

Recognition of Arabic Handwritten Words using Contextual Character Models

Ramy El-Hajj ^{a,b}, Chafic Mokbel ^a and Laurence Likforman-Sulem ^b

^a University of Balamand, Faculty of Engineering, PoBox 100 Tripoli, LEBANON.

^b GET-Ecole Nationale Supérieure des Télécommunications, 46 rue Barrault, 75013 Paris, FRANCE

ABSTRACT

In this paper we present a system for the off-line recognition of cursive Arabic handwritten words. This system is an enhanced version of our reference system presented in [El-Hajj et al., 05] which is based on Hidden Markov Models (HMMs) and uses a sliding window approach. The enhanced version proposed here uses contextual character models. This approach is motivated by the fact that the set of Arabic characters includes a lot of ascending and descending strokes which overlap with one or two neighboring characters. Additional character models are constructed according to characters in their left or right neighborhood. Our experiments on images of the benchmark IFN/ENIT database of handwritten villages/towns names show that using contextual character models improves recognition. For a lexicon of 306 name classes, accuracy is increased by 0.6 % in absolute value which corresponds to a 7.8% reduction in error rate.

Keywords: Arabic words, HMMs, contextual character models, AWHR, handwriting recognition.

1. INTRODUCTION

The recognition of Arabic handwriting is an active field in the pattern recognition domain [Lorigo and Govindaraju 06]. Constructing off-line recognition systems is a challenging task because of the variability and the cursive nature of the Arabic handwriting. Arabic handwriting is difficult to pre-segment so that many recognition systems are based on the HMM framework [Amin 98; Khorsheed 03; Ben Amara and Bouslama 03]. HMM-based methods can be used with two main basic strategies: holistic and analytical. The holistic strategy considers word images as a whole and does not attempt to segment words into characters or any other units. Thus models are trained from word images and this approach is restricted to small lexicons. In HMM-based analytical strategies, words are modeled by the concatenation of compound character HMMs. When segmentation is *external*, the word image is first segmented into characters or smaller units and then these units are recognized by single character HMM classifiers [Arica and Yarman-Vural, 01]. When segmentation is *implicit*, there is no attempt to segment the image word before recognition. Segmentation into characters is performed jointly with recognition. The advantage of analytical strategies is that the size of the lexicon may be large as new word models can be easily added by concatenating character models.