

Artificial Intelligence for Precision Agriculture

Jaime Lloret Mauri



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Prof. Jaime Lloret Mauri (PhD.)

IEEE Senior, ACM Senior, IARIA Fellow, EAI Fellow

Department of Communications, Universidad Politecnica de Valencia (Spain)

Chair of the Integrated Management Coastal Research Institute (IGIC) since January 2017

IEEE Spain Section Officer

Chair of the Internet Technical Committee (IEEE Communications Society & Internet Society) (Term 2014-2015)

Chair IEEE 1907.1 WG (from 2013 to 2018)

Head of the Innovation Group *Active and collaborative techniques and use of technological resources in the education*

Co-editor-in-Chief of Ad Hoc and Sensor Wireless Networks (JCR)

Advisory Board of International Journal of Distributed Sensor Networks (JCR)

Associate Editor Wireless Communications and Mobile Computing (JCR)

Editor-in-Chief of the International Journal "Network Protocols and Algorithms"

Chair of: 21st CDVE 2024, 9th IOTSMS 2024, MCNA 2024, FCSIT 2024, WIRELESS ANALYTICS 2024

Since 2016: Spanish researcher with highest h-index in the TELECOMMUNICATIONS (Clarivate Analytics Ranking).

Since 2020: Included in the world's top 2% Scientists according to the Stanford University List.



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Publications:

<http://scholar.google.com/citations?user=ZJYUEGAAAAJ>

https://www.researchgate.net/profile/Jaime_Lloret2/publications/

http://www.informatik.uni-trier.de/~ley/pers/hd/m/Mauri:Jaime_Lloret

<http://www.scopus.com/authid/detail.url?authorId=23389476400>

<http://orcid.org/0000-0002-0862-0533>



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Introduction - University

Polytechnic University of Valencia (UPV) is a public educational institution (3 campus sites with more than 36,000 students, almost 3,000 members of teaching and research staff, and about 2,400 administrative and services staff).

UPV combines training with research and encouraging investigation and projects, balancing theoretical and applied research.

It has 41 departments, 40 research centres and institutes, 4,055 people involved in research structures, 410 skills, 222 patents, 13 results, 41 software, and offering 56 Master's degrees and 28 Doctor's degrees.

UPV is composed of 11 schools, 2 faculties and 2 higher polytechnic schools.



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Introduction - University

Quality Metrics:

UPV is in the top 310 best universities of the world, according to the QS World University Rankings, and it is in the position 155 in the international patents.

<http://www.upv.es/noticias-upv/noticia-10133-qs-world-unive-es.html>

UPV is the best technical university in Spain, according to Shangay University Rankings (it is in the best 400 universities of the world)

<http://www.upv.es/noticias-upv/noticia-6802-ranking-de-shan-es.html>

Times Higher Education (THE) Young University Rankings recognizes UPV in the first 150 universities of the world.

<http://www.upv.es/noticias-upv/noticia-10152-the-young-univ-es.html>



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Introduction – Research Institute

The **Integrated Management Coastal Research Institute (IGIC)** belongs to the UPV.

<http://cienciagandia.webs.upv.es/2015/01/el-instituto-de-investigacion-igic-situa-al-campus-de-gandia-como-referente-internacional/>

<https://www.upv.es/entidades/IGIC/indexi.html>

IGIC's general aim is to promote and conduct scientific research of excellence on various aspects of integrated coastal zone management.

The research of the institute is structured into three main areas:

- (1) Environmental study and conservation of biological resources in coastal zones;
- (2) Technological tools applied to marine and coastal environments;
- (3) Coastal zone planning and management.

It is a multidisciplinary Institute with 70 researchers from different areas.



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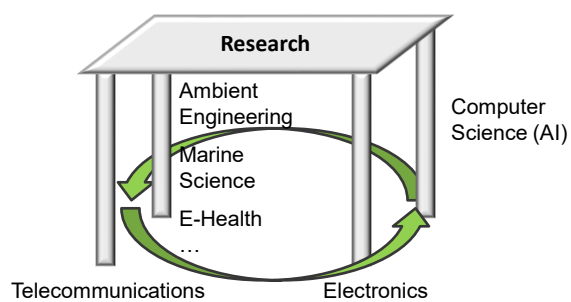
Introduction – Research Group

24 Members

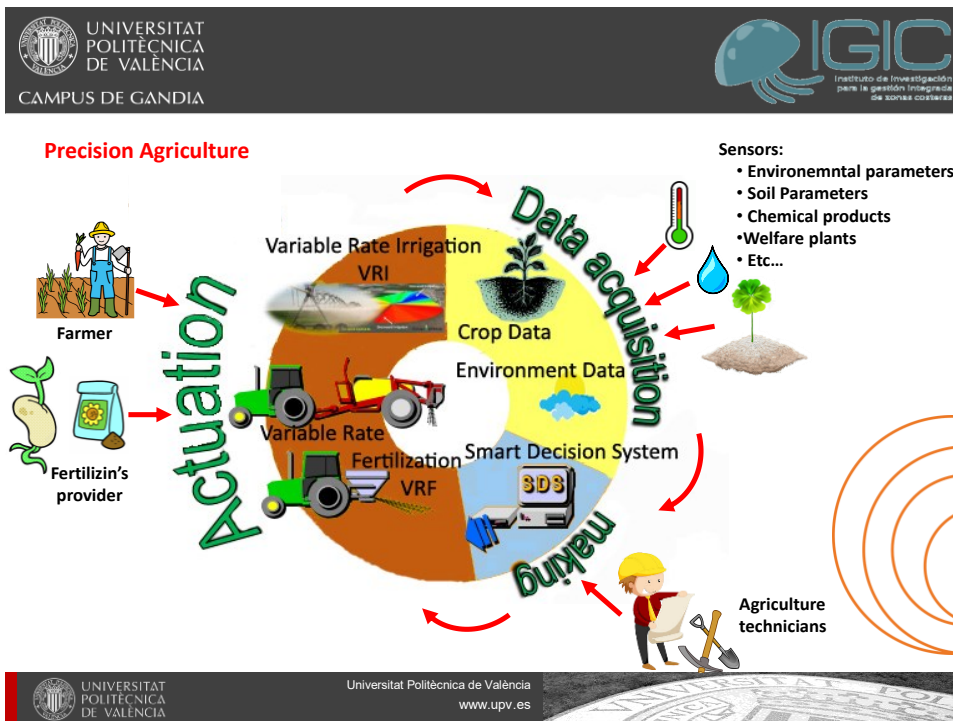
7 Professors (2 from another university)
 6 Postdoc
 7 PhD Students
 3 Master Students
 1 staff



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Outline

- **Sensors**
- **Sensor Nodes**
- **(Wireless) Sensor Networks**
- **Network Protocols**
- **Artificial Intelligence in Wireless Sensor Networks**



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Sensors

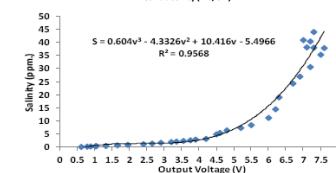
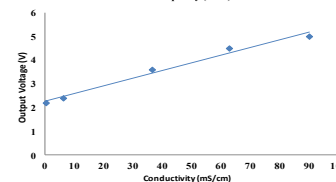
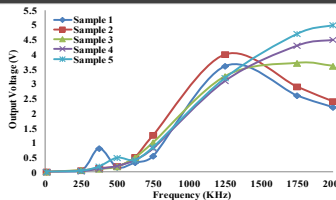


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Sensors

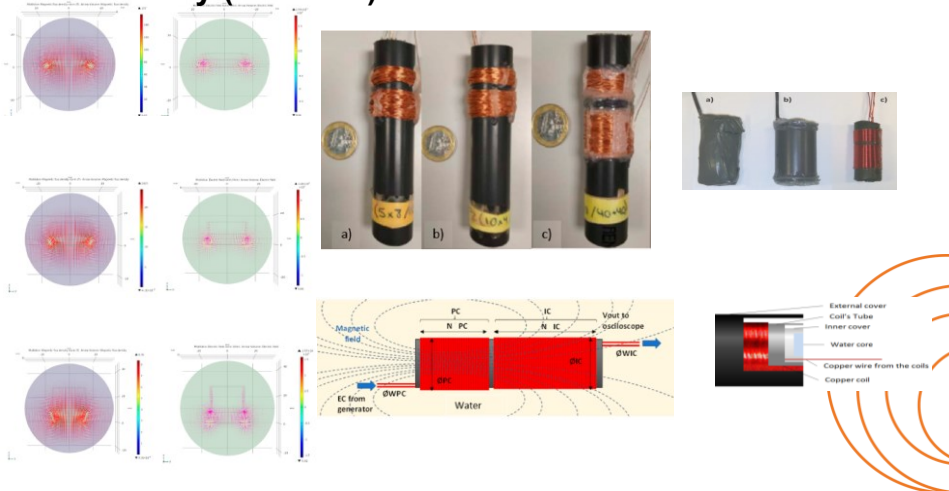
Conductivity (Salinity) Sensor

Model	POW	Features PC	INDC	Features IC
1	S	Wire Diam.: 0.6 mm Coil Diam.: 29.6 mm Coil High: 13.8 mm - Nº of Spires: 21	S	Wire Diam.: 0.6 mm Coil Diam.: 29.6 mm Coil High: 27 mm Nº of Spires: 45
2	T	Wire Diam.: 0.4 mm Inner Coil Diam.: 19.6 mm Outer Coil Diam.: 26.4 mm Coil High: 24.9 mm Nº of Spires: 77	T	Wire Diam.: 0.4 mm Inner Coil Diam.: 39.8 mm Outer Coil Diam.: 51.2 mm Coil High: 24.9 mm Nº of Spires: 304
3	S	Wire Diam.: 0.6 mm Coil Diam.: 27.2 mm Coil High: 17.8 m Nº of Spires: 31	T	Wire Diam.: 0.8 mm Inner Coil Diam.: 30.6 mm Outer Coil Diam.: 44.7 mm Coil High: 22.3 mm Nº of Spires: 132
4	T	Wire Diam.: 0.8 mm Inner Coil Diam.: 23.2 mm Outer Coil Diam.: 56.5 mm Coil High: 26.9 mm Nº of Spires: 81	S	Wire Diam.: 0.8 mm Inner Coil Diam.: 25.3 mm Outer Coil Diam.: 33.6 mm Coil High: 22.6 mm Nº of Spires: 324 distributed in 9 layers.



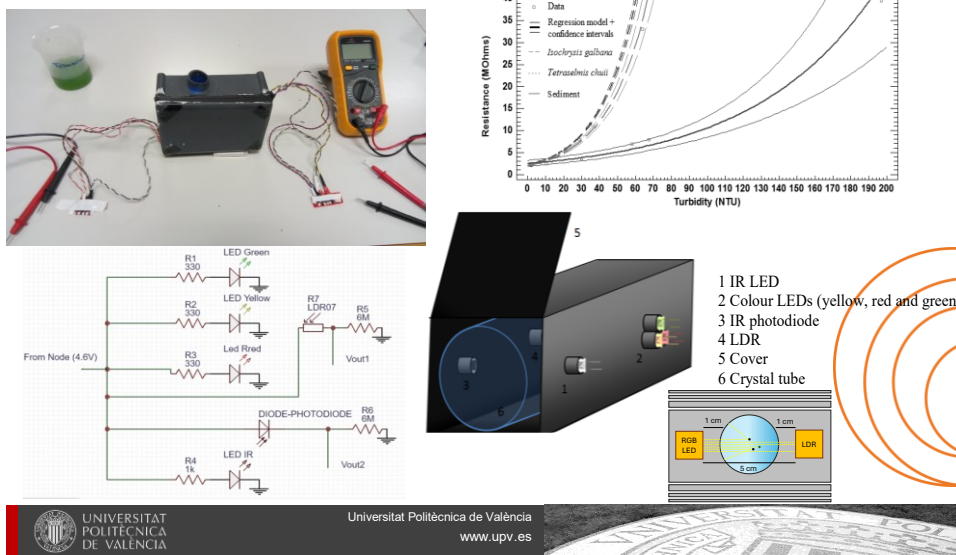
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Conductivity (Fertilizer) Sensor



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Turbidity Sensor and Suspended particles

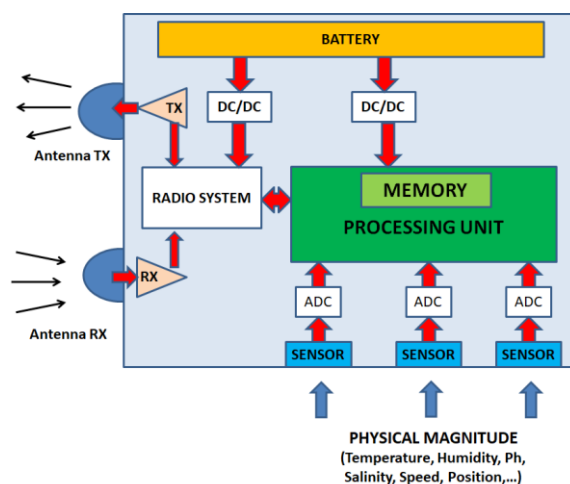


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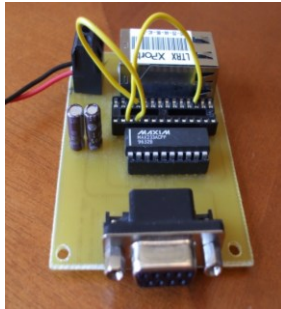
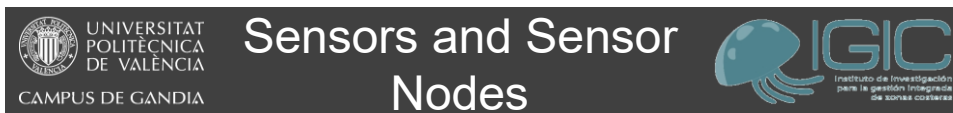
Sensor Nodes



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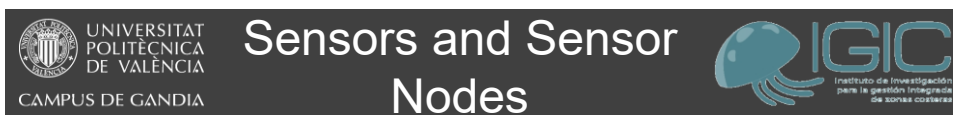
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XPort and Matchport, from Lantronix



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**Flyport**

http://wiki.openpicus.com/index.php/Main_Page



Flyport Lite



Flyport Wi-Fi 802.11g



Flyport Ethernet



Flyport GPRS

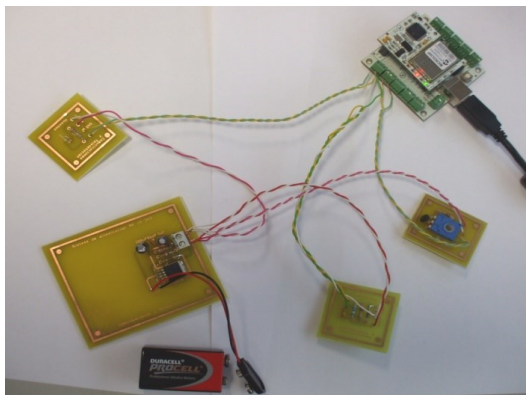


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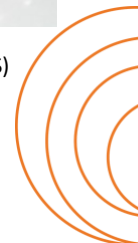
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 CAMPUS DE GANDIA

Sensors and Sensor Nodes

IGIC
 Instituto de Investigación para la gestión integrada de zonas costeras



Flyport (openPICUS)



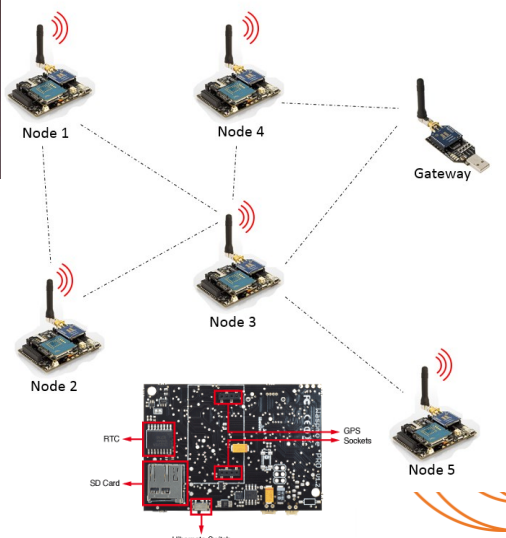
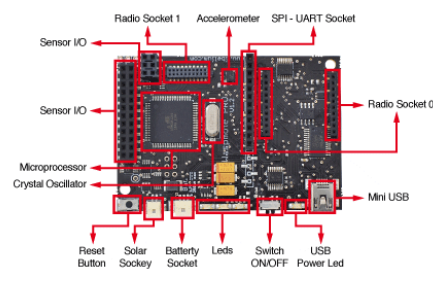
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Wasp mote (Libelium)



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Sensors and Sensor Nodes

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Arduino UNO

ENTRY LEVEL	UNO LEONARDO 101 ESPLORA MICRO NANO MINI MKR2UNO ADAPTER
	STARTER KIT LCD SCREEN
ENHANCED FEATURES	MEGA ZERO DUE MEGA ADK MO MO PRO MKR ZERO MOTOR SHIELD
	USB HOST SHIELD PROTO SHIELD MKR PROTO SHIELD 4 RELAYS SHIELD
	MEGA PROTO SHIELD MKR RELAY PROTO SHIELD ISP USB2SERIAL MICRO
	USB2SERIAL CONVERTER
INTERNET OF THINGS	YUN ETHERNET TIAN INDUSTRIAL 101 LEONARDO ETH MKR FOX 1200
	MKR WAN 1300 MKR GSM 1400 MKR1000 YUN MINI YUN SHIELD WIRELESS SD SHIELD
	WIRELESS PROTO SHIELD ETHERNET SHIELD V2 GSM SHIELD V2 MKR IoT BUNDLE

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Sensors and Sensor Nodes

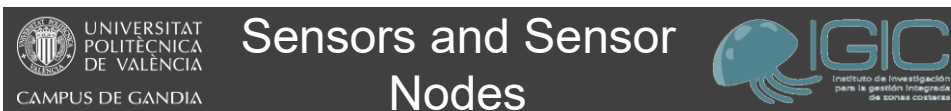
IGIC
Instituto de Investigación para la gestión integrada de zonas costeras



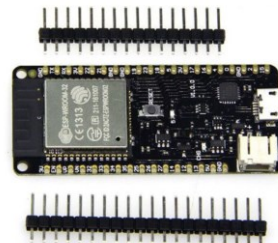
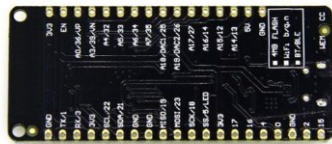
Arduino Mega

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

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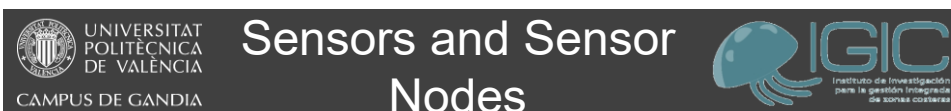
WEMS LOLIN32 V1.0.0 ESP-32 Rev1 wifi y bluetooth con Flash de 4 MB



WIFI
Bluetooth
4 MB Flash
Battery: Lithium 500mA Max



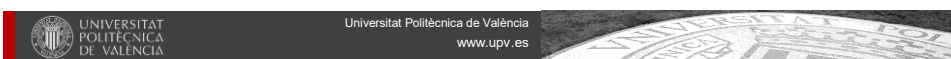
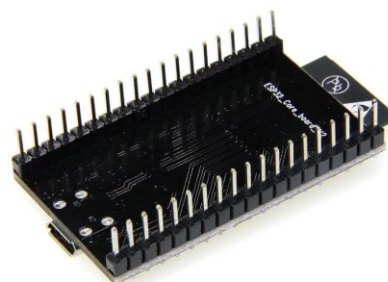
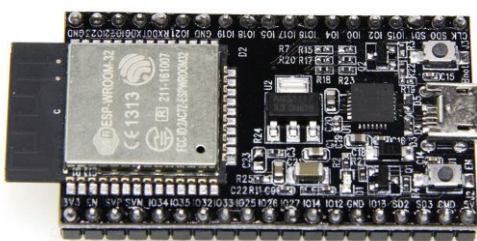
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ESP32 WiFi + Bluetooth Ultra-Low power consumption

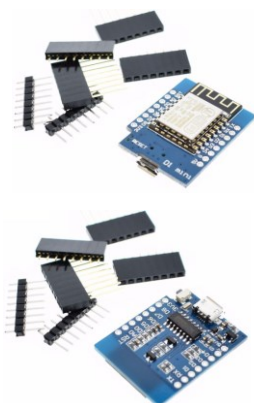
Dual Core ESP-32S ESP32 ESP8266

<http://espressif.com/en/products/hardware/esp32-devkitc/overview>



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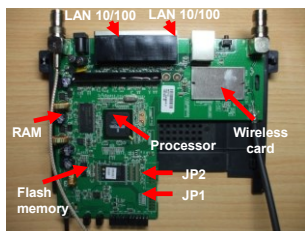
D1 mini-Mini NodeMcu 4Mbytes ESP8266 Lua WIFI



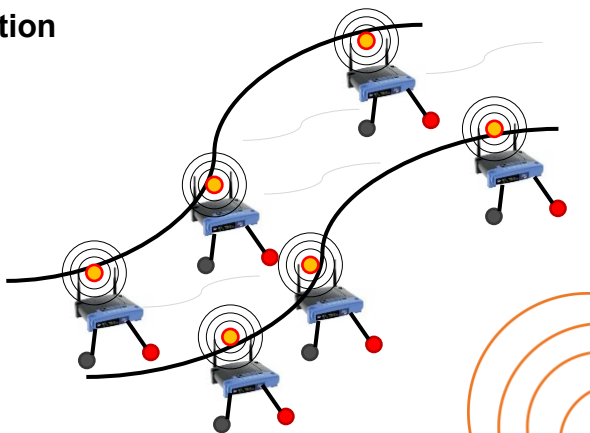
WeMos System
 11 digital inputs/outputs
 1 in analog Input (3.3 V max)
 Micro USB connection



Sensor node modification



Linksys WRT

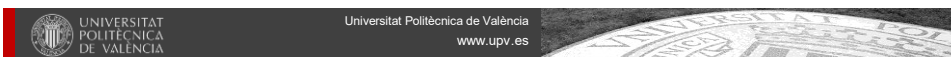


- Environment pollution multisensing
- Presence detection, speed detection, etc.

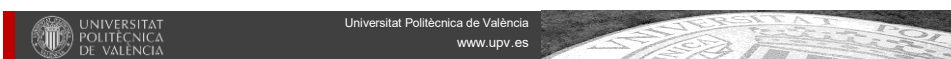
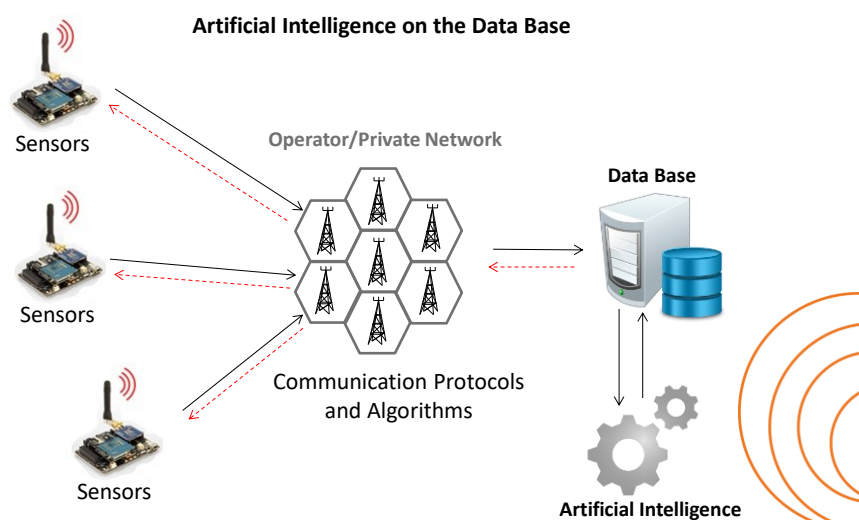




Artificial Intelligence in Wireless Sensor Networks

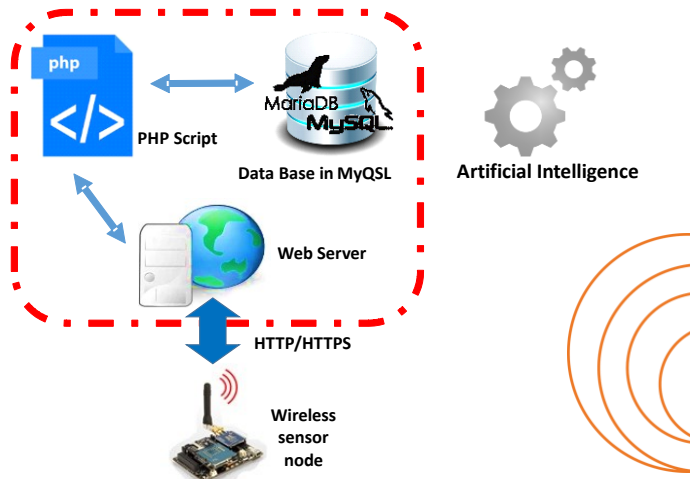


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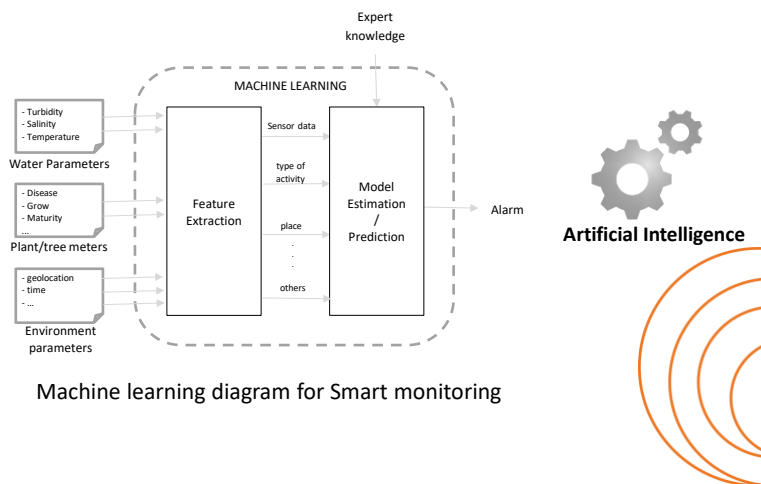


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Artificial Intelligence on the Data Base



Artificial Intelligence on the Data Base



Machine learning diagram for Smart monitoring



Artificial Intelligence on the Data Base

Title: Smart Wireless Sensor Network to Detect and Purificate Water Salinity and Pollution for Agriculture Irrigation
 Funding Entity: DLR Project Management Agency / European and International Cooperation. ERANETMED3-227
 SMARTWATIR. AGENCIA ESTATAL DE INVESTIGACION. PCI2018-093268
 From: 04-03-2018 To: 03-03-2021

Title: Grupo Operativo de Innovación para el uso combinado de sensores y teledetección, una solución holística para la monitorización y mejora del cultivo del garbanzo (GO TECNOGAR)
 Funding Entity: Programa Nacional de Desarrollo Rural (2014-2020): FEADER y MAPA/. 2019ES06RDEI44576
 From: 07-11-2020 To: 15/03/2023

Title: Red Heterogenea Inteligente de Sensores Inalambricos para Monitorizar y Estimar el Contenido de Resina de Cistus Ladanifer
 Funding Entity: Ministerio de Economía y Competitividad. PID2020-114467RR-C33
 From: 01-01-2021 To: 31-12-2023

Title: red de Sensores y big dAta para La obserVAcion Del entOrno maRino (SALVADOR)
 Funding Entity: Generalitat Valenciana GVA-THINKINAZUL/2021/002
 From: 01-01-2022 To: 31-12-2024

Title: Red Cognitiva Basada en Grupos de Sensores Colaborativos para el Sensado y Monitorización del Entorno Acuático.
 Funding Entity: Ministerio de Ciencia y Tecnología. TEC2011-27516
 From: 01-01-2012 To: 31-12-2014

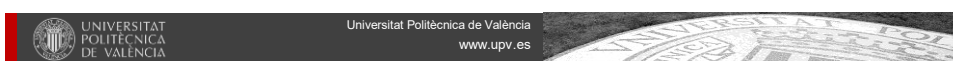


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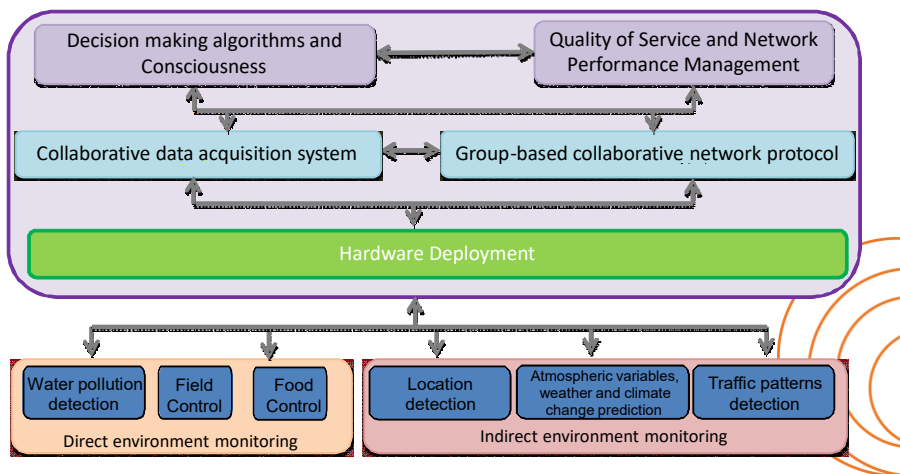


Observatorio de Cultivos Leñosos: Agricultura digital inteligente, sostenible y competitiva para agricultores, investigadores, consumidores y comunidad educativa (AGRICULTURA 6.0)

<http://agricultura6.es>



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jlloret@dcom.upv.es

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