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HANDWRITING RECOGNITION OF WHITEBOARD NOTES

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Outline

1. Introduction
2. System Overview
3. Recognition
4. Experiments and Results
5. Conclusions and Future Work

Introduction

- > Writer independent recognition of handwritten text
- > Traditionally divided into on-line and off-line recognition
- > Novel task: text on a whiteboard captured with the eBeam System

Motivation:

- > Smart Meeting Room
- > For indexing and browsing the collected handwritten data.

The eBeam System



- > Pen in special casing
- > Infrared signals
- > Receiver in one corner

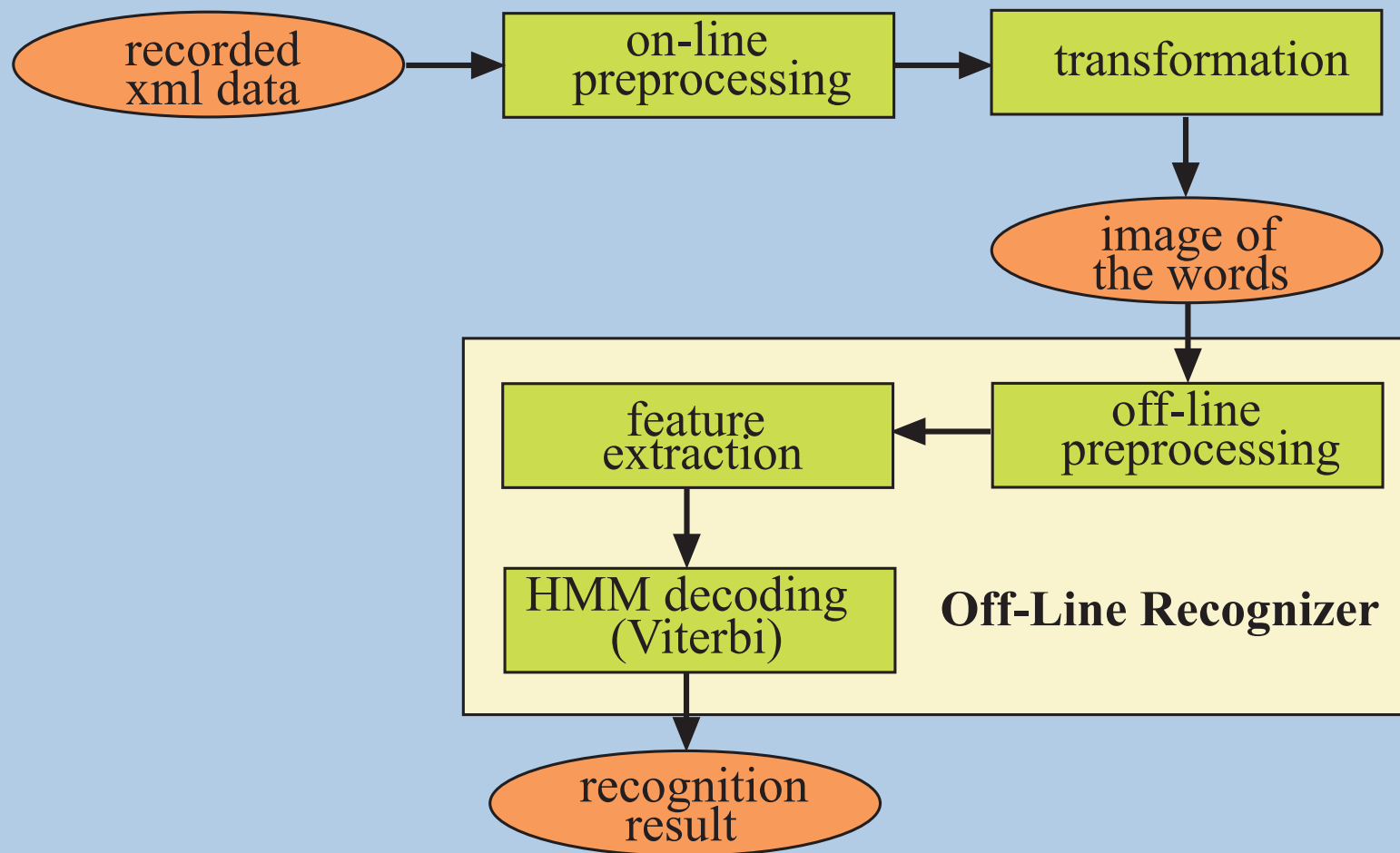
The Database

- > IAM-OnDB acquired during last months
- > 221 writers 86,272 word instances from a 11,059 word dictionary
- > <http://www.iam.unibe.ch/~fki/iamondb/>
- > For experiments only a subset from 20 writers

Basic Idea

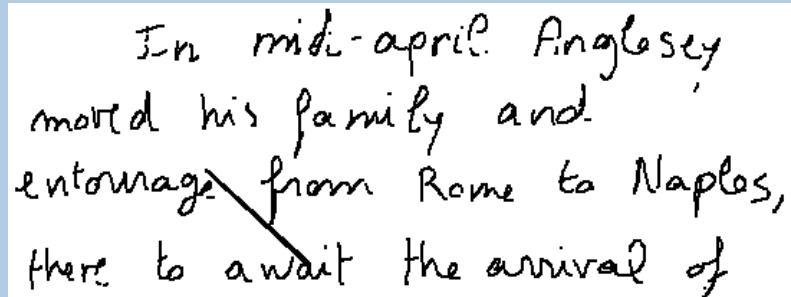
- > Use existing off-line recognition system
- > Transformation of strokes to images
- > Adopt preprocessing methods of off-line recognizer
- > Optimize important parameters on a validation set

System Overview



On-Line Preprocessing

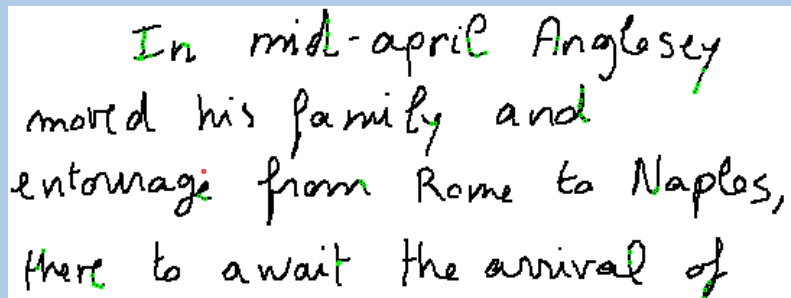
Artifacts of the recordings:



In mid-april Anglesey
moved his family and
entourage from Rome to Naples,
there to await the arrival of

- > Spurious points
- > Gaps within characters

Processing methods:



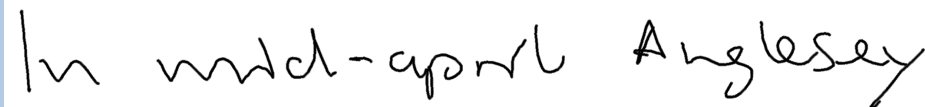
In mid-april Anglesey
moved his family and
entourage from Rome to Naples,
there to await the arrival of

- > Remove noise
- > Merge succeeding strokes with small time gap

Transforming to Images

For each stroke:

- > Connect succeeding points
- > Dilate lines with different gray-values
- > Smooth lines
- > Examples for comparison:

A white rectangular box containing a gray-scale image of the handwritten text 'In mid-april Anglesey'. The text is rendered in a dark gray, slightly blurred font.

Generated gray-scale image

A white rectangular box containing a line of handwritten text 'In mid-april Anglesey' from the IAM-database. The text is in a clear, black, cursive script.

Line from the IAM-database

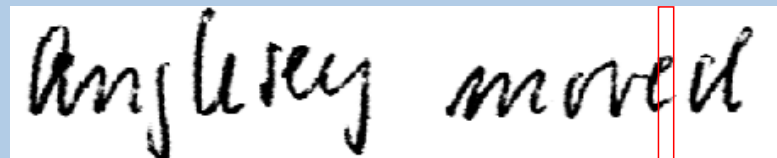
Off-Line Preprocessing

Normalization methods:

- > Slant / skew correction
- > Positioning and width normalization

Feature Extraction:

- > Sliding window



- > Nine features computed at each position

Recognition

- > Based on Hidden Markov Models
- > One Hidden Markov Model for each character
- > Individual number of states
- > Baum-Welch based training
- > Number of Gaussian components and training iterations jointly optimized
- > Viterbi decoding step
- > Statistical bigram language model included

Experiments and Results

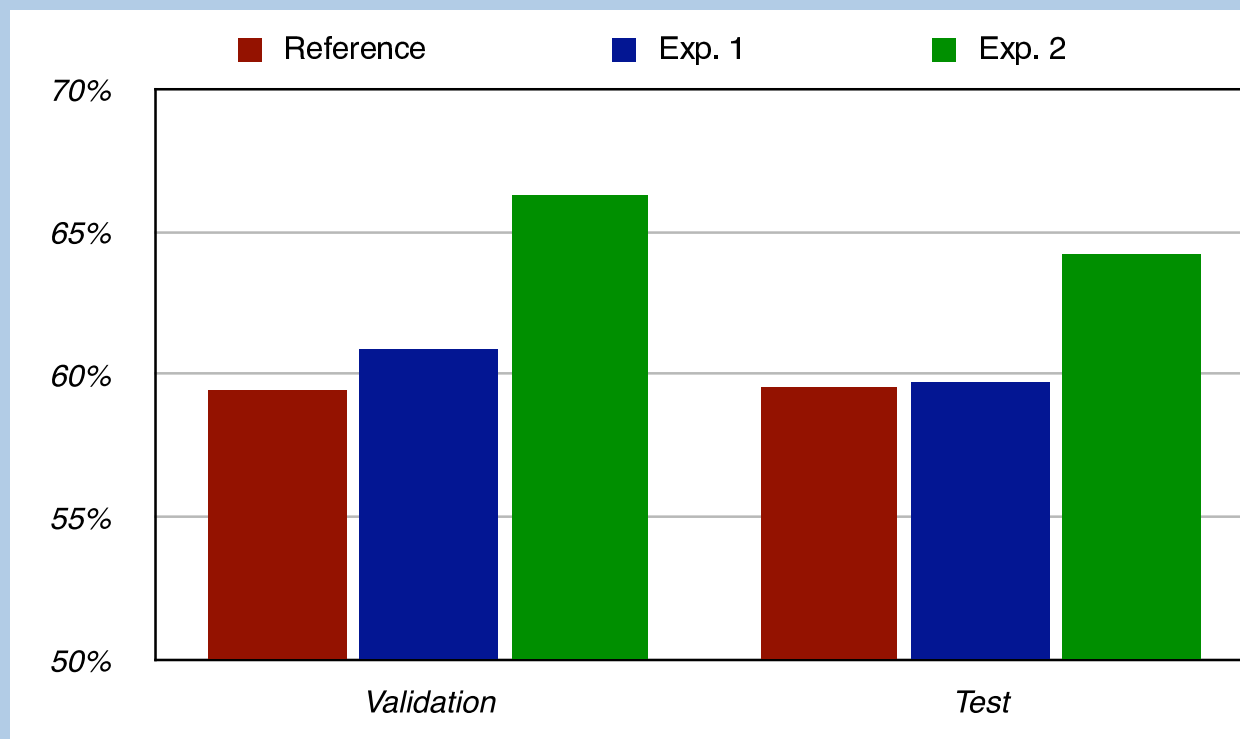
Experimental Setup:

- > 6204 words in 1258 lines
- > Closed dictionary (2337 words)
- > 20 writers divided into 5 sets, each containing 4 writers
- > Writer independent text recognition
- > 5-fold cross-validation

Parameters for reference system:

- > 8 Gaussian components
- > No language model

Overall Results



- > Exp. 1: Optimization of Gaussians and States
- > Exp. 2: Including a bigram language Model

Conclusions and Future Work

- > Recognition system for handwritten whiteboard notes
- > New preprocessing steps
- > Recognition results of about 60% on basic system
- > Improvements by optimizations of about 5%

Future Work

- > Increase size of training set
 - Adaptation of an off-line recognizer, which has been trained on the IAM-DB
 - Training on mixed data sets
 - Use IAM-OnDB
- > On-line recognition system
- > Combination of on-line and off-line recognizers

Last Slide



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Thank you

Questions?