Lecture Notes in Computer Science 12917

Founding Editors

Gerhard Goos
Karlsruhe Institute of Technology, Karlsruhe, Germany
Juris Hartmanis
Cornell University, Ithaca, NY, USA

Editorial Board Members

Elisa Bertino
Purdue University, West Lafayette, IN, USA
Wen Gao
Peking University, Beijing, China
Bernhard Steffen
TU Dortmund University, Dortmund, Germany
Gerhard Woeginger
RWTH Aachen, Aachen, Germany
Moti Yung
Columbia University, New York, NY, USA

More information about this subseries at http://www.springer.com/series/7412

Elisa H. Barney Smith ·
Umapada Pal (Eds.)

Document Analysis and Recognition – ICDAR 2021 Workshops

Lausanne, Switzerland, September 5–10, 2021
Proceedings, Part II

Springer

Editors
Elisa H. Barney Smith
Boise State University
Boise, ID, USA

Umapada Pal
Indian Statistical Institute
Kolkata, India

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-030-86158-2 ISBN 978-3-030-86159-9 (eBook)
https://doi.org/10.1007/978-3-030-86159-9

LNCS Sublibrary: SL6 – Image Processing, Computer Vision, Pattern Recognition, and Graphics

© Springer Nature Switzerland AG 2021
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

Our warmest welcome to the proceedings of ICDAR 2021, the 16th IAPR International Conference on Document Analysis and Recognition, which was held in Switzerland for the first time. Organizing an international conference of significant size during the COVID-19 pandemic, with the goal of welcoming at least some of the participants physically, is similar to navigating a rowboat across the ocean during a storm. Fortunately, we were able to work together with partners who have shown a tremendous amount of flexibility and patience including, in particular, our local partners, namely the Beaulieu convention center in Lausanne, EPFL, and Lausanne Tourisme, and also the international ICDAR advisory board and IAPR-TC 10/11 leadership teams who have supported us not only with excellent advice but also financially, encouraging us to setup a hybrid format for the conference.

We were not a hundred percent sure if we would see each other in Lausanne but we remained confident, together with almost half of the attendees who registered for on-site participation. We relied on the hybridization support of a motivated team from the Lule University of Technology during the pre-conference, and professional support from Imavox during the main conference, to ensure a smooth connection between the physical and the virtual world. Indeed, our welcome is extended especially to all our colleagues who were not able to travel to Switzerland this year. We hope you had an exciting virtual conference week, and look forward to seeing you in person again at another event of the active DAR community.

With ICDAR 2021, we stepped into the shoes of a longstanding conference series, which is the premier international event for scientists and practitioners involved in document analysis and recognition, a field of growing importance in the current age of digital transitions. The conference is endorsed by IAPR-TC 10/11 and celebrates its 30th anniversary this year with the 16th edition. The very first ICDAR conference was held in St. Malo, France in 1991, followed by Tsukuba, Japan (1993), Montreal, Canada (1995), Ulm, Germany (1997), Bangalore, India (1999), Seattle, USA (2001), Edinburgh, UK (2003), Seoul, South Korea (2005), Curitiba, Brazil (2007), Barcelona, Spain (2009), Beijing, China (2011), Washington DC, USA (2013), Nancy, France (2015), Kyoto, Japan (2017), and Syndey, Australia in 2019.

The attentive reader may have remarked that this list of cities includes several venues for the Olympic Games. This year the conference was hosted in Lausanne, which is the headquarters of the International Olympic Committee. Not unlike the athletes who were recently competing in Tokyo, Japan, the researchers profited from a healthy spirit of competition, aimed at advancing our knowledge on how a machine can understand written communication. Indeed, following the tradition from previous years, 13 scientific competitions were held in conjunction with ICDAR 2021 including, for the first time, three so-called “long-term” competitions, addressing wider challenges that may continue over the next few years.

Other highlights of the conference included the keynote talks given by Masaki Nakagawa, recipient of the IAPR/ICDAR Outstanding Achievements Award, and Mickaël Coustaty, recipient of the IAPR/ICDAR Young Investigator Award, as well as our distinguished keynote speakers Prem Natarajan, vice president at Amazon, who gave a talk on "OCR: A Journey through Advances in the Science, Engineering, and Productization of AI/ML", and Beta Megyesi, professor of computational linguistics at Uppsala University, who elaborated on "Cracking Ciphers with 'AI-in-the-loop': Transcription and Decryption in a Cross-Disciplinary Field".

A total of 340 publications were submitted to the main conference, which was held at the Beaulieu convention center during September 8–10, 2021. Based on the reviews, our Program Committee chairs accepted 40 papers for oral presentation and 142 papers for poster presentation. In addition, nine articles accepted for the ICDAR-IJDAR journal track were presented orally at the conference and a workshop was integrated in a poster session. Furthermore, 12 workshops, 2 tutorials, and the doctoral consortium were held during the pre-conference at EPFL during September 5–7, 2021, focusing on specific aspects of document analysis and recognition, such as graphics recognition, camera-based document analysis, and historical documents.

The conference would not have been possible without hundreds of hours of work done by volunteers in the organizing committee. First of all we would like to express our deepest gratitude to our Program Committee chairs, Joseph Lladós, Dan Lopresti, and Seiichi Uchida, who oversaw a comprehensive reviewing process and designed the intriguing technical program of the main conference. We are also very grateful for all the hours invested by the members of the Program Committee to deliver high-quality peer reviews. Furthermore, we would like to highlight the excellent contribution by our publication chairs, Liangrui Peng, Fouad Slimane, and Oussama Zayene, who negotiated a great online visibility of the conference proceedings with Springer and ensured flawless camera-ready versions of all publications. Many thanks also to our chairs and organizers of the workshops, competitions, tutorials, and the doctoral consortium for setting up such an inspiring environment around the main conference. Finally, we are thankful for the support we have received from the sponsorship chairs, from our valued sponsors, and from our local organization chairs, which together enabled us to put in the extra effort required for a hybrid conference setup.

Our main motivation for organizing ICDAR 2021 was to give practitioners in the DAR community a chance to showcase their research, both at this conference and its satellite events. Thank you to all the authors for submitting and presenting your outstanding work. We sincerely hope that you enjoyed the conference and the exchange with your colleagues, be it on-site or online.

September 2021

Andreas Fischer
Rolf Ingold
Marcus Liwicki

Preface

Our heartiest welcome to the proceedings of the ICDAR 2021 Workshops, which were organized under the 16th International Conference on Document Analysis and Recognition (ICDAR) held in Lausanne, Switzerland during September 5–10, 2021.

We are delighted that this conference was able to include 13 workshops. The workshops were held in Lausanne during September 5–7, 2021. Some were held in a hybrid live/online format and others were held entirely online, with space at the main conference for in-person participants to attend. The workshops received over 100 papers on diverse document analysis topics, and these volumes collect the edited papers from 12 of the workshops.

We sincerely thank the ICDAR general chairs for trusting us with the responsibility for the workshops, and for assisting us with the complicated logistics in order to include remote participants. We also want to thank the workshop organizers for their involvement in this event of primary importance in our field. Finally, we thank the workshop presenters and authors without whom the workshops would not exist.

September 2021

Elisa H. Barney Smith
Umapada Pal

Organization

Organizing Committee

General Chairs

Andreas Fischer	University of Applied Sciences and Arts Western Switzerland
Rolf Ingold	University of Fribourg, Switzerland
Marcus Liwicki	Luleå University of Technology, Sweden

Program Committee Chairs

Josep Lladós	Computer Vision Center, Spain
Daniel Lopresti	Lehigh University, USA
Seiichi Uchida	Kyushu University, Japan

Workshop Chairs

Elisa H. Barney Smith	Boise State University, USA
Umapada Pal	Indian Statistical Institute, India

Competition Chairs

Harold Mouchère	University of Nantes, France
Foteini Simistira	Luleå University of Technology, Sweden

Tutorial Chairs

Véronique Eglin	Institut National des Sciences Appliquées, France
Alicia Fornés	Computer Vision Center, Spain

Doctoral Consortium Chairs

Jean-Christophe Burie	La Rochelle University, France
Nibal Nayef	MyScript, France

Publication Chairs

Liangrui Peng	Tsinghua University, China
Fouad Slimane	University of Fribourg, Switzerland
Oussama Zayene	University of Applied Sciences and Arts Western Switzerland, Switzerland

Sponsorship Chairs

David Doermann	University at Buffalo, USA
Koichi Kise	Osaka Prefecture University, Japan
Jean-Marc Ogier	University of La Rochelle, France

Local Organization Chairs

Jean Hennebert	University of Applied Sciences and Arts Western Switzerland, Switzerland
Anna Scius-Bertrand	University of Applied Sciences and Arts Western Switzerland, Switzerland
Sabine Süsstrunk	École Polytechnique Fédérale de Lausanne, Switzerland

Industrial Liaison

Aurélie Lemaitre	University of Rennes, France

Social Media Manager

Linda Studer	University of Fribourg, Switzerland

Workshops Organizers

W01-Graphics Recognition (GREC)

Jean-Christophe Burie	La Rochelle University, France
Richard Zanibbi	Rochester Institute of Technology, USA
Motoi Iwata	Osaka Prefecture University, Japan
Pau Riba	Universitat Autnoma de Barcelona, Spain

W02-Camera-based Document Analysis and Recognition (CBDAR)

Sheraz Ahmed	DFKI, Kaiserslautern, Germany
Muhammad Muzzamil Luqman	La Rochelle University, France

W03-Arabic and Derived Script Analysis and Recognition (ASAR)

Adel M. Alimi	University of Sfax, Tunisia
Bidyut Baran Chaudhur	Indian Statistical Institute, Kolkata, India
Fadoua Drira	University of Sfax, Tunisia
Tarek M. Hamdani	University of Monastir, Tunisia
Amir Hussain	Edinburgh Napier University, UK
Imran Razzak	Deakin University, Australia

W04-Computational Document Forensics (IWCDF)

Nicolas Sidère	La Rochelle University, France
Imran Ahmed Siddiqi	Bahria University, Pakistan
Jean-Marc Ogier	La Rochelle University, France
Chawki Djeddi	Larbi Tebessi University, Algeria
Haikal El Abed	Technische Universitaet Braunschweig, Germany
Xunfeng Lin	Deakin University, Australia

W05-Machine Learning (WML)

Umapada Pal	Indian Statistical Institute, Kolkata, India
Yi Yang	University of Technology Sydney, Australia
Xiao-Jun Wu	Jiangnan University, China
Faisal Shafait	National University of Sciences and Technology, Pakistan
Jianwen Jin	South China University of Technology, China
Miguel A. Ferrer	University of Las Palmas de Gran Canaria, Spain

W06-Open Services and Tools for Document Analysis (OST)

Fouad Slimane	University of Fribourg, Switzerland
Oussama Zayene	University of Applied Sciences and Arts Western Switzerland, Switzerland
Lars Vögtlin	University of Fribourg, Switzerland
Paul Märgner	University of Fribourg, Switzerland
Ridha Ejbali	National School of Engineers Gabes, Tunisia

W07-Industrial Applications of Document Analysis and Recognition (WIADAR)

Elisa H. Barney Smith	Boise State University, USA
Vincent Poulain d'Andecy	Yooz, France
Hiroshi Tanaka	Fujitsu, Japan

W08-Computational Paleography (IWCP)

Isabelle Marthot-Santaniello	University of Basel, Switzerland
Hussein Mohammed	University of Hamburg, Germany

W09-Document Images and Language (DIL)

Andreas Dengel	DFKI and University of Kaiserslautern, Germany
Cheng-Lin Liu	Institute of Automation of Chinese Academy of Sciences, China
David Doermann	University of Buffalo, USA
Errui Ding	Baidu Inc., China
Hua Wu	Baidu Inc., China
Jingtuo Liu	Baidu Inc., China

W10-Graph Representation Learning for Scanned Document Analysis (GLESDO)

Rim Hantach	Engie, France
Rafika Boutalbi	Trinov, France, and University of Stuttgart, Germany
Philippe Calvez	Engie, France
Balsam Ajib	Trinov, France
Thibault Defourneau	Trinov, France

Contents – Part II

ICDAR 2021 Workshop on Machine Learning (WML)

Benchmarking of Shallow Learning and Deep Learning Techniques with Transfer Learning for Neurodegenerative Disease Assessment Through Handwriting 7
Vincenzo Dentamaro, Paolo Giglio, Donato Impedovo, and Giuseppe Pirlo

Robust End-to-End Offline Chinese Handwriting Text Page Spotter with Text Kernel 21
Zhihao Wang, Yanwei Yu, Yibo Wang, Haixu Long, and Fazheng Wang

Data Augmentation vs. PyraD-DCNN: A Fast, Light, and Shift Invariant FCNN for Text Recognition 36
Ahmad-Montaser Awal, Timothée Neitthoffer, and Nabil Ghanmi

A Handwritten Text Detection Model Based on Cascade Feature Fusion Network Improved by FCOS 51
Ruiqi Feng, Fujia Zhao, Shanxiong Chen, Shixue Zhang, and Dingwang Wang

Table Structure Recognition Using CoDec Encoder-Decoder 66
Bhanupriya Pegu, Maneet Singh, Aakash Agarwal, Aniruddha Mitra, and Karamjit Singh

Advertisement Extraction Using Deep Learning 81
Boraq Madi, Reem Alaasam, Ahmad Droby, and Jihad El-Sana

Detection and Localisation of Struck-Out-Strokes in Handwritten Manuscripts 98
Arnab Poddar, Akash Chakraborty, Jayanta Mukhopadhyay, and Prabir Kumar Biswas

Temporal Classification Constraint for Improving Handwritten Mathematical Expression Recognition 113
Cuong Tuan Nguyen, Hung Tuan Nguyen, Kei Morizumi, and Masaki Nakagawa

Using Robust Regression to Find Font Usage Trends 126
Kaigen Tsuji, Seiichi Uchida, and Brian Kenji Iwana

Binarization Strategy Using Multiple Convolutional Autoencoder Network for Old Sundanese Manuscript Images 142
Erick Paulus, Jean-Christophe Burie, and Fons J. Verbeek

A Connected Component-Based Deep Learning Model for Multi-type Struck-Out Component Classification. 158
Palaiahnakote Shivakumara, Tanmay Jain, Nitish Surana, Umapada Pal, Tong Lu, Michael Blumenstein, and Sukalpa Chanda

Contextualized Knowledge Base Sense Embeddings in Word Sense Disambiguation 174
Mozhgan Saeidi, Evangelos Milios, and Norbert Zeh

ICDAR 2021 Workshop on Open Services and Tools for Document Analysis (OST)

Automatic Generation of Semi-structured Documents. 191
Djedjiga Belhadj, Yolande Belaïd, and Abdel Belaïd

DocVisor: A Multi-purpose Web-Based Interactive Visualizer for Document Image Analytics 206
Khadiravana Belagavi, Pranav Tadimeti, and Ravi Kiran Sarvadevabhatla

ICDAR 2021 Workshop on Industrial Applications of Document Analysis and Recognition (WIADAR)

Object Detection Based Handwriting Localization 225
Yuli Wu, Yucheng Hu, and Suting Miao

Toward an Incremental Classification Process of Document Stream Using a Cascade of Systems 240
Joris Voerman, Ibrahim Souleiman Mahamoud, Aurélie Joseph, Mickael Coustaty, Vincent Poulain d'Andecy, and Jean-Marc Ogier

Automating Web GUI Compatibility Testing Using X-BROT: Prototyping and Field Trial. 255
Hiroshi Tanaka

A Deep Learning Digitisation Framework to Mark up Corrosion Circuits in Piping and Instrumentation Diagrams. 268
Luis Toral, Carlos Francisco Moreno-García, Eyad Elyan, and Shahram Memon

Playful Interactive Environment for Learning to Spell at Elementary School 277
Sofiane Medjram, Véronique Eglin, Stephane Bres, Adrien Piffaretti, and Jobert Timothée

ICDAR 2021 Workshop on Computational Paleography (IWCP)

A Computational Approach of Armenian Paleography 295
Chahan Vidal-Gorène and Aliénor Decours-Perez

Handling Heavily Abbreviated Manuscripts: HTR Engines vs Text Normalisation Approaches 306
Jean-Baptiste Camps, Chahan Vidal-Gorène, and Marguerite Vernet

Exploiting Insertion Symbols for Marginal Additions in the Recognition Process to Establish Reading Order 317
Daniel Stökl Ben Ezra, Bronson Brown-DeVost, and Pawel Jablonski

Neural Representation Learning for Scribal Hands of Linear B 325
Nikita Srivatsan, Jason Vega, Christina Skelton, and Taylor Berg-Kirkpatrick

READ for Solving Manuscript Riddles: A Preliminary Study of the Manuscripts of the 3rd *ṣaṭka* of the *Jayadrathayāmala* 339
Olga Serbaeva and Stephen White

ICDAR 2021 Workshop on Document Images and Language (DIL)

A Span Extraction Approach for Information Extraction on Visually-Rich Documents 353
Tuan-Anh D. Nguyen, Hieu M. Vu, Nguyen Hong Son, and Minh-Tien Nguyen

Recurrent Neural Network Transducer for Japanese and Chinese Offline Handwritten Text Recognition 364
Trung Tan Ngo, Hung Tuan Nguyen, Nam Tuan Ly, and Masaki Nakagawa

MTL-FoUn: A Multi-Task Learning Approach to Form Understanding 377
Nishant Prabhu, Hiteshi Jain, and Abhishek Tripathi

VisualWordGrid: Information Extraction from Scanned Documents Using a Multimodal Approach 389
Mohamed Kerroumi, Othmane Sayem, and Aymen Shabou

A Transformer-Based Math Language Model for Handwritten Math Expression Recognition 403
Huy Quang Ung, Cuong Tuan Nguyen, Hung Tuan Nguyen, Thanh-Nghia Truong, and Masaki Nakagawa

Exploring Out-of-Distribution Generalization in Text Classifiers Trained on Tobacco-3482 and RVL-CDIP 416
Stefan Larson, Navtej Singh, Saarthak Maheshwari, Shanti Stewart, and Uma Krishnaswamy

Labeling Document Images for E-Commence Products with Tree-Based Segment Re-organizing and Hierarchical Transformer 424
Peng Li, Pingguang Yuan, Yong Li, Yongjun Bao, and Weipeng Yan

Multi-task Learning for Newspaper Image Segmentation and Baseline Detection Using Attention-Based U-Net Architecture 440
Anukriti Bansal, Prerana Mukherjee, Divyansh Joshi, Devashish Tripathi, and Arun Pratap Singh

Data-Efficient Information Extraction from Documents with Pre-trained Language Models 455
Clément Sage, Thibault Douzon, Alex Aussem, Véronique Eglin, Haytham Elghazel, Stefan Duffner, Christophe Garcia, and Jérémy Espinas

ICDAR 2021 Workshop on Graph Representation Learning for Scanned Document Analysis (GLESDO)

Representing Standard Text Formulations as Directed Graphs 475
Frieda Josi, Christian Wartena, and Ulrich Heid

Multivalent Graph Matching for Symbol Recognition 488
D. K. Ho, J. Y. Ramel, and N. Monmarché

Key Information Recognition from Piping and Instrumentation Diagrams: Where We Are? 504
Rim Hantach, Gisela Lechuga, and Philippe Calvez

Graph Representation Learning in Document Wikification 509
Mozhgan Saeidi, Evangelos Milios, and Norbert Zeh

Graph-Based Deep Generative Modelling for Document Layout Generation 525
Sanket Biswas, Pau Riba, Josep Lladós, and Umapada Pal

Author Index 539

Contents – Part I

ICDAR 2021 Workshop on Graphics Recognition (GREC)

Relation-Based Representation for Handwritten Mathematical Expression Recognition 7
Thanh-Nghia Truong, Huy Quang Ung, Hung Tuan Nguyen, Cuong Tuan Nguyen, and Masaki Nakagawa

A Public Ground-Truth Dataset for Handwritten Circuit Diagram Images 20
Felix Thoma, Johannes Bayer, Yakun Li, and Andreas Dengel

A Self-supervised Inverse Graphics Approach for Sketch Parametrization 28
Albert Suso, Pau Riba, Oriol Ramos Terrades, and Josep Lladós

Border Detection for Seamless Connection of Historical Cadastral Maps 43
Ladislav Lenc, Martin Prantl, Jiří Martínek, and Pavel Král

Data Augmentation for End-to-End Optical Music Recognition 59
Juan C. López-Gutiérrez, Jose J. Valero-Mas, Francisco J. Castellanos, and Jorge Calvo-Zaragoza

Graph-Based Object Detection Enhancement for Symbolic Engineering Drawings 74
Syed Mizanur Rahman, Johannes Bayer, and Andreas Dengel

ScanSSD-XYc: Faster Detection for Math Formulas 91
Abhisek Dey and Richard Zanibbi

Famous Companies Use More Letters in Logo: A Large-Scale Analysis of Text Area in Logo 97
Shintaro Nishi, Takeaki Kadota, and Seiichi Uchida

MediTables: A New Dataset and Deep Network for Multi-category Table Localization in Medical Documents 112
Akshay Praveen Deshpande, Vaishnav Rao Potlapalli, and Ravi Kiran Sarvadevabhatla

Online Analysis of Children Handwritten Words in Dictation Context 125
Omar Krichen, Simon Corbillé, Eric Anquetil, Nathalie Girard, and Pauline Nerdeux

A Transcription Is All You Need: Learning to Align Through Attention 141
Pau Torras, Mohamed Ali Souibgui, Jialuo Chen, and Alicia Fornés

Accurate Graphic Symbol Detection in Ancient Document Digital Reproductions 147
Zahra Ziran, Eleonora Bernasconi, Antonella Ghignoli, Francesco Leotta, and Massimo Mecella

ICDAR 2021 Workshop on Camera-Based Document Analysis and Recognition (CBDAR)

Inscription Segmentation Using Synthetic Inscription Images for Text Detection at Stone Monuments 167
Naoto Morita, Ryunosuke Inoue, Masashi Yamada, Takatoshi Naka, Atsuko Kanematsu, Shinya Miyazaki, and Junichi Hasegawa

Transfer Learning for Scene Text Recognition in Indian Languages. 182
Sanjana Gunna, Rohit Saluja, and C. V. Jawahar

How Far Deep Learning Systems for Text Detection and Recognition in Natural Scenes are Affected by Occlusion?. 198
Aline Geovanna Soares, Byron Leite Dantas Bezerra, and Estanislau Baptista Lima

CATALIST: CAmera TrAnsformations for Multi-LIngual Scene Text Recognition 213
Shivam Sood, Rohit Saluja, Ganesh Ramakrishnan, and Parag Chaudhuri

DDocE: Deep Document Enhancement with Multi-scale Feature Aggregation and Pixel-Wise Adjustments. 229
Karina O. M. Bogdan, Guilherme A. S. Megeto, Rovilson Leal, Gustavo Souza, Augusto C. Valente, and Lucas N. Kirsten

Handwritten Chess Scoresheet Recognition Using a Convolutional BiLSTM Network 245
Owen Eicher, Denzel Farmer, Yiyan Li, and Nishatul Majid

ICDAR 2021 Workshop on Arabic and Derived Script Analysis and Recognition (ASAR)

RASAM – A Dataset for the Recognition and Analysis of Scripts in Arabic Maghrebi 265
Chahan Vidal-Gorène, Noëmie Lucas, Clément Salah, Aliénor Decours-Perez, and Boris Dupin

Towards Boosting the Accuracy of Non-latin Scene Text Recognition 282
Sanjana Gunna, Rohit Saluja, and C. V. Jawahar

Aolah Databases for New Arabic Online Handwriting Recognition Algorithm. 294
Samia Heshmat and Mohamed Abdelnafea

Line Segmentation of Individual Demographic Data from Arabic Handwritten Population Registers of Ottoman Empire 312
Yekta Said Can and M. Erdem Kabadayı

Improving Handwritten Arabic Text Recognition Using an Adaptive Data-Augmentation Algorithm 322
Mohamed Eltay, Abdelmalek Zidouri, Irfan Ahmad, and Yousef Elarian

High Performance Urdu and Arabic Video Text Recognition Using Convolutional Recurrent Neural Networks 336
Abdul Rehman, Adnan Ul-Hasan, and Faisal Shafait

ASAR 2021 Online Arabic Writer Identification Competition 353
Thameur Dhieb, Houcine Boubaker, Sourour Njah, Mounir Ben Ayed, and Adel M. Alimi

ASAR 2021 Competition on Online Signal Restoration Using Arabic Handwriting Dhad Dataset 366
Besma Rabhi, Abdelkarim Elbaati, Tarek M. Hamdani, and Adel M. Alimi

ASAR 2021 Competition on Online Arabic Character Recognition: ACRC 379
Yahia Hamdi, Houcine Boubaker, Tarek M. Hamdani, and Adel M. Alimi

ASAR 2021 Competition on Online Arabic Word Recognition 390
Hanen Akouaydi, Houcine Boubaker, Sourour Njah, Mourad Zaied, and Adel M. Alimi

ICDAR 2021 Workshop on Computational Document Forensics (IWCDF)

Recognition of Laser-Printed Characters Based on Creation of New Laser-Printed Characters Datasets 407
Takeshi Furukawa

CheckSim: A Reference-Based Identity Document Verification by Image Similarity Measure 422
Nabil Ghanmi, Cyrine Nabli, and Ahmad-Montaser Awal

Crossing Number Features: From Biometrics to Printed Character Matching 437
Pauline Puteaux and Iuliia Tkachenko

Writer Characterization from Handwriting on Papyri Using Multi-step Feature Learning 451
Sidra Nasir, Imran Siddiqi, and Momina Moetesum

Robust Hashing for Character Authentication and Retrieval Using Deep Features and Iterative Quantization 466
Musab Al-Ghadi, Théo Azzouza, Petra Gomez-Krämer, Jean-Christophe Burie, and Mickaël Coustaty

Author Index 483