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Dependency Pairs for Simply Typed Term Rewriting, Takahito AOTO* and Toshiyuki YAMADA: Proceedings of the 16th International Conference on Rewriting Techniques and Applications (RTA 2005), Lecture Notes in Computer Science 3467, pp.120-134, 2005

Simply typed term rewriting proposed by Yamada (RTA, 2001) is a framework of higher-order term rewriting without bound variables. In this paper, the dependency pair method of first-order term rewriting introduced by Arts and Giesl (TCS, 2000) is extended in order to show termination of simply typed term rewriting systems. Basic concepts such as dependency pairs and estimated dependency graph in the simply typed term rewriting framework are clarified. The subterm criterion introduced by Hirokawa and Middeldorp (RTA, 2004) is successfully extended to the case where terms of function type are allowed. Finally, an experimental result for a collection of simply typed term rewriting systems is presented. Our method is compared with the direct application of the first-order dependency pair method to a first-order encoding of simply typed term rewriting systems.

The Reachability and Related Decision Problems for Semi-Constructor TRSs, Ichiro MITSUHASHI, Michio OYAMAGUCHI and Toshiyuki YAMADA; KOKYUROKU of Research Institure for Mathematical Sciences Kyoto University, Theoretical Computer Science and its Applications, vol.1426, pp.101-105, 2005

This paper shows that reachability is undecidable for confluent monadic and semi-constructor TRSs, and Joinability and confluence are undecidable for monadic and semi-constructor TRSs. Here, a TRS is monadic if the height of the right-hand side of each rewrite rule is at most 1, and semi-constructor if all defined symbols appearing in the right-hand side of each rewrite rule occur only in its ground subterms.

An Improved Approximation Ratio for Task Scheduling Algorithm using Maximum Matching [in Japanese], Shinnosuke NIIMI, Michio OYAMAGUCHI, Yoshikatsu OHTA and Kohei YAMAMOTO: KOKYUROKU of Research Institure for Mathematical Sciences Kyoto University, Theoretical Computer Science and its Applications, vol.1426, pp.184-188, 2005

Papadimitriou et al. (1990) showed that the scheduling problem which allows making copies of tasks and takes communication delay into account is NP-complete. They also presented an algorithm of approximation ratio 2 by introducing the notion of e-value, which gives a lower-bound of the optimal solution. Kato et al. (2004) introduced an improved lower bound, called low-value, and gave an approximation algorithm. This result is the best result known so far.
We further improve the results by Kato et al. and present an algorithm of approximation ratio 26/17 when c is 1 and 2-1/1.67c when c is greater than 1 where c is the least integer which does not exceed low-value/(communication delay)+1. Moreover, we give an approximation algorithm which allows arbitrary natural number as execution time by relaxing the requirement that execution time to be constant.

Widely-distributed implementation of Task Parallel Script Language MegaScript [in Japanese], Takehiko NISHIKAWA, Yuji TAKAGI, Kazuhiko OHNO, Takahiro SASAKI, Toshio KONDO and Hiroshi NAKASHIMA*: Symposium on Advanced Computing Systems and Infrastructures SACSIS2005, pp.251-252, 2005

We are developing a task parallel script language MegaScript for megascale computing. MegaScript regards independent programs as tasks, and executes them in parallel. Single scheduler controls all tasks in current implementation, but it will cause large overhead in megascale environment. In this paper, we describe the design of the scheduler and runtime for widely-distributed environment.

A Design of Prototype Low Energy Processor by Variable Stages Pipeline Technique, Yuji ICHIKAWA*, Takahiro SASAKI, Tetsuo HIRONAKA*, Kazuya TANIGAWA*, Toshiaki KITAMURA* and Toshio KONDO: Proc. of International Technical Conference on Circuits/Systems Computers and Communications (ITC-CSCC2004), Vol.2, pp.561-562, 2005

Recently, in the field of mobile computing specially, the simultaneous achievement of low energy and high performance computing is required rather than just low power computing. We propose the VSP (Variable Stages Pipeline) as low energy technique with logic cell called LDS-cell (Latch D-FF Selector - cell) which is key technology to satisfy the above requirements. We show that VSP can reduce more energy than DVS and PSU (Pipeline Stage Unification).

Chip size and performance Evaluations of Shared Cache for On-Chip Multiprocessor, Takahiro SASAKI, Tomohiro INOUE*, Nobuhiko OMORI*, Tetsuo HIRONAKA*, Hans J. MATTAUSCH*, Tetsushi KOIDE*: Systems and Computers in Japan, Vol.36, No.9, pp.1-13, 2005

Recent semiconductor technology makes on-chip multiprocessor, with several CPU s and cache memories on a single chip, realistic. Generally, the conventional multiprocessor systems with shared memory offer simple programming model, but needs cache coherency mechanism that may become the bottleneck of the systems. Furthermore, same data may be cached on two or more caches, and it prevents effective cache utilization. Multiport cache is one solution, but by using the conventional multiport memory architecture, the chip size of multiport cache will proportion to the square of the number of ports. On the other hand, with our proposing hierarchical multiport memory architecture, the multiport memory can be implemented with less chip size than the conventional methods. This paper proposes the shared cache with hierarchical multiport memory architecture that does not need coherency mechanism. This paper also shows the results of performance evaluations and chip size estimations.

Telecommunications tunnel monitoring system based on distributed optical fiber strain measurement, Hiroshi NARUSE, Koji KOMATSU*, Kazuhiko FUJIHASHI* and Masaru OKUTSU*: Proceedings of the 17th International Conference on Optical Fiber Sensors (OFS-17), SPIE Vol.5855, pp.168-171, 2005

We have developed a system for monitoring telecommunications tunnels to improve the reliability of telecommunication and to reduce maintenance costs through early damage detection. Core components of the system are a Brillouin optical time-domain reflectometer (BOTDR), which allows distributed and long-distance strain measurement, and optical fiber sensors installed in tunnels. Experimental results show that this system can detect tunnel deformation with a measurement error of 0.1 mm from a contraction of 1 mm to an elongation of 6 mm over a span of 10 km. The system used in practice at present is introduced.

Telecommunications Tunnel Monitoring System Employing BOTDR, Hiroshi NARUSE, Kazuhiko FUJIHASHI* and Masaru OKUTSU*: Proceedings of the 1st International Workshop on Opto-electronic Sensor-based Monitoring in Geo-engineering (OSMG-2005), pp.57-65, 2005

We have developed a system for monitoring the state of telecommunications tunnels. This system detects deformation and damage by measuring the strain produced in the tunnels. Core components of the system are a Brillouin optical time-domain reflectometer (BOTDR), which allows distributed and long-distance strain measurement, and optical fiber sensors installed in tunnels. Basic performances of the system were confirmed by experiments in a laboratory. For example, the system can detect tunnel deformation with a measurement error of 0.1 mm from a contraction of 1 mm to an elongation of 5 mm over a span of 10 km. And earthquake resistance was confirmed. A system used in practice at present is introduced in detail.

Design of digital polarity correlators in a multiple user sonar ranging system, K. NAKAHIEA*, T. KODAMA, T. FURUHASHI* and H. MAEDA*: IEEE Trans. Instrum. Meas. vol.54, pp.305-310, 2005

Pulsed ultrasonic distance measurement systems are frequently used in robotics applications, thanks to their low cost and small size. The pulse compression techniques, originally developed by radar engineers, were adopted to eliminate frequent misreadings caused by crosstalk or external ultrasound sources. However, a few problems become apparent when implementing the pulse compression techniques in robotics applications. First, due to the implementation of correlation functions, the complexity of the total system may significantly increase. Second, if the piezoelectric transducer is excited by a chirp signal, efficiency is reduced due to the narrow bandwidth. In this paper, we present a digital polarity correlator designed for binary coded frequency shift keyed signals which increase the number of different sequences having the same length in a restricted band. The digital signal processing system is integrated into a single programmable logic device. Experimental measurements have been made and a good agreement with reference data has been obtained with noise added.

Evolutionary computation applied to the reconstruction of 3-D surface topography in the SEM, Tetsuji KODAMA, Xiaoyuan LI*, Kenji NAKAHIRA* and Dai ITO*: J. Electron Microsc. Vol. 54, pp. 429-435, 2005

A genetic algorithm has been applied to the line profile reconstruction from the signals of the

standard secondary and/or backscattered electron detectors in a scanning electron microscope (SEM). The topographical surface reconstruction problem is treated as one of combinatorial optimization. To reconstruct three-dimensional (3-D) surface topography using the optimization approach, we must examine a number of string coding alternatives for mapping a finite-length string to the 3-D surface topography. In this paper the 3-D surface topography is represented by a set of coordinates of vertices and we introduce the Delaunay triangulation which attains the minimum roughness for any set of the height data to capture the fundamental features of the surface being probed by the electron beam. Experimental results on secondary electron images are presented using a class of hybrid algorithms based on a combination of the genetic algorithm and simulated annealing.

Estimatiors for Conditional Expectations under Asymmetric and Heteroscedastic Error Distribution, Takafumi KANAMORI* and Ichiro TAKEUCHI: Proceedings of International Symposium on The Art of Statistical Metaware (CD-ROM), 2005

We propose a new estimator for regression problems in the form of the linear combination of quantile regressions. The proposed method is helpful to estimate the conditional expectation especially when the error distribution is asymmetric or/and heteroscedastic, where conventional robust regressions yield considerable bias to the conditional expectation. Numerical experiments on real data are shown to illustrate the usefulness of the proposed estimator.

Conditional mean estimation under asymmetric and heteroscedastic error by linear combination of quantile regressions, Takafumi KANAMORI* and Ichiro TAKEUCHI: Computational Statistics and Data Analysis, vol.50, pp. 3605-3618, 2006, Available online 18 August 2005

In this paper we propose a new estimator for regression problems in the form of the linear combination of quantile regressions. The proposed estimator is helpful for the conditional mean estimation when the error distribution is asymmetric and heteroscedastic. It is shown that the proposed estimator has the consistency under heteroscedastic regression model: $Y = \mathcal{M}(X) + \sigma(X) e$, where X is a vector of covariates, Y is a scalar response, e is a zero mean random variable independent of X and $\sigma(X)$ is a positive value function. When the error term e is asymmetric, we show that the proposed estimator yields better conditional mean estimation performance than the other estimators. Numerical experiments both in synthetic and real data are shown to illustrate the usefulness of the proposed estimator.

Motion sickness susceptibility associated with visually induced postural instability and cardiac autonomic responses in healthy subjects, Y. YOKOTA*, M. AOKI*, K. MIZUTA*, Y. ITO, N. ISU: Acta Oto-Laryngol. 125, pp. 280-285, 2005

This study assessed the relationship between postural and autonomic responses to a simulated visual motion environment and reported susceptibility to motion sickness. Fifteen healthy subjects were exposed to sinusoidally oscillating visual motion in roll at frequencies of 0.1-0.4 Hz. Recordings were taken of postural sway, respiratory frequency and ECG from which heart rate variability (HRV) was computed to probe cardiac sympathetic and parasympathetic activity. In subjects rating low

susceptibility to motion sickness on a standardised questionnaire, there was no significant effect of visual stimulus on postural sway and HRV at any frequency of motion. Subjects with high susceptibility to motion sickness showed significant postural instability induced by the visual stimuli ($p<0.01$). The visual stimuli of 0.1 Hz significantly increased the low frequency power (LF) and LF/HF, and decreased the high frequency power (HF) of HRV in these subjects ($p<0.05$). This study supports a hypothesis that the postural sway and autonomic responses to moving visual stimuli may be associated with motion sickness susceptibility. Characteristics of the cardiac sympathovagal balance during exposure to provocative stimulation may be a marker for individual susceptibility to motion sickness.

Improvement of compression characteristic of LSP parameters by cascading sandglass type neural network [in Japanese], Masaya KIMOTO*, Tadaaki SHIMIZU*, Hiroki YOSHIMURA*, Naoki ISU, Kazuhiro SUGATA*: Transactions of Information Processing Society of Japan, 46, pp. 845-848, 2005

We proposed a new scheme that derives the characteristics of Japanese five vowels out of LSP parameters by compressing information in terms of cascaded five-layer-sandglass-type neural network (CSNN (NL5)). We have verified the ability of CSNN (NL5) by using five vowels pronounced by a male speaker. The followings were clarified, 1) the distribution of LSP parameters compressed by CSNN (NL5) is similar to the distribution of F_1-F_2 formants, 2) CSNN (NL5) can reproduce the LSP parameters from the compressed parameters usable for speech synthesis.

Are Open-domain Question Answering Technologies Useful for Information Access Dialog?, Tuneaki KATO*, Jun-ichi FUKUMOTO*, Fumito MASUI and Noriko KANDO*: ACM-TALIP, No.3, pp.243-262, 2005

There are strong expectations for the use of question answering technologies in information access dialogues such as for information gathering and browsing. In this paper, we empirically examine what kinds of abilities are needed for question answering systems in such situations, and propose a challenge for evaluating those abilities objectively and quantitatively. We also show that existing technologies have the potential to address this challenge. From the empirical study, we found that questions that have values and names as answers account for a majority in realistic information-gathering situations and that those sequences of questions contain a wide range of reference expressions and are sometimes complicated by the inclusion of subdialogues and focus shifts. The challenge proposed is not only novel as an evaluation of the handling of information access dialogues, but also includes several valuable ideas such as categorization and characterization of information access dialogues, and introduces three measures to evaluate various aspects in addressing list-type questions and reference test sets for evaluating context processing ability in isolation.

Three Systems and One Verifier -- HOKUM's Participation in QAC3 of NTCIR-5, Yasutomo KIMURA*, Kenji ISHIDA, Hirotaka IMAOKA, Fumito MASUI, Marcin SKOWRON*, Rafal RZEPKA* and Kenji ARAKI*: 2005

This paper is a report from collective participation in NTCIR-5 Question Answering Challenge

between researchers from Mie University, Hokkaido University and Otaru University of Commerce. Although our results were not impressive, we would like to share our experiences with everyone who think about participating in the challenge but is afraid of his or her lack of experience in the field. Understanding the problems of QA from the practical side was very instructive and gave us a stronger base for future trials. We briefly introduce our preparations and participation then conclude with analysis what can be simply done with freely available tools.

An Overview of NTCIR-5 QAC3, Tsuneaki KATO*, Jun-ichi FUKUMOTO* and Fumito MASUI: In Proceedings of fifth NTCIR Workshop(QAC3), 2005

This paper provides an overview of NTCIR-5 QAC3 (Question Answering Challenge 3). QAC3 is a series of challenges for evaluating question answering technologies in Japanese. QAC3 follows the same course as QAC based on the success of the previous two workshops, with its task limited to that corresponding to QAC2 Subtask 3 aiming at the convergence of research resources for novel subjects. This task assumes interactive use of QA systems and evaluates, among other things, the abilities needed under such circumstances, i.e. proper interpretation of questions under a given dialogue context; in other words, context processing abilities such as anaphora resolution and ellipses handling (hereafter we refer to the task as the IAD task, where IAD stands for Information Access Dialogue, and to the whole workshop as QAC3). The IAD task in QAC3 is based on QAC2 Subtask 3 with several questions and answers and introduction of multi-grade evaluation and the concept of a correct answer set. In addition, a new WoZ method was devised and applied in the QAC3 test set construction. QAC3 has as many participants as QAC2 Subtask 3, and new trials and advances in existing methods were observed from the submission results.

Recognizing Article Errors Using Prepositional Information [in Japanese], Ryo NAGATA, Tatsuya IGUCHI, Kenta WAKIDERA, Fumito MASUI, Atsuo KAWAI, Naoki ISU: IEICE Transactions on Information & Systems, PT.1 (Japanese Edition), Vol.J88-D- I , No.4, pp.873-881, 2005

A Statistical Model Based on the Three Head Words for Detecting Article Errors, R. Nagata, T. IGUCHI, F. MASUI, A. KAWAI and N. ISU: IEICE Transactions on Information and Systems, Vol.E88-D, No. 7, pp.1700-1706, 2005

Mass Count Distinction of English Nouns [in Japanese], Ryo NAGATA, Fumito MASUI, Atsuo KAWAI, Naoki ISU: Natural Language Processing, Vol.12, No.4, pp.227-243, 2005

An unsupervised method for distinguishing mass and count nouns in context, R. NAGATA, F. MASUI, A. KAWAI and N. ISU: 6th International Workshop on Computational Semantics IWCS-6, 2005

This paper proposes an unsupervised method for distinguishing mass and count nouns in context using decision lists. The mass count distinction is particularly important in detecting errors

concerning the articles　and the singular/plural usage in the writing of learners of English. In general, decision lists require manually tagged training data. In this method, however, training data can be automatically generated from a raw corpus by some rules based on linguistic knowledge. Decision lists trained on the British National Corpus achieves an accuracy of 79.7%, an improvement of 4.8% over the baseline.

Detecting article errors based on the mass count distinction, R. NAGATA, T. WAKANA, F. MASUI, A. KAWAI and N. ISU: Proc.of the 2nd Int. Joint Conf. on Natural Language Processing, pp.815-826, 2005

This paper proposes a method for detecting errors concerning article usage and singular/plural usage based on the mass/count distinction. Although the mass count distinction is particularly important in detecting these errors, it has been pointed out that is is hard to make heuristic rules for distinguishing mass and count nouns. To solve the problem, first, instances of mass and count nouns are automatically collected from a corpus exploiting surface information in the proposed method. Then, words surrounding the mass(count) instances are weighted based on their frequencies. Finally, the weighted words are used for distinguishing mass and count nouns. After distinguishing mass and count nouns, the above errors can be detected by some heuristic rules. Experiments show that the proposed method distinguishes mass and count nouns in the writing of Japanese learners of English with an accuracy of 93% and that 65% of article errors are detected with a precision of 70%.

Extracting collocations for determining articles in English writing, R. NAGATA, T. IGUCHI, Y. FURUICHI, F. MASUI, A. KAWAI and N. ISU: Proc. of the Conf. Pacific Association for Computational Linguistics (PACLING 2005), pp.264-268, 2005

There are a lot of phrases or collocations that are useful for determining proper articles in English writing. For example,　it has been reported that the phrase chemistry of almost always takes the definite article　in the domain of organic chemistry. These collocations are especially useful for people whose mother tongue does not have an article system. This paper proposes a method for extracting such collocations from a corpus. This method extracts collocations based n-gram statistics. N-gram statistics are computed using KWIC (Key Word In Context) and surrounding contexts. Experiments show that the proposed method extracts 560 collocations from a half million words of corpus data.

Automatic Text Classification of Engilish Newswire Articles Based on Statistical Classification Techniques, Guowei ZU, Wataru OHYAMA, Tetsushi WAKABAYASHI and Fumitaka KIMURA: Electrical Engineering in Japan Vol.152, No.1, pp 50-60, 2005

The basic process of automatic text classification is learning a classification scheme from training examples and then using it to classify unseen textual documents. It is essentially the same as the process of graphic or character pattern recognition. Thus, the pattern recognition approaches can be used for automatic text categorization. In this research several statistical classification techniques that include Euclidean distance, various similarity measures, linear discriminant function, projection distance, modified projection distance, and SVM, have been used for automatic text classification.

Principal component analysis was used to reduce the dimensionality of the feature vector. Comparative experiments have been conducted using the Reuters-21578 test collection of English newswire articles. The results illustrate that the overall efficiency of modified projection distance is better than the other methods and that principal component analysis is suitable for reducing the dimensionality of the text features.

Machine Learning with Transformed features in Automatic Text Classification, Busagala, L.S.P., Wataru OHYAMA, Tetsushi WAKABAYASHI, Fumitaka KIMURA: Proceedings of ECML/PKDD-05 workshop on Sub-symbolic Paradigms for Learning in Structured Domains (Relational Machine Learning), pp. 11-20, 2005

Automatic text classification (ATC) is the task of automatically assigning a set of documents into appropriate categories (or classes, or topics). One of the feature generation techniques is extracting absolute word frequency from textual documents to be used as feature vectors in machine learning techniques. One of the limitations of this technique is the dependency on text length leading into lower classification rates. Another problem in ATC is the
high dimensional space. We present a performance evaluation of feature transformation techniques and regularized linear discriminant function (RLD) in automatic text classification. Moreover we provide experimental evaluation of Principal Component Analysis (PCA) in reducing the high dimensionality. Feature transformation techniques used considerably improved the classification accuracy, and RLD outperformed all classifiers used. Experimental results showed effective dimension reduction.

Myocardial Motion Tracking by Adaptive combination of Correlation and Phase Difference of US RF signals, K. NAGATA, W. OHYAMA, T. WAKABAYASHI, F. KIMURA, S. TSURUOKA and K. SEKIOKA*: The 12th International Conference on BioMedical Engineering, sessionID: 3B2-08, 2005

In this paper, we propose a novel method for noninvasive extraction of 2-dimensional regional motion of left ventricular myocardium by means of the adaptive combination of correlation and instantaneous phase difference of ultrasonic RF signals. The proposed method is motivated by the successfully achievement on the myocardial motion tracking by means of both ultrasonic Doppler and RF signals which are backscattered from myocardium. The proposed method moreover employs an adaptive combination of these methods. At first, the method extracts the velocity on each sampling point by instantaneous phase difference of the digitized ultrasonic signals. Next, the velocities on each sampling point are evaluated for the accuracy by the correlation of amplitude of ultrasonic RF signals. Finally, the velocities are corrected by the amount associated with the value of accuracy and accumulated into the position of tracking points for error reduction. Experimental results show the proposed method is suitable for the evaluation of regional myocardial performance.

Estimation of Respiratory Rate Using Long Term ECG Recording, T. USAMI, W. OHYAMA, T. WAKABAYASHI, F. KIMURA, S. TSURUOKA and K. SEKIOKA*: The 12th International Conference on BioMedical Engineering, sessionID: 2B1-09, 2005

In this paper, we propose a new method for extracting respiratory signals from long-term echocardiogram (ECG) recording. The proposed method employs some filtering techniques on frequency domain followed by the estimation of instantaneous frequency by Hilbert transform to estimate respiratory frequency. The evaluation examination, which compares the respiratory frequency estimated from ECG and the one derived from the respiratory signal measured with oronasal thermistor, shows that the proposed method has potentiality for detection and diagnosis of respiratory disorders. From this result, we conclude that temporal frequency estimation of respiration gives more detailed information on respiratory state than power spectrum of R-R interval.

Oriya handwritten Numeral Recognition System, K. ROY*, T. PAL*, U. PAL* and F. KIMURA: Proc. 8th International Conference on Document Analysis and Recognition, Vol.2, pp. 770-774, 2005

This paper deals with recognition of off-line unconstrained Oriya handwritten numerals. To take care of variability involved in the writing style of different individuals, the features are mainly considered from the contour of the numerals. At first, the bounding box of a numeral is segmented into few blocks and chain code histogram is computed in each of the blocks. Features are mainly based on the direction chain code histogram of these blocks. Neural Network (NN) classifier and Quadratic classifier are used separately for recognition and the results obtained from these two classifiers are compared. We tested the result on 3850 data collected from different individuals of various background and we obtained about 94.81% recognition accuracy from Quadratic classifier with a rejection rate of about 1.31%.

Two-stage Recognition of Handwritten Bangla Alphanumeric Characters using Neural Classifiers, U. BHATTACHARYA*, S. K. PARUI*, M. SHRIDHAR* and F. KIMURA: Proc. 2nd Indian International Conference on Artificial Intelligence (IICAI-05) pp. 1357-1376, 2005

No significant research work towards recognition of handwritten Bangla characters has yet been done. Only a few works in this area are found in the literature which are based on small databases collected in laboratory environments. Recently, a large and representative database of Bangla character images has been developed. The first part of this article is devoted to shape analysis of samaples of this database vis-a-vis shapes of the respective printed characters. The next part describes a to-stage scheme for recognition of handwritten Bangla alphanumeric characters. This is a 57 class problem (shapes of 3 numerals are not distinguishable from shapes of 3 basic characters among 10 numerals and 50 basec characters). In the first stage of this recognition scheme, an input character is identified in one of 11 smaller groups of characters. In the second stage, classification is performed within the particular smaller group as determined by the first stage. In both the stages of the proposed approach, local chain code histograms of character skeleton are used as the feature vector and multilayer perceptron (MLP) as the classifier. Recognition accuracies obtained by the proposed approach on the training and test sets of the present handwritten Bangla alphanumeric character database are respectively 91.45% and 84.65%.

English Multi-oriented Character Recognition, K. ROY*, U. PAL* and F. KIMURA*: Proc. Thirteenth International Conference on Advanced Computing and Communications- ADCOM, 2005

There are many printed artistic documents where text lines of a single page may have different orientations or they may be curved in shape. For the OCR of such documents we have to extract individual text lines from the documents. Extraction of individual text lines from multi-oriented and/or curved text document is a difficult problem. In this paper, we propose a bottom-up approach to extract individual text lines from English artistic document pages and the method is based on the foreground and background information of the characters of the text lines. Here at first, individual components are detected and grouped into *candidate clusters* using the positions of the center of gravity (CG) of the components and the background information obtained from the components using *water reservoir* concept. From each candidate cluster we find some *candidate points* based on the *water flow level* of the reservoirs obtained from the components of the cluster. Finally, based on these candidate points, individual clusters are grouped to extract different text lines from a document.

A system for Bangla Handwritten Numeral Recognition based of Directional Feature, K. ROY*, T. PAL*, U. PAL* and F. KIMURA: Proc. Int. Conf. on Cognition and Recognition, pp.497-505, 2005

In this paper a lexicon driven segmentation-recognition scheme for unconstrained Bangla handwritten word recognition is proposed for Indian postal automation. In the proposed method, at first, binarization of the input document is done and slant correction of the individual words is performed. Next, using water reservoir concept words are pre-segmented into possible primitive components (characters or its parts). In order to merge these primitive components into characters and to find optimum character segmentation, dynamic programming (DP) is applied using total likelihood of characters as the objective function. To compute the likelihood of a character, modified quadratic discriminant function (MQDF) is used for the purpose. The features used in the MQDF are mainly based on the directional features of the contour points of the components. We tested our system on Bangla city name images and at present an overall accuracy of 87.21% is obtained from the proposed system.