PREFACE

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Bankcheck processing represents an important challenge for the scientific community working in the field of document analysis and handwriting recognition. Difficulties in solving the problem derive mainly from the nature of bankchecks, which is extremely complex intrinsically.

Bankchecks differ not only in background, but also in type and position of the preprinted information fields and of the information fields that must be filled in by the customer. Many different color pictures are used as background images, and additional stylistic paintings or logos can make the background extremely complex. Furthermore, many other components are typically preprinted on a bankcheck, for instance the boxes and the guidelines which are generally used to indicate the position of each information field are to be filled in.

The preprinted fields generally regard the name of the bank and its identification number, the name and the identification number of the bank agency, the number of the check and the account number of the customer. Other additional information can be present, like the tax identification number of the customer or the symbol of the currency in the amount fields. The preprinted fields vary greatly in position, size, text style, color, and so on. For instance, in some cases, a magnetic ink CMC-7 code is used.

The information fields to be filled in by the customer generally regard the legal (worded) amount and the courtesy (digit) amount. In some cases, two different fields exist for the latter amount. A field is also present to enter information on the place and the date of check filling and another for the name of the payee. A specific field of the check is generally devoted to the signature, which ensures the authenticity of the check. In other cases, authenticity is verified by a secret code that is written on the check and that codifies information on the check date, amount, and check customer. Also these fields vary considerably in the position that they can assume in the bankcheck.

Finally, it must be underlined that the size and the structure of a bankcheck can change consistently not only depending on the country, but also on the bank. This variability, together with the intrinsic complexity of the character recognition problem, makes the development of general algorithms and strategies for bankcheck processing extremely difficult, in spite of several solutions proposed up to now.

For instance, in the field of layout analysis, many different algorithms have been proposed for image filtering and thresholding, image segmentation and automatic location of text blocks, textual data capture, both using subtraction and extraction

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techniques, noise removal and particularly box and guideline removal, using both mathematical transforms and powerful operators of the mathematical morphology.

For preprocessing of textual components, many algorithms have been proposed for contour detection, thinning, size normalization, skew and slant correction, segmentation of phrases into words and alphanumeric strings into isolated characters.

In the traditional field of printed and handwritten digit recognition, hundreds of different types of features have been considered in the past, like geometrical and topological features, directional, mathematical and structural features. Furthermore, many classification strategies have been used, based on pattern matching, structural analysis, polynomial classifiers, neural networks and so on.

For the recognition of handwritten words, several different global and analytical approaches have been investigated more recently. In this field, the complexity of handwritten words has required the use of higher levels of abstraction, based on graph structures, for word description, as well as the use of Edit Distance, Dynamic Programming and Probabilistic Relaxation techniques for classification. Furthermore, advanced statistical approaches based on hidden Markov models and Time-Delay Neural Networks have been used, to avoid difficulties related to the effective segmentation of handwritten words.

Many advanced algorithms, which use the contextual knowledge to improve recognition, have also been developed. Syntactic and semantic constraints can be used, both during the recognition process of courtesy and legal amounts in a closed-loop strategy, and also as postprocessing tools, to check the consistency of the results with the contextual constraints.

In the field of static signature verification, many advanced algorithms have been proposed, which also use advanced signature description models, based on the identification of its fundamental components. Many different parameters and functions have been considered as discriminant features, like dominant slant, high density factor, ratio between the middle zone width and the vertical extension, envelope of the signature, Granlund descriptors, direction probability density function and so on. Consequently, new approaches have been adopted for regional matching and multiple regional matching procedures, which use multi-level verification strategies, in order to allow fast rejection of random forgeries and accurate recognition of skilled forgeries.

Of course, the large number of different algorithms for the design and development of advanced document analysis systems require the use of advanced tools for computer aided software engineering (CASE).

The main goal of this volume is to report the state of the art and progress recently made in the field. It is organized in two parts: the first part contains eight papers, which present complete systems for bankcheck recognition; the second part contains nine papers, which propose innovative solutions for key aspects of the problem, like layout analysis and data extraction, numeric string segmentation, word recognition and signature verification.

In the first part of the volume, the paper by G. Dimauro, S. Impedovo, G. Pirlo and A. Salzo gives an example of a complete system for bankcheck processing. The

use of an advanced software engineering tool is proposed for the system design and development. It allows the reengineering of the system, in order to reuse the software and easily integrate new solutions. Another prototype of a bankcheck system, capable of processing courtesy and legal amounts is presented by S. Knerr, V. Anisimov, O. Baret, N. Gorski, D. Price and J. C. Simon, in the second paper. The paper by L. L. Lee, M. G. Lizarraga, N. R. Gomes, A. L. Koerich presents a Brazilian bankcheck recognition system, which is able to recognize the digit amount and verify the authenticity of the signature. A fault tolerant Chinese check recognition system is presented in the paper by H. Su, B. Zhao, F. Ma, S. Wang and S. Xia. It is based on a digit recognizer which reads the courtesy amount and the secret code, which is used to verify the authenticity of the check. The paper by L.Huette, P.Barbosa-Pereira, O. Bougeois, J. V. Moreau, B. Plessis, P. Corellemont and Y. Lecourtier reports some recent advances in courtesy amount recognition. A syntactic analyzer is also used to process effectively literal entities in the courtesy amount. The system presented in the paper by M. Leroux, E. Lethélier, M. Gilloux, B. Lemarié, reads the courtesy and the legal amount separately. Courtesy amount recognition is based on a segmentation-by-recognition approach. Legal amount recognition uses hidden Markov models of words. In the next paper by G. Dzuba, A. Filatov, D. Gershuny, I. Kil, and V. Nikitin the courtesy amount recognition module uses a graph-based procedure, while the legal amount recognition module uses a dynamic programming approach. The problem of the cross validation is also dealt with in the paper by G.Kim and V.Govindaraju, which concludes the first part of the volume.

In the second part, the first paper by K. Liu, C. Y. Suen, M. Cheriet, J. N. Said, C. Nadal, Y. Y. Tang presents a formal model for processing visual data of bankchecks and describes in detail the procedure for data extraction. A different approach, based on a morphological interimage subtraction procedure, is presented in the successive paper by M. Okada and M. Shridhar to extract user-entered components from a personal bankcheck. In the paper by J. M. Westall and M. S. Narashima, the complex problem of string segmentation is considered and a new solution is proposed. It is based on monotone fuzzy valued decision functions, computed by a neural network. Legal amount recognition is performed by a symbolic and a neural classifier in the paper by J. P. Dodel and R. Shinghal, whereas a solution based on a local associative scheme is proposed in the paper by K. Han and I. K. Sethi. A promising approach for literal amount recognition is presented in G. Saon and A. Belaid's paper, which uses hidden Markov models and Markov random fields. The following paper by C. Olivier, T. Paquet, M. Avila and Y. Lecourtier describes in depth the problem of the optimal order of a Markov model for cursive words and presents a useful solution. A more complicated problem involved in bankcheck processing is signature verification. The last two papers of this volume deal specifically with this problem. The signature verification system discussed in the paper by N. A. Murshed, R. Sabourin, F. Bortolozzi is based on a two stage verification process, by which a global and/or local analysis is performed on the unknown signature. In their paper, G. Dimauro, S. Impedovo, G. Pirlo and A. Salzo, follow the most recent approaches in literature and present a system for

signature verification, which combines three different approaches. A high level of accuracy and a good capacity of the system to adapt its working parameters to the writers' signature changes have been obtained.

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