Guido Borghi

Curriculum Vitae

✉ *guido.borghi@unibo.it*
Research Keywords: Computer Vision,
Deep Learning, Biometrics, Continual Learning
Face Analysis, Depth Sensors, 3D Vision

Research Experience

2021 - curr. **Assistant Professor (RTD-A)**.
Department of Computer Science and Engineering, University of Bologna, Italy
Research Title: *Image Manipulation Attack Resolving Solutions* (Horizon2020 European Project)
Research Topics: Continual Learning, Human-Computer Interaction, Face Morphing Attack Detection

2020 - 2021 **Postdoctoral Fellow**.
Department of Computer Science and Engineering, University of Bologna, Italy
Research Title: *Biometry and Machine Learning*
In collaboration with the italian *State Mint and Polygraphic Institute* (IPZS SpA)
Research Topics: Face Morphing Attack Detection

2019 - 2020 **Postdoctoral Fellow**.
Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia, Italy
Research Title: *Anomaly Detection on Italian railways*
In collaboration with *Italian Railways* (RFI SpA)
Research Topics: Anomaly Detection, Human Pose Estimation

2020 **Short Research Activity**.
Artificial Intelligence Research and Innovation Center, University of Modena and Reggio Emilia, Italy
Research Title: *Generation of a synthetic dataset for the Human-Robot Interaction*
Research Topics: Human-Robot Interaction

Education

2015 - 2019 **PhD in Information and Communication Technologies (ICT)**.
Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia
Research Title: *3D Vision for Human Computer Interaction*
Research Topics: Head Pose Estimation, Face Analysis (Face Detection and Recognition, Facial Landmarks, Sentiment Analysis) from RGB, depth and thermal images
Supervisors: Prof. Rita Cucchiara, Prof. Roberto Vezzani

2017 - 2018 **Visiting Student Researcher at Stanford**.
Stanford University, California (USA)
Research Project: *Head Pose and Fine Gaze Estimation for Human-Robot Interaction*
Supervisor: Prof. Silvio Savarese (Stanford Vision and Learning lab)

2012 - 2015 **Master Degree in Computer Engineering**.
Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia
Thesis title: *Gesture Classification and Segmentation for Human Computer Interaction*
Supervisor: Prof. Rita Cucchiara, Prof. Roberto Vezzani

2009 - 2012 **Bachelor Degree in Computer Engineering**.
Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia
Thesis title: *Simulation and implementation of a 32 bit CPU with VHDL*
Supervisor: Prof. Costantino Grana

2005 - 2009 **Classical High School Diploma**.
High School "L.A.Muratori", Modena, Italia

Academic Activities

2022	Guest Editor of the SI "Computer Vision in Human Analysis: From Face and Body to Clothes" (MDPI Sensors)
2022	Member of the Organizing Committee of the WCPA workshop (ECCV 2022)
2022	Member of the Organizing Committee of the 2nd T-CAP workshop (ICPR 2022)
2022	Associate Editor of *Simulation&Gaming* (SAGE) journal
2021	Member of the Organizing Committee of the 1st T-CAP workshop (ICIAP 2022)
2021	Member of the Grading Committe for PhD defenses (University of Coruna)
2020	Member of the Technical Program Committee of 3DHU 2020 workshop (ICPR 2020)
2020	Guest Editor of the SI "People Detection and Analysis Using Depth Sensors" (MDPI Sensors)
2020	Member of the Topics Board in the Journal of Imaging (MDPI)
2018 - 2021	Member of the RedVision laboratory, in collaboration with *Ferrari SpA*

Academic Services

Journal and Conference Reviewing.
- IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)
- IEEE Transactions on Biometrics, Behavior, and Identity Science (TBIOM)
- Multimedia Tools and Applications
- Machine Vision and Applications
- ACM Transactions on Intelligent Systems and Technology
- IEEE Sensors Letters
- MDPI Sensor Journal
- Conferences: CVPR, ICCV, ECCV, ICPR, ICIAP

Invited Speaker, Seminars.
- Invited Talk: "The state-of-the-art Driver Monitoring systems and future ADAS" (Pi School, Italy)
- Tutorial: "Human Pose Understanding on Depth Maps" (IEEE FG International Conference, France)
- Invited Talk: "Depth based Vision for Driver Monitoring" (University of Modena and Reggio Emilia)
- Invited Talk: "Deep Depth Vision for Driver Attention Monitoring" (Univ. Politecnica delle Marche)
- Invited Talk: "Person analysis and Human-Computer Interaction" (Fondazione Moro, Italy)
- Presentation Talk: "Head Pose Estimation and Gaze Detection" (Stanford University, USA)

Thesis co-Advisor.
- Riconoscimento di volti morphed: un approccio basato su Deep Learning (MSc)
- Analisi posturali e misure antropometriche di persone alla guida mediante telecamere ToF (MSc)
- Riconoscimento di gesti per l'interazione uomo-veicolo mediante sensori infrarossi e 3D (MSc)
- Body Pose Estimation and Hand Detection for Driver Monitoring (MSc)
- Deep learning-based framework for driver attention analysis and human car interaction (MSc)
- Analysis and Investigation of Computer Vision algorithms for driver's attention monitoring (MSc)
- Deep Learning-based Pose Estimation for Automotive (MSc)
- ADAS systems and driver's attention monitoring (MSc)

Speaker in International Conferences

2020	International Conference on Patter Recognition, Milan (Italy) Online
2020	International Workshop on Artificial Intelligence for Railways, Munich (Germany) Online
2020	International Conference on Intelligent Human Systems Integration (IHSI), Modena (Italy)
2019	International Conference on Image Analysis and Processing (ICIAP), Trento (Italy)
2018	International Conference on 3D Vision (3DV), Verona (Italy)
2018	International Workshop on Human Behavior Understanding (HBU), Xi'An (China)
2017	Intelligent Vehicles Symposium (IV), Los Angeles (CA, USA)
2016	International Conference on Pattern Recognition (ICPR), Cancun (Mexico)

Academic Teaching

2022 - 2023 **Machine Learning and Data Mining**.
Master Degree in Digital Transformation Management, University of Bologna
Module: Machine Learning. Credits: 3 CFU. Language: English

2021 - 2023 **Programming and Computer Architectures**.
Master Degree in Digital Transformation Management, University of Bologna
Module: Computer Architectures. Credits: 4 CFU. Language: English

2022 **Depth-based Computer Vision for In-vehicle Monitoring**.
Computer Science and Engineering PhD school, University of Bologna
Credits: 2 CFD (10 hours). Language: English

2021 - 2022 **Computer Architectures and Operating Systems**.
Bachelor Degree in Computer Systems Technologies, University of Bologna
30 hours, language: Italian

2020 - 2021 **Smart Technologies for Sustainable Design Laboratory**.
Master Degree in Innovation Design, University of Ferrara
Module: ICT for smart products (50 hours), language: English

2016 - 2018 **Computer Vision**.
Master Degree in Computer Engineering, University of Modena and Reggio Emilia
Laboratory Assistant, language: Italian

Side Work Experience

2019 **Visual Inspection of Medical Syringes**.
I designed and implemented a vision-based tool for the detection and the classification of gaseous nuclei during the optical inspection of syringes, filled with pharmaceutical liquids.
Companies: *G.F.* SpA, *Mimesis* Srl.

2016 - 2018 **Extraction of Foam Dynamics from Camera Images**.
I designed and implemented a vision-based software for the automatic extraction of foam levels during the filling process with different liquid types and plastic bottles.
Companies: *Sidel* SpA, *Mimesis* Srl.

2015 - 2016 **Website creation for a Master course at University of Modena and Reggio Emilia**.
I was the webmaster and also the content creator.
Company: *Fondazione Democenter-Sipe*

2012 - 2018 **Private Lessons**.
Subjects: Mathematics, Physics, Computer Science and History

Complementary Education

2021 Italian State certification exam for Engineer Profession (Association of Engineers)

2019 Advanced Course on Data Science and Machine Learning (ACDL)

2019 English Course Level B2/C1 (CLA Unimore)

2018 International Summer School on Artificial Intelligence (AI-DLDA)

2017 International Computer Vision Summer School (ICVSS)

2016 International IAPR Summer School on Machine and Vision Intelligence (VISMAC)

2016 Big Data Analytics course in collaboration with CINECA

2015 Academic English Workshop II (University of Modena and Reggio Emilia)

2015 Academic English Workshop I (University of Modena and Reggio Emilia)

Languages

Italian **Mothertongue**
English **Intermediate**

Computer Skills

Progr. Languages	Python, C++, C, Java, Javascript, SQL
Web	HTML, PHP, JSP
CV Libraries	OpenCV, Qt, Intel TBB, Kinect SDK
DL Libraries	PyTorch, Keras, TensorFlow, Theano, Avalanche

Grants and Awards

2021 1st **place in SSLAD 2021 competition** *Self-supervised Learning for Next-Generation Industry-level Autonomous Driving - Continual Classification challenge (5000$ prize)*

2020 **Best Scientific Paper Award** *25th International Conference on Pattern Recognition*, Milan Paper: *RefiNet: 3D Human Pose Refinement with Depth Maps*

2020 **Best Paper Award** *15th International Conference on Computer Vision Theory and Application*, Malta. Paper: *Learn to See by Events: Color Frame Synthesis from Event and RGB Cameras*

2018 1st **place for the best Msc Thesis** for the Road Safety. ANIA fundation. Thesis title (as co-advisor): *Studio e sperimentazione di sistemi di Visione Artificiale in ambito automotive per il monitoraggio del conducente*

2017 1st **place for the best Msc Thesis** for the Road Safety. ANIA fundation. Thesis title (as co-advisor): *Pose Estimation tramite tecniche di Deep Learning per Automotive*

2017 **Best Paper Award** *19th Int. Conference on Image Analysis and Processing*, Catania. Paper: *Learning to Map Vehicles into Bird's Eye View*

2016 Italian Supercomputing Resource Allocation (ISCRA) Grant, CINECA. In collaboration with the AImagelab research group (UNIMORE), resources of the HPC Galileo computer.

2015 3rd place in national contest *Innovaconnoi* (Telecom - TIM).

2014 1rd place in contest *Idee per Modena Digitale* (Town of Modena)

Publications and Patents

Patents

Patent number 102018000008237 (24/08/2020) Titolo: *A system for People Identification in low-light Environments*. Inventors: Guido Borghi, Stefano Pini, Filippo Grazioli, Roberto Vezzani, Rita Cucchiara.

Journals

1. M. Emporio, A. Caputo, A. Giachettia, M. Cristani, G. Borghi et al. *SHREC 2022: Track on online detection of heterogeneous gestures*. Computers & Graphics Journal, 2022. DOI: 10.1016/j.cag.2022.07.015

2. Alessandro Simoni, Stefano Pini, Guido Borghi, Roberto Vezzani *Semi-Perspective Decoupled Heatmaps for 3D Robot Pose Estimation from Depth Maps*. IEEE Robotics and Automation Letters (RA-L), 2022.

3. Graffieti Gabriele, Borghi Guido, Davide Maltoni *Continual Learning in Real-Life Applications*. IEEE Robotics and Automation Letters (RA-L), 2022. DOI: 10.1109/LRA.2022.3167736

4. Borghi Guido, Franco Annalisa, Graffieti Gabriele, Maltoni Davide. *Automated Artifact Retouching in Morphed Images with Attention Maps*. IEEE ACCESS, 2021. DOI: 10.1109/ACCESS.2021.3117718

5. Caputo, A., Giachetti, A., Soso, S., Pintani, D., D'Eusanio, A., Pini, S., Borghi G. et al. *SHREC 2021: Track on Skeleton-based Hand Gesture Recognition in the Wild*, Computers & Graphics Journal, 2021. DOI: 10.1016/j.cag.2021.07.007

6. Borghi Guido, Pancisi Emanuele, Ferrara Matteo, Maltoni Davide. *A Double Siamese Framework for Differential Morphing Attack Detection*, MDPI Sensors, 2021. DOI: 10.3390/s21103466

7. Pini Stefano, Borghi Guido, Vezzani Roberto. *Video Frame Synthesis combining Conventional and Event Cameras*, International Journal of Pattern Recognition and Artificial Intelligence, World Scientific Publishing, 2021. DOI: 10.1142/S0218001421600132

8. Pini Stefano, Borghi Guido, Vezzani Roberto, Davide Maltoni, Rita Cucchiara. *A Systematic Comparison of Depth Map Representations for Face Recognition*, MDPI Sensors, 2021. DOI: 10.3390/s21030944

9. Borghi Guido, Pini Stefano, Vezzani Roberto, Cucchiara, Rita. *Driver Face Verification with Depth Maps*, MDPI Sensors, 2019. DOI: 10.3390/s19153361

10. Borghi Guido, Matteo Fabbri, Roberto Vezzani, Simone Calderara, Cucchiara Rita. *Face-from-Depth for Head Pose Estimation on Depth Images*. IEEE Transaction of Pattern Analysis and Machine Intelligence (IEEE TPAMI), 2018. DOI: 10.1109/TPAMI.2018.2885472

11. D'Eusanio Andrea, Simoni Alessandro, Pini Stefano, Borghi Guido, Vezzani Roberto, Cucchiara Rita. *Multimodal Hand Gesture Classification for the Human-Car Interaction*, MDPI Informatics, 2020. DOI: 10.3390/informatics7030031

Conference Papers

1. Borghi Guido, Graffieti Gabriele, Franco Annalisa, Maltoni Davide. *Incremental Training of Face Morphing Detectors*. Proceedings of the 26th International Conference of Pattern Recognition (ICPR), 2022.

2. Andrea D'Eusanio, Stefano Pini, Guido Borghi, Alessandro Simoni, Roberto Vezzani *Unsupervised Detection of Dynamic Hand Gestures from Leap Motion Data*. Proceedings of the 21st International Conference on Image Analysis and Processing (ICIAP), 2022.

3. Alessandro Simoni, D'Eusanio Andrea, Pini Stefano, Borghi Guido, Vezzani Roberto. *Improving Car Model Classification through Vehicle Keypoint Localization*. Proceedings of the 16th International Conference on Computer Vision Theory and Applications (VISAPP), 2021

4. D'Eusanio Andrea, Pini Stefano, Borghi Guido, Vezzani Roberto, Cucchiara Rita. *RefiNet: 3D Human Pose Refinementwith Depth Maps*. Proceedings of the 25th International Conference of Pattern Recognition (ICPR), Milan, 2020

5. Gasparini Riccardo, D'Eusanio Andrea, Borghi Guido, Pini Stefano, Scaglione Giuseppe, Calderara Simone, Fedeli Eugenio, Cucchiara Rita. *Anomaly Detection, Localization and Classification for Railway Inspection*. Proceedings of the 25th International Conference of Pattern Recognition (ICPR), Milan, 2020

6. D'Eusanio Andrea, Simoni Alessandro, Pini Stefano, Borghi Guido, Vezzani Roberto, Cucchiara Rita. *A Transformer-Based Network for Dynamic Hand Gesture Recognition*. Proceedings of the International Conference on 3D Vision (3DV), Houston, 2020

7. Pini Stefano, D'Eusanio Andrea, Borghi Guido, Vezzani Roberto, Cucchiara Rita. *Baracca: a Multimodal Dataset for Anthropometric Measurements in Automotive*, International Joint Conference on Biometrics (IJCB), 2020

8. Gasparini Riccardo, Pini Stefano, Borghi Guido, Scaglione Giuseppe, Calderara Simone, Fedeli Eugenio, Cucchiara Rita. *Anomaly Detection for Vision-based Railway Inspection*. Proceedings of the 1st International Workshop on Artificial Intelligence for RAILwayS (AI4RAILS), Munich, 2020

9. Pini Stefano, Borghi Guido, Vezzani Roberto. *Learn to See by Events: Color Frame Synthesis from Event and RGB Cameras*, International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISAPP), Malta, 2020

10. Borghi Guido, Pini Stefano, Vezzani Roberto, Cucchiara, Rita *Mercury: a vision-based framework for Driver Monitoring*, Intelligent Human Systems Integration: Integrating People and Intelligent Systems (IHSI), Modena, 2019

11. Manganaro Fabio, Pini Stefano, Borghi Guido, Roberto Vezzani, Cucchiara Rita *Hand Gestures for the Human-Car Interaction: the Briareo dataset*. Proceedings of the 20th International Conference on Image Analysis and Processing (ICIAP), Trento, 2019

12. D'Esuanio Andrea, Pini Stefano, Borghi Guido, Roberto Vezzani, Cucchiara Rita *Manual Annotations on Depth Maps for Human Pose Estimation*. Proceedings of the 20th International Conference on Image Analysis and Processing (ICIAP), Trento, 2019

13. Pini Stefano, Borghi Guido, Roberto Vezzani, Cucchiara Rita *Video Synthesis from Intensity and Event Frames*. Proceedings of the 20th International Conference on Image Analysis and Processing (ICIAP), Trento, 2019

14. Caputo, F. M.; Burato, S.; Pavan, G.; Voillemin, T.; Wannous, H.; Vandeborre, J. P.; Maghoumi, M.; Taranta, E. M.; Razmjoo, A.; J. LaViola Jr., J.; Manganaro, F.; Pini, S.; Borghi, G.; Vezzani, R.; Cucchiara, R.; Nguyen, H.; Tran, M. T.; Giachetti, A. *Online gesture recognition*. 12th EG Workshop 3D Object Retrieval (3DOR), Genova, 2019

15. Borghi Guido, Pini Stefano, Grazioli Filippo, Vezzani Roberto, Cucchiara Rita *Face Verification from Depth using Privileged Information*. Proceedings of the 29th British Machine Vision Conference (BMVC), Newcastle, 2018

16. Pini Stefano, Grazioli Filippo, Guido Borghi, Vezzani Roberto, Cucchiara Rita *Learning to Generate Facial Depth Maps* Proceedings of the 6th international conference on 3D Vision (3DV), Verona, 2018

17. Ballotta, Diego; Borghi, Guido; Vezzani, Roberto; Cucchiara, Rita *Fully Convolutional Network for Head Detection with Depth Images*. Proceedings of the 24th International Conference on Pattern Recognition (ICPR), Beijing, 2018

18. Ballotta, Diego; Borghi, Guido; Vezzani, Roberto; Cucchiara, Rita *Head Detection with Depth Images in the Wild*. Proceedings of the 13th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISAPP), Funchal, 2018

19. Fabbri, Matteo; Borghi, Guido; Lanzi, Fabio; Vezzani, Roberto; Calderara, Simone; Cucchiara, Rita *Domain Translation with Conditional GANs: from Depth to RGB Face-to-Face*. Proceedings of the 24th International Conference on Pattern Recognition (ICPR), Beijing, 2018

20. Borghi, Guido; Frigieri, Elia; Vezzani, Roberto; Cucchiara, Rita *Hands on the wheel: a Dataset for Driver Hand Detection and Tracking*. Proceedings of the 8th International Workshop on Human Behavior Understanding (HBU), Xi'An, 2018

21. Bolelli, Federico; Borghi, Guido; Grana, Costantino *XDOCS: An Application to Index Historical Documents*. Digital Libraries and Multimedia Archives, Udine, 2018

22. Balducci, Fabrizio; Borghi, Guido. *An Annotation Tool for a Digital Library System of Epidermal Data*. In Proceedings of the 13th Italian Research Conference on Digital Libraries (IRCDL), Modena, 2017

23. Borghi, Guido; Venturelli, Marco; Vezzani, Roberto; Cucchiara, Rita. *POSEidon: Face-from-Depth for Driver Pose Estimation*. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Hawaii, 2017

24. Borghi, Guido; Gasparini, Riccardo; Vezzani, Roberto; Cucchiara, Rita. *Embedded Recurrent Network for Head Pose Estimation in Car*. In Proceedings of the 2017 IEEE Intelligent Vehicles Symposium (IV), Los Angeles, 2017

25. Frigieri, Elia; Borghi, Guido; Vezzani, Roberto; Cucchiara, Rita *Fast and Accurate Facial Landmark Localization in Depth Images for In-car Applications*. Proceedings of the 19th International Conference on Image Analysis and Processing (ICIAP), Catania, 2017

26. Palazzi, Andrea; Borghi, Guido; Abati, Davide; Calderara, Simone; Cucchiara, Rita *Learning to Map Vehicles into Bird's Eye View*. Proceedings of the 19th International Conference on Image Analysis and Processing (ICIAP), Catania, 2017

27. Bolelli, Federico; Borghi, Guido; Grana, Costantino *Historical Handwritten Text Images Word Spotting through Sliding Window HOG Features*. Proceedings of the 19th International Conference on Image Analysis and Processing (ICIAP), Catania, 2017

28. Venturelli, Marco; Borghi, Guido; Vezzani, Roberto; Cucchiara, Rita. *From Depth Data to Head Pose Estimation: a Siamese approach*. In Proceedings of the 12th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISAPP), Porto, 2017

29. Borghi, Guido; Vezzani, Roberto; Cucchiara, Rita; *Fast gesture recognition with Multiple StreamDiscrete HMMs on 3D Skeletons*. Proceedings of the 23rd International Conference on Pattern Recognition (ICPR), Cancun, 2016

30. Venturelli, Marco; Borghi, Guido; Vezzani, Roberto; Cucchiara, Rita. *Deep Head Pose Estimation from Depth Data for In-car Automotive Applications* In Proceedings of the 2nd International Workshop on Understanding Human Activities through 3D Sensors (ICPRW), Cancun, 2016

31. Baraldi, Lorenzo; Grana, Costantino; Borghi, Guido; Vezzani, Roberto; Cucchiara, Rita. *Shot, scene and keyframe ordering for interactive video re-use*. In Proceedings of the 11th International Conference on Computer Vision Theory and Applications (VISAPP), 2016