Improved Fake Iris Recognition System Using Decision Tree Algorithm

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Abstract

Biometric recognition systems are more advantageous than traditional methods of recognition as they allow the recognition of an individual for what he is and not for what he possesses or knows. Two of the currently most used biometric traits are the iris and the fingerprint. These traits have unique characteristics that allow people's recognition and distinction. However, they can also be reproduced or used fraudulently. A possible way of accessing the system fraudulently is by presenting a fake reproduction of the biometric trait to the sensor, which can prevented by studying the liveness of the biometric trait. Therefore, in the context of this work, liveness detection algorithms for iris will be studied. Concerning this, for the iris images the study is focused on cases where contact lenses are used to spoof the recognition system. For the iris, databases with fake samples obtained from molds of real iris are used to test the methods. Decision tree algorithm is used to compare the iris in database. The results show that it is possible to obtain results comparable or even better than the state-of the art ones, using other iris databases, but that does not occur for every database tested. This proves that it is still necessary to improve or maybe combine the algorithms, so that the classification error rate drops.

Introduction

The use of biometrics can be split in two branches: identification and verification. Identification implies establishing a person's identity based on his/hers biometric traits and aims to answer the question: "Who is this person?". Verification, on the other hand, involves confirming or denying someone's identity, aiming to reply the query: "Is this person who he/she claims he/she is?". Biometric Traits Biometric traits are physical and behavioural human features used by identification and verification applications. The most common human features used for biometric purposes are:

- Fingerprint
- Iris
- Face
- Voice
- Signature
- Hand Geometry
- DNA
- Keystroke
- Gait

Physical traits normally refer to a part of the human body like the face, the eyes, the hands, etc. On the other hand, behavioural traits relate to the conduct of a person, e.g. the voice or the signature. Biometric traits can also be labelled as genotypic or phenotypic. Genotypic features are genetically defined, while phenotypic features can be changed over time and depend on the surrounding environment.

Decision Tree method

The main principles of a biometric system based on iris. His method of iris recognition can be decomposed in four main stages

- Iris segmentation
- Normalization
- Feature extraction
- Feature comparison using Decision Tree

Decision and prediction are all examples of directed data mining or supervised learning from feature based examples. It has undergone a number of alterations to deal with the language, memory requirements and efficiency consideration.

A Decision tree is a classification scheme which generates a tree and a set of rules. Representing the Model of different classes, from a given dataset. Decision Tree is a Flow chart like tree classes, where each internal node denotes

a test on an attribute, each Branch represents an outcome of the test and leaf nodes represent the classes or class Distributions. the top most node in a tree is the root node.

The major strength of the DT methods are the following:

1. Decision Tree are able to generate understandable rules.
2. They are able to handle both numerical and categorical attributes.
3. They provide a clear indication of which fields are the most important for prediction or classification.

Iris Databases

The main characteristics of some available iris databases are described. In the description of each database, the quality of the images and its noise factors as well as the number of real and fake images are presented. Iris databases aim to promote the development of iris recognition and assess the technology's current level of performance.

- BATH
- CASIA
- ICE
- WVU
- UBIRIS.v1
- MMU

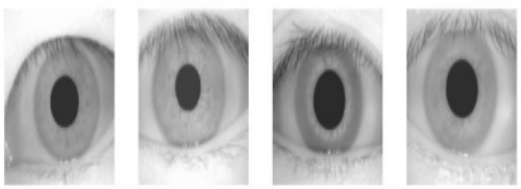


Fig: Examples of iris images from CASIA database

CASIA

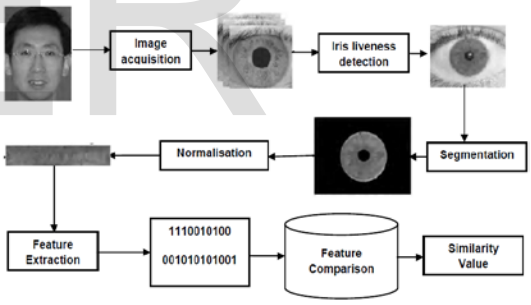
The latest version of CASIA database, CASIA-Irisv4, contains a total of 54,607 iris images. This database has several similarities with the BATH database since its images were also captured under very constrained circumstances thus conditioning the resultant images. All iris images from the CASIA-Irisv4 database are 8 bit gray-level JPEG files; they present homogeneous characteristics and their noise Factors are related with iris obstructions.

It comprises six data subsets, which were collected or synthesized at different times:

- CASIA-Iris Interval
- CASIA-Iris-Lamp
- CASIA-Iris-Distance
- CASIA-Iris-Thousand
- CASIA-Iris-Twins
- CASIA-Iris-Syn

SYSTEM ARCHITECTURE

A biometric system can be divided in two stages: the enrolment and the identification/verification. The enrolment consists in acquiring data from specific individuals so that a database can be built.



It can be said that the enrolment is the registration of individuals to the database and those will be the ones who, should be recognized during the identification or verification process. The second stage of a biometric system is the identification which, no matter what feature is chosen to work with, follows the process schematized in Figure.

The process starts with the capture of the images, acquiring a biometric sample, followed by a pre-processing module where several steps are taken like iris liveness detection, boundary detection, eyelid detection and removal and also the normalization of the iris region. The third part of the process consists in the feature extraction, where conspicuous features are identified for classification. Lastly, the features are

compared and matched with stored ones, resulting in a possible recognition.

ALGORITHM

FUNCTION build_dec_tree(examples,atts)
// Takes a set of classified examples and
// a list of attributes, atts. Returns the
// root node of a decision tree
Create node N;
IF examples are all in same class
THEN RETURN N labelled with that class;
IF atts is empty
THEN RETURN N labelled with modal example class;
best_att = choose_best_att(examples,atts);
label N with best_att;
FOR each value ai of best_att
si = subset examples with best_att = ai;
IF si is not empty
THEN
new_atts = atts – best_att;
subtree = build_dec_tree(si,new_atts);
attach subtree as child of N;
ELSE
Create leaf node L;
Label L with modal example class;
attach L as child of N;
RETURN N;

Accuracy Measurements

To determine whether a liveness detection method is viable or not, one should assess the performance of its classification system. The classification is usually measured in terms of error rate or accuracy . The error rate is calculated by finding the ratio between the number of misclassified images and the total number of images in the testing set. The accuracy is precisely the opposite of the error rate, that is, the percentage of correctly classified images

$$\text{Error rate} = \frac{\text{misclassified images}}{\text{total number of images}} \text{x} 100\%$$

$$\text{Accuracy} = 100\% - \text{Error Rate}$$

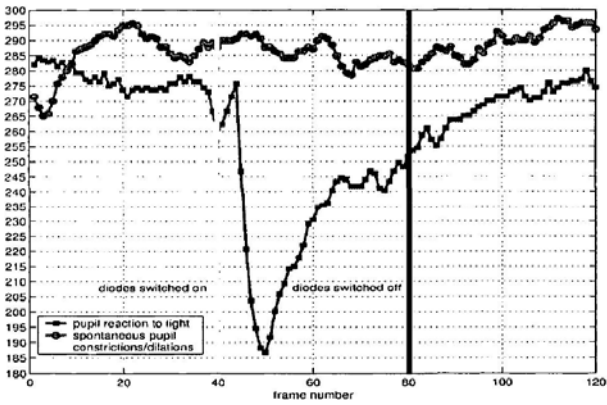


Fig: Variation of pupil size

CLASSIFICATION

Classification is a critical task in liveness detection. Its objective is to categorize one or more classes by labeling each similar set of data as one class. A regular classifier is constructed in two phases: the training and the testing. In the first phase, a training set is used to decide how the features should be weighted in order to separate the different classes. During testing, the weights selected in the training set are applied to another set of data, outputting the class that they should belong to previous research. Previous results show, by comparing several classifiers such as k- Nearest Neighbour, Discriminant Analysis and Decision tree, that this last one performs better than the others in liveness detection situations and thus we decided to use it in the work. Decision Tree(DT) is based on the concept of decision planes. A decision plane splits a set of objects having different classes thus defining the boundary between one class and another. There are two main types of DT classification methods, a binary and a multi-class. It also supports two tasks, regression and classification, being also efficient when working with large-scale samples and variables. Since we are dealing with the problem "Is this image real or false?" we are using a binary DT classifier with linear kernel, taking advantage of the LIBSVM package for Matlab.

Conclusions

During the research and the development of this work, it was possible to better understand the liveness detection problem and how iris recognition systems work. Even though the usage of iris recognition system is now usual, there is still a need to improve their efficiency, security

and applicability. Detecting the liveness detection of these traits is a great concern as successful spoofing attacks may lead to the leakage of important information or theft of important objects. This work is selected and implemented decision tree algorithm for liveness detection and tested them in iris databases. This worked with two iris databases: Notre Dame and Clarkson and four datasets from the fingerprint database LivDet2013, cassia. Each of these corresponding to a sensor used to capture of images. The two iris databases are quite singular as their fake samples correspond to iris wearing cosmetic contact lenses, which allowed us to use the same algorithms for both traits, as they both have textural characteristics. The most important step of this work was feature extraction, as the classifying the images, depend on the relevancy of the extracted features. Two types of texture features were extracted. In terms of classifier, the DT were chosen, because it has presented the best results in previous works.

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