ACADEMIC GRADUATION MONITORING REPORT

2020

European Association for Biometrics (EAB)

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RESEARCH MONITOR CONTENT

PREFACE

During the 2019 EAB general assembly it was proposed to compose an annual academic graduation monitoring report, which should provide information about academic theses that are completed in EAB member institutions.

Such report should contain lists of entries of Bachelor-, Master- or PhD-theses and a short summary of each thesis.

EAB is proud to provide now an overview of the research going on in Europe. If you are member of EAB and you can contribute information about your graduated students. In order to facilitate the data collection, a webform, accessible to EAB members, has been added to the EAB website, in which author and contact information can be provided as well as a title, and abstract and an optional link to the report. The webform can be found here: https://eab.org/information/academic_report.html

This report was composed by the European Association for Biometrics (EAB) for its members. If you are not EAB member yet – please join and share the non-profit spirit of EAB. We are grateful for your continuous support of the EAB initiatives through your membership.

MONITOR
PHD-THESES

PAWEL DROZDOWSKI - EFFICIENT BIOMETRIC IDENTIFICATION

Full Title: Efficient privacy-preserving biometric identification in large-scale multibiometric systems
Institution: Norwegian University of Science and Technology (NTNU)
Supervisor: Prof. Dr. Christoph Busch, Dr. Christian Rathgeb
URL: https://ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2650398
Link description: NTNU University Library
Contact email: pawel.drozdowski@h-da.de

Abstract:
Nowadays, biometrics find application as an integral component of identity management systems. The recent rapid growth of the size and popularity of such systems has prompted research into technologies which support efficient, secure, and accurate processing of large amounts of biometric data. In this context and specifically relating to biometric identification, the contributions of this thesis are as follows:

- Contribution I: State-of-the-art survey of the field and modality-agnostic taxonomy of efficient biometric identification methods.
- Contribution II: Computational workload concepts, evaluation methodology, and metrics contributed to the revision of ISO/IEC 19795-1 standard.
- Contribution III: Methods of computational workload reduction which are applied prior to feature extraction.
- Contribution IV: Method of computational workload reduction which works irrespective of the used biometric characteristic and/or feature extraction.
- Contribution V: Methods coupling efficient biometric identification with biometric information fusion.
- Contribution VI: First academic publications for methods coupling efficient biometric identification with biometric template protection.
- Contribution VII: Open-source method of generation of visually and statistically realistic Iris-Codes for the purposes of large-scale systems testing.
- Contribution VIII: High practical value of the proposed approaches, due to focusing on the feasibility of seamless integration into operational systems.
- Contribution IX: High degree of algorithmic transparency and explainability of the proposed methods (all have been handcrafted without the use of machine learning).

KLEMEN GRM - FACE RECOGNITION FROM LOW-RESOLUTION IMAGERY

Full Title: Automated face recognition from low-resolution imagery
Institution: University of Ljubljana
Supervisor: Vitomir Štruc
URL: https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114881&lang=eng
Link description: Link to thesis PDF
Contact email: vitomir.struc@fe.uni-lj.si

Abstract:
Recently, significant advances in the field of automated face recognition have been achieved using computer vision, machine learning, and deep learning methodologies. However, despite claims of super-human performance of face recognition algorithms on select key benchmark tasks, there remain several open problems that preclude the general replacement of human face recognition work with automated systems. State-of-the-art automated face recognition systems based on deep learning methods are able to achieve high accuracy when the face images they are tasked with recognizing subjects from are of sufficiently high quality. However, low image resolution remains one of the principal obstacles to face recognition systems, and their performance in the low-resolution regime is decidedly below human capabilities. In this PhD thesis, we present a systematic study of modern automated face recognition systems in the presence of image degradation in various forms. Based on our findings, we then propose a novel technique for improving the quality of low-resolution face images. Specifically, we present a novel deep learning model architecture for image superresolution, and a novel training procedure for face hallucination that trains the model to super-resolve face images in a manner that preserves the information about the subject identity present in the low-resolution image. We validate the model by comparing its image reconstruction capability against several state-of-the-art models, as well as its performance on downstream semantic tasks including face recognition and face landmark localization. Next, we study the generalization capabilities of super-resolution-based face hallucination models, and find most of the models studied to be heavily biased towards the artificial image degradation process used to generate their training datasets. We notice that due to this bias, none of the face hallucination models considered are able to outperform an interpolation baseline on face recognition benchmarks with real-life low resolution images. To overcome this problem, we then develop a novel method for face recognition from low-resolution images that uses the results of multi-scale face hallucination models developed earlier. The proposed method is able to benefit from the high-resolution information added by the face hallucination models without suffering from the training set bias they exhibit, and systematically outperform the interpolation baseline and other state-of-the-art low-resolution face recognition models on the SCFace benchmark. Our proposed methods are trained on large face image datasets in a manner typical for deep learning models. However, the resulting trained models are useful for face recognition applications in an open-set regime, and do not need to be re-trained for novel subjects.

ANTONIO MAGNANI - HUMAN ACTION RECOGNITION FOR AMBIENT ASSISTED LIVING

Full Title: Human Action Recognition and Monitoring in Ambient Assisted Living Environment
Institution: University of Bologna
Supervisor: Annalisa Franco
URL: http://amsdottorato.unibo.it/9373/
Link description: Institutional Doctoral Theses Repository
Contact email: antonio.magnani@unibo.it

Abstract:
Population ageing is set to become one of the most significant challenges of the 21st century, with implications for almost all sectors of society. Especially in developed countries, governments should immediately implement policies and solutions to facilitate the needs of an increasingly older population. Ambient Intelligence (AmI) and in particular the area of Ambient Assisted Living (AAL) offer a feasible response, allowing the creation of human-centric smart environments that are sensitive and responsive to the needs and behaviours of the user. In such a scenario, understand what a human being is doing, if and how he/she is interacting with specific objects, or whether abnormal situations are occurring is critical. This thesis is focused on two related research areas of AAL: the development of innovative vision-based techniques for human action recognition and the remote monitoring of users behaviour in smart environments. The former topic is addressed through different approaches based on data extracted from RGB-D sensors. A first algorithm exploiting skeleton joints orientations is proposed. This approach is extended through a multi-modal strategy that includes the RGB channel to define a number of temporal images, capable of describing the time evolution of actions. Finally, the concept of template co-updating concerning action recognition is introduced. Indeed, exploiting different data categories (e.g., skeleton and RGB information) improve the effectiveness of template updating through co-updating techniques. The action recognition algorithms have been evaluated on CAD-60 and CAD-120, achieving results comparable with the state-of-the-art. Moreover, due to the lack of datasets including skeleton joints orientations, a new benchmark named Office Activity Dataset has been internally acquired and released. Regarding the second topic addressed, the goal is to provide a detailed implementation strategy concerning a generic Internet of Things monitoring platform that could be used for checking users' behaviour in AmI/AAL contexts.

AMIR MOHAMMADI - TRUSTWORTHY FACE RECOGNITION

Full Title: Trustworthy Face Recognition: Improving Generalization of Deep Face Presentation Attack Detection
Institution: École Polytechnique Fédérale de Lausanne and Idiap Research Institue
Supervisor: Dr Sébastien Marcel
URL: http://publications.idiap.ch/index.php/publications/show/4284
Link description: PhD Thesis manuscript
Contact email: sebastien.marcel@idiap.ch

Abstract:
The extremely high recognition accuracy achieved by modern, convolutional neural network (CNN) based face recognition (FR) systems has contributed significantly to the adoption of such systems in a variety of applications, from mundane activities like unlocking phones to high-security applications such as border-control. Nonetheless, they have been shown to be highly vulnerable to presentation attacks (PA), also known as spoof-attacks. A face PA is said to have occurred when a face biometric-sample is presented to the camera of an FR system with the intention of interfering with the operation of biometric recognition. An example PA is when someone tries to illicitly access an FR system by presenting a printed face photo of an authorized person to the camera. State-of-the-art face presentation attack detection (PAD) systems which are based on CNNs as well offer counter-measures to PAs. Over the past decade, several datasets have been collected and publicly shared by different research groups, for face PAD experiments. It has been shown that most face PAD systems do not generalize well. That is, PAD systems show satisfactory classification performance when they are trained and evaluated on disjoint subsets of a dataset (known as an intra-dataset evaluation). However, their performance degrades significantly when they are trained using data from one dataset and evaluated using data from another dataset (a cross-dataset evaluation). The poor generalization of PAD systems precludes FR systems from deployment in many real-world applications. In this thesis, I address generalization issues in face PAD systems in three ways: 1. Although many CNN architectures have been proposed for face PAD, no systematic evaluation of their classification performance has been done before. Here, I evaluate six different CNN architectures on four face PAD datasets in terms of both intra-dataset and cross-dataset performance, and show that patch-based CNN architectures generalize better. Moreover, I propose a novel CNN that analyzes the face images at different scales. This multi-scale analysis allows the proposed CNN to generalize better compared to baseline CNNs. 2. I formulate the low cross-dataset performance of PAD as a domain shift problem and investigate domain adaptation methods as a solution. I propose a novel domain adaptation method based on the hypothesis that some learned filters in CNNs are domain specific and do not generalize to the other datasets. Pruning these filters leads to higher performance in both intra-dataset and cross-dataset evaluations. 3. I hypothesize that the variability of face images in an FR dataset are nuisance factors in face PAD systems. Based on that, I propose to model the variability of face images in an FR dataset explicitly and induce invariance to these variabilities in the PAD system. The proposed method shows improvements over the baselines in terms of cross-dataset performance. Extensive experiments on four recent PAD datasets (Replay-Mobile, OULU-NPU, SWAN, and WMCA) are conducted to support the claims. Overall, generalization in face PAD systems still remains a challenge and more research effort is needed to address this problem. Finally, this thesis is reproducible as complete implementation of the baselines and the proposed methods are made available freely via the machine-learning library Bob.

ULRICH SCHERHAG - MORPHING ATTACK DETECTION

Full Title: Face Morphing and Morphing Attack Detection
Institution: Hochschule Darmstadt
Supervisor: Christoph Busch and Christian Rathgeb
URL: https://christoph-busch.de/files/Scherhag-PhD-Thesis-2020.pdf
Link description: PhD-Thesis
Contact email: christoph.busch@h-da.de

Abstract:
In modern society, biometrics is gaining more and more importance, driven by the increase in recognition performance of the systems. In some areas, such as automatic border controls, there is no alternative to the application of biometric systems. Despite all the advantages of biometric systems, the vulnerability of these still poses a problem. Facial recognition systems for example offer various attack points, like faces printed on paper or silicone masks. Besides the long known and well researched presentation attacks there is also the danger of the so-called morphing attack. The research field of morphing attacks is quite young, which is why it has only been investigated to a limited extent so far. Publications proposing algorithms for the detection of morphing attacks often lack uniform databases and evaluation methods, which leads to a restricted comparability of the previously published work. Thus, the focus of this thesis is the comprehensive analysis of different features and classifiers in their suitability as algorithms for the detection of morphing attacks. In this context, evaluations are performed with uniform metrics on a realistic morphing database, allowing the simulation of various realistic scenarios. If only the suspected morph is available, a HOG feature extraction in combination with an SVM is able to detect morphs with a DEER ranging from 13.25% to 24.05%. If a trusted live capture image is available in addition, for example from a border gate, the deep ArcFace features in combination with an SVM can detect morphs with a D-EER ranging from 2.71% to 7.17%.

ALIREZA SEPAS-MOGHADDAM - LIGHT FIELD BASED BIOMETRIC RECOGNITION AND PRESENTATION ATTACK DETECTION

Full Title: Light Field Based Biometric Recognition and Presentation Attack Detection
Institution: Instituto Superior Tecnico - Universidade de Lisboa, Portugal
Supervisor: Paulo Lobato Correia, Fernando Pereira
URL: https://www.it.pt/Supervisions/Supervision/4489
Contact email: paulo.lobato.correia@tecnico.ulisboa.pt

Abstract:
In a world where security issues have been gaining explosive importance, face and ear recognition systems have attracted increasing attention in multiple application areas, ranging from forensics and surveillance to commerce and entertainment. While the recognition performance has been steadily improving, there are still challenging recognition scenarios and conditions, notably when facing large variations in the biometric data characteristics. Additionally, the widespread use of face and ear recognition solutions raises new security concerns, making the robustness against presentation attacks a very active field of research. Lenslet light field cameras have recently come into prominence as they are able to also capture the intensity of the light rays coming from multiple directions, thus offering a richer representation of the visual scene, notably spatio-angular information. To take benefit of this richer representation, light field cameras have recently been successfully applied, not only to biometric recognition, but also to biometric Presentation Attack Detection (PAD).

This Thesis focuses on exploiting the advances in light field imaging technology towards developing more advanced biometric recognition and PAD systems with improved performance. In this context, new taxonomies have been developed for face and ear recognition and PAD, to facilitate the organization and categorization of face and ear recognition and PAD solutions. Following the proposed taxonomies, a comprehensive review on recent, representative and relevant face and ear recognition solutions has been made.

In the context of this Thesis, two light field face and ear databases have been created, towards allowing more powerful benchmarking for testing and validating face and ear recognition solutions while exploiting the full light field data. Additionally, two light field face and ear artefact databases have been created consisting of bona fide images and artefact images using different types of presentation attack instruments, such as printed papers and digital displays.

Concerning recognition and PAD solutions, two hand-crafted light field based face and ear recognition descriptors and five deep learning light field based face recognition descriptors have been developed, evolving through progressive levels of functionality and performance. Concerning PAD, this Thesis has developed two solutions for light field based face and ear PAD, exploiting the variations associated to different directions of light captured in the light field images.

A comprehensive evaluation of the proposed and benchmarking face and ear recognition and PAD solutions has been performed. The obtained results have shown the added value of light field information for face and ear recognition and PAD purposes as the proposed solutions have achieved superior recognition and PAD performance when compared to the state-of-the-art benchmarking solutions.

TANMAY VERLEKAR - GAIT ANALYSIS IN UNCONSTRAINED ENVIRONMENTS

Full Title: Gait Analysis in Unconstrained Environments
Institution: Instituto Superior Tecnico - Universidade de Lisboa, Portugal
Supervisor: Paulo Lobato Correia, Luis Ducla Soares
URL: https://www.it.pt/Supervisions/Supervision/4490
Contact email: paulo.lobato.correia@tecnico.ulisboa.pt

Abstract:
Gait can be defined as the individuals' manner of walking. Its analysis can provide significant information about their identity and health, opening a wide range of possibilities in the field of biometric recognition and medical diagnosis. In the field of biometric, the use of gait to perform recognition can provide advantages, such as acquisition from a distance and without the cooperation of the individual being observed. In the field of medicine, gait analysis can be used to detect or assess the development of different gait related pathologies. It can also be used to assess neurological or systemic disorders as their effects are reflected in the individuals' gait.

This Thesis focuses on performing gait analysis in unconstrained environments, using a single 2D camera. This can be a challenging task due to the lack of depth information and self-occlusions in a 2D video sequence. The Thesis explores the use of gait, to perform biometric recognition and pathology detection and classification by reviewing the state-of-the-art and presenting novel taxonomies to organise the systems.

In the field of biometrics, the work done in this Thesis improves the performance of the recognition systems by proposing two novel gait representations. It also addressesthe problems faced by recognition systems in unconstrained environments, such as change in the viewpoint of the camera and change in the appearance of the individuals being observed, presenting three novel systems to detect the viewpoint of the camera and a system to tackle appearance change.

Finally, the Thesis explores the possibility of obtaining gait features from the shadow cast by the individuals, presenting two systems to rectify the distortion and deformation in the shadow silhouettes and a system to detect if the shadow is usable. It also presents two datasets to evaluate these systems.

In the field of medicine, this Thesis presents a novel system to obtain biomechanical features, from a video sequence captured with a 2D camera, with a high level of accuracy, while also being robust to viewpoint change. To evaluate the system the Thesis presents a dataset containing sequences acquired from a 2D camera and the "gold standard" motion capture system. The Thesis also explores the ability of gait to classify different gait related pathologies. It presents two novel systems that perform classification of gait across different gait related pathologies using biomechanical features and deep convolutional neural networks.

A comprehensive evaluation of the proposed systems and comparison with the state-of-the-art highlight the advantages of the proposed systems for biometric recognition and pathology classification.

MONITOR
MASTER-THESES

ANANTHU ANURAJ - COW SEGMENTATION

Full Title: Instance Level Cow Body Part Parsing
Institution: University of Twente
Supervisor: Luuk Spreeuwers
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
Monitoring the health, behavior, and environmental interactions of a cow are crucial for a dairy farm. Computer vision can help create such an autonomous monitoring system by recognizing different parts of a cow which is the focus of this project. This task is not trivial as some of the body parts in cows, such as their legs, are homogeneous in appearance which makes it difficult for standard object detection/image segmentation algorithms to learn the difference between these body parts. The algorithm should also be capable of identifying and analyzing each instance of cow body parts in an image separately. This paper, which is a continuation of the work done in the same field by Mohamed Asif in [1], proposes a singular end-to-end trainable model to perform this task by focusing on finding a well-performing convolutional backbone network. To facilitate this research, four different data-sets that can detect and segment cow parts are created. The images in these data-sets represent different conditions of cow pose, camera viewpoint,and lighting. The proposed algorithms are evaluated separately on these data-sets to check their generalization capability. The experimental results show that the performance of the simplest proposed model, which runs at 17 fps on an Nvidia RTX 2080 Ti graphics card, is comparable to the performance of state-of-the-art algorithms in the related field of human part segmentation.

TATJANA WINGARZ - PRIVACY-PRESERVING FACIAL RECOGNITION USING HOMOMORPHIC ENCRYPTION AND NEURAL NETWORKS

Full Title: Privacy-Preserving Facial Recognition Using Homomorphic Encryption and Neural Networks
Institution: Ruhr-Universität Bochum
Supervisor: Markus Dürmuth, Christoph Busch, Marta Gomez-Barrero
Contact email: wingarz@informatik.uni-hamburg.de

Abstract:
Given the high sensitivity of biometric data, such samples need to be handled in a secure privacy-preserving manner. While traditional cryptographic techniques do not allow operations in the encrypted domain, Homomorphic Encryption schemes enable a system to work on protected data without the need of preliminary decryption. Facial recognition can be utilized as a passive, non-intrusive method for biometric authentication. As such, facial recognition has many application fields: from being used in the entertainment field, over unlocking a smartphone, to video surveillance or border control checks. As facial recognition is a complex visual problem, convolutional neural networks are often employed to perform the desired classification. This thesis utilizes homomorphic encryption in order to secure a convolutional neural network trained for facial recognition. Furthermore, an overview of the accuracy, efficiency and computational requirements compared to an unencrypted system is presented.

HAOYU ZHANG - GENERATING MORPHS USING GAN

Full Title: Generating High-Quality Morphs using Generative Adversarial Networks (GAN)
Institution: DTU and NTNU
Supervisor: Raghavendra Ramachandra, Christoph Busch and Sushma Venkatesh
Contact email: christoph.busch@ntnu.no

Abstract:
In recent years, deep neural networks (DNN) have led to breakthrough improvement in face recognition systems (FRS). The high generalizability of DNN and deep FRS has significantly enhanced their performance in unconstrained environments and promoted the widespread deployment of them. However, researchers have also revealed that it also increases their vulnerability against attacks [FFM14]. Morphing attacks is one of the popular topics among them in the last few years and have posed a severe threat to FRSs. Normally, these morphs are generated from traditional facial key-point detector-based methods, where face images are aligned by their landmarks and then combined. Some researchers have also worked on using generative adversarial networks (GAN) to generate morphing attacks, however, their morph attacks were not that powerful due to the limited performance of their generative model. Meanwhile, with the recent advancements of GAN, it becomes possible to generate face images with high quality. Motivated by these, in this thesis we carry out the research of using state-of-the-art image generation model StyleGAN and StyleGAN2 to generate high-quality morphed face images. We will first introduce relevant backgrounds and summarize the previous methods as a framework and apply it with the advanced models. This approach achieved a much better image quality and generalizability on the open-set morph generation (training data are not used in morph generation). However, its performance in attacking FRS is not as satisfying as landmark-based algorithms (LMA). Then, we will analyze the old framework and propose an improved one to increase the threat of generated morphs toward FRS. We also fine-tuned the StyleGAN2 model with our dataset of conditioned face images and achieved the best result which is close to LMA.Finally, we will benchmark these methods by carrying vulnerability analysis to a commercial off-the-shelf (COTS) FRS using the generated morphing databases and give a conclusion to our work.

ABRAHAM THEODORUS - RECONSTRUCTION ROMAN EMPERORS

Full Title: Restoration Of Damaged Face Statues Using Deep Generative Inpainting Model
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/82706
Link description: RESTORATION OF DAMAGED FACE STATUES USING DEEP GENERATIVE INPAINTING MODEL
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
Face statues restoration can be considered as an image inpainting task where a model aims to replace damaged regions with semantically correct pixels. In this thesis, Generative Adversarial Networks (GANs) with several objective functions are investigated in order to perform the task. As a comparison, a traditional technique, namely the recursive PCA algorithm, is also involved. The experiment results indicate superior performance of GANs in reconstructing the damaged face statues compared to the recursive PCA. Specifically, GANs are able to restore more complex face attributes well, i.e., eyes and mouths, while the recursive PCA still manages to restore noses which are considerably simpler. FID score is used to evaluate the inpainting results and it is suitable to be adopted as an early-stopping criterion for training GANs. However, among the inpainting results induced by GANs, only subtle differences are observed despite some slight FID score lead by certain GAN-based models. Therefore, manual observation is still deemed necessary.

THOMAS NIELSEN - VIDEO TAMPERING DETECTION

Full Title: Digital Passive Video Tampering Detection using Deep Learning
Institution: DTU and NTNU
Supervisor: Christoph Busch and Ali Khodabakhsh
URL: https://dl.gi.de/bitstream/handle/20.500.12116/34348/BIOSIG_2020_paper_6_update.pdf?sequence=1&isAllowed=y
Link description: Summary paper of the Thesis
Contact email: christoph.busch@h-da.de

Abstract:
With the increasing use of digital devices, the capturing and sharing of digital video content is now commonplace, but so is the editing of video content for either entertainment or malicious intent. The field of video forensics exists to study the abilities for us to authenticate and/or guarantee the integrity of the content of a video. The thesis contributes insight into the field of video forensics and the methodologies that are applied, as well as the document the contribution of a new large-scale, publicly available unit-selection-based video manipulation dataset containing 1000 videos and the design of a new detection method build on this dataset able to achieve an equal error rate of 4.95%.

YVO DELAERE - DETECTION WIRES IN TYRE PRODUCTION

Full Title: Design Of a Machine Vision Based Faulty Bead Wire Detection System
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/83586
Link description: DESIGN OF A MACHINE VISION BASED FAULTY BEAD WIRE DETECTION SYSTEM
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
Technological innovations are key to be ahead of your competitors in the tire manufacturing industry. This research proposes a prototype tire bead defect system, which can greatly reduce costs and wasted materials. Machine vision technology is utilized and expanded in the design and realization of a prototype of this system. Images of the tire beads are acquired using a Raspberry Pi based 2-camera system without adding an extra step in the production process. These images are rectified and fused into a top view image using a novel single image calibration approach. The width of the bead is measured using the generated top view image, and beads are classified based on this information. Existing technologies and methods are used in a smart way to construct a low budget solution. Initial results show the potential of the system and show areas where the system can be improved.

WOUT DIPHOORN - MAKING ICAO PASSPORT SELFIE IMAGES

Full Title: a Smartphone Application For the Creation Of Legal Document Photographs
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/81684
Link description: A SMARTPHONE APPLICATION FOR THE CREATION OF LEGAL DOCUMENT PHOTOGRAPHS
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
Legal document photographs have to conform to the requirements stated in the ICAO photograph guidelines. Due to the average individual being unfamiliar with these requirements, legal document photographs are normally taken by a professional photographer. This research is focused on offering an alternative to the photographer with a smartphone application. The application detects the conformance to all requirements using modern image processing and computer vision algorithms. The user is informed to which requirements the image does not conform and is instructed by on-screen gestures, text and vocal messages.

AKUL MEHRA - DETECTION OF DEEP FAKES

Full Title: Deepfake Detection Using Capsule Networks With Long Short-term Memory Networks
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/83028
Link description: DEEPFAKE DETECTION USING CAPSULE NETWORKS WITH LONG SHORT-TERM MEMORY NETWORKS
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
With the recent advancement of technology, particularly with graphics processing and artificial intelligence algorithms, fake media generation has become easier. Using deep learning techniques like Deepfakes and FaceSwap, anyone can generate fake videos by manipulating the face/voice of the target in the video. These deepfakes can be used for malicious purposes like phishing scams and fake news. Detecting face tampering in realistic forged videos generated has become of utmost importance. This paper provides an overview of what inconsistencies are introduced in videos due to deepfake generation and proposes a spatio-temporal hybrid model of Capsule Networks integrated with LSTM Networks. This model exploits the inconsistencies and identifies real and fake videos and is our contribution towards deepfake detection. Using visualization of the capsule's activation, we understand what features the capsules learn and provide an explanation for identifying deepfakes and real videos. Using 3 different frame selection techniques, we also show that frame selection has a significant impact on performance. With almost comparable performance with the state-of-the-art model, in contrast to the size, our model has 1/5th the number of parameters and 1/4th the size of the state-of-the-art model and hence, is a lighter model and has reduced computational cost.

MATIC BIZJAK - MODEL DISTILLATION FOR SCLERA BIOMETRICS

Full Title: Knowledge distillation of deep learning models for sclera biometrics
Institution: University of Ljubljana
Supervisor: Vitomir Štruc and Peter Peer
URL: https://repozitorij.uni-lj.si/IzpisGradiva.php?id=121899&lang=eng
Link description: Link to thesis PDF in slovene
Contact email: vitomir.struc@fe.uni-lj.si

Abstract:
Knowledge distillation is a technique for the development of lightweight models by transferring knowledge from a deep model with high memory footprint and high computational complexity. In this work we evaluate knowledge distillation for eye biometrics. We propose a new algorithm for creating a lightweight model for sclera segmentation by combining knowledge distillation with filter pruning and show that both techniques are key to achieving good results. With the presented algorithm we remove 74% floating point operations needed for one inference and 73.2% parameters and sacrifice 1.27% of the accuracy. In addition, we remove twice as many parameters as the current state-of-the-art filter pruning approach and in comparison sacrifice 1.74% of the accuracy. In the light of this comparison, we identify possible improvements that have a potential to further increase the accuracy of our algorithm.

SHUNXIN WANG - GENDER OBFUSCATION THROUGH FACE MORPHING

Full Title: Gender Obfuscation Through Face Morphing
Institution: University of Twente
Supervisor: Raymond Veldhuis
URL: http://purl.utwente.nl/essays/83123
Link description: GENDER OBFUSCATION THROUGH FACE MORPHING
Contact email: r.n.j.veldhuis@utwente.nl

Abstract:
While facial biometric data has been widely adopted for person recognition, recent developments in machine learning show that soft biometrics such as gender, age and ethnicity can be automatically extracted from the facial photographs without permission, which raises privacy concerns. In this work, face morphing is applied to face images so that facial attributes such as gender, can no longer be deduced correctly by the corresponding attribute classifier. Meanwhile, the face images can still be used for identity verification. Experiments show that soft biometrics obfuscated through face morphing cannot be recovered or retrieved easily. It is concluded that face morphing is a good approach to protect soft biometric privacy in face images.

DEEPAK YELESHETTY - COW IDENTIFICATION

Full Title: 3D Face Recognition for Cows
Institution: University of Twente
Supervisor: Luuk Spreeuwers
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
Abstract—This master's thesis assignment presents a method to recognize cows using their 3D face point clouds. Face is chosen because of the rigid structure of the skull compared to other parts. The 3D face point clouds are acquired using a newly designed dual RGBD camera setup. After registering the 3D faces to a specific pose, the cow ID is determined by running Iterative Closest Point (ICP) method on the probe against all the point clouds in the gallery. The identification results are based on the the mean squared distance of between the ICP correspondences called inlier root mean square error (RMSE). In a closed set of 32 cows with 5 point clouds per cow in the gallery, the ICP recognition demonstrates an almost perfect identification rate of 99.37% to 100%.

MATIC BIZJAK - SCLERA BIOMETRICS

Full Title: Knowledge distillation of deep learning models for sclera biometrics
Institution: University of Ljubljana
Supervisor: Peter Peer, Vitomir Štruc
URL: https://repozitorij.uni-lj.si/IzpisGradiva.php?id=121899&lang=slv
Link description: Link to thesis PDF in slovene
Contact email: vitomir.struc@fe.uni-lj.si

Abstract:
Knowledge distillation is a technique for the development of lightweight models by transferring knowledge from a deep model with high memory footprint and high computational complexity. In this work we evaluate knowledge distillation for eye biometrics. We propose a new algorithm for creating a lightweight model for sclera segmentation by combining knowledge distillation with filter pruning and show that both techniques are key to achieving good results. With the presented algorithm we remove 74% floating point operations needed for one inference and 73.2% parameters and sacrifice 1.27% of the accuracy. In addition, we remove twice as many parameters as the current state-of-the-art filter pruning approach and in comparison sacrifice 1.74% of the accuracy. In the light of this comparison, we identify possible improvements that have a potential to further increase the accuracy of our algorithm.

THOMAS ELBO - CROSS-LINGUAL SPEAKER VERIFICATION

Full Title: Cross-lingual Speaker Verification using Deep Learning Approach
Institution: DTU and NTNU
Supervisor: Christoph Busch and Raghavendra Ramachandra
Contact email: christoph.busch@ntnu.no

Abstract:
In a world where security is receiving increased attention, the research areas of biometric authentication systems are experiencing rapid growth. One of these areas is Automatic Speaker Verification systems (ASV systems), which authenticate a person by recognizing their speech. However, such systems have a problem: They do not perform well when enrolling a person with one language and validating using another language. This thesis brings the research area forward by doing comparative testing on the pre-trained x-vector models for SRE16 and VoxCeleb created by Snyder et al., using two new multi-lingual datasets, SPARC and SWAN. Furthermore are two feature extraction methods, the Glottal Flow Cepstral Coefficients and the Residual Phase Cepstral Coefficients, implemented. The tests on the x-vector models include different combinations of channels and languages. Both models showed that the language used in enrollment and validation had a high impact on performance, and validating with a previously unseen language further degraded system performance.

JOÃO MACHADO - EXTRACTION OF BIOMEDICAL INDICATORS FROM GAIT VIDEOS

Full Title: Extraction of Biomedical Indicators from Gait Videos
Institution: ISCTE - Instituto Universitário de Lisboa
Supervisor: Luís Ducla Soares, Paulo Lobato Correia
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Abstract:
Gait has been an extensively investigated topic in recent years. Through the analysis of gait it is possible to detect pathologies, which makes this analysis very important to assess anomalies and, consequently, help in the diagnosis and rehabilitation of patients. There are some systems for analyzing gait, but they are usually either systems with subjective evaluations or systems used in specialized laboratories with complex equipment, which makes them very expensive and inaccessible. However, there has been a significant effort of making available simpler and more accurate systems for gait analysis and classification. This dissertation reviews recent gait analysis and classification systems, presents a new database with videos of 21 subjects, simulating 4 different pathologies as well as normal gait, and also presents a web application that allows the user to remotely access an automatic classification system and thus obtain the expected classification and heatmaps for the given input. The classification system is based on the use of gait representation images such as the Gait Energy Image (GEI) and the Skeleton Gait Energy Image (SEI), which are used as input to a VGG-19 Convolutional Neural Network (CNN) that is used to perform classification. This classification system is a vision-based system. To sum up, the developed web application aims to show the usefulness of the classification system, making it possible for anyone to access it.

NICOLE BELVISI - DIGITAL FORENSICS THROUGH TEXTUAL ANALYSIS

Full Title: Document Forensics Through Textual Analysis
Institution: Halmstad University
Supervisor: Naveed Muhammad
URL: http://urn.kb.se/resolve?urn=urn:nbn:se:hh:diva-40157
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Abstract:
This project aims at giving a brief overview of the area of research called Authorship Analysis with main focus on Authorship Attribution and the existing methods. The second objective of this project is to test whether one of the main approaches in the field can be still be applied successfully to today's new ways of communicating. The study uses multiple stylometric features to establish the authorship of a text as well as a model based on the TF-IDF model.

IRFAN DWIKI BHASWARA - AUTO ENCODERS FOR FACE RECOGNITION

Full Title: Exploration Of Autoencoder As Feature Extractor For Face Recognition System
Institution: University of Twente
Supervisor: Raymond Veldhuis
URL: http://purl.utwente.nl/essays/83138
Link description: EXPLORATION OF AUTOENCODER AS FEATURE EXTRACTOR FOR FACE RECOGNITION SYSTEM
Contact email: r.n.j.veldhuis@utwente.nl

Abstract:
Face recognition has been a challenging research problem due to many variations, for example occlusions, illuminations, poses, and expressions. In this paper, we review one of the unsupervised learning methods called autoencoder to be used as feature extractor for face recognition system. We explore several types of autoencoder, including regular and generative model, and take quantitative measurements on reconstruction and recognition of face images. Experimental results on Face Recognition Grand Challenge dataset show that there is a potential ability in using autoencoder as feature extractor for face recognition. Furthermore, apart from the latent variable dimensions, the encoder and decoder network of the autoencoder have an important role in the reconstruction and recognition performance. We also found that generative autoencoder model gives better clustering against identity of a subject. In addition, we apply residual network in the generative autoencoder model. We called this Resnet-WAE. It performs better in reconstruction and recognition and achieves area under the curve score of 0.8763 using likelihood ratio classifier. In the end, Resnet-WAE demonstrates promising results of using generative model as feature extractor in face recognition system.

AART STUURMAN - EVIDENTIAL VALUE OF FINGERMARKS

Full Title: Improving Frequency Estimation Of Fingerprint Minutia Configurations Using Automated Pre-selection
Institution: University of Twente
Supervisor: Raymond Veldhuis
URL: http://purl.utwente.nl/essays/82516
Link description: IMPROVING FREQUENCY ESTIMATION OF FINGERPRINT MINUTIA CONFIGURATIONS USING AUTOMATED PRE-SELECTION
Contact email: r.n.j.veldhuis@utwente.nl

Abstract:
Likelihood ratio based statistical reporting on the comparison of fingerprints is thought to convey more information than traditional discrete reports such as a yes or no answer. Additionally, using a weight for each minutia based on their rarity improves the precision of the comparison process. During this research a tool was designed that assists in estimating the rarity of configurations of one or two minutiae with a core or delta as a reference position. It performs a pre-selection of fingerprints from a database by utilizing an existing minutia extraction and encoding tool and using an orientation and pixel position based matching technique. The found fingerprints are expected to be further examined manually, but since part of the database is automatically discarded the workload is reduced. The minimum requirements set are shown to be marginally reached, after which the shortcomings of the implementation are analyzed, and additional and alternative techniques are introduced that are expected to improve the tool's performance.

THOMAS REESINK - 3D FACE FROM 2D USING GANS

Full Title: Creating 3d Faces From 2d Images Using Gans
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/81483
Link description: CREATING 3D FACES FROM 2D IMAGES USING GANS
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
This research looks into the viability of generating realistic 3D data based on a single 2D image by means of Generative Adversarial Networks. Many existing methods for generating 3D faces from 2D information require models, making them lose detail as they tend to smooth identifying traits. This research aims to make a system which generates raw 3D data and does not require a predefined model. This is achieved by utilizing Generative Adversarial Networks (GANs) which can generate convincing samples based on a given dataset. By conditioning the GAN it is possible to base the generated 3D data on a given 2D image. In order to objectively measure the quality of 3D data generated by its models, this research trains its models using 3D facial data and uses 3D facial recognition to verify its results. Using 3D facial recognition on the generated samples allows for comparison between methods as well as new insights. By transforming 3D to a 2D matrix it was possible to train a conditional Wasserstein GAN to produce 3D data which could be correctly identified in 63.3% of the cases.

SRIRAM NATARAJAN - LEARNED CLUSTERING FOR 3D OBJECT SEGMENTATION

Full Title: Learned Clustering For 3d Object Segmentation
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/82920
Link description: LEARNED CLUSTERING FOR 3D OBJECT SEGMENTATION
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Abstract:
Applications related to autonomous driving, urban planning and asset monitoring rely on accurate information about the objects and their location in real world coordinates. Identifying stationary objects is one such application that finds importance in urban planning and asset monitoring, for instance: detection of roadside billboards, lamp posts etc. With the availability of point cloud representations of the environment, several approaches have been proposed for detection and segmentation of stationary objects in 3D. The detection of billboards is one such application which is challenging because of its incoherent visibility in multi-view images and absence of depth information due to its shape. This paper proposes Joint SPLATNet3D for semantic-instance segmentation of stationary objects in the scene. The proposed network performs two tasks: predicts a semantic label and generates an instance embedding for every 3D point. The multi-task loss function enables the network to jointly optimize the two tasks. This paper describes the dataset generation and feasibility study of semantic and instance segmentation for billboards. The paper gives a comparative analysis of Joint SPLATNet3D and MT-PNet for both the tasks. Preliminary experiments on semantic segmentation show that SPLATNet3D gives an average IoU of 75% in comparison with MT-PNet which gives an IoU of 46%. Experiments on joint training show that Joint SPLATNet3D gives an IoU of 68% in comparison with MT-PNet which gives an IoU of 48% for semantic segmentation. The results of instance segmentation for both the networks do not show good improvements for this dataset.

RIEN HEUVER - MORPHING IN LATENT FACE SPACE

Full Title: Rien Heuver
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/81372
Link description: GENERATING FACIAL MORPHS THROUGH PCA AND VAE
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
Morphing attacks currently are a threat to face identification systems, which is why various morph detection systems are being investigated. The most-used method for morphing is the landmark-based method. Therefore, it is possible that novel morph detection systems are overfitted to detect landmark-based morphs. This research addresses methods to construct fundamentally different morphs using latent spaces. One approach uses Principal Component Analysis (PCA) for generating morphs. We found that PCA is not suitable and explain why. We also used a Variational Auto Encoder (VAE) to create a method for creating morphs through latent spaces which was more successful. The resulting morphs are not convincing enough to fool an existing face recognition system, but they are close. These VAE-based morphs were tested on an existing morph detection system, which was trained on landmark-based morphs, and it was not able to detect any of the novel morphs we created using the VAE-based method.

SHU YU - DEEP LEARNING FOR FINGERPRINT RECOGNITION

Full Title: Fingerprint Recognition Based On Spectral Minutiae Representation And Deep Learning
Institution: University of Twente
Supervisor: Raymond Veldhuis
URL: http://purl.utwente.nl/essays/85579
Link description: FINGERPRINT RECOGNITION BASED ON SPECTRAL MINUTIAE REPRESENTATION AND DEEP LEARNING
Contact email: r.n.j.veldhuis@utwente.nl

Abstract:
This paper proposes to apply spectral minutiae representation and deep learning for fingerprint recognition. The fingerprint is one important biometric feature, and its recognition typically incorporates four steps: image acquisition, processing, feature extraction, and comparison. The powerful functionality of deep learning in imaging processing makes it plausible to recognize the fingerprint patterns. Conventionally, deep learning has mainly been used to extract the minutiae or the feature vectors from raw fingerprint images. There has been no hybrid use of the two. In this paper, we propose to use the spectral minutiae representation and the convolutional neural network (CNN) in combination to advance direct matching of spectral minutiae representation in fingerprint recognition. In the proposed approach, a minutia set is represented by a spectrum with a fixed size, specifically, this spectral minutia representation converts a minutiae set into a 128×256 sized magnitude spectrum. This spectrum serves as the input to CNN, while the output of CNN is a 128-dimensional feature vector. The fingerprint recognition is then completed by feature vector comparison. In this paper, the CNN with 19 layers is used and the whole network is trained by triplet loss. This proposed approach makes the fingerprint recognition using CNN more efficient, as no complicated pre-processing is needed compared to process endowing raw images to CNN. The performance of the proposed approach is compared to direct matching of complex spectral minutiae representation.

ALEXANDRU MORARU - CONE-BEAM COMPUTED TOMOGRAPHY

Full Title: Iterative Computed Tomography Reconstruction Using Deep Learning
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: https://essay.utwente.nl/85407/
Link description: ITERATIVE COMPUTED TOMOGRAPHY RECONSTRUCTION USING DEEP LEARNING
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
In computed tomography it is important not only to obtain images of good quality but also to minimize the radiation dose given to the patient. Research efforts are dedicated to increase the quality of the reconstructed images and minimize the radiation exposure. This work addresses the problem of reducing the dose by using deep learning to correct the update term of the simultaneous iterative reconstruction technique (SIRT). The aim is to improve the output of the backprojection operator which does not rely on any prior knowledge about the object and distributes all the rays back into the volume under reconstruction uniformly. We propose a deep learning solution to correct the update term of the SIRT algorithm after the backprojection operator has been applied with the purpose to increase the image quality. We evaluate the quality of the images obtained with the proposed method using similarity measures between the low dose reconstructions obtained with the proposed method and the high dose reconstructions taken as ground truth. We also investigate whether the iterative scheme converges faster with the proposed modification. We obtained a structural similarity index (SSIM) of 0.725, a peak signal-to-noise ratio (PSNR) of 29.42 dB and a mean absolute error (MAE) of 92.69 HU which indicates that our method performs better than the classical SIRT algorithm. We also demonstrated that the proposed iterative scheme has the side benefit that it converges faster, achieving with three iterations the similarity that is obtained with the classical scheme with 115 iterations.

MATHIAS IBSEN - TATTOS AND FACE RECOGNITION

Full Title: Impact of Facial Tattoos on Face Recognition Systems
Institution: Hochschule Darmstadt and DTU
Supervisor: Christian Jensen, Christoph Busch, Christian Rathgeb and Pawel Drozdowski
Contact email: mathias.ibsen@h-da.de

Abstract:
Biometric systems are widely used for automated recognition of individuals based on their biological and behavioural characteristics. A popular biometric approach is face recognition which accurately and conveniently can recognise individuals based on face characteristics. Recent advances in deep learning techniques have meant that modern face recognition systems are able to use large face databases to learn complex representation of faces and as such have achieved good performance on several challenging data-sets. However, these state-of-the-art face recognition systems have shown to be vulnerable to different kind of face manipulations like plastic surgery, makeup and facial retouching. Therefore, facial tattoos are expected to have an impact on the performance of face recognition systems, but this is yet to be investigated. The research in this thesis, therefore, investigates the impact of facial tattoos on face recognition systems. To do this, a categorisation of tattoos is defined and used to collect appropriate tattoo templates from different sources. Thereafter, different databases containing facial images with tattoos are created synthetically by blending tattoos to facial images without tattoos. The created databases, of facial images with tattoos, are used to evaluate the impact that facial tattoos have on face recognition systems by comparing the performance of the created databases on six different face recognition systems with the performance of the same facial images without tattoos. Obtained results show that facial tattoos affect both the tested commercial and open-source systems, especially for facial images with high intensities of tattoos and when facial images with tattoos are compared to more unconstrained probe images without tattoos. Moreover, some of the tested face recognition and detection algorithms have shown to be particularly vulnerable to facial tattoos portraying human faces for which a significant performance drop was revealed compared to the baseline experiments.

ANKA KAVČIČ - FACE SUPER-RESOLUTION

Full Title: Analysis of bias in deep learning models for face super-resolution
Institution: University of Ljubljana
Supervisor: Vitomir Štruc
URL: https://repozitorij.uni-lj.si/IzpisGradiva.php?id=122944&lang=slv
Link description: Link to thesis PDF in slovene
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Abstract:
The goal of super-resolution is to obtain a high-resolution (HR) image from a low-resolution image (LR). Super-resolution techniques are used in several areas, e.g. to improve the quality of image data for object detection in images, face recognition in surveillance images, medical images, astronomical images, and forensics. Super-resolution is inherently ill-posed. Instead of one solution, there are several HR images that equally well explain a given LR image. The severity of the problem increases with an increasing scale factor. In addition, it is difficult to assess the quality of the output, as numerical metrics do not correspond completely to human perception.

The most advanced models in this field are based on learning from pairs of LR and HR images. Because such learning depends on the characteristics of the data, existing models are not equally successful in all types of images and consequently exhibit a certain type of bias. In this thesis, we analyze the bias of five state-of-the-art super-resolution models. We use various metrics from the literature to measure the performance of the models. In addition to the bias analysis, we also analyze the impact of use of super-resolution techniques on the performance of a face detector on very small facial images that were enhanced with super-resolution models. Finally, face recognition performance is studied on super-resolved images.

KARINA KNUDSEN - FINGERPRINT PAD

Full Title: Improving Fingerprint Presentation Attack Detection using Deep Learning and Computer Vision
Institution: Hochschule Darmstadt
Supervisor: Jascha Kolberg
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Abstract:
The purpose of this thesis is to explore different options that can help improve the performance of fingerprint presentation attack detection (FPAD) methods. Two specific approaches are chosen due to their novelty and explained in depth from a theoretical perspective and an attempt at an implementation is made. First of all, a regular feed forward neural network (FFNN) is trained to learn how to classify images of fingerprints to either be real or fake. This is done based on certain features that are extracted from known computer vision methods. Another strategy, based on the latest research in deep learning, is improving FPAD through expanding on the training data using a deep convolutional generative adversarial network (DCGAN). Theoretically, the DCGAN should be able to generate artificial images of both real and fake fingerprints, which in turn can be used to train a convolutional neural network (CNN) for classification. The motive behind this method is first of all that increasing the amount of training data should improve the performance of the CNN and thus help make the most of the data available. Second of all, it also addresses the privacy concerns related to storing a large database of fingerprints as fingerprint images generated by a DCGAN does not belong to a person who can be compromised. However, despite being founded on a strong theoretical basis, the implementations of these two models turns out not to yield results as expected. Particularly, the DCGAN encounters issues that are known from research to be challenging in order
to make the DCGAN converge. Therefore, different techniques on how to mitigate these problems are proposed for further work instead.

MARCEL GRIMMER - DETECTING UNKNOWN FINGERPRINT PRESENTATION ATTACKS

Full Title: Unknown Fingerprint Presentation Attack Detection Using Convolutional Autoencoders
Institution: Hochschule Darmstadt
Supervisor: Christoph Busch and Jascha Kolberg
Contact email: christoph.busch@h-da.de

Abstract:
The increasing popularity of biometric authentication systems simultaneously raises privacy and security issues. Among other vulnerabilities, presentation attacks (PAs) that are directed to the capture device pose a severe threat. In order to be prepared against such attacks, presentation attack detection methods are deployed. However, due to the variety of materials that can be used to fabricate a presentation attack instrument (PAI), the classification models must be designed to also protect against unknown presentation attacks.
The contribution of this thesis is the development of an unsupervised learning technique based on Convolutional Autoencoders and finger images stemming from two novel sensor technologies: Laser Speckle Contrast Imaging and Multi-Spectrum Short-Wave Infrared. On an experimental evaluation over a database of 19,598 bona fide images and 4, 226 PAs, including 43 unique PAIs, an average detection equal error rate of 2.47% could be achieved.

BEEREND GERATS - HUMAN ACTIVITY DETECTION IN SOCCER

Full Title: Individual Action And Group Activity Recognition In Soccer Videos
Institution: University of Twente
Supervisor: Luuk Spreeuwers
URL: http://purl.utwente.nl/essays/84038
Link description: INDIVIDUAL ACTION AND GROUP ACTIVITY RECOGNITION IN SOCCER VIDEOS
Contact email: l.j.spreeuwers@utwente.nl

Abstract:
Data and statistics are key to soccer analytics and have important roles in player evaluation and fan engagement. Automatic recognition of soccer events - such as passes and corners - would ease the data gathering process, potentially opening up the market for non-professional soccer analytics. We propose a novel method for the automatic recognition of soccer events from video. To the best of our knowledge, it is the first method that infers both individual actions and group activities simultaneously from soccer videos. Three key contributions in the proposed method are (1) the use of player-centric snippets as model input, (2) per-player feature extraction with an I3D CNN - based on RGB video and optical flow - and (3) the use of feature suppression and zero-padding in graph attention networks for feature contextualisation. The results show that the proposed method performs better than an alternative state-of-the-art method, designed for action and activity recognition in volleyball. Our method gains 98.7% accuracy for the recognition of eight actions and 75.2% for eleven activities.

MARTA BLAZQUEZ - STATIC SIGNATURE VERIFICATION

Full Title: Verificacion de firma manuscrita estatica mediante redes neuronales convolucionales - Verification of static handwritten signature using convolutional neural networks.
Institution: Universidad Autonoma de Madrid – BiDA Lab
Supervisor: Ruben Vera-Rodriguez
URL: https://repositorio.uam.es/handle/10486/687091
Contact email: marta.blazquezc@estudiante.uam.es

Abstract:
The research in deep neural networks has produced a great improvement in the world of biometrics. Facial recognition systems are used more often and require a higher accuracy. A common way of improving these systems is the reinforcement through characteristic attributes from each person which are known as soft biometrics. The gender, age or ethnic group are the most common attributes.

Analyzing the performance of facial recognition systems, differences are observed within each demographic group. Considering the gender, women obtain the worst results. Regarding the ethnicity group, dark skin persons or Asian have more difficulties in the facial recognition. This problem is mainly due to the training sets used for the learning process of the models. These are not usually balanced and that is reflected in the results obtained for each class. Usually datasets include more men and more white race identities.

In this project, specific models are developed for the demographic groups of gender and ethnicity. The experimental results show that using trained models with images from a single class, it is possible to the performance of a generic facial recognition system trained with images from all classes. Two estimators for the gender and ethnic group attributes are also proposed. System performance is compared when race and gender information is obtained automatically or manually, through label. Moreover, a more complete system is proposed combining gender and ethnic group information. Proposing a fusion of this information at the scores or the features level.

MONITOR
BACHELOR-THESES

THOMAS FINK - IMPACT OF FACIAL TATTOOS AND PAINTINGS ON FACE RECOGNITION

Full Title: Impact of Facial Tattoos and Paintings on Face Recognition
Institution: Hochschule Darmstadt
Supervisor: Christoph Busch and Christian Rathgeb
Contact email: christian.rathgeb@h-da.de

Abstract:
This thesis deals with the effects of facial tattoos and facial painting on the different processing steps of facial recognition systems. For this purpose, a database of image pairs was created, each of which represents an individual with and without facial tattoo or painting. The database was categorized and then subjected to face detection and quality assessment. In addition, the image pairs were compared and the recognition performance was calculated. The evaluated results showed that facial tattoos and paintings have measurable negative effects on all processing steps investigated. Furthermore, it can be seen that the effects deteriorate with the size of the tattoos or paintings.

TOMAŽ ČRNIGOJ - EAR RECOGNITION

Full Title: Comparative analysis of automatic ear recognition techniques
Institution: University of Ljubljana
Supervisor: Vitomir Štruc
URL: https://repozitorij.uni-lj.si/IzpisGradiva.php?id=119079&lang=slv
Link description: Link to thesis PDF in slovene
Contact email: vitomir.struc@fe.uni-lj.si

Abstract:
In this thesis we focus on recognition of subjects using ear images; more accurately, we focus on evaluation of four algorithms, used as feature extractors, which can be uses for either identification or verification with ear images. The four algorithms are: Local Binary Patterns – LBP, Local Phase Quantisation – LPQ, Histogram of Oriented Patterns – HOG and Gabor wavelets (also Gabor). Our main tool for evaluating algorithm success is the Receiver Operating Characteristic (ROC) curve. We compare algorithms with respect to overal recognition performance, but also with respect to performance in the presence of variou covariates. Finally, we study the impact of demographic attributes, such as gender and ethnicity on the performance achieved with the considered feature extractors.

FABIAN STOCKHARDT - ACCERLATING FACIAL IDENTIFICATION

Full Title: Accerlating Facial Identification with Morphing
Institution: Hochschule Darmstadt
Supervisor: Christoph Busch and Pawel Drozdowski
Contact email: christoph.busch@h-da.de

Abstract:
Despite steadily increasing computational power, increasing numbers of subjects in data sets can cause identification systems such as face recognition to take a unreasonable long time to produce results. This is mainly due to the fact that the systems have to compare the input subject to every person contained in the data set in order to perform a comprehensive identification. In this thesis the so-called "morph acceleration" method is covered, which is able to reduce the number of comparisons needed for identification by fusing subjects at the sample level. Previous experiments on this method have shown that it is possible to reduce the number of comparisons, but the identification rate is also reduced. In this thesis alternative methods for the morph pair selection are proposed and tested on various combinations of face recognition and morphing systems. These methods enable the morphing acceleration to improve the morph-acceleration system in such a way, that a reduction of comparisons can be achieved without a loss in identification rate.

SIRI LORENZ - MORPHING ATTACK DETECTION

Full Title: A Fusion Approach to Morphing Attack Detection
Institution: Hochschule Darmstadt
Supervisor: Christoph Busch and Ulrich Scherhag
Contact email: christoph.busch@h-da.de

Abstract:
Morphing Attack Detection is a current field of research. Morphing is the targeted combination of several images, for example of human faces. These morphed images can be used during the passport application process. All subjects contained in the morph can be recognised by existing face recognition systems and as a result (automatic) border controls can be circumvented. A number of studies have shown that existing face recognition systems and human experts can be deceived by morphed images. Based on this finding, various approaches for morphing as well as for the automatic recognition of morphing attacks have been published. Automated morphing detection is still a young branch of research with many recent publications.
During the previous internship we were given features extracted from various images using different feature extractors: ArcFace, FaceNet, Eyedea, LM-Wing, LM-Dlib, LBP13, LBP43, BSIF13 and BSIF43. This thesis will fo- cus on developing a fusion approach to Morphing Attack Detection using scores generated based on different classifiers with optimised hyperparameters. Four different algorithms were used for classification, namely: Support Vector Machines, Random Forest, AdaBoost and GradientBoosting. The hyperparameters were optimised in three different ways: using grid-search, an evolutionary approach, and bayesian optimisation. We used different fusion techniques and compared their results. Our focus in this work was score-level fusion and sum-rule - an equally weighted sum-rule and two non-equally weighted sum-rules were used for fusion. One of the non-equally weighted approaches finds its weights using grid-search and the other using random forest. We noticed that not using equal weights achieves better results and even though grid-search weights might lead to better results than random forest weights, grid-search is more time-consuming. However, both random forest and grid-search weights can significantly improve the Detection Equal Error Rate.

DOMINIK BÖTTINGER - DETECTION OF ADVERSARIAL SAMPLES

Full Title: Einfluss der Farbkanäle auf die Detektion von Adversarial Samples
Institution: Hochschule Darmstadt
Supervisor: Christoph Busch and Ulrich Scherhag
Contact email: christoph.busch@h-da.de

Abstract:
Due to the increasing use of autonomous systems for the authentication of images, e.g. in the areas of facial recognition or autonomous driving, the importance of attacks through adversarial samples is also increasing. In the following, the detection of adversarial samples in face recognition will be examined in more detail. One approach would be to remove the adversarial pattern from the images or to reduce the influence of the pattern so that the original image is recognised as such. In this context, an investigation of the influence of the colour channels of the Adversarial Pattern on the information change of the original image is promising, since the colour channels are known to date as the simplest and most significant disturbance of image recognition. Based on the findings, a test will be developed to distinguish the adversarial samples from the original images. Furthermore, the presented approach will be evaluated on self-made adversarial samples of visual images.

FELIX OHMS - TOUCHLESS FINGERPRINT CAPTURING USING SMARTPHONES

Full Title: Integrated Quality Assessment of mobile touchless Fingerprint capturing using Android Smartphones
Institution: Hochschule Darmstadt
Supervisor: Christoph Busch and Jannis Priesnitz
Contact email: christoph.busch@h-da.de

Abstract:
In recent years fingerprint technology has become a widespread means of securing data, objects and locations. This is largely due to the ease of using it, the low chance of losing the authenticating key, a finger, to a key or a password, and the hardships that come with mounting an attack on such a system. All these factors combined make for a relatively secure technology, making fingerprints a solid choice for security needs.
However, it is far from perfect as there is still room to improve aspects, like the usability. Previously, when a fingerprint needed to be acquired specialised sensors were required which mandated direct contact with the fingertips. This made the acquisition fairly cumbersome, as the user needed to touch a specific surface in a specific way for the sensor to produce useable data. This is even more of an issue when fingerprints should be acquired from more than one finger, as they could either be done in sequence, which would dramatically increase the needed time, or require a larger sensor with a shape which permits comfortable placement of all fingers with all fingerprints touching a surface with a sensor, all scaleable for different hand sizes, which would dramatically increase the price of the sensor. Due to these factors attention has recently been given to touchless acquisition of fingerprints, which allows capturing many fingerprints at once with only a camera. Touchless acquisition presents its own, unique set of challenges as matching algorithms need highlighted minutiae, well defined areas and large contrasts. Therefore any image captured by a normal camera needs to be processed before it can be given to matching algorithm. A smartphone application aimed at solving exactly this has been developed in a previous Master Thesis. This projects expands upon that application by designing a logging module with a modern approach to logging design and development. Alongside the module logging guidelines and examples are proposed. The logging module is then used to analyse the processing pipeline of the application and identify two weak spots in its performance. These are then improved upon and the analysis performed again to measure the improvement to the processing time.