

# Dr. Roberto Arroyo

## Personal Details

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**Full name:** Roberto Arroyo Contera.  
**Birth date:** 10<sup>th</sup> August 1988.  
**Birth place:** Guadalajara (Spain).  
**Nationality:** Spanish.  
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## Interests and Research Topics

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**Computer Vision:** Image features, image matching, object recognition, place recognition, visual learning, SVM, 3D scene understanding, deep learning, CNNs.

**Robotics:** Visual SLAM, visual navigation, life-long topological localization, loop closure detection, geometric change detection, service robots, rescue robots.

**Intelligent Transportation Systems:** Autonomous vehicles, vehicle logo and license plate recognition, driver drowsiness detection, smart driving applications, ADAS.

**Automated Video-Surveillance Systems:** Background subtraction, semantic segmentation, people tracking, behavioural analysis.

**Software Engineering:** Programming in multiple platforms and languages, software design and testing, web applications, embedded systems, mobile devices.

## Experience

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**Post-doctoral Researcher**  
**University of Alcalá (UAH), Madrid (Spain)**

*April 2017 - present*

Topic: The work carried out is related to a project focused on a post-doctoral research for developing an autonomous vehicle adapted to elderly people. The title of this project is "Smart Elderly Car".

Supervisor: Dr. Luis Miguel Bergasa.

**Teaching Assistant**  
**University of Alcalá (UAH), Madrid (Spain)**

*February 2015 - present*

Topic: Teaching and supervision of laboratory activities in the MsC in Electronic Engineering and the MsC in Telecommunication Engineering at the Electronics Department of the University of Alcalá (UAH). My educational work is focused on the subject of Computer Vision.

Supervisor: Dr. Luis Miguel Bergasa.

**Researcher in Computer Vision and PhD candidate** *April 2013 - March 2017*  
**University of Alcalá (UAH), Madrid (Spain)**

Topic: Development of my PhD Thesis in the RobeSafe Research Group at the Electronics Department of the University of Alcalá (UAH). This work is supported by a FPI-UAH fellowship of four years of duration. The title of my Thesis is "Topological place recognition for life-long visual localization".

Supervisor: Dr. Luis Miguel Bergasa. Co-supervisor: Dr. Pablo F. Alcantarilla.

Grants: FPI-UAH (April 2013 - March 2017).

**Research Internship** *September 2016 - December 2016*  
**Australian Centre for Field Robotics, Sydney (Australia)**

Topic: A three months internship in the Australian Centre for Field Robotics (ACFR) at the University of Sydney. The internship is focused on the application of visual localization algorithms in autonomous navigation for intelligent vehicles.

Supervisor: Dr. Eduardo Nebot.

**Research Internship** *September 2014 - November 2014*  
**Toshiba Research Europe, Cambridge (United Kingdom)**

Topic: A three months internship in the Computer Vision Group (CVG) at the Cambridge Research Laboratory (CRL) of Toshiba Research Europe. The internship is focused on the detection of geometric changes in city-scale scenarios using 3D reconstructions.

Supervisor: Dr. Pablo F. Alcantarilla. Co-supervisor: Dr. Björn Stenger.

**Research Assistant** *April 2012 - March 2013*  
**University of Alcalá (UAH), Madrid (Spain)**

Topic: Research in several topics related to computer vision in the RobeSafe Research Group at the Electronics Department of the University of Alcalá (UAH). Different projects in diverse areas, such as automated video-surveillance, visual navigation or mobile robotics.

Supervisor: Dr. Luis Miguel Bergasa.

**Junior Researcher** *April 2011 - November 2011*  
**University of Alcalá (UAH), Madrid (Spain)**

Topic: Development of my MSc Thesis in Computer Engineering in the RobeSafe Research Group at the Electronics Department of the University of Alcalá (UAH). The title of the MSc Thesis is "Computer vision system for vehicle logo recognition" and it is honoured, patented and published in ITSC.

Supervisor: Dr. David F. Llorca.

## **Education**

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**PhD in Electronics, Computer Vision** *March 2013 - March 2017*  
**University of Alcalá (UAH), Madrid (Spain)**

Thesis (Hons.): Topological place recognition for life-long visual localization.

Supervisor: Dr. Luis Miguel Bergasa. Co-supervisor: Dr. Pablo F. Alcantarilla.

Grants: FPI-UAH (April 2013 - March 2017).

Awards: Prize to the Best Spanish PhD Thesis in Intelligent Vehicles.

"Cum Laude" mark and International Mention.

**MSc in Electronic Engineering** *September 2012 - June 2013*  
**University of Alcalá (UAH), Madrid (Spain)**  
Thesis (Hons.): Intelligent video-surveillance system based on computer vision.  
Supervisor: Dr. Luis Miguel Bergasa.  
Awards: Best MSc Thesis in Electronics at the UAH (2012/2013).

**MSc in Computer Engineering** *September 2009 - March 2012*  
**University of Alcalá (UAH), Madrid (Spain)**  
Thesis (Hons.): Computer vision system for vehicle logo recognition.  
Supervisor: Dr. David F. Llorca.  
Awards: Best Student (Rank #1) in Computer Engineering at the UAH (2011/2012).

**BSc in Computer Engineering** *September 2006 - December 2009*  
**University of Alcalá (UAH), Madrid (Spain)**

## **Awards and Honours**

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**Prize to the Best Spanish PhD Thesis in Intelligent Vehicles** *September 2017*  
*Awarded by ASEPA, RETEVI and IEEE, Canary Islands (Spain).*

**Best Student Paper Award in IEEE IV 2017** *June 2017*  
*Awarded by IEEE and ITSS, Los Angeles, California (United States).*

**Best Systems Paper Award Finalist in RSS 2016** *June 2016*  
*Awarded by Robotics: Science and Systems, Ann Arbor, Michigan (United States).*

**Best Poster Award in IV 2014** *June 2014*  
*Awarded by IEEE and ITSS, Dearborn, Michigan (United States).*

**Best MSc Thesis in Electronics at the UAH (2012/2013)** *June 2013*  
*Awarded by the University of Alcalá (UAH), Madrid (Spain).*

**Best Student in Computer Engineering at the UAH (2011/2012)** *March 2013*  
*Awarded by the University of Alcalá (UAH), Madrid (Spain).*

**FPI Grant for PhD Studies** *March 2013*  
*Awarded by the Spanish Ministry and the University of Alcalá (UAH), Madrid (Spain).*

## **Technical Skills**

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**Programming Languages:** C, C++, Java, Python, Caml, Pascal, Matlab, etc.

**Programming Tools:** Qt Creator, Eclipse, Netbeans, Visual Studio, GitHub, Svn, etc.

**Web Design:** HTML 5.0, XML, PHP, CSS, Javascript, Dreamweaver, etc.

**Databases:** Microsoft SQL Server, PostgreSQL, Oracle, etc.

**Operating Systems:** Linux, Windows, Mac, Android, etc.

**Computer Vision:** OpenCV, PCL, Cuda, Ogre 3D, Caffe, Torch, TensorFlow, etc.

## Languages

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### Spanish

Native language.

### English

Advanced level.

IELTS Academic Certificate (*British Council and University of Cambridge*)

Overall Band 6.0: Listening 5.0. Reading 7.0. Writing 6.5. Speaking 6.0 (*March 2013*).

### French

Basic level.

## Publications

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### Publications in journals

R. Arroyo, P. F. Alcantarilla, L. M. Bergasa and E. Romera, "**Are you ABLE to perform a life-long visual topological localization?**", *Autonomous Robots (AURO)*, published online, 2017.

E. Romera, J. M. Álvarez, L. M. Bergasa and R. Arroyo, "**ERFNet: Efficient Residual Factorized ConvNet for Real-Time Semantic Segmentation**", *IEEE Transactions on Intelligent Transportation Systems (T-ITS)*, published online, 2017.

E. López, S. García, R. Barea, L. M. Bergasa, E. J. Molinos, R. Arroyo, E. Romera and S. Pardo, "**A Multi-Sensorial Simultaneous Localization and Mapping (SLAM) System for Low-Cost Micro Aerial Vehicles in GPS-Denied Environments**", *Sensors 2017*, vol. 17, no. 4, pp. 802, April 2017.

R. Arroyo, J. J. Yebes, L. M. Bergasa, I. G. Daza and J. Almazán, "**Expert Video-Surveillance System for Real-Time Detection of Suspicious Behaviors in Shopping Malls**", *Expert Systems With Applications (ESWA)*, vol. 42, no. 21, pp. 7991-8005, November 2015.

I. G. Daza, L. M. Bergasa, S. Bronte, J. J. Yebes, J. Almazán and R. Arroyo, "**Fusion of Optimized Indicators from Advanced Driver Assistance Systems (ADAS) for Driver Drowsiness Detection**", *Sensors 2014*, vol. 14, no. 1, pp. 1106-1131, January 2014.

A. Cela, J. J. Yebes, R. Arroyo, L. M. Bergasa, R. Barea and E. López, "**Complete Low-Cost Implementation of a Teleoperated Control System for a Humanoid Robot**", *Sensors 2013*, vol. 13, no. 2, pp. 1385-1401, January 2013.

## **Publications in conferences**

E. Romera, J. M. Álvarez, L. M. Bergasa and R. Arroyo, "**Efficient ConvNet for Real-time Semantic Segmentation**", in *IEEE Intelligent Vehicles Symposium (IV)*, pp. 1789-1794, Los Angeles, California (United States), June 2017. BEST STUDENT PAPER AWARD.

R. Arroyo, P. F. Alcantarilla, L. M. Bergasa and E. Romera, "**OpenABLE: An Open-source Toolbox for Application in Life-Long Visual Localization of Autonomous Vehicles**", in *IEEE Intelligent Transportation Systems Conference (ITSC)*, pp. 965-970, Rio de Janeiro (Brazil), November 2016.

E. Romera, L. M. Bergasa and R. Arroyo, "**Need Data for Driver Behaviour Analysis? Presenting the Public UAH-DriveSet**", in *IEEE Intelligent Transportation Systems Conference (ITSC)*, pp. 387-392, Rio de Janeiro (Brazil), November 2016.

R. Arroyo, P. F. Alcantarilla, L. M. Bergasa and E. Romera, "**Fusion and Binarization of CNN Features for Robust Topological Localization across Seasons**", in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 4656-4663, Daejeon (South Korea), October 2016.

E. Romera, L. M. Bergasa and R. Arroyo "**Can we unify monocular detectors for autonomous driving by using the pixel-wise semantic segmentation of CNNs?**", in *Workshops of IEEE Intelligent Vehicles Symposium (IV)*, Gothenburg (Sweden), June 2016.

P. F. Alcantarilla, S. Stent, G. Ros, R. Arroyo and R. Gherardi, "**Street-View Change Detection with Deconvolutional Networks**", in *Robotics: Science and Systems Conference (RSS)*, Ann Arbor, Michigan (United States), June 2016. BEST SYSTEMS PAPER AWARD FINALIST.

L. Caramazana, R. Arroyo and L. M. Bergasa, "**Visual Odometry Correction based on Loop Closure Detection**", in *Open Conference on Future Trends in Robotics (RoboCity16)*, pp. 97-104, Madrid (Spain), May 2016.

E. Romera, L. M. Bergasa and R. Arroyo, "**A Real-time Multi-scale Vehicle Detection and Tracking Approach for Smartphones**", in *IEEE Intelligent Transportation Systems Conference (ITSC)*, pp. 1298-1303, Las Palmas, Canary Islands (Spain), September 2015.

R. Arroyo, P. F. Alcantarilla, L. M. Bergasa and E. Romera "**Towards Life-Long Visual Localization using an Efficient Matching of Binary Sequences from Images**", in *IEEE International Conference on Robotics and Automation (ICRA)*, pp. 6328-6335, Seattle, Washington (United States), May 2015.

R. Arroyo, P. F. Alcantarilla, L. M. Bergasa, J. J. Yebes and S. Bronte, "**Fast and Effective Visual Place Recognition using Binary Codes and Disparity Information**", in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 3089-3094, Chicago, Illinois (United States), September 2014.

S. Bronte, M. Paladini, L. M. Bergasa, L. Agapito and R. Arroyo, "**Real-Time Sequential Model-based Non-rigid SFM**", in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 1026-1031, Chicago, Illinois (United States), September 2014.

R. Arroyo, P. F. Alcantarilla, L. M. Bergasa, J. J. Yebes and S. Gámez, "**Bidirectional Loop Closure Detection on Panoramas for Visual Navigation**", in *IEEE Intelligent Vehicles Symposium (IV)*, pp. 1378-1383, Dearborn, Michigan (United States), June 2014.

J. J. Yebes, L. M. Bergasa, R. Arroyo and A. Lázaro, "**Supervised learning and evaluation of KITTI's cars detector with DPM**", in *IEEE Intelligent Vehicles Symposium (IV)*, pp. 768-773, Dearborn, Michigan (United States), June 2014.

L. M. Bergasa, D. Almería, J. Almazán, J. J. Yebes and R. Arroyo, "**DriveSafe: an App for Alerting Inattentive Drivers and Scoring Driving Behaviors**", in *IEEE Intelligent Vehicles Symposium (IV)*, pp. 240-245, Dearborn, Michigan (United States), June 2014. BEST POSTER AWARD.

E. J. Molinos, A. Llamazares, N. Hernández, R. Arroyo, A. Cela, J. J. Yebes, M. Ocaña and L. M. Bergasa, "**Perception and Navigation in Unknown Environments: The DARPA Robotics Challenge**", in *First Iberian Robotics Conference (ROBOT), Advances in Intelligent Systems and Computing (Springer)*, vol. 253, pp. 321-329, Madrid (Spain), November 2013.

A. Cela, L. M. Bergasa and R. Arroyo, "**Gate Recognition and Reconstruction for DARPA Robotics Challenge Using Bayesian Classifier Optimized by Mahalanobis Distance**", in *IEEE European Modelling Symposium (EMS)*, pp. 255-260, Manchester (United Kingdom), November 2013.

D. F. Llorca, R. Arroyo and M. A. Sotelo, "**Vehicle logo recognition in traffic images using HOG features and SVM**", in *IEEE Intelligent Transportation Systems Conference (ITSC)*, pp. 2229-2234, The Hague (Netherlands), October 2013.

J. Almazán, L. M. Bergasa, J. J. Yebes, R. Barea and R. Arroyo, "**Full auto-calibration of a smartphone on board a vehicle using IMU and GPS embedded sensors**", in *IEEE Intelligent Vehicles Symposium (IV)*, pp. 1374-1380, Gold Coast (Australia), June 2013.

### **Other interesting publications**

R. Arroyo, L. M. Bergasa, E. Romera and P. F. Alcantarilla, "**Life-Long Visual Localization using Probabilistic Temporal Inference**", in *International Computer Vision Summer School (ICVSS)*, Sicily (Italy), July 2015.

### **Patents**

D. F. Llorca, M. A. Sotelo, I. G. Daza, R. Arroyo, S. Álvarez, C. Fernández and R. Quintero, "**Procedimiento para el reconocimiento de marcas de vehículos mediante la clasificación del logo y dispositivo para su realización**", Spanish Ministry of Industry, Energy and Tourism, March 2013.

D. F. Llorca, M. A. Sotelo, I. G. Daza, M. Gavilan, S. Álvarez, C. Fernández, I. Parra, R. Arroyo and T. A. Alonso, "**Dispositivo de asistencia en ángulo muerto para maniobra de salida de aparcamiento en batería o ángulo**", Spanish Ministry of Industry, Energy and Tourism, March 2012.