摘　要

人脸识别是身份认证的重要技术手段之一。尽管人脸识别技术发展迅速，但在实际应用中仍然面临巨大挑战。例如表情、遮挡、姿态等因素引起的表观的巨大变化，以及利用照片或视频等方式进行恶意假冒合法用户身份等都严重影响人脸识别系统的鲁棒性与安全性。因此，为提升人脸识别系统在实际应用中的稳定性与安全性，本文将着重研究恶意假冒身份以及黑框眼镜引起的遮挡问题，即活体检测与黑框眼镜检测。此外，随着各种智能终端的迅速发展以及用户的迅猛增长，人脸识别在移动终端上也得到了广泛的应用，如隐私保护、交互、社交、用户信息管理、游戏等方面。为提升移动终端上人脸识别系统的性能，本文还研究了适合应用在手机平台上的轻量级人脸识别系统。主要工作如下：

1. 提出一种基于视频的活体检测方法。该方法利用分块的局部纹理特征对视频中每帧图像进行活体信度预测，然后统计视频中被判为活体的比例，从而判断该段视频是否是活体。在此框架下，该部分主要比较了LBP、LTP、HOG以及Dense SIFT等多种局部特征的活体检测效果。通过在ReplayAttack数据库上的大量实验表明，在活体检测中LBP和LTP等基于纹理的特征明显优于HOG和Dense SIFT等侧重方向与梯度信息的特征。
2. 提出一种黑框眼镜检测方法。针对待检测图像，首先定位人脸区域，然后提取分块局部特征，进而构建二类分类器判断是否戴有黑框的眼镜。该部分构建了较大规模的戴边框明显眼镜的人脸数据库，并评测LBP、LTP、HOG和Dense SIFT等局部特征在此数据库上的性能，均取得了超过97%的检测正确率。
3. 面向移动平台，设计并实现Android系统下的轻量级人脸识别算法。该应用在PCA+LDA框架下采用图像金字塔以及分块局部特征实现快速识别，并保持了较高的识别准确率。通过比较多种特征的性能与速度，最终选择了LBP特征。

综上所述，本文针对实际应用中人脸识别系统遇到的身份假冒、黑框眼镜遮挡、以及在移动终端的轻量级人脸识别系统设计三个问题进行了深入的研究与设计，尤其对比与分析多种描述子在这些场景下的性能，从而确定较为有效与快速的解决方案，取得了良好的性能，提升了人脸识别系统在实际场景以及移动平台上的实用性与安全性。

关键词：活体检测　黑框眼镜检测　轻量级人脸识别　手机人脸识别

Robust and Lightweight Face Recognition System Design

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Face recognition is one of the most important approaches for identity authentication, and it is developing rapidly. However, it still confronts great challenges in real-world applications. Appearance variations caused by expressions, occlusions, posture and so on seriously affect the robustness and security of face recognition system, and so do spoofing attacks with photographs or videos of valid users. In order to enhance the stability and security of face recognition system, this work will focus on anti-spoofing and occlusion resulted from black framed glasses, i.e. liveness detection and black framed glasses detection. In addition, with the rapid development of smart terminals and the growth of subscribers, face recognition has also been widely used on the mobile terminals, such as privacy protection, human-machine interaction, social networking services, user information management, game etc. To enhance the performance of the face recognition system on mobile platforms, this work also studies face recognition running on mobile platforms named lightweight face recognition system. The main contributions are as follows:

1. Propose a video-based liveness detection method. The proposed method predicts the liveness confidence of each frame with local feature in blocks, and then calculates the proportion of live frame in order to determine whether the video is live. In this framework, the performance of LBP LTP, HOG and Dense SIFT were investigated. The experiments on ReplayAttack database show that the texture features such as LBP and LTP are much better than features focusing on direction and gradient information, for example HOG and Dense SIFT.
2. Propose a black framed glasses detection method. For the input image, firstly locate the face area and extract the local feature in nonoverlapping blocks, then learn binary classifier to determine whether wearing black framed glasses. Besides, a large-scale database containing faces wearing obvious framed glasses is collected. On this dataset, the performance of local feature such as LBP, LTP, HOG and Dense SIFT are evaluated and all four local features achieved a high detection accuracy rate of over 97
3. For mobile platform, design and implement lightweight face recognition algorithm running on Android system. Under the framework of PCA and LDA, the image pyramid strategy and local features in blocks are employed to achieve high recognition accuracy

and fast speed. After comparing the performance and speed of many local features, the application exploits LBP considering its advantages of accuracy and speed. In summary, this dissertation studies the anti-spoofing, black framed glasses detection and as well as lightweight face recognition system for mobile terminals, in particular compares and analyzes the performance of a variety of descriptors in these scenarios to determine more effective solution and achieve good performance, so as to improve availability and safety of face recognition system in the real world and mobile platforms.

Keywords: liveness detection　black-framed glasses detection　lightweight face recognition system　mobile phone face recognition