**IEEE SPS Megatrend Autonomous Systems Initiative (ASI)**

1. **Rationale**

Over the last decade, researchers have been proposing and investigating computing systems with advanced levels of autonomy, in order to manage the ever-increasing requirements in complexity. An autonomous system (AS) is an artificial system able to perform a certain number of tasks with a high degree of autonomy.  Many real-world systems frequently experience non-stationary conditions (i.e., unknown situations) due to uncertain interactions with the environment (incl. human agents) and users, failures or structural changes. AS aim at building up behavior rules over time by learning through interactions with the environment with complex perception-action cycles, towards dealing with environment changes and uncertainties.

A fully autonomous system can:

* Gain information about the environment
* Work for an extended period without human intervention
* Move either all or part of itself throughout its operating environment without human assistance
* Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications

An autonomous system may also learn or gain new knowledge like adjusting for new methods of accomplishing its tasks or adapting to changing surroundings.

From an industrial point of view, AS have exhibited an impressive growth in the last decade, notably in autonomous cars, robots and drones.

Signal processing plays an important role in the perception-action cycle of AS:

* In AS perception, signal analysis is important for any perception modalities, e.g., visual, sonar/ultrasound, laser, radio/GPS.
* In AS communications, signal (e.g., video) compression, transmission and error resilience are very important aspects.
* In AS action, adaptive signal processing can play an important role in AS command and control.

1. **Scope**

From a scientific point of view, ASI can cover the following areas:

* Perception
* Sensor information processing
* Mission planning and control
* Machine learning for perception and control
* Robust/secure mobile communications
* Embedded systems
* Security
* Societal issues, e.g., data protection, privacy.

From an industrial/sectorial point of view, it can cover autonomous systems operating in any environment, whether this is on land, underwater, in the air, underground, or in space. More specifically:

* Autonomous cars
* Autonomous robotic systems
* Marine, underwater vessels
* Drones and unmanned aircraft.

1. **Synergies within SPS, IEEE and with other scientific communities.**

ASI is expected to draw significant interest within the SPS constituency, but also in the wider scientific community and in the related industry.

To this end, it will cooperate with all relevant SPS TCs and other initiatives, e.g., IVMSP, MMSP, IFS, Data Science Initiative (complete list will be compiled), who will have representatives in ASI.

The creation of SPS megatrend ASI will boost SPS involvement in this important and expanding area and will allow interaction with other IEEE Societies, notably, the Robotics/Automation and the Cybernetic ones. Furthermore, it will allow interfacing to other scientific communities, e.g.:

* Machine learning community
* Computer vision community

and with industrial bodies, e.g., the European Robotics Forum.

1. **Organizational efforts so far**

ASI started through an adhoc technical meeting organized at ICIP2018 by Prof. I. Pitas that was subsequently streamlined to an informal initiative through the support of the SPS TD VC Prof. W. Kellerman. The following provisional steering committee was appointed by:

* Robert Heath <rheath@utexas.edu>
* Lina Karam <karam@asu.edu>
* Lucio Marcenaro <lucio.marcenaro@unige.it>
* Ioannis Pitas <pitas@aiia.csd.auth.gr>
* Kostas Plataniotis <kostas@ece.utoronto.ca>
* Carlo Regazzoni <carlo.regazzoni@unige.it>
* Brian Sadler <brian.m.sadler6.civ@mail.mil>
* Walter Kellermann <[walter.kellermann@fau.de](mailto:walter.kellermann@fau.de)>
* Ambarish Natu <[ambarish.natu@gmail.com](mailto:ambarish.natu@gmail.com)>

chaired by an interim chair (Prof. I. Pitas). Medatrend Inititative bylaws were drafted by the TD VC and, if/once approved, the SPS ASI should restructure to meet the bylawas provisions.

In the meanwhile, ASI has already performed and planned a Multitude of activities.

1. **ASI activities and plans**
2. **Organizational activities.**

An ASI www site <http://asi.politecnica.unige.it/> and a google drive <https://drive.google.com/drive/folders/1E0D7thxEblOeiNfbiFS6OV4DyNE6aD-R>

have been created and populated.

ASI will be launched during ICIP2018 (ASI@ICIP2018 events).

1. **Conference activities**

# **ASI@ICIP2018 Program**

ASI will organize and sponsor a series of events at IEEE ICIP 2018 (ASI@ICIP):

* October 7th 2018: Tutorial on Drone Vision for Cinematography and Media Production (separate registration required)
* October 7th 2018 (events sponsored by EC Horizon2020 R&D project Multidrone <https://multidrone.eu/>):
  + 10:30-12:10: Paper session on Autonomous Systems
  + 12:10-13:10 Plenary ASI and ASI steering committee meeting
  + 13:10-14:10 ASI Steering Committee meeting
  + 14:10-15:00 Headline talk: Dr. A. Messina (RAI, Radiotelevisione Italiana, Italy) ‘Autonomous drone systems for media production’
  + 15:00-15:50 Headline talk: Dr. G. Yovanof (Strategis, Greece) ‘Autonomous Marine Systems – A Driver for Sustainable Growth in the Ocean Economy’
  + 15:50-16:20 Coffee break
  + 16:20-17:10 Headline talk: Dr. Gian-Luca Mariottini (Draper, USA) ‘ Perceptual Autonomy’

**ICASSP2018 Special session on: “SS-L2: Signal Processing for Autonomous and Self Aware systems”**

Session Chairs: Lucio Marcenaro, University of Genoa, Carlo S. Regazzoni, University of Genova and Konstantinos N. Plataniotis, University of Toronto

Summary:The main topic of the proposed Special Session is autonomous and self-aware systems. The recent development of novel Signal Processing techniques allows a new level of awareness in artificial systems. In the last decade, the increasing role of information and communication technologies tools in the modern society has led to research challenges towards the study and development of innovative applications aiming at improving quality of life, supporting human everyday tasks and fulfilling urgent society needs. However, often the focus of such applications has been systems that are built and programmed to perform a certain stream of actions when they recognize specific situations.This Special Session reflects current state-of-the-art approaches for Signal Processing for Autonomous and Self Aware Systems. In particular, contributions related to the impact of deep learning onto signal processing methods for autonomous systems, self aware signal processing (eg tracking , etc.), the role of time and context in signal processing for autonomous systems, signal processing and control theory: new frontiers, the necessity of a different dynamical semantic for model driven signal processing, signal processing for incremental learning, have been published.

**IEEE Conference on Autonomous Systems**

The possibility of such an event for 2020 is currently investigated by Prof. Regazzoni.

1. **Educational activities**

# **Drone School & Workshops: Deep learning and Computer vision for drone imaging and cinematography, Aristotle University of Thessaloniki, Greece, 28-31/8/2018.**

The course provides an overview of the various computer vision and deep learning problems encountered in drone imaging and cinematography, which is one of the main application areas of drone technologies. The same machine learning and computer vision problems do occur in other drone applications as well, e.g., for land/marine surveillance, search&rescue, building and machine inspection.

# **Tutorial at EUSIPCO2018**

A tutorial about “Signal Processing for Self awareness in Autonomous systems” took place during EUSIPCO 2018 in Rome, Italy. Presenters are Carlo Regazzoni and Lucio Marcenaro from the University of Genova, Italy.

## Summary: This tutorial describes recent advancements in last generation autonomous systems where self-awareness methods can be introduced that are based on fusion of multimodal signals into dynamic behavioral models. Self-awareness is a broad concept which describes the property of a system, which has knowledge of “itself”, based on its own senses and internal models. This knowledge may take different forms, is based on perceptions of both internal and external phenomena and is essential for being able to anticipate and adapt to unknown situations. Self-awareness (in a computational context) is founded on advanced methods and algorithms from different disciplines including signal processing, machine learning, control engineering and decision making. Self-awareness models can be learned from data about experiences where a teacher has shown an entity how to perform a task, as human do. Learned self-awareness models can be used for different purposes like

* predicting self and external situation evolution,
* detecting non-stationary conditions
* selecting the best way to adapt agent behavior to current conditions based on the set of learned behaviors.

The tutorial comprehensively addresses self-awareness in autonomous systems along with multiple fundamental and practical dimensions.

**ICIP2018 Tutorial “Drone Vision for Cinematography and Media Production”, Athens 7/10/2018.**

Presenters are: Ioannis Pitas (Aristotle University of Thessaloniki, Greece), J. R. Martínez-de Dios (University of Seville, Spain), Anastasios Tefas (Aristotle University of Thessaloniki, Greece).

## Summary: The aim of drone cinematography is to develop innovative intelligent single- and multiple-drone platforms for media production. Such systems should be able to cover outdoor events (e.g., sports) that are typically distributed over large expanses, ranging, for example, from a stadium to an entire city. The drone or drone team, to be managed by the production director and his/her production crew, shall have: a) increased multiple drone decisional autonomy, hence allowing event coverage in the time span of around one hour in an outdoor environment and b) improved multiple drone robustness and safety mechanisms (e.g., communication robustness/safety, embedded flight regulation compliance, enhanced crowd avoidance and emergency landing mechanisms), enabling it to carry out its mission against errors or crew inaction and to handle emergencies. Such robustness is particularly important, as the drones will operate close to crowds and/or may face environmental hazards (e.g., wind). Therefore, it must be contextually aware and adaptive, towards maximizing shooting creativity and productivity, while minimizing production costs. Drone vision and machine learning play an important role towards this end, covering the following topics: a) drone localization, b) drone visual analysis for target/obstacle/crowd/point of interest detection, c) 2D/3D target tracking, d) privacy protection technologies in drones (e.g. face de-identification). The tutorial will offer an overview of all the above plus other related topics such as: a) current state of the art on the use of drones in cinematography, advertisement, news coverage, sports and media production in general, b) multiple drone mission planning and flight control, c) communication issues in drones (e.g. video streaming), d) security and ethics issues in drones.

**AVSS2018 Tutorial ‘Deep learning and multiple drone vision’, Auckland, New Zealand, 27/11/2018.**

Presenter: Ioannis Pitas (Aristotle University of Thessaloniki, Greece).

**ACCV2018 Tutorial ‘Multiple Drone Vision for Media Production’, Perth, Australia, 2/12/2018.**

Presenter: Ioannis Pitas (Aristotle University of Thessaloniki, Greece).