An Adaptive Video-to-Video Face Identification System Based on Self-Training

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1. Introduction

In the development face identification system for video-surveillance scenarios the key **challenges** are:

- **Individuals are often require to collaborate** for the enrolment in the system in costly and time-consuming process.
- Video-frames extracted these contexts are **low-quality**
- **Face variations over time** are quite important (pose, look, illumination, etc.)
- There is an important **shortage of labelled data**

In this regard, we propose a system capable of:

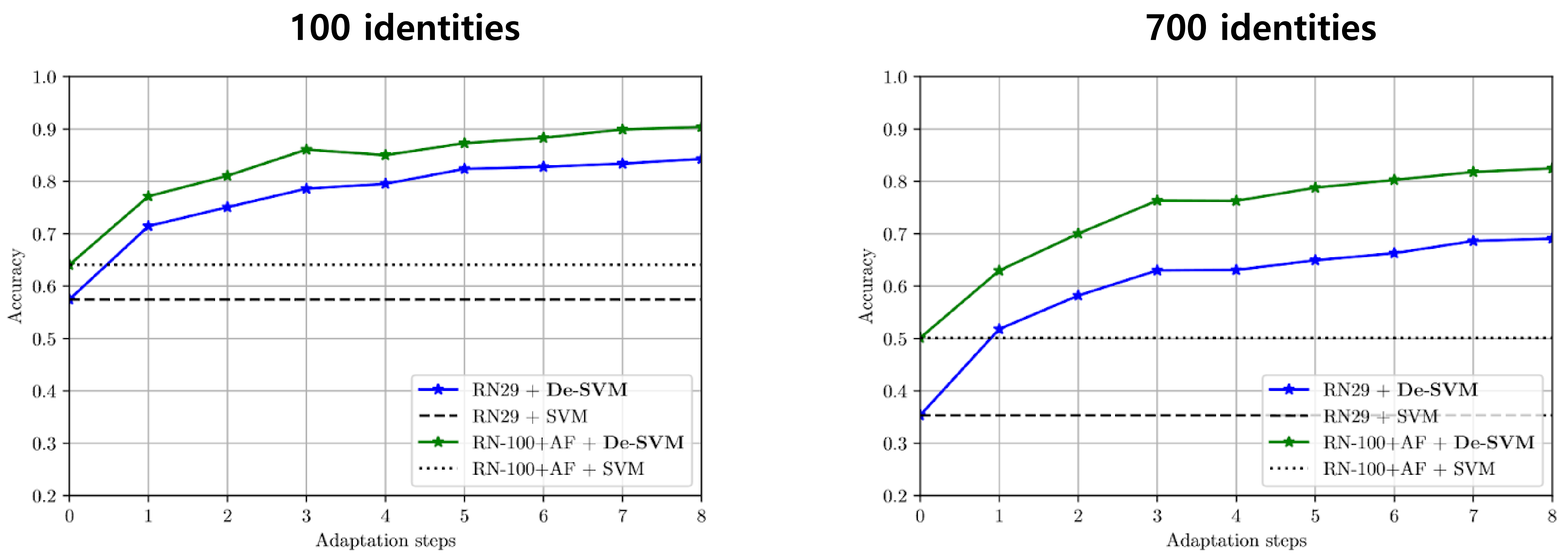
- Using only data extracted from the video footage (**video-to-video**).
- Providing a way of **adaptation** to frame characteristics and time evolution.
- Performing this adaptation **without additional supervision** after the initialisation.

2. An Adaptive Video-to-video Face Identification System

The proposed **Dynamic Ensembles of SVM** is an incremental learning system that presents the following characteristics:

- It uses deep feature encoders as a basis.
- It creates and updates an ensemble of SVM for each enrolled individual.
- The initialisation is done using only 5 frames from footage, creating "ensembles" of one classifier.
- In each update, the system adds a new classifier to the ensemble.
- Unsupervised incremental learning is achieved by the use of the self-update paradigm in which predictions of the system itself play the role of pseudo-labels.
- Temporal coherence within query video sequences is assumed.
- It is designed for a closed-set scenario.

Results



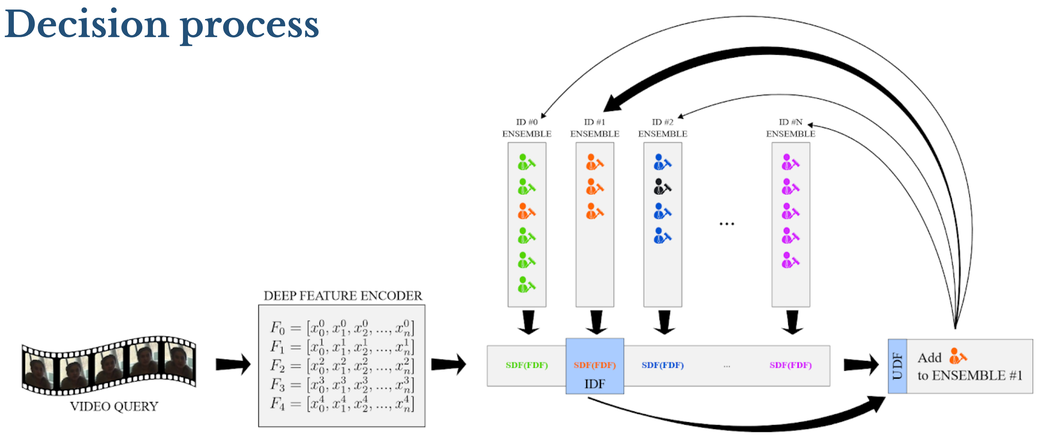
Key-points

1. De-SVM effectively **improves performance** over time **without any additional supervision** after initialisation.

2. This improvement is relatively independent on the number of identities to recognise.

3. After adaptation, De-SVM surpasses state-of-the-art performance with the available labelled information.

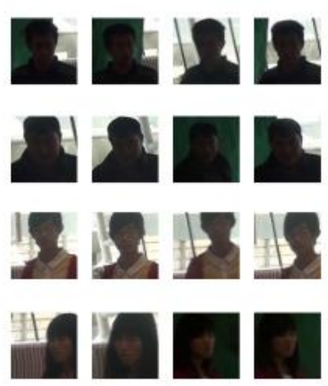
3. Decision process



De-SVM assumes that is queried with video-sequences containing faces of just one identity. In the process of assigning identities to query sequences we need to define a bunch of decision functions:

- The **Frame Decision Function (FDF)** by which one ensemble assigns an score to each of frames of the query sequence.
- The **Sequence Decision Function (SDF)** by which one ensemble combines the FDF scores in order to assign one score per sequence.
- The **Identification Decision Function (IDF)** uses the SDF scores given by each of the ensembles in order to assign an identity label to the query sequence.
- The **Update Decision Function (UDF)** selects the frames used to create the next classifier.

4. Experimental Methodology



Samples of the COX Face Database used in for experiments

- **COX Face Database**. Video-frames of 1000 identities taken using 3 non-overlapping cameras.
- We **divide each camera sequence into 3 sub-sequences**, having a total o 8 adaptation sub-sequences + 1 testing subsequence per identity.
- Two different feature encoders:
  - **RN29**, the one provided by Dlib library (achieving a 99,13% in LFW verification)
  - **RN50-AF**, using the ArcFace separation, this is one of the top state-of-the-art feature encoder (achieving 99,80%)
- **Accuracy** measured after each adaptation step (iteration over the whole set of identities).

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