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The reachability and related decision problems for monadic and semi-constructor TRSs, Ichiro MITSUHASHI, Michio OYAMAGUCHI, Toshiyuki YAMADA: Information Processing Letters, Vol.98, pp.219-224, 2006

This paper shows that reachability is undecidable for confluent monadic and semi-constructor TRSs, and that 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 is semi-constructor if all defined symbols appearing in the right-hand side of each rewrite rule occur only in its ground subterms.

The Confluence Problem for Flat TRSs, Ichiro MITSUHASHI, Michio OYAMAGUCHI, Florent JACQUEMARD*: KOKYUROKU of Research Institute for Mathematical Sciences Kyoto University, New Trends in Theory of Computation and Algorithm, vol.1489, pp.250-255, 2006

We prove that confluence is undecidable for flat TRSs. Here, a TRS is flat if the heights of the left and right-hand sides of each rewrite rule are at most one.

The Joinability and Related Decision Problems for Semi-constructor TRSs, Ichiro MITSUHASHI, Michio OYAMAGUCHI, Yoshikatsu OHTA and Toshiyuki YAMADA: Trans. IPS Japan, Vol.47, No.5, pp.1502-1514, 2006

The word and unification problems for term rewriting systems (TRSs) are most important ones and their decision algorithms have various useful applications in computer science. Algorithms of deciding joinability for TRSs are often used to obtain algorithms that decide these problems. In this paper, we first show that the joinability problem is undecidable for linear semi-constructor TRSs. Here, a semi-constructor TRS is such a TRS that all defined symbols appearing in the right-hand side of each rewrite rule occur only in its ground subterms. Next, we show that problem is decidable both for confluent semi-constructor TRSs and for confluent semi-monadic TRSs. This result implies that the word problem is decidable for these classes, and will be used to show that unification is decidable for confluent semi-constructor TRSs in our forthcoming paper.

The Confluence Problem for Flat TRSs, Ichiro MITSUHASHI, Michio OYAMAGUCHI and Florent JACQUEMARD*: Proceedings of the 8th International Conference on Artificial Intelligence and Symbolic Computation (AISC 2006), Lecture Notes in Artificial Intelligence 4120, pp.68-81, 2006

We prove that the properties of reachability, joinability and confluence are undecidable for flat TRSs. Here, a TRS is flat if the heights of the left and right-hand sides of each rewrite rule are at most one.

Scheduling support hardware for multiprocessor system and its evaluations, Takahiro SASAKI, Tetsuo HIRONAKA*, Naoki NISHIMURA*, Noriyoshi YOSHIDA*: Systems and Computers in Japan, Vol.37, No.2, pp.79-95, 2006

It is important to write portable programs while concealing various latencies that would be problematic in

getting the optimal performance out of a parallel processing environment. Fine Grain Parallelism is one of the methods for implementing this. However there is a problem in achieving Fine Grain Parallelism using a conventional OS. This is because, as the granularity becomes finer, the frequency of context switching, scheduling and the like increases, leading to an increase in the overhead due to those factors, and there would be a risk of causing severe performance degradation. Therefore, we propose a multiprocessor architecture using a Scheduling Support Hardware (SSH), which aims to achieve high speed context switching and scheduling while utilizing fine grain parallelism, by having the hardware support the thread scheduling and the allocation / release of the CPU resources, which are part of the function of the OS. In this paper, we designed a multi-processor system with SSH using the Verilog-HDL and showed the effectiveness of our approach in an evaluation by a computer simulation. In the evaluation, we found that the scheduling time could be reduced by using the SSH, and thus it became possible to use a parallelism with a finer granularity.

Motion Estimation Using Adaptively Hierarchical Spiral Search [in Japanese], Motoki MIYAMAE, Takahiro SASAKI, Kazuhiko OHNO, Toshio KONDO: Trans. of the Institute of Electronics, Information and Communication Engineers, Vol.J89-D, No.3, pp.482-491, 2006

Motion estimation is computationally complicated task in video coding process. Block-matching-based fast algorithms reduce the computational complexity of motion estimation at the expense of accuracy. However, the improvement of the accuracy of motion estimation is attached to importance for the high quality video coding. This paper proposes a new motion estimation algorithm executing adaptively two-stage hierarchical spiral search. The proposed algorithm a little better average image quality (PSNR) than the full-search for the evaluation image. Moreover, the quality for the worst condition image was improved from 0.46dB to 0.19dB in comparison with a current superior spiral search.

A Design and Evaluation of Low Energy Processor by Variable Stages Pipeline Technique [in Japanese], Yuji ICHIKAWA*, Takahiro SASAKI, Tetsuo HIRONAKA*, Kazuya TANIGAWA*, Toshiaki KITAMURA*, Toshio KONDO: IPSJ Trans. on Advanced Computing Systems, Vol.47, No.SIG7(ACS14), pp.231-242, 2006

Recently, in the field of mobile computing, the achievement of low energy computing and high performance computing is required simultaneously. DVS (Dynamic Voltage Scaling) is a current major technique to realize that. However, the lower the chip voltage becomes in the future, the less energy saving we get by DVS. So we propose VSP (Variable Stages Pipeline) processor by a unifying pipeline stages in the use of flip-flop called LDS-cell which has an ability to act as a latch or flip-flop. VSP can achieve low energy computing without any dependence on chip voltage. We show that VSP processor can achieve lower energy computing and higher performance computing than the DVS processor in low energy mode.

Evaluation of Bank-Based Multiport Memory Architecture with Blocking Network, Tomohiro INOUE*, Tetsuo HIRONAKA*, Takahiro SASAKI, Seiji FUKAE*, Tetsushi KOIDE*, Hans J. MATTAUSCH*: Electronics and communications in Japan (Part 3), Vol.89, No.6, pp.22-33, 2006

The bank-based multiport memory is better composition approach to realizing realistic chip area and high access bandwidth than a conventional N-Port memory cell approach. However this method is unsuitable for large numbers of ports and banks because the hardware resources of the crossbar network which connects the ports and banks increase in proportion to the product of the numbers of ports and banks. In order to solve this problem, this paper

proposes a new bank-based multiport memory architecture using a blocking network instead of a crossbar network. Many blocking networks have been researched so far. However, these researches evaluated hardware resources based on the number of switches, but the compositions and circuit scale of the switches used in crossbar network and blocking network are different. Hence, this paper compares the number of transistors to show that the bank-based multiport memory using the blocking network achieves high access bandwidth with smaller hardware resources than the conventional approach. According to our results, our approach achieves the same access bandwidth with half the number of transistors, for 512 ports and 512 banks.

A User-Level Extension Scheme for a Task Parallel Script Language [In Japanese], Yusuke SAKAGUCHI, Kazuhiko OHNO, Takahiro SASAKI, Toshio KONDO, Hiroshi NAKASHIMA*: IPSJ Transactions on Advanced Computing Systems, Vol. 47, No. SIG 12 (ACS 15), pp.296-307, 2006

We are developing a task-parallel script language named *MegaScript* for mega-scale parallel processing. MegaScript regards existing sequential/parallel programs as tasks, and controls them for massively parallel execution. Although MegaScript runtime and task programs should be specialized to the target application and platform to obtain high performance, it is undesirable for portability and reusability. To satisfy these conflicting requirements, we propose a user-level runtime extension scheme named *Adapter*. This scheme enables programmers to extend and optimize behavior of the application without modifying the runtime nor task programs. The evaluation of our implementation achieved both efficient programming and enough performance for practical use.

Structure Monitoring by Optical Fiber [in Japanese], Hiroshi NARUSE: Journal of the Japan Society of Mechanical Engineers, Vol.109, No.1048, pp.22-23, 2006

The Entire Solution Path of Kernel-based Nonparametric Conditional Quantile Estimator, Ichiro TAKEUCHI, Kaname NOMURA and Takafumi KANAMORI*: Proceedings of the 2006 IEEE World Congress on Computational Intelligence (WCCI 2006) / International Joint Conference on Neural Networks, pp.153-158, 2006

The goal of regression analysis is to describe the relationship between an output y and a vector of inputs x . Least squares regression provides how the mean of y changes with x , i.e., it estimates the conditional mean function. Estimating a set of conditional quantile functions provides a more complete view of the relationship between y and x . *Quantile regression* [1] is one of the promising approaches to estimate conditional quantile functions. Several types of quantile regression estimator have been studied in the literature. In this paper, we are particularly concerned with kernel-based nonparametric quantile regression formulated as a quadratic programming problem similar to those in support vector machine literature [2].

A group of conditional quantile functions, say, at the orders $q = 0.1, 0.2, \dots, 0.9$, can provide a nonparametric description of the conditional probability density $p(y|x)$. This requires us to solve many quadratic programming problems and it could be computationally demanding for large-scale problems. In this paper, inspired by the recently developed *path following strategy* [3][4], we derive an algorithm to solve a sequence of quadratic programming problems for the entire range of quantile orders $q \in (0, 1)$. As well as the computational efficiency, the derived algorithm provides the full nonparametric description of the conditional distribution $p(y|x)$. A few examples are given to illustrate the algorithm.

Nonparametric Quantile Estimation, Ichiro TAKEUCHI, Quoc V. LE*, Timothy D. SEARS*, Alexander J. SMOLA*: Journal of Machine Learning Research, Vol.7, pp.1231-1268, 2006

In regression, the desired estimate of $y|x$ is not always given by a conditional mean, although this is most common. Sometimes one wants to obtain a good estimate that satisfies the property that a proportion, τ , of $y|x$, will be below the estimate. For $\tau=0.5$ this is an estimate of the *median*. What might be called median regression, is subsumed under the term *quantile regression*. We present a nonparametric version of a quantile estimator, which can be obtained by solving a simple quadratic programming problem and provide uniform convergence statements and bounds on the quantile property of our estimator. Experimental results show the feasibility of the approach and competitiveness of our method with existing ones. We discuss several types of extensions including an approach to solve the *quantile crossing* problems, as well as a method to incorporate prior qualitative knowledge such as monotonicity constraints.

A Reconstruction Method of 3-D Surface Topography Using Evolutionary Computation in the SEM, Tetsuji KODAMA, Xiaoyuan LI* and Kenji NAKAHIRA*: Proceedings of the 16th International Microscopy Congress (IMC 16), p.955, 2006

Casualty Insurance Pure Premium Estimation Using Two-Stage Regression Tree, Kumiko NISHI, Ichiro TAKEUCHI: Proceedings of the International Workshop on Data-Mining and Statistical Science (DMSS 2006), pp.159-166, 2006

We study a regression tree algorithm tailored to casualty insurance pure premium estimation problem. Casualty insurance premium is mainly determined by the expected amount that the insurance companies have to pay for the contract. Therefore, casualty insurance companies have to estimate the expected insurance amount on the basis of insurance risk factors. This problem is formulated as a regression problem, i.e. estimation of conditional mean $E[Y|x]$, where Y is insurance amounts and x is risk factors. In this paper, we aim to implement the regression problem in regression tree framework. The difficulty of the problem lies in the fact that the distribution of insurance amount $P(Y|x)$ is highly skewed and exhibits a long-tail toward positive direction. Conventional least-square-error regression tree algorithm is notoriously unstable under such long-tailed error distribution. On the other hand, several types of robust regression trees, such as least-absolute-error regression tree, are neither appropriate in this situation because they yields significant bias to conditional mean $E[Y|x]$. In this paper, we propose a two-stage tree fitting algorithm. In the first stage, the algorithm constructs a quantile tree, a kind of robust regression tree, which is stable but biased to conditional mean $E[Y|x]$. In the second stage, the algorithm corrects the bias using least-square error regression tree. We discuss the theoretical background of the algorithm and empirically investigate the performances. We applied the proposed algorithm to a car insurance data set of 318, 564 records provided from a north-american insurance company and obtained significantly better results than conventional regression tree algorithm.

Underground Mine monitoring Using Distributed Fiber Optic Strain Sensing System, Hiroshi NARUSE, Hideki UEHARA*, Taishi DEGUCHI*, Kazuhiko FUJIHASHI*, Yasuhiko ISHIKURA*, Masatoshi ONISHI*, Raul ESPINOZA*, Cesar GUZMAN*, Cesar PARDO*, Cesar ORTEGA*, Manuel PINTO* and Francisco GALVEZ*: Proceedings of the 18th International Optical Fiber Sensors Conference (OSA 18), ThD5, CD-ROM, 2006

We demonstrated the applicability of a distributed fiber optic strain sensing system for monitoring changes in an underground mine through a half-year field trial. This paper outlines the mine structure and the monitoring system and presents monitoring results.

Effectiveness of Relative Expressions for Trend Information Extraction, Hiroki IMAOKA, Fumito MASUI, Atsuo KAWAI and Naoki ISU: *Journal of Japan Society for Fuzzy Theory and Intelligent Informatics*, Vol.18, No.5, pp.735-744, 2006

In this paper, we discuss effectiveness of “relative expressions” for trend information extraction. Relative expressions, for example, “12% increase”, “last year”, “the first place” and so forth, show relative difference and variation of numerical value implicitly. To extract more trend information from newspaper articles, one of possible means would be to utilize relative expressions. We investigated functions and statistical trend of the relative expressions in newspaper articles. And rules to extract basic elements were generated for trend information extraction. To evaluate effectiveness of the extraction rules, we experimented on newspaper articles. The result shows 0.8 or more F-measure. It was confirmed that relative expression-based extraction should well-performed.

An Automatic Relevance Estimation of Property Values and Its Feedback based on World Wide Web for Metaphor Recognition [in Japanese], Fumito MASUI, Jun'ichi FUKUMOTO* and Kenji ARAKI*: *IEICE Transactions on Information and Systems*, Vol.J89-D, No.9, pp.860-870, 2006

This paper proposes a method which estimates the relevance of closed-up property values as salience features during the metaphor recognition process and feeds the estimation results back to a property value set to deal with an evaluation cost problem of metaphor recognition. Evaluating the relevance of closed-up property values, the specific expressions (a comparative expression and an adnominal expression) which was generated with a pair of concepts and each closed-up property value between these concepts are retrieved from the World Wide Web (WWW). In case of a non-relevant result, it is fed back to the property ranking by reconstructing a property value set with the retrieved information. Some experiments have been conducted and those experimental results showed that our method performs human-level estimation, as about 80% of the estimation results were the same with human judgments. Also by adding a feedback process we achieved about a 20% increase of property ranking accuracy.

WoZ Simulation of Interactive Question Answering, Tsuneaki KATO*, Jun'ichi FUKUMOTO*, Fumito MASUI and Noriko KANDO*: *Proceedings of Workshop on Interactive Question Answering at HLT-NAACL2006*, 2006

Question answering (QA) systems that can be used in interactive environments are need in various applications. It is important to develop proper evaluation frameworks in order to guide the direction of research, based on a proper understanding of what functions and abilities are needed for such interactive QA systems and also what range of language phenomena should be handled by them. QACIAD (Question Answering Challenge for Information Access Dialogue) is one of such evaluation frameworks and assumes that users interactively collect information using a QA system for writing a report on a given topic and evaluates, among other things, the abilities needed under such circumstances. In this research, in order to examine the assumptions made by QACIAD, dialogues under the situation that it assumes are collected using WoZ (Wizard of Oz) simulating, which is frequently used for collecting dialogue data for designing speech dialogue systems, and then analyzed. The results indicate that the setting of QACIAD is real and appropriate and that one of the important abilities for future interactive QA systems is providing cooperative and helpful responses.

Countermeasures Against Carsickness Enhanced by Watching an Onboard Video Display, Akihiro MORIMOTO, Tomohiro OKUMURA, Noritaka HIDAKA, Dan PIAO, Yusuke ARAKI, Fumito MASUI, Atsuo KAWAI, Naoki ISU: *Information Technology Letters*, Vol. 5, pp. 323-326, 2006

Three approaches were proposed for reducing carsickness while watching an onboard display in a vehicle. The approaches are based on the sensory conflict theory to reduce a conflict of sensory information between the vestibular and the visual systems. Visual stimulus along with the original content is presented on the onboard display to provide optokinetic sensation of yaw rotation of a vehicle. Experimental study showed that the carsickness severity was remarkably reduced by the proposed approaches.

Recognizing Errors in English Writing Based on the Mass Count Distinction, [in Japanese], R.NAGATA*, T.WAKANA, A.KAWAI, K.MORHIRO*, F.MASUI, N.ISU: *Trans. of the Institute of Electronics, Information and Communication Engineers*, J89-D, pp.1777-1790, 2006

This paper proposes a method for detecting errors in article usage and singular plural usage based on the mass count distinction. First, it learns decision lists from training data generated automatically to distinguish mass and count nouns. Then, it detects errors by applying rules(the decision lists) to the mass count distinction. Experiments show that it achieves a recall of 0.648 and a precision of 0.747 and outperforms other methods(a recall of 0.564 and a precision of 0.528).

Recognizing article errors using prepositional information, R.NAGATA*, T.IGUCHI, K.WAKIDERA, F.MASUI, A.KAWAI, and N.ISU: *Systems and Computers in Japan*, vol.37, pp. 17-26, 2006

In this paper, the authors propose a method to recognize article errors often seen in English text written by Japanese learners of English. In this method, article errors are recognized using prepositional information. The results of experiments confirm that the performance of the author's method is a F-measure of 0.72 and superior to our earlier method(F-measure of 0.53).

A Feedback-augmented method for detecting errors in the writing of learners of English, R.NAGATA*, A.KAWAI, K.MORHIRO*, and N.ISU: *Proceedings of the 21st International Conference on Computational Linguistics and 44th Annual Meeting of the Association for Computational Linguistics*, pp.241-248, 2006

This paper proposes a method for detecting errors in article usage and singular plural usage based on the mass count distinction. First, it learns decision lists from training data generated automatically to distinguish mass and count nouns. Then, in order to improve its performance, it is augmented by feedback that is obtained from the writing of learners. Finally, it detects errors by applying rules to the mass count distinction. Experiments show that it achieves a recall of 0.71 and a precision of 0.72 and outperforms other methods used for comparison when augmented by feedback.

Reinforcing English countability prediction with one countability per discourse property, R.NAGATA*, A.KAWAI, K.MORHIRO*, and N.ISU: *Proceedings of the 21st International Conference on Computational Linguistics and 44th Annual Meeting of the Association for Computational Linguistics Main Conference Poster Sessions*, pp.595-602, 2006

Countability of English nouns is important in various natural language processing tasks. It especially plays an important role in machine translation since it determines the range of possible determiners. This paper proposes a method for reinforcing countability prediction by introducing a novel concept called *one countability per discourse*. It claims that when a noun appears more than once in a discourse, they will all share the same countability in the discourse. The basic idea of the proposed method is that mispredictions can be correctly overridden using efficiently the one countability per discourse property. Experiments show that the proposed method successfully reinforces countability prediction and outperforms other methods used for comparison.

The Impact of OCR Accuracy and Feature Transformation on Automatic Text Classification, Mayo MURATA, BUSAGALA, L.S.P., Wataru OHYAMA, Tetsushi WAKABAYASHI, Fumitaka KIMURA: Document Analysis Systems VII by Bunke, H. and Spdz, A.(Eds.) DAS 2006, pp.506-517, 2006

Digitization process of various printed documents involves generating texts by an OCR system for different applications including full-text retrieval and document organizations. However, OCR-generated texts have errors as per present OCR technology. Moreover, previous studies have revealed that as OCR accuracy decreases the classification performance also decreases. The reason for this is the use of absolute word frequency as feature vector. Representing OCR texts using absolute word frequency has limitations such as dependency on text length and word recognition rate consequently lower classification performance due to higher within-class variances. We describe feature transformation techniques which do not have such limitations and present improved experimental results from all used classifiers.

Automatic Assembling of Cadastral Maps Based on Generalized Hough Transformation, Fei LIU, Wataru OHYAMA, Tetsushi WAKABAYASHI, Fumitaka KIMURA: Document Analysis Systems VII by Bunke, H. and Spdz, A.(Eds.) DAS 2006, pp.593-603, 2006

There are numerous cadastral maps generated by past land surveying. The raster digitization of these paper maps is in progress. For effective and efficient use of these maps, we have to assemble the set of maps to make them superimposable on other geographic information in a Geographic Information System. The problem can be seen as a complex jigsaw puzzle where the pieces are the cadastre sections extracted from the map. We present an automatic solution to this geographic jigsaw puzzle, based on the generalized Hough transformation that detects the longest common boundary between every piece and its neighbors. The experiments have been conducted using the map of Mie Prefecture, Japan and the French cadastral map. The results of the experiment with the French cadastral maps show that the proposed method, which consists of extracting an external area and extracting and regularizing the north arrow, is suitable for assembling the cadastral map. The final goal of the process is to integrate every piece of the puzzle into a national geographic reference frame and database.

Facial Feature Extraction Using Gradient Features and MQDF Matching, Wataru OHYAMA, M.SHRIDHAR* and Paul WATTA*: Proceedings of Eighth IASTED International Conference Signal and Image Processing, pp.329-334, 2006

We propose a novel approach for the extraction of facial features from frontal face images. The proposed approach involves 3 main processing stages. In the first stage, a bounding box is placed over the face. In the second stage, candidate positions for the facial features are identified using a set of MQDF-based distance functions. Finally, in

the third stage, the candidate feature positions are evaluated using an MQDF-based verification function, and an optimal configuration is chosen. Results on the FERET database indicate that with a proper setting of parameters, the proposed algorithm can accurately extract facial features over many different scales.

Recognition of handwritten Tamil characters, N.SHARMA*, U.PAL* and F.KIMURA: In Proc. National Conference on Recent Trends in Information Systems, pp.180-183, 2006

Recognition of Handwritten characters is challenging task because of the variability involved in the writing styles of different individuals. This paper deals with the recognition of off-line Tamil handwritten characters using the quadratic classifier based on the features obtained from directional chain code histogram. The bounding box of a character is segmented into blocks and the chain code histogram is computed in each of the blocks. This chain code features are fed to the quadratic classifier for recognition. We used 50687 numbers of samples comprising all the class of the Tamil script for the present work. We obtained 90.95% recognition accuracy.

Recognition of English Multi-oriented Characters, U.PAL*, F.KIMURA, K.ROY* and T.PAL*: In. Proc International Conference on Pattern Recognition, pp. 873-876, 2006

There are some printed artistic documents where text lines may be curved in shape. As a result, characters of a single line may be multi-oriented. To handle such artistic documents, in this paper, we present a scheme towards the recognition of multi-oriented and multi-sized English characters. The features used here are invariant to character orientation and computed based on the angular information of the border points of the characters. We used modified quadratic discriminant function (MQDF) for recognition. We tested our proposed scheme on a dataset of 18232 characters and obtained 98.34% accuracy from the system.

A Lexicon Driven Method for Unconstrained Bangla Handwritten Word Recognition, U.PAL*, K.ROY* and F.KIMURA: In Proc. 10th International Workshop on Frontiers in Handwriting Recognition (IWFHR), pp. 601-606, 2006

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.

Recognition of Handwritten Kannada Numerals, N.SHARMA*, U.PAL* and F.KIMURA: Proc. 9th International Conference on Information Technology (ICIT-2006), IEEE Computer Society Press, pp.133-136, 2006

This paper deals with a quadratic classifier based scheme for the recognition of off-line handwritten numerals of

Kannada, an important Indian script. The features used in the classifier are obtained from the directional chain code information of the contour points of the characters. The bounding box of a character is segmented into blocks and the chain code histogram is computed in each of the blocks. Here we have used 64 dimensional and 100 dimensional features for a comparative study on the recognition accuracy of our proposed system. This chain code features are fed to the quadratic classifier for recognition. We tested our scheme on 2300 data samples and obtained 97.87% and 98.45% recognition accuracy using 64 dimensional and 100 dimensional features respectively, from the proposed scheme using five-fold cross-validation technique.

Recognition of Offline Handwritten Devnagari Characters using Quadratic Classifier, N.SHARMA*, U.PAL*, F.KIMURA and S.PAL*: Indian Conference on Computer Vision Graphics and Image Processing (ICVGIP), LNCS, Springer Verlag, pp. 805-816, 2006

Recognition of handwritten characters is a challenging task because of the variability involved in the writing styles of different individuals. In this paper we propose a quadratic classifier based scheme for the recognition of off-line Devnagari handwritten characters. The features used in the classifier are obtained from the directional chain code information of the contour points of the characters. The bounding box of a character is segmented into blocks and the chain code histogram is computed in each of the blocks. Based on the chain code histogram, here we have used 64 dimensional features for recognition. These chain code features are fed to the quadratic classifier for recognition. At present we obtained 95.81% and 80.36% recognition accuracy on Devnagari numerals and characters, respectively, from the proposed scheme.

Quadratic Classifier Based approach for Recognition of Handwritten Kannada Numerals, U.PAL*, F.KIMURA, and N.SHARMA*: 41st National Annual Convention, Computer Society of India (CSI-2006), Tata McGraw Hill, pp.159-163, 2006

Recognition of handwritten characters is a challenging task because of the variability involved in the writing styles of different individuals. In this paper we propose a quadratic classifier based scheme for the recognition of off-line Kannada handwritten numerals. The features used in the classifier are obtained from the directional chain code information of the contour points of the characters. The bounding box of a character is segmented into blocks and the chain code histogram is computed in each of the blocks. Here we have used 64 dimensional and 400 dimensional features for a comparative study on the recognition accuracy of our proposed system. This chain code features are fed to the quadratic classifier for recognition. At present we modified the parameters of the classifier and obtained 98.54% and 98.98% recognition accuracy using 64 dimensional and 400 dimensional features respectively from the proposed scheme.

Offline Handwritten Kannada Character Recognition, U.PAL*, N.SHARMA*, F.KIMURA and S.PAL*: IEEE International Conference on Signal and Image Processing (ICSIP), Macmillan Advanced Research, Vol.-1, pp.174-177, 2006

Recognition of handwritten characters is challenging task because of the variability involved in the writing styles of different individuals. In this paper we propose a quadratic classifier based scheme for the recognition of off-line Kannada handwritten Characters. The features used in the classifier are obtained from the directional chain code information of the contour points of the characters. The bounding box of a character is segmented into blocks and

the chain code histogram is computed in each of the blocks. Here we have used 64 dimensional features for high speed recognition and 400 dimensional features for high accuracy recognition in our proposed system. This chain code features are fed to the quadratic classifier for recognition. At present we obtained 80.87% and 85.71% recognition accuracy using 64 dimensional and 400 dimensional features respectively from the proposed scheme.

Extraction of English Multi-oriented and Curved Text line, U.PAL*, N.SHARMA*, N.TRIPATHY*, and F.KIMURA: IEEE International Conference on Signal and Image Processing (ICSIP), Macmillan Advanced Research, Vol.-2, pp.581-586, 2006

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.