TESI @UNIVERSITY OF GRONINGEN (THE NETHERLAND)

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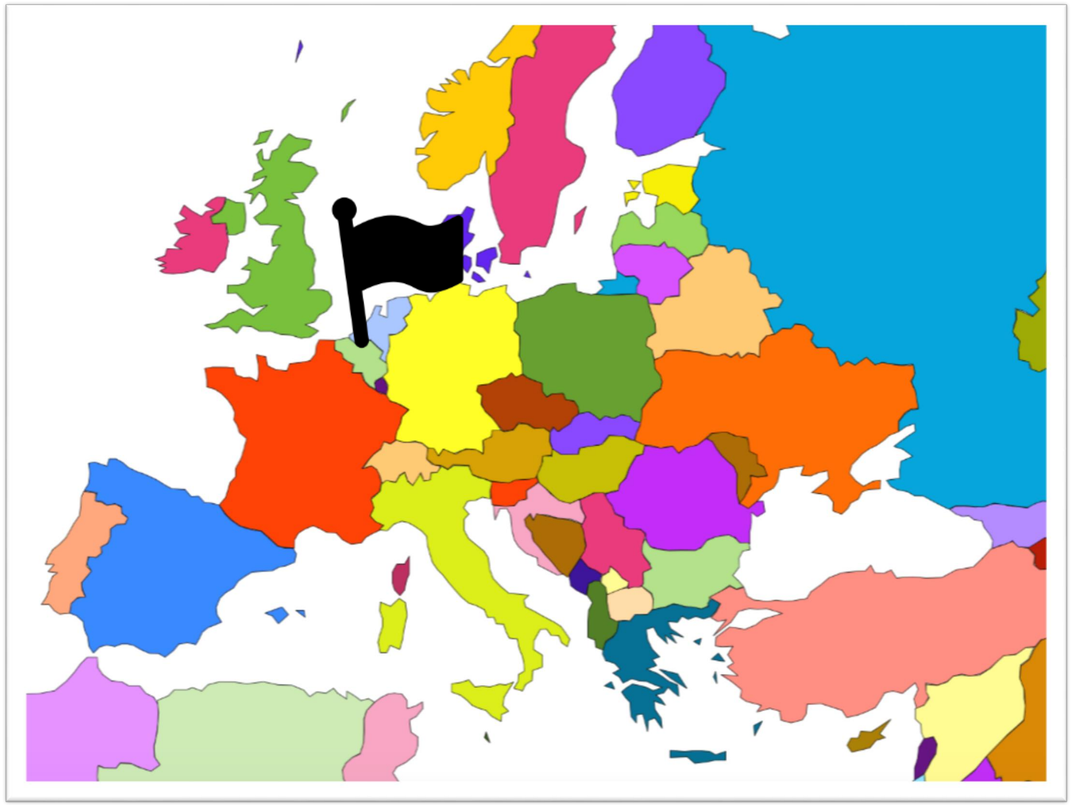
The **Intelligent Systems** group of the University of Groningen works with the aim to give computers abilities to perceive (e.g. see, hear and smell), analyze, learn, take decisions and enhance human creativity.

Nicolai Petkov, the contact professor for the ERASMUS@University of Groningen, is the head of the Intelligent Systems group.

Prof. Petkov in numbers: H-Index: 31; Citations: 5518



Required Skills for the thesis:

Machine Learning e Big Data Analytics

Give a look to the Lab Website

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UNIVERSITÀ DEGLI STUDI DI SALERNO

MIVIA

Francesco Formato

University of Groningen

REAL TIME AGE ESTIMATION FROM FACE IMAGES

Abstract

From human face you can retrieve a lot of information like gender, age and expression and a lot of people are able to easily recognize these human traits. Why a machine can not do the same?

This work aims to design an algorithm able to analyze the face images and to estimate the age of a person. To simplify the estimation and to reduce the error probability, the age could not be an absolute number, but a class (for example one between child, adult or elder).

The method has to be tested on publicly available standard datasets.
The performance of all the proposed techniques have to be experimentally evaluated on all the datasets.

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UNIVERSITÀ DEGLI STUDI DI SALERNO

MIVIA

Raffaella Patronelli

University of Groningen

A REAL-TIME TRAINABLE METHOD FOR FACE RECOGNITION

Abstract

The capacity of recognizing faces is a fundamental human ability that represents a great challenge for modern computer vision systems. Humans can identify thousands of faces learned throughout their lifetime and recognize them at a glance even after years of separation, despite changes in their appearance related to viewing conditions, different expressions, aging and occlusions. A properly trained face recognition system should be able to identify a person whose face is in the database or report that the detected face belongs to an unknown subject. Modern calculators can overcome humans limitations thanks to better resources in terms of memory and computational power, releasing the full potential of face recognition: compared with other popular biometrics methods such as fingerprint, iris and retina recognition, face recognition has the advantage of identifying uncooperative subjects in a non-intrusive manner. This possibility opens up a whole world of different application scenarios, ranging from surveillance security to digital entertainment, passing through human-computer interactions and marketing.

Unfortunately, developing a computational model of face is not that easy because of a series of factors:

- Faces are multidimensional, while their discrete representations are two-dimensional;
- Subjects can assume different poses and facial expressions;
- Rigid rotations of the head result in self-occlusion, which leads to a loss of information;
- Faces can also be occluded by accessories (hat, sunglasses, scarves, etc);
- Other factors can make the task harder, such as low resolution and illumination variations.

In the last decades, many approaches have been developed and tested on public datasets. Generally methods that outperform others have a greater computational burden and require a huge amount of training data. A first phase of analysis of the state of the art was required in order to understand which approach could
have been suitable according to the available resources and the application requirements. Several experimentations were then conducted to evaluate the performances of the selected methods, leading to the final decision on the basic technique to be adopted for the development of the classification system. The final goal was to design and develop a complete application made up of an easily trainable recognition system able to analyse different kinds of video streams, detect one or more faces present in the videos and classify them.

After the research phase, the classification system was implemented along with a web application that allows the user to access to the streams, acquire and manage data for the training stage, perform training and classification. A tracking algorithm and a reject option were then implemented and integrated with the classification system in order to make the framework more robust. In this work, all the different stages will be described in details in order to provide a comprehensive overview of the design choices and implementation processes that led to the final version of the application.

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UNIVERSITÀ DEGLI STUDI DI SALERNO

MIVIA

Raffaele Cafaro

University of Groningen

AUDIO EVENTS DETECTION USING TRAINABLE FILTERS

Abstract

In this thesis we focused on the problem of sound event recognition, with particular reference to the context of audio surveillance. We represent the audio signal by means of the gammatonegram, a brain inspired representation emulating how to human auditory system works. Then, we use the COSFIRE filter so as to detect events of interest.

A set of COSFIRE filters, configured taking as input the gammatone filter responses of audio streams, is learned from the training data and a coverage procedure is employed to determine the number of filters to be used. The model is learned directly from the visual audio data, with no need to engineer a feature set. One of the advantages is the intrinsic modularity of the approach: in fact the filters for different classes of sound are learned independently from each other.

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UNIVERSITÀ DEGLI STUDI DI SALERNO

MIVIA

Francesco De Martino

University of Groningen

SKELETAL ACTION RECOGNITION WITH S-COSFIRE FILTERS

Abstract

Human motion analysis is nowadays one of the most important and challenging topic in computer vision.

It consists in the automatic detection and classification of actions by using information acquired from different kinds of sensor, such as RGB cameras, range sensors or marker based systems.

In this thesis an innovative trainable skeletal pattern descriptor, named S-COSFIRE, is proposed. The S-COSFIRE filter provides a new representation of body parts spatial configuration, which is obtained automatically by training the filter from samples.
This representation is then enriched and processed at a higher level to take into account the temporal evolution that characterizes the movement.

The developed algorithm has been tested on three different public datasets providing results that are comparable with the best state-of-the-art proposed solutions. (Obtained accuracy: MHAD 97.4% - MIVIA-S 95% - MSRDA 68%)

UNIVERSITÀ DEGLI STUDI DI SALERNO

Giovanni Galatro

University of Groningen

A KERNEL-BASED CLUSTERING APPROACH FOR TRENDS MODELLING IN FINANCIAL TIME SERIES

Abstract

Reliable time series prediction and forecasting have many important applications ranging from finance to supply chain management and inventory planning. Stock market prediction is regarded as a challenging task of financial time-series prediction, because of the non-stationary and chaotic nature of data.

The Efficient Market Hypothesis (EMH) asserts that the movement of the price of an asset is unpredictable, assuming that this movement evolves as a random walk.

Basing on this consideration, trying to do prediction or regression in finance is an impossible task. Traditionally Support Vector Regression, as well as other machine learning algorithms such as Artificial Neural Networks, are used for classifications and regression in pattern recognition applications.

UNIVERSITÀ DEGLI STUDI DI SALERNO

Antonio Roberto

University of Groningen

A METHOD FOR FORECASTING FINANCIAL TIME SERIES BASED ON EMPIRICAL MODE DECOMPOSITION AND MANIFOLD-LEARNING

Abstract

Non-linear time series regression and forecasting are well-known as hard problems which have many applications ranging from finance time series analysis to signal processing, from electric utility load forecasting to natural phenomena prediction. Stock market prediction is considered a challenging task of financial time series prediction. In literature several approaches are proposed for facing these problems. Support Vector Regressor (SVR) has proven to be a good model for the processing of high noise, non-stationary signals. Furthermore, it is known that preprocessing affects the performance of regressors built using this method. Therefore, opportune preprocessing approaches have been developed and applied to clustering and regression tasks. Some transformations to frequency domain have been used like Fourier and Wavelet Transforms. Among these, good results have been obtained using the Empirical Mode Decomposition (EMD) for analyzing financial time series data. Some works are focused on the clustering of the time series in order to group samples with similar statistical distributions to reduce the error due to the non-stationary property. The problem of using SVR and other method based on the learning from examples is that training data can be fitted well by infinite models, but only few of them generalize well on unseen data. To address this issue, it is desirable to use a large amount of data. Training on samples of different stocks requires the abstraction from the specific time series; most commonly used techniques are whitening and scaling. These methods are influenced by the representativity of the dataset in describing the fundamental parameters (mean, min/max, etc.) which are not constant over the time due to the non-stationarity. Moreover, clustering algorithms use Euclidean distances and, therefore, they are influenced by the way in which data are preprocessed. In this thesis, I conducted two macro-experiments; in the first one, I analyzed how preprocessing affects the forecasting performance proposing a new preprocessing method based on the normalization of the feature vector on the current day (most recent stock price in the vector). Using this approach, I showed that is possible to get away from the specific time series by focusing on the concept of trends modeling. In the second one, I used EMD and Manifold Learning preprocessing methods for the clustering in a two-stage architecture. In this way, I reduced the error contribute due to the non-stationary property using denoised relative changes in the stock price to improve the ability of the clustering algorithms in grouping particular time series dynamics. I evaluated the performance by using the Efficient Market Hypothesis (EMH) to compare performance, measured with 2 and using a 5-fold Cross Validation (CV) specific for time series performance estimation. Taking in the account the statistics nature of the CV, a TStudent Test is used to get a degree of confidence of the obtained results in terms of means. The results evidenced as the proposed normalization outperforms classic methods like the linear scaling and how a preprocessing method based on Empirical Mode Decomposition and the Manifold Learning can increase the performance of the two-stage architecture.

UNIVERSITÀ DEGLI STUDI DI SALERNO

Andrea Porfido

University of Groningen

A REAL-TIME METHOD FOR ONLINE FACE RE-IDENTIFICATION

Abstract

In last years, face recognition has become one of the most interesting topic in Computer Vision and it has carried many challenges and incentives for the scientific research. A face recognition system has to identify a person analyzing his/her face.

The system is trained offline using one or more images of each person and the aim is to identify known persons and reject strangers. This texts is about face re-identification: its goal is the same of face recognition, but the main difference is that the database of faces is dynamically populated. So, in addition to a classic face recognition algorithm, the system has to be able to track the face of a person and to collect some face images if the person is not already in the knowledge base.

After a brief introduction, in which the main issues of face recognition are presented, the texts present the actual state of the art in face verification, a task simpler than recognition, consisting in verify if two face images belong to the same subject. The section presents the main categories and the more powerful methods, reporting the results on the LFW dataset for each of them. The method "Fisher Vector Face" is extracted from this review and tested for face recognition together with HOG (Histogram of Gradients) and LBP (Local Binary Pattern) descriptors. From the experimentations on various public datasets it turned out that HOG reaches the best performances.

The texts presents moreover a complete implementation of a face re-identification system, developed in C++ with the OpenCV library and web technologies. The system is able to work in real-time and to perform an online training on new incoming subjects. The last chapter describes possible real-context applications of face re-identification and mentions the future challenges of face analysis.