MÉXICO IMAV

12th International Micro Air Vehicle Conference

November 17-19, 2021

Puebla, México

www.imavs.org

Jose Martinez-Carranza
Editor

INAOE UDLAP UNIVERSIDAD DE LAS AMÉRICAS PUEBLA BENEMÉRITA UNIVERSIDAD AUTÓNOMA DE PUEBLA 1578 Cinvestav

Contents

Preface

On behalf of the Local Organising Committee, It is my pleasure to present the proceedings of the 12^{th} International Micro Air Vehicle Conference, which was held in Puebla, México from November 17-19, 2021. These proceedings are available to the public as open-access publications, seeking to promote and contribute to the advancement of the state-of-the-art in the area of small flying robots and their applications for the benefit of society.

For the first time ever, The 12^{th} International Micro Air Vehicle Conference was run by Latin American academic institutions based in Mexico: Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE), Universidad de las Américas Puebla (UDLAP), Benemérita Universidad Autónoma de Puebla (BUAP) and Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV), Unidad Zacatenco.

The IMAV is a pioneer scientific-technological event in the field of aerial robotics and has been established as a stellar event among the communities of researchers dedicated to the study, development and research of Micro Air Vehicles. This year of 2021, due to the COVID-19 pandemic, the IMAV-2021 was run in a virtual mode as a conference only; this is, no competitions were run this time. Yet, I believe the event offered a huge opportunity to communicate the latest developments regarding Micro Air Vehicles as much as to foster collaborations among the members of the IMAV international community.

These proceedings contain 27 peer-reviewed scientific papers by 88 authors organised in 9 sessions presented at the IMAV-2021. The topics of these papers contain a nice mix ranging from aerial vehicle design and energy sources to control, navigation and perception. Together, the papers give an overview of the current state-of-the-art on the field of Micro Air Vehicles. In the awards ceremony of the conference, the following awards were announced: Best Conference Paper, Best Technical/Application Paper, and Best Student Paper. Based on the quality of the scientific and technical contribution, some papers were selected to be published in two scientific journals: the International Journal of Micro Air Vehicles (Sage), and Unmanned Systems (World Scientific).

In addition to the presentation of the scientific papers, 6 keynote talks were delivered by experts in the field. The first speaker, Rear Adm Leopoldo Díaz, Head of the Research and Technological Development Unit of the Mexican Navy, presented the research and technological work on UAS that has been developed in this Unit. Prof. Guido de Croon from TUDelft, talked about his work on insect-inspired AI for swarms and tiny drones. Prof. Tom Richardson from the University of Bristol, talked about studying volcanic emissions by operating drones beyond visual line of sight. Brandon Gilles, CEO of Luxonis, introduced the OAK-D Lite smart camera capable of running Spatial AI on the chip and its use on drone applications. Nicolas Marchand from GIPSA-lab/CNRS, presented his work on event-based control for flying robotics. Finally, Rogelio Lozano from the Université de Technologie de Compiègne, presented his work on the dynamical model of a mini helicopter without a swashplate and the challenges behind this problem in outdoor flight.

We also had the privilege of gathering former IMAV General Chairs who shared nice memories of previous IMAVs. The participation of these former Chairs was split into 2 panel sessions. The first one was attended by Prof. Simon Watkins from RMIT and Prof. Ben M. Chen from CUHK, Chairs of the IMAV 2016 and IMAV 2018, respectively. The second panel was attended by Prof. Guido de Croon from TUDelft, Prof. Jean-Marc Moschetta from ISAE, Dr. Gautier Hattenberger from ENAC, and Prof. Pascual Campoy from UPM, Chairs of IMAV 2014, 2017 and 2019. I have no doubt these sessions summarised the influence and legacy that IMAV conferences and competitions have had in the field of Micro Air Vehicles over the last years.

Finally, my deepest gratitude goes to all members of the Local Organising Committee for their invaluable support in the organisation of this IMAV-2021, even during this difficult pandemic period. Also, I appreciate the guidance and support of the members of the International Committee, whose enthusiasm and kindness inspired us to do our best to prepare and run this event. Last but not least, we are very grateful for the sponsorship of the awards provided by LUXonis.

Puebla, México. November 2021

Jose Martinez-Carranza
Instituto Nacional de Astrofísica, Óptica y Electrónica

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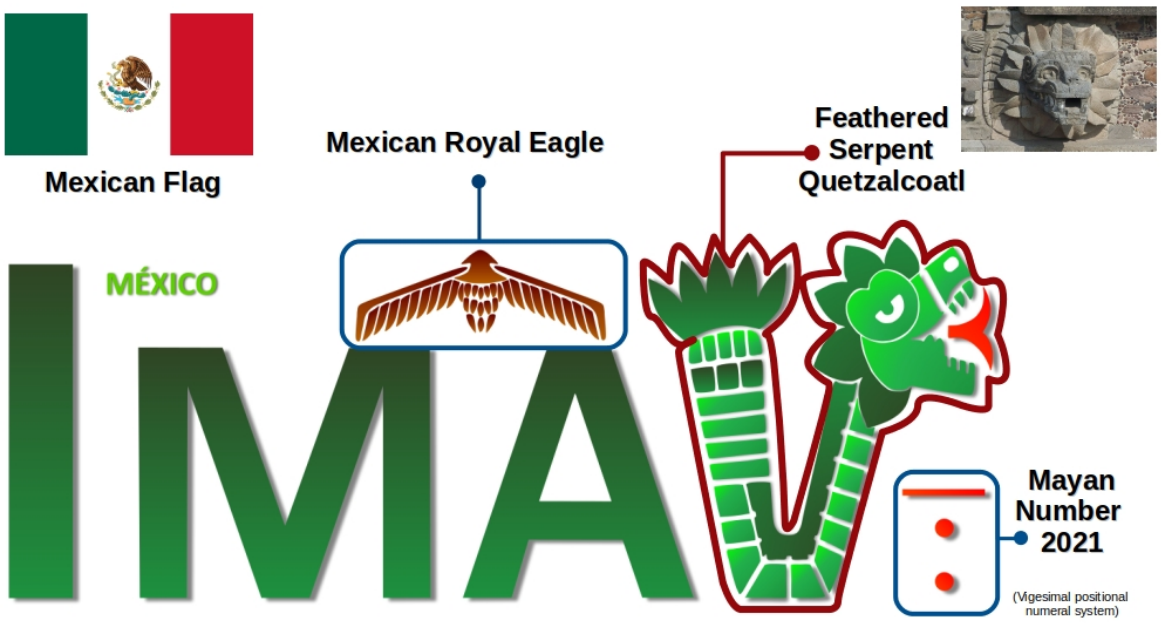
Meaning of the IMAV 2021 Logo

The logo of the IMAV 2021 was inspired by the Mexican flag, seen at the top left of the image below. The logo shows the letters of the acronym IMAV in green, the first colour of the flag. At the top of the log we see a figure with a fixed-wing like shape. This is intended to represent a fixed-wing MAV dressed with brown feathers, representing the *Mexican Royal Eagle*, located at the center of the Mexican flag. The letter 'V' in the acronym has been depicted in the shape of a snake. This symbol represents a Deity from the Aztec culture: the *feathered Serpent* popularly known as *Quetzalcoatl*. The tongue of the snake is in red as in the Mexican flag, and also located to the right. Finally, a bar and two dots in red are seen at the right bottom part of the logo, representing a Mayan number, a vigesimal positional numeral system that uses bars and dots to represent numbers. In this logo, the Mayan number represents the number 2021. The logo also has the word "México" in a smaller font size, above the acronym. Therefore, buy putting everything together and with some imagination, the logo portraits a Mexican flag shaped by the IMAV acronym, the year of the conference and containing representative symbols of the Mexican culture.

We are thankful to Guadalupe Cabrera-Ponce for her design on the Quetzalcoatl symbol and to Oyuki Rojas-Perez for her design on the eagle and Mayan number symbols. Their help was essential to create this IMAV 2021 logo. Jose Martinez-Carranza conceptualise and supervised the elaboration of the logo.



Call for Papers

We cordially invite all experts, users, scientists, young researchers, and students being active or interested in the field of Micro Unmanned Aerial Vehicles to attend the 12th International Micro Air Vehicle Conference. This edition of the IMAV will be organized in the virtual model. The conference will take place November 17-19 2021. Topics for scientific and technical papers include, but are not limited to:

- Low Reynolds number aerodynamics
- Unsteady aerodynamics
- Smart morphing materials
- Propulsion set and new energy sources
- Autonomous navigation
- Autonomous Drone Racing
- Cooperation and formation flight
- Control theory and state estimation
- Computer vision for MAVs
- Sense & avoid Integration of UAVs in airspace
- Reconfiguration in unpredicted events
- New MAV architectures
- Characterization of noise emission for MAVs
- Low noise and noise mitigation

Dedicated applicative sessions will be set up for the following topics:

- Atmospheric research
- Archaeological research
- Search and rescue operations
- Industrial inspection
- Agriculture & environment
- Artificial Intelligence for MAVs
- Ethics & Regulations
- The societal impact of MAVs

Based on the quality of the papers and after a thorough evaluation by the IMAV's international committee, selected papers and Finalist to the "Best Conference Paper Award" will be offered to be published in one of the following two Journals (note that the Article Processing Charges will be waived):

- International Journal of Micro Air Vehicles
- Unmanned Systems

Important Dates:

- *Paper Submission Deadline: June 21, 2021*
- *Notification of Acceptance: August 1st, 2021*
- *Camera-ready: August 30, 2021*
- *Registration: Before September 1, 2021*

The proceedings of the conference will be available on-line with free access for anybody.

For further questions, please visit the conference web pages http://imav2021.inaoep.mx/ http://www.imavs.org/

Best regards,

Hugo Rodríguez Cortés - Program Committee Chair
Jose Martinez-Carranza - General Chair

Conference Oral Presentations

Control Systems 1

Autonomous Navigation 1

Control Systems 2

Control Systems 3

Applications

Control Systems 4

Design 1

Design 2

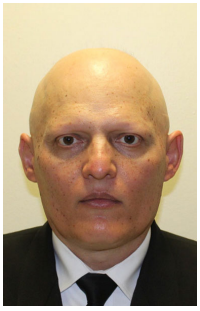
Autonomous Navigation 2

Keynote Speakers

Urban Air Mobility, a vision by Airbus

Rear Adm. Leopoldo Jesus Diaz González Solórzano – Head of the Research and Technological Development Unit Mexican Navy

Biography



Admiral González Solórzano graduated as Naval Science Engineer from the Heroica Escuela Naval Militar of the Mexican Navy. He has held several appointments in the Mexican Navy such as Patrol commander, Deputy and later Area Head of the Deputy General Management Office of Communications and Informatics, Inspector of the Naval Command of the 3rd Naval Zone, and Permanent alternate Representative of Mexico to the International Maritime Organization, a specialised agency of the United Nations with Headquarters in London, United Kingdom. In 2016, he was promoted to Rear Admiral of the Mexican Navy. He has also received several distinctions throughout his career. He was awarded the naval merit of First-Class due to this high performance during his studies at the Heroica Escuela Naval Militar, and awarded the Argentine Navy Prize for his high performance in military skills during these studies. He received an Honorary Mention for his high performance during a course given by the international Hydrographic Organization. To date, he is the Head of the Research and Technological Development Unit of the Mexican Navy.

Abstract

Unmanned Aerial Vehicles developed by the Mexican Navy

The Research and Technological Development Unit is a department within the Mexican Navy responsible for developing projects that support the navy forces, units and naval establishments. The main research projects focus on Unmanned Aerial Systems (UAS), radars, datalink systems, sonars, simulators, and rockets. This talk will present the research, and technological work carried out since 2011 on UAS. To date, two aerial vehicles have been developed and tested in different operation environments; one of these vehicles is under the production of more units. The development of these vehicles implies a continuous learning curve, but in particular, it is essential to design adequate schemes for validation and verification of the vehicle's performance. Nowadays, with the support of the National Council of Science and Technology of Mexico, an Unmanned Aerial Vehicle (UAV) is under development, capable of performing vertical take-off and landing. Since two years ago, this vehicle has been in the stage of testing to validate its design and functionality. For future work, we are considering the deployment of UAS from naval ships, the development of cooperative UAVs with swarm capabilities and the use of alternative energies.

Autonomous Drone Racing

Prof. Guido de Croon, Full Professor in Bio-inspired Micro Air Vehicles Department of Aerospace Engineering Delft University of Technology

Biography

Received his M.Sc. and Ph.D. in the field of Artificial Intelligence (AI) at Maastricht University, the Netherlands. His research interest lies with computationally efficient and often bio-inspired algorithms for robot autonomy, with an emphasis on computer vision. Since 2008 he has worked on algorithms for achieving autonomous flight with small and light-weight flying robots, such as the DelFly flapping wing MAV. In 2011-2012, he was a research fellow in the Advanced Concepts Team of the European Space Agency, where he studied topics such as optical flow based control algorithms for extraterrestrial landing scenarios. Currently, he is Full Professor at TU Delft and scientific lead of the Micro Air Vehicle lab (MAV-lab) of Delft University of Technology.

Abstract

Insect-inspired AI for swarms of tiny autonomous drones

Swarms of tiny autonomous drones can help humans in search-and-rescue missions, in keeping track of the stock in warehouses or in monitoring crop in greenhouses. Tiny drones (think below 30 grams) are very safe for humans, are suitable for flying in narrow environments, and are very cheap so that they can be produced in large numbers. However, it is also notoriously hard to make such tiny drones fly autonomously. Due to their extremely low weight, they are very limited in terms of energy and payload. This implies that they can carry few sensors and extremely little processing compared to, e.g., self-driving cars. In my talk, I will talk about the effort at TU Delft's MAVLab to make swarms of tiny autonomous drones, and how we approach this by drawing inspiration from insect intelligence. I will present our work on the lightest autonomous drone in the world, the 20 gram "DelFly Explorer" and on a swarm of 33-gram Crazyflies that is able to autonomously explore an unknown environment and come back to the departure point. Furthermore, I will discuss our recent study in which we designed a swarm of CrazyFlie drones able to autonomously localize gas sources. I will end with our efforts into incorporating spiking neural networks in neuromorphic hardware on our drones, showing results of an evolved spiking neural controller that was successfully ported to the real world, for the first time controlling a flying drone with neuromorphic processing in the control loop.

Tom Richardson - Senior Lecturer in Flight Dynamics and Control Flight Lab University of Bristol

Biography

Tom is a senior lecturer in flight dynamics and control at the University of Bristol. With a PhD in nonlinear control system design, he specializes in the application of modern control theory and novel sensors to Unmanned Air Systems (UAS). Tom has held an NPPL (pilots license) for over 15 years, runs the University of Bristol glider flight test course, and has been responsible for UAS operations in multiple countries. He has been granted permission multiple times for Beyond Visual Line Of Sight (BVLOS) operations, and holds the University of Bristol CAA UAS Permission for Commercial Operations. He has also run flight demonstrations and test flights for DSTL, BAE Systems, QinetiQ, DSTL and Roke Manor. Tom is also a founding partner of Perceptual Robotics which has recently been awarded 'Robotics & AI in Extreme Environments' funding by Innovate UK for Offshore Wind Turbine Inspection. https://www.perceptual-robotics.com/

Abstract

Remote Sampling and Measurement of Volcanic Emissions using Drones

Recent drone developments are having a significant impact on the way that volcanic emissions are being studied. This talk will cover collaborations between the Bristol University Flight Lab and Earth Science colleagues on field campaigns to a range of volcanoes worldwide. Beyond Visual Line of Sight (BVLOS) operations have enabled ash samples to be collected and gas measurements to be made at distances up to 14km and altitudes up to 14,000ft above take-off. Target volcanoes include Fuego which is an active stratovolcano in Guatemala and is almost constantly active at a low level. Small gas and ash eruptions occur every 15 to 20 minutes and multiple flights have been carried out to collect a range of ash samples from within the plume. Most recently, Dr Richardson has been part of the international collaborative multi-drone 'ABOVE' field campaign to Manam and Rabul volcanoes in Papua New Guinea - the objective of which was to achieve the first simultaneous inter-comparison of ground, aerial, and satellite-based measurement techniques for volcanic gas (SO2) emissions.

Brandon Gilles - CEO Luxonis

Biography

Brandon is driven by the singular belief that the biggest impact he can have on the world is fostering innovation. And the understanding that a 5-fold increase in productivity is the difference between the middle ages and now. And the driver of that productivity increase - and the tremendous increase in the quality of life we all have - is innovation. And for innovation to happen, simplification needs to happen first. So that powerful things can be used easily and readily - and then combined with other powerful things. Brandon's mission is to make embedding performant, spatial AI and CV into products simple - to enable and foster a wave of innovation powered by being able to embed human-like perception into products across all sorts of industries.

Abstract

Spatial AI Meets Embedded Systems

The combination of high-resolution depth perception, real-time artificial intelligence, advanced computer vision functions, and high-frame-rate/high-resolution/multi-sensor cameras systems used to be only available to those with huge budgets. Monetary, size, weight, and power budgets. Now, it's possible to have all of this on an embedded system - in a tiny device that costs $99. It's going to change every industry.

Nicolas Marchand - Deputy director of GIPSA-lab Directeur de Recherche CNRS - HDR GIPSA-lab, Control Systems Department, Grenoble, France

Biography

Nicolas Marchand received the M.Sc. and Ph.D. degrees in control theory from Grenoble-INP, in 1995 and 1999, Grenoble, France. He is a CNRS researcher and director of GIPSA-lab since 2020, Grenoble, France. His research focuses on event-based control, control and stabilization of flying robots and control theory for computer sciences.

Abstract

Controlling UAV's based on events: a new approach for new solutions

In this talk, we will present the theoretical framework of event-based control. Through examples, we will show how event-based control approach can improve or give new abilities to robotic systems and especially UAVs. Examples will cover safer remote control of UAVs, faster learning for artificial intelligence and other examples related to flying robotics.

Rogelio Lozano - CNRS Research Director Université de Technologie de Compiègne Compiègne, France

Biography

Rogelio Lozano was born in Monterrey Mexico, on July 12, 1954. He received the B.S. degree in electronic engineering from the National Polytechnic Institute of Mexico in 1975, the M.S. degree in electrical engineering from Centro de Investigación y de Estudios Avanzados (CINVESTAV), Mexico in 1977, and the Ph.D. degree in automatic control from Laboratoire d'Automatique de Grenoble, France, in 1981. He joined the Department of Electrical Engineering at CINVESTAV, Mexico, in 1981 where he worked until 1989. He was Head of the Section of Automatic Control from June 1985 to August 1987. He has held visiting positions at the University of Newcastle, Australia, from November 1983 to November 1984, NASA Langley Research Center VA, from August 1987 to August 1988, and Laboratoire d'Automatique de Grenoble, France, from February 1989 to July 1990. Since 1990 he is a CNRS (Centre National de la Recherche Scientifique) Research Director at University of Technology of Compiègne, France. He was Associate Editor of Automatica in the period 1987-2000. He is associate Editor of the Journal of Intelligent and Robotics Systems since 2012 and Associate Editor in the Int. J. of Adaptive Control and Signal Processing since 1988.

He has coordinated or participated in numerous French projects dealing with UAVs. He has recently organized 2 international workshops on UAVs (IFAC RED UAS 2013 and IEEE RAS RED UAS 2015). He participates in the organization of the annual international conference ICUAS (International Conference on Unmanned Aerial Systems) since 2010. He is IPC Chairman of the ICSTCC in Rumania since 2012. He was Head of Heudiasyc Laboratory in the period 1995-2007 and since 2008 He is Head of the Joint Mexican-French UMI 3175 CNRS. His areas of expertise include UAVs, mini-submarines, exo-squelettons and Automatic Control. He has been the advisor or co-advisor of more than 35 PhD theses and published more than 130 international journal papers and 10 books.

Abstract

Stabilization and nonlinear control for a helicopter with virtual swashplate in outdoor flight

The dynamical model of a mini helicopter without swashplate is presented. The helicopter is composed of two rotors, the main rotor with torque modulation and variable pitch propellers to stabilize roll and pitch angles, the second rotor stabilizes yaw displacement. The torque modulation is performed accelerating and decelerating the main rotor which produces a variation in the blades pitch. This helicopter does not have the classical swashplate. The dynamical model is obtained via the Euler–Lagrange approach and a nonlinear control strategy is proposed. The roll and the forward displacement are controlled by using a virtual swashplate. The pitch and lateral displacement are controlled in a similar way. The yaw displacement is stabilized by a classical linear state-feedback controller. The nonlinear controller performance is tested on real experiments using a mini helicopter. It is shown that the controller is robust to disturbances in outdoor flights.

Panels with Former IMAV General Chairs

Panel 1: Former General Chairs of IMAV 2016 and IMAV 2018

Prof. Ben M. Chen
General Chair, IMAV 2016
Beijing, China

Biography

Ben M. Chen is currently a Professor of Mechanical and Automation Engineering at the Chinese University of Hong Kong (CUHK). He was a Provost's Chair Professor in the Department of Electrical and Computer Engineering at the National University of Singapore, before joining CUHK in 2018. He was an Assistant Professor in the Department of Electrical Engineering at the State University of New York at Stony Brook, in 1992–1993. His current research interests are in unmanned systems, robust control and control applications. Dr. Chen is a Fellow of IEEE and Fellow of Academy of Engineering, Singapore. He has authored/co-authored about 500 journal and conference articles, and a dozen research monographs in control theory and applications, unmanned systems and financial market modeling. He had served on the editorial boards of a dozen international journals including Automatica and IEEE Transactions on Automatic Control. He currently serves as an Editor-in-Chief of Unmanned Systems. Dr. Chen has received a number of research awards. His research team has actively participated in international UAV competitions and won many championships in the contests.

Prof. Simon Watkins
General Chair, IMAV 2018
Melbourne, Australia

Biography

Simon Watkins is a Professor of Engineering at RMIT and was Chair of IMAV held at RMIT in 2018. He was listed in the top 2% scientists in the world in 2019 in the field of "Aerospace and Aeronautics", based on Stanford University standardised citation metrics and wrote some of the first papers on atmospheric winds and micro air vehicles. He founded the RMIT Unmanned Aircraft Systems Research Team which comprises a multidisciplinary group of senior academics, research fellows and PhD students. His current research interest is bird and insect flight and trying to reveal the methods by which they maintain steady flight in the turbulent outdoor wind.

Panel 2: Former General Chairs of IMAV 2014, IMAV 2017, IMAV 2019

Prof. Guido de Croon
General Chair, IMAV 2014
Delft, The Netherlands

Biography

Swarms of tiny autonomous drones can help humans in search-and-rescue missions, in keeping track of the stock in warehouses or in monitoring crop in greenhouses. Tiny drones (think below 30 grams) are very safe for humans, are suitable for flying in narrow environments, and are very cheap so that they can be produced in large numbers. However, it is also notoriously hard to make such tiny drones fly autonomously. Due to their extremely low weight, they are very limited in terms of energy and payload. This implies that they can carry few sensors and extremely little processing compared to, e.g., self-driving cars. In my talk, I will talk about the effort at TUDelft's MAVLab to make swarms of tiny autonomous drones, and how we approach this by drawing inspiration from insect intelligence. I will present our work on the lightest autonomous drone in the world, the 20 gram "DelFly Explorer" and on a swarm of 33-gram Crazyflies that is able to autonomously explore an unknown environment and come back to the departure point. Furthermore, I will discuss our recent study in which we designed a swarm of CrazyFlie drones able to autonomously localize gas sources. I will end with our efforts into incorporating spiking neural networks in neuromorphic hardware on our drones, showing results of an evolved spiking neural controller that was successfully ported to the real world, for the first time controlling a flying drone with neuromorphic processing in the control loop.

Prof. Jean-Marc Moschetta
General Chair, IMAV 2017
Toulouse, France

Biography

Jean-Marc Moschetta is a Professor of Aerodynamics at ISAE-SUPAERO, Toulouse, France and Director of the Micro Air Vehicle Research Center. Since 2000, he has devoted his research activity to rotary-wing and fixed-wing drones including : aerodynamic design, energy-harvesting techniques, transitioning vehicles, quiet propellers. Recently, Dr Moschetta has started the development of an Hydrogen-powered fixed-wing UAV for flying over the Atlantic Ocean with low carbon emissions.

Asst. Prof. Gautier Hattenberger
Deputy Chair, IMAV 2017
Toulouse, France

Biography

Gautier Hattenberger is an assistant-professor at the French Civil Aviation University (ENAC) in Toulouse, France. As a member of the UAV Research Program, he is working on flight dynamics and control of micro-UAVs, modeling and simulation, architecture of embedded systems, trajectory planing and formation flight. Most of his work is based on the Open-Source UAV system "Paparazzi", for which he is now one of the head developer. He graduate from the French national engineering school of aeronautical construction in 2004 and received his Ph.D Degree at the Robotic department of the Laboratory for Analysis and Architecture of Systems (LAAS-CNRS, Toulouse), for his work on formation flight control and planing of UAVs in 2008.

Prof. Pascual Campoy
General Chair, IMAV 2019
Madrid, Spain

Biography

Pascual Campoy is Full Professor on Automatics at the Universidad Politécnica Madrid UPM (Spain) where he lectures on Control, Machine Learning and Computer Vision. He has been visiting professor at DCSC Department in TUDelft (The Netherlands) from 2014 to 2019, and previously visiting professor at Tong Ji University (Shanghai-China) in 2013 and Q.U.T. (Australia) 2011. He received his PhD in Automatics & Robotics at Universidad Politecnica Madrid in 1988, where he previously received his Master tittle in Automatics Engineering in 1983. He is leading the Research Group on "Computer Vision and Aerial Robotics" at U.P.M. within the Centre of Automatics and Robotics (C.A.R.), whose activities are aimed at increasing the autonomy of the Unmanned Aerial Vehicles (UAV) by exploiting the powerful sensor of Vision, using cutting-edge technologies in Image Processing, Control and Artificial Intelligence. He has been heading director of over 40 R&D projects, including R&D European projects, national R&D projects and over 25 technological transfer projects directly contracted with the industry. He is author of around 200 international scientific publications and nine patents, three of them registered internationally. He is awarded in the top international UAV competitions: IMAV12, IMAV13, IARC14, IMAV16 and IMAV17, General Chair for IMAV 2019 and he coordinated the international team that was awarded in the third place in the Grand Challenge MBZIRC20.

Papers

Best Paper Awards and Special issues

For this IMAV 2021, three prizes were awarded during the Awards Ceremony: Best Conference Paper, two runners-up were also mentioned and received a certificate; Best Technical/Application Paper; and Best Student Paper. These 5 papers were selected to be published in a Special Issue of the International Journal of Micro Air Vehicles (Sage).

Best Conference Paper

Nonlinear model predictive control for improving range-based relative localization by maximizing observability.
Shushuai Li, Christophe De Wagter and Guido de Croon. [2] on page 28.

Runners-Up

Estimating wind using a quadrotor.
Gautier Hattenberger, Murat Bronz and Jean-Philippe Condomines. [15] on page 124.

Extended Incremental Non-linear Control Allocation on the TU Delft Quadplane.
Jan Karssies and Christophe De Wagter. [9] on page 74.

Best Technical/Application Paper

Field report: deployment of a fleet of drones for cloud exploration.
Gautier Hattenberger, Titouan Verdu, Nicolas Maury, Pierre Narvor, Fleur Couvreux, Murat Bronz, Simon Lacroix, Grégoire Cayez and Gregory Roberts. [13] on page 109.

Best Student Paper

Design of aeroacoustically stealth MAV rotors. *Pietro Li Volsi, David Gomez-Ariza, Thierry Jardin, Romain Gojon and Jean-Marc Moschetta.* [19] on page 153.

Selection of papers for Unmanned Systems

In addition to the papers above, the following papers were selected to be published in a Special Issue of Unmanned Systems (World Scientific).

Onboard Time-Optimal Control for Tiny Quadcopters
Jelle Westenberger, Christophe De Wagter and Guido C.H.E. de Croon [11] on page 93.

Developing a modular tool to simulate regeneration power potential using orographic wind-hovering UAVs
Midas Gossye, Sunyou Hwang and Bart Remes [14] on page 116.

Framework and evaluation methodology for Autonomous Drone Racing
Miguel Fernandez-Cortizas, Pablo Santamaria, David Perez-Saura, Javier Rodriguez-Vazquez, Martin Molina, Pascual Campoy [5] on page 50.

Position controller for a flapping-wing drone using UWB
*Guillermo González * , Guido C.H.E de Croon, Diana Olejnik and Matěj Karásek* [10] on page 85.

Immersion and Invariance Based Trajectory Tracking Control of an Aerial Manipulation System
Aaron Lopez, Hugo Rodríguez Cortés, Israel Cruz Vega and Jose Martinez-Carranza. [8] on page 68.

Authors

Release

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