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Face Recognition with Mask Detection using LBP and MLBP

Shihana Fathima R[1], Naveen S[2], Dr. R S Moni[3]
M.Tech Student, Dept of ECE, LBSITW, Thiruvananthapuram, Kerala[1]
Assistant Professor, Dept of ECE, LBSITW, Thiruvananthapuram, Kerala[2]
Professor, Dept of ECE, Marian Engineering College, Thiruvananthapuram, Kerala[3]
shihanafathima09@gmail.com[1], *nsnair11176@gmail.com*[2], *moni2006rs@gmail.com*[3]

Abstract- Face recognition systems are one of the popular biometric systems which use facial features for recognition. But these systems are highly exposed to spoofing attack. Spoofing is the act of presenting false biometric trait to gain access. A face recognition system can be spoofed using a photo, video or a 3D mask. Here, a face recognition system that detects and eliminates mask attack is proposed. The proposed scheme utilizes efficient face descriptors Local Binary Pattern (LBP) and Modified Local Binary Pattern (MLBP) for face recognition. Along with nose area and spectrum of eye are analyzed for mask elimination. 3D Mask Attack Database (3DMAD) is used for the performance analysis of the proposed scheme.

Index Terms- Face Recognition; Mask Detection; LBP; MLBP.

1. INTRODUCTION

Biometrics is the science that uses one or more fundamental physical or behavioral characteristics for human recognition. Automatic recognition of human biometric traits has numerous important advantages over conventional methods like passwords or ID cards. Hence, it has become a vast research field today as the need and investment for access control systems grow continuously. It has evolved as a promising solution for reliable subject identification and verification applications. Among the wide range of biometric characteristics, the face is very popular as it is hand free and user friendly. User doesn't have to carry anything or remember anything. However these advantages are overridden in vicious situation, enabling un-authorized users to easily get access to the system. Such an attempt to gain authentication through a biometric system by presenting a counterfeit evidence of a valid user is called spoofing attack. Among all biometric traits, face is the one that is exposed to the most serious threat, since it is exceptionally easy to access. Nevertheless, the wide deployment of low-cost capture devices on the one hand and the trend towards innovative presentation attacks or spoofing attacks has given rise to additional challenging problems for facial image capture processes. In the domain of face modality, an attacker has a variety of options: from a simple print of the valid user's face [6] to video replays [8] or even more complex 3D masks [2] [4]. Obtaining face images of a valid user is nowadays nearly a trivial task: they are present in abundance on the Internet or can be easily taken cooperatively or at distance.

A wide range of counter measures exists to address the problem of spoofing attack. Many anti-spoofing approaches examine texture of the captured face images to find clues for the presence of artifacts. Another approach aims at examining the motion in the scene. Motion of planar objects is different from that of real face. Finally there are approaches that detect the aliveness of the captured face by eye blinking [8] or lip movement. The study in [7] includes brief information about different types of 2D face countermeasures, which were developed for a competition on countermeasures against 2D facial spoofing attacks. Usage of photo and video can also be detected using 3D face recognition. This is because a 3D face recognition system makes use of three dimensional geometry of the face along with 2D face recognition. Still 3D face recognition systems can be forged using 3D masks.

Counter measures for spoofing attack in 2D face recognition system relying on eye blinking and lip movements can be defeated by using photographic masks wrapped over face with eyes and mouth regions cut out. Also, since motion based countermeasures depend on different movements of 2D and 3D surfaces, they are not applicable when masks are used instead of photos or videos. It appears that the detection of 3D mask attacks is more challenging compared to the detection of 2D facial attacks.

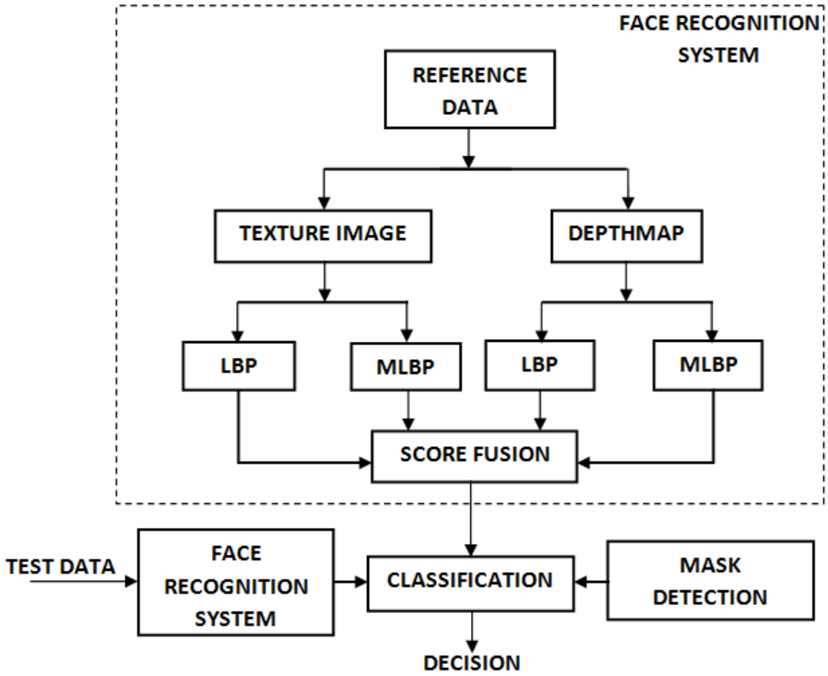

Fig. 1: Block diagram of the proposed scheme

In this work, a face recognition system with mask detection is proposed. The proposed scheme uses texture descriptors Local Binary Pattern (LBP) [9] and Modified Local Binary Pattern (MLBP) [5] are used for face recognition. Here, a Euclidean distance classifier is used for classification. Along with this spectrum of the eye region and area of nose region is extracted for examining the presence of mask. Efficacy of the proposed scheme is evaluated using 3DMAD [1] [4] database.

2. PROPOSED METHOD

The proposed face recognition system with mask detection is shown in Figure 1. The proposed system can be broadly structured into two units: (1) Face recognition (2) Mask Detection.

2.1. *Face Recognition*

Initially face region is detected using vision cascade object detector. Texture features are extracted from the detected face region using LBP and MLBP. These features are used for face recognition.

LBP is a simple texture operator that converts each pixel of the face image into a binary code. This binary code is calculated by comparing the pixel with its neighboring pixels as in equation (1).

$$LBP_{R,N}(x,y)=\sum_{i=0}^{N-1} r(g_i-g_c)2^i \qquad (1)$$

where g_c corresponds to the centre pixel of a local neighborhood N and g_i to the gray levels of N equally spaced pixels in a circle of radius R. Here, r(x) is given by the equation (2).

$$r(x)=\begin{cases}1, & if \;\; x\geq 0\\ 0, & otherwise\end{cases} \qquad (2)$$

MLBP combines the sign and magnitude features for improved facial texture classification as given in equation (3).

$$g_i-g_c=s_i*m_i \quad and \quad \begin{cases} s_i=sign(g_i-g_c)\\ m_i=|g_i-g_c|\end{cases} \qquad (3)$$

Figure 2 illustrates LBP and MLBP features derived from the texture image and depth map of the face region for a real face as well as a 3D mask. The different features LBP and MLBP extracted from both texture image and depth map of the reference image as well as test image are compared to get comparison scores. These scores are used for recognition. Again, these scores are fused together for better recognition accuracy [3].

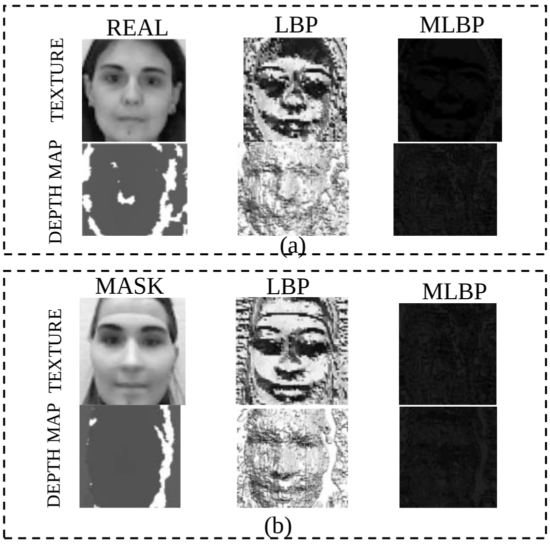

Fig. 2: Illustration of LBP and MLBP

2.2. *Mask Detection*

Figure 3 shows the block diagram of mask detection procedure used in the proposed scheme. Spectrum of eye region and area of nose region are used for mask detection. Spectrum is obtained from both texture image and depth map of eye region. Using 3D mask in which eye regions are left open to fit eye are expected to hide the details of the eye region [2]. Also, area of the nose region is calculated as the size of nose for a real face and 3D mask is different. After face recognition, data of the recognized face is analyzed for mask detection.

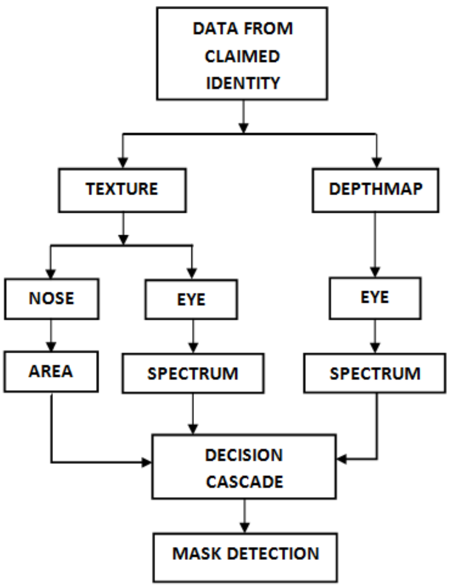

Fig. 3: Block diagram for Mask Detection

3. EXPERIMENT AND RESULTS

The performance of the proposed scheme is evaluated using a publically available database 3D MAD and is implemented with MATLAB. The whole database consists of three sessions. First two sessions consists of real access and the third session consists of mask attempt. The first real session is used for training and second and third sessions are used for testing.
LBP and MLBP are derived from texture image and depth map. They are fused together by giving different weights to different features. These features are given to classifier for face recognition. After recognition, the data of the recognized face is analyzed for mask detection. Figure 4 shows the accuracies obtained for the proposed scheme using different number of samples. Txt_fus and Dep_fus denote fusion of LBP and MLBP applied on texture and depth map respectively.

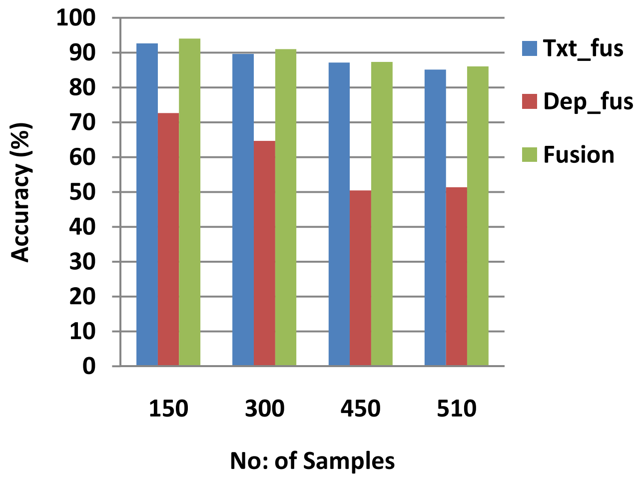

Fig. 4: Graphical representation of accuracies obtained for texture, depth and fusion.

Table 1: Accuracies obtained for different features and their fusion

Features	Accuracy (in %)
LBP_Dep	47.84
MLBP_Dep	50.59
Dep_Fus	51.37
LBP_Txt	84.90
MLBP_Txt	84.90
Txt_Fus	85.10
Fusion	86.07

4. CONCLUSION

The problem of mask attack is addressed in this work. Texture features obtained using LBP and MLBP are use for face recognition. Along with this spectrum of eye region corresponding to texture image and depth map and area of nose region is computed for mask elimination. Accuracy of 86.07% is obtained for the proposed face recognition with mask detection method.

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