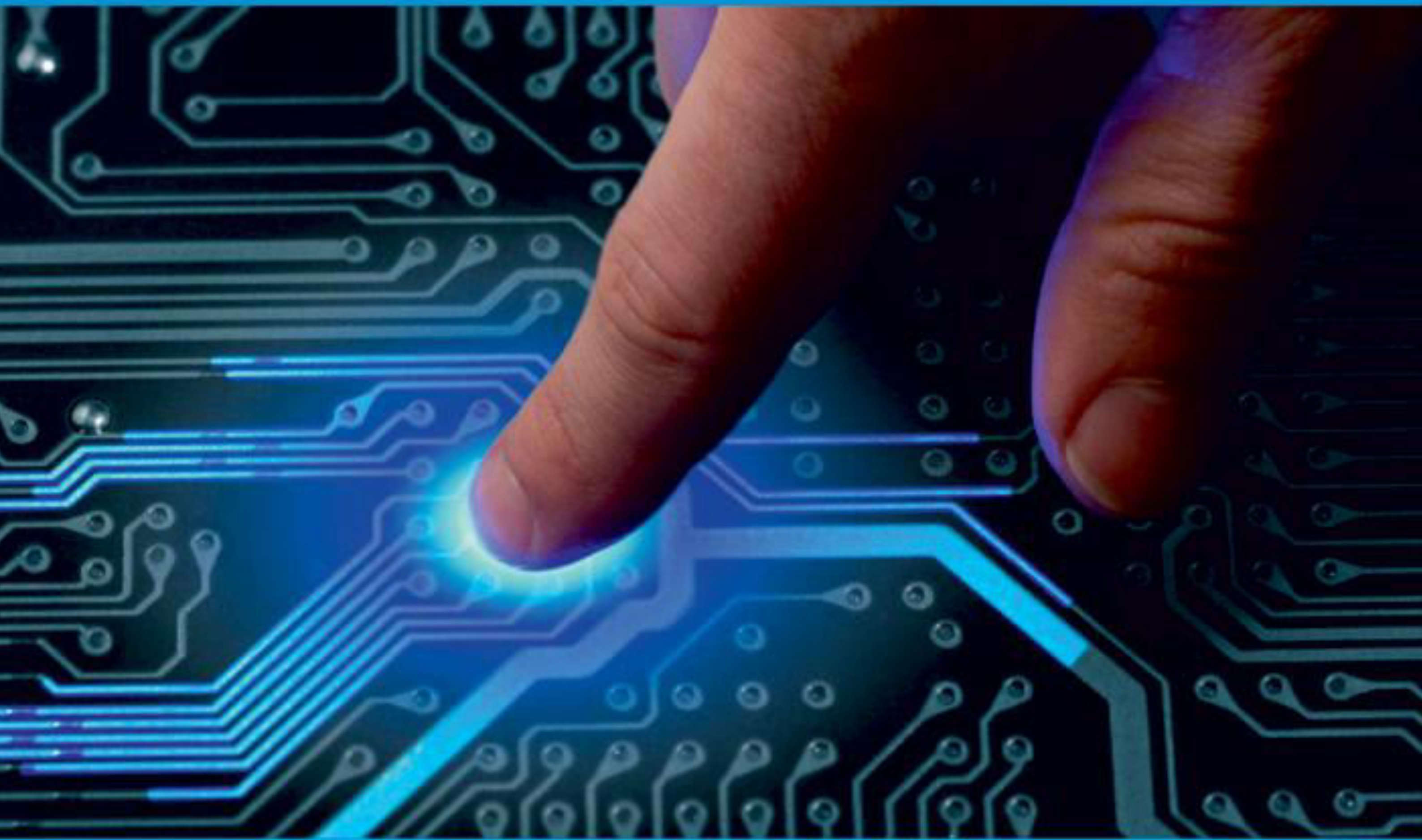

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Face Liveness Monitoring System Using Fourier Transform and LBP

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ABSTRACT: Face recognition is a method of identifying or verifying the identity of an the individual using their face. Face Recognition is becoming more prevalent than ever. As there is a rise in face recognition, which has significantly led to an increase in cybercrime. Liveness detection is the significant step in face recognition, to make the system more secure. We are proposing a system where we exploit Frequency Based Deep feature extraction and Texture Based Deep feature extraction for Face Liveness monitoring.

KEYWORDS: Face Recognition; Face Liveness Detection; LBP ; Fourier Transform; CNN;

I INTRODUCTION

Face recognition is a method of identifying or verifying the identity of an the individual using their face. Face recognition has evolved as a distinguished biometric authentication modality. It's employed in the work area, smartphones, ATM, Mass police investigation, and then on. When it comes to face authentication, accuracy is not a concern. However, as promising as facial recognition is, it still has flaws. User photos will simply be found through social networks and any fraud is impersonating as a real person. It could easily be outwitted either through photos from devices, printed photo attacks, or 3D masks. So the Face Recognition system answers whether he is the person or not. It doesn't answer if he is present. This is often wherever the requirement for anti-spoofing solutions comes into play. We rely on Liveness detection to validate an individual's identity. These checks will verify whether or not a person is present or trying to spoof the system.

In recent years, numerous algorithmic development for face liveness detection systems is reported. These developments are broadly classified into 2 domains: fixed features-based face anti-spoofing systems and deep feature-based face anti- spoofing systems. Fixed feature-based face anti-spoofing systems exploit hand-crafted features to perform classification between live face and fake face. On the other hand, deep features-based face anti-spoofing systems utilize deep neural networks, such as CNN, to classify a live face and a fake face. We are proposing a system where we exploit Frequency Based Deep feature extraction and Texture Based Deep feature extraction for Face Liveness monitoring. Since features learned by deep neural networks are dynamic, they are currently the most preferred choice for most face anti-spoofing systems.

II PROPOSED ALGORITHM

A *Methodology:*

Live/Real face could be discriminated from the fake face with a single 2d image -based face detection method based on frequency and texture analyses. In frequency analysis, we have executed Fourier spectrum-based method information collected is not only limited to the low-frequency information but also in the high-frequency regions are exploited. And in Local Binary Pattern (LBP) based description method has been employed for analyzing the textures on the given facial images. The fused information of the decision values from the frequency-based analysis and the texture-based analysis has also been utilized for detecting fake faces[1].

B *Liveness Architecture:*

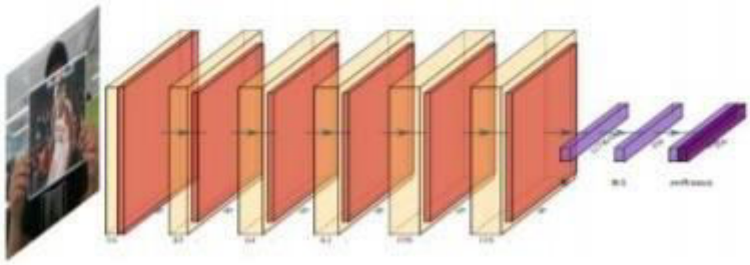

Fig: 2.1 -Neural Network Achitecture

C *Local Binary Pattern:*

Local Binary Pattern (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. Due to its discriminative power and computational simplicity, LBP is a broadly adopted descriptor in texture analysis. The ideology behind LBP is that local spatial patterns and grayscale contrast complementary measures can be described by using 2D surface textures.

$$LBP_{P,R} = \sum_{p=0}^{P-1} s(g_p - g_c)2^P, \quad s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$

Eq.1 – Local Binary Pattern

In LBP each pixcel is assigned with a code considering relative intensity differences between the pixel and its neighbors.

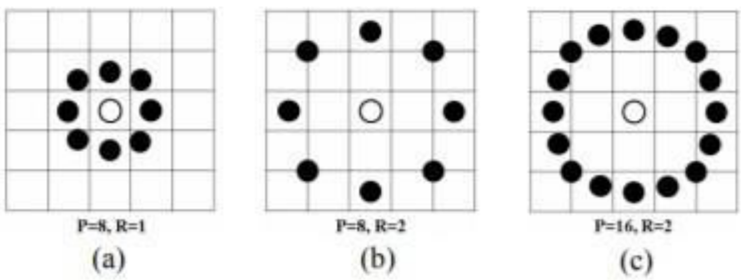

Fig 2.2 Feature vector extraction process based on LBP (a) original facial image (b) LBP-coded image (c) histogram of the LBP-coded image [3]

D *Fourier Transform:*

The Fourier transformation is a key mathematical tool that connects the time and frequency domains such that sound can be parametrized in terms of frequency[2]. In Fourier Transform, images are decomposed into their sine and cosine components. The transformed output is in the Fourier or frequency domain, while the input image is the spatial domain equivalent. In the Fourier transform image, each point represents a particular frequency contained in the spatial domain image.

In image analysis digital images are the only concern, thus Discrete Fourier Transform(DFT) would be the method of approach in frequency analysis.

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The DFT is the sampled Fourier Transform and therefore does not contain all frequencies forming an image, but only a set of samples which is large enough to fully describe the spatial domain image.
For a square image of size N×N, the two-dimensional DFT is given by:

$$F(k,l) = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} f(i,j)\ e^{-\iota 2\pi (\frac{ki}{N} + \frac{lj}{N})}$$

Eq 2- *Discrete Fourier Transform*

where f(a,b) is the image in the spatial domain and the exponential term is the basis function corresponding to each point F(k,l)nin the Fourier space. The equation can be interpreted as: the value of each point F(k,l) is obtained by multiplying the spatial image with the corresponding base function and summing the result.

E *System Architecture:*

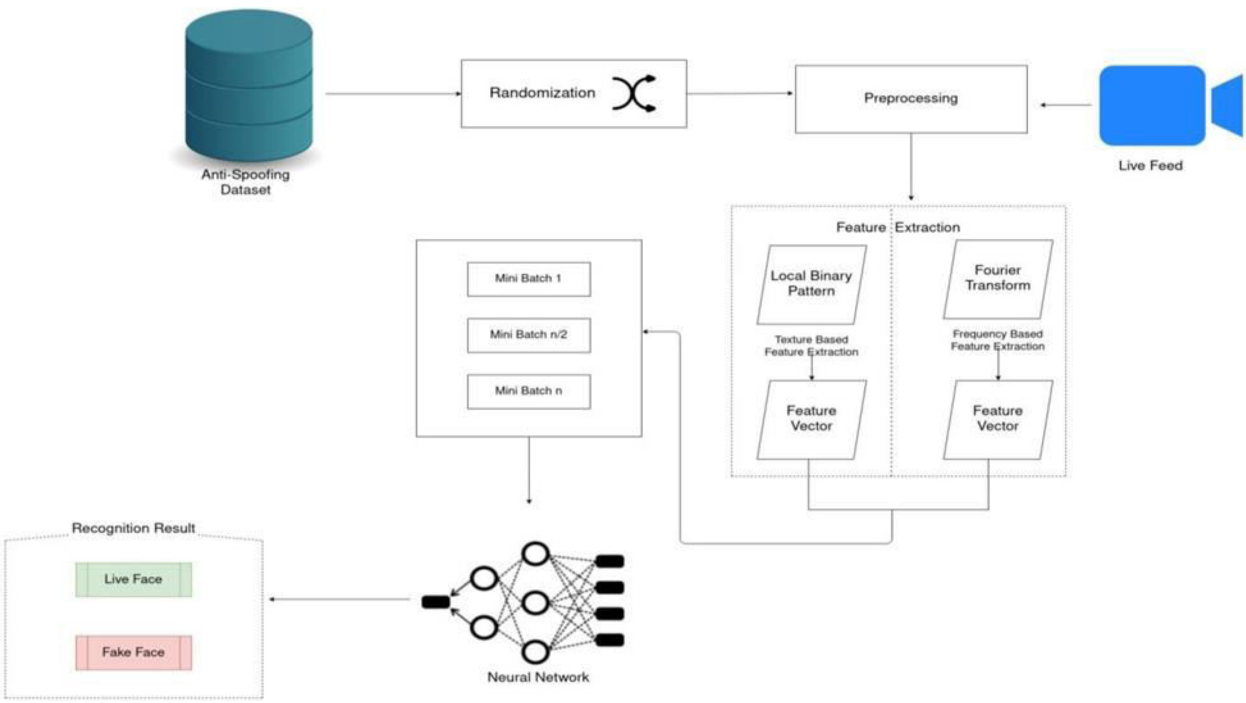

Fig 2.3 System Architecture

F *Module*

F.iDatasetCollection
F.iiPreprocessing
F.iiiFeature Extraction
F.ivNeuralNetwork-LivenessNet

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a DatasetCollection

Dataset is generated by extracting the image frames from a live video and re-recorded video. The re-recorded video is labelled to be fake whereas live video is labelled real.

Fig 2.4 Dataset

S.No	Title	No.of Images
1	Fake	4,677
2	Real	4,698
	Total	9,375

Table 2.1 Description of Dataset

b Preprocessing

b.i Face Eye Detection and FaceStraighten

When working on a facial classification problem there might be a need for face detection in order to validate (is there a face?), crop and straighten the images. Before to straighten the image, the alignment and angle of eye must be detected. This can be done by the Haar Feature-Based Cascade Classifier for object detection included in OpenCv. The image can be straighten by rotating according to the angle of eye.

b.ii Face Crop and Resize

In order to help neural network in the task, it'd be nice to get rid of external distracting info, like the background, clothes, or accessories. A face cropping is very convenient in these cases. Draw a rectangle box around the face with padding or without padding, the rectangle box can be cropped and resized by cubic.

c Feature Extraction

Face feature is extracted by LBP (Texture Based) and Fourier Transform(Frequency Based) i) Texture Based Analysis

Texture feactures of face is extracted from the preprocessed image through LBP. δδ-LBP, an LBP variant is utilized to detect the expression frame. The original LBP vector is not sufficient, to improve it we use proper sampling radius in subareas of an image also the same approach is applied to extract facial texture features from the expression frame as a histogram.[4],[5]

ii) Frequency Based Analysis

Frequency feactures of face is extracted from the preprocessed image through Fourier Transform.Given spatial domain image, is transformed into frequency domain image with 2D DFT. It is then divided into several concentric

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circles with the radius of each neighbor pair as 1. Also, the transformed result is shifted to make the zero-frequency component lie in the center of the spectrum.For an image with 64x64, a set of 32 concentric rings are generated. Each circle represents the frequency information of the image. Thus, an image with a lower frequency has very less information about the image. The feature vector can be obtained by concatenating concentric rings.

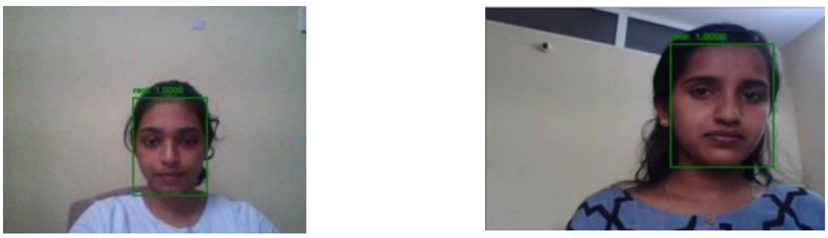
d Neural Network –LivenessNet:

A CNN uses a system much like a multilayer perceptron that has been designed for reduced processing requirements. The layers of a CNN consist of an input layer, an output layer and a hidden layer that includes multiple convolutional layers, pooling layers, fully connected layers and normalization layers. The removal of limitations and increase in efficiency for image processing results in a system that is far more effective, simpler to trains limited for image processing.

Name	**Filter-Size/num**	**Output Size**
Input	-	96 X 96 X 3
Conv2d_1 Pooling	(3,3)/16 (2,2)	96 X 96 X 16
Conv2d_2 Pooling	(3,3)/32 (2,2)	96 X 96 X 32
FlattendDense	-	64

Table 2.2 Description of CNN Architecture.

III SNAPSHOT



Webcam Image (Live)

Webcam Image (Live) vs Fake Image

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IV EXPERIMENTRESULT

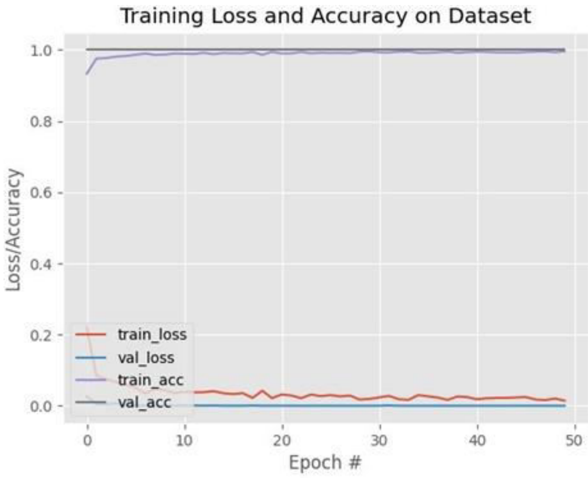

Fig 4.1 Experiment Result

V CONCLUSION AND FUTUREWORK

Thus facial liveness monitoring explained in the report could prevent potential presentation attacks in existing face recognition systems, making it more secure. The system is faster, efficient and has the potential to replace the existing liveness detection. One of the first extensions to this work would be to simply gather additional training data, to invest in additional image/face sources outside of simple screen recording playbacks. After training the model with different data and the system could be rolled out as a product.

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