IE 2022 Tutorial Proposal: Embedding lightweight software agents into single board computers for controlling IoT scenarios

- **Names and affiliations of speakers**

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- **Abstract, objectives and motivations**
The Internet of Things (IoT) is an emerging paradigm that has gradually been introduced in several areas to support the automation of tasks that solve real-world problems and help people have a better quality of life. In IoT environments, mechanisms that enable things, objects or devices to have greater autonomy, degree of collaboration and adaptation at runtime are increasingly necessary. In this sense, agents play an important role because they are entities with high communication capabilities that can modify their behavior according to environment changes and user and developer needs. In consequence, the agents should require reconfiguration or reprogramming for adapting to the novel conditions. The objective of this tutorial is to present two techniques to identify IoT ecosystems, that is, through embedded agents running on the devices themselves, and through Multiagent systems running in the cloud. More specifically, the proposed tutorial emphasizes the agentification technique using embedded software agents on the devices themselves. For this, it is proposed to use Raspberry Pi as the support to embed the agents, which in turn will be programmed in Python using the OsBrain tool. Through embedded agents, it is proposed to create proactive object networks to overcome the limitations of IoT devices, which are currently passive and can only be reconfigured under arguments defined by the manufacturer.

- **Keywords**
Software agent, embedded, Raspberry Pi, OsBrain, IoT

- **Intendance audience**
The tutorial is intended for researchers, including both, Master and PhD students who are interested in starting research in the area of Internet of Things based on intelligent agents and multiagent systems. This tutorial is oriented to people who want to learn how integrate lightweight software agents into single board computers such as Raspberry Pi for programming collaborative tasks in the context of the IoT. It is recommended that the audience has basic skills in Python language programming and some experience using basic commands for managing directories and files in Linux.

- **Content outline**
  Internet of Agents (IoA)
  Agentification of the IoT, techniques
  Single board computers (SBC) and Raspberry PI
  OsBrain platform and lightweight software agents
  Collaborative agents in embedded systems
  Agentification of the IoT via embedded software agents

- **Description**
  Multiple scenarios in which people interact on a daily basis are integrating IoT technologies. Consequently, there is a need to create collaborative IoT ecosystems in which certain objects, things or devices can collaborate actively with their counterparts in a network to achieve specific objectives. Hence, IoT objects transit from merely passive objects to proactive objects that communicate with others ones autonomously, being able to run model complex behaviors and tasks based on data provided by other objects. In this scenario, performing an IoT agentification process is relevant to model complex behaviors, so that objects can search for information of interest and support others with data that are not within their reach. In order to materialize the IoT agentification approach using embedded agents, it is important to know how Raspberry Pi works, its components, GPIO and how to access data from sensors connected to the board. In addition, the use of lightweight agents such as OsBrain agents can help to the development of agents particularly focused on embedded systems. From their integration, a model is presented where agents will run on a device created from Raspberry Pi for a particular IoT context.

- **Teaching mode**
  The tutorial is planned to be face-to-face because the participants could form teams of 4 people in order to work collaboratively to program OsBrain agents and embedded into Raspberry PI. The expected duration of the tutorial is one hour and a half. According to the health situation caused by COVID19 the tutorial will also be prepared to be taught virtually through the Zoom platform.

- **Materials**
  The audience will have access to Internet for downloading Python 3 and OsBrain. In addition, all participants will have access to the slides of the presentation and some basic scripts for both, reading the GPIO of the Raspberry Pi and initializing basic OsBrain agents. All digital resources will be uploaded on a public repository.

- **Additional information**
  N/A

- **Bio-scketches**

  José G.Caicedo-Ortiz José Gregorio Caicedo-Ortiz received his Electronic Engineering degree and Master's degree in Engineering with an emphasis on software and networks at the Universidad de la Costa in Barranquilla, Colombia. He is currently a PhD candidate at the University of Granada Spain. His research interests are focused on solutions based on embedded systems, wireless sensor networks, internet of things, intelligent software agents and the integration of intelligent software agents in embedded systems to improve and boost the characteristics and capabilities of the IoT.

Juan A. Holgado-Terriza received his Ph.D. degree from the University of Granada. He is currently a professor of the University of Granada and his main research interests are focused on methodologies and techniques for Internet of Things and agent-based systems applied to ambient intelligence, smart homes, instrumentation, and industry. He is also interested in the development of real time, embedded and mobile systems for cyber-physical systems, wearables, and consumer electronic devices.

Pablo Pico-Valencia received his PhD degree from the University of Granada, Spain. He is a professor at the Pontificia Universidad Católica del Ecuador in the area of Information and Communications Technology. His research interests lie in the development of Internet of Things (IoT) agent-based applications based on the Internet of Services and Linked Open Data aimed at improving the interoperability, collaboration and intelligence within IoT networks.