Panel
Sensing Huge Data and IoT Systems
Moderator
Paulo E. Cruvinel, Ph.D

Panelists

Underwater acoustics - Challenges and Applications.
Paulo Jorge Maia dos Santos, Ph.D

Challenges in the recognition of activities of daily living anywhere at anytime without special requirements using mobile devices.
Ivan Miguel Serrano Pires, Ph.D

Huge Data and IoT Applications in Precision Agriculture.
Paulo E. Cruvinel, Ph.D
The sound is the only practical way to propagate signals to great distances in the ocean. The sound is used, not only for communication between marine animals but also for underwater parameter estimation, localization of objects and sources, etc.

Although the ocean exploration is a complex challenge, underwater acousticians study the propagation of sound in water and its interaction with the ocean boundaries (surface and seafloor) to predict the characteristics of physical and biological parameters of the ocean.

Basically, the signals are acquired by pressure sensors (hydrophones) and recently the use of vector sensors became a more advantage way for underwater applications.
Underwater Acoustics
Challenges and Applications

...to listen or not to listen?

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Objectives

**Use sound to...**

- **active:** improve technology for ocean exploration/exploitation
  - comms
  - sonar
  - adcp
  - geophysics (multibeam, seismic, ...)

- **passive:** monitor the ocean environment and resources
  - mammals
  - fish and litoral
  - shipping noise
  - earthquakes
Challenges

Active
1. Underwater communications estimate $s$ or $H$ (knowing $s$)
2. Geophysical exploration estimate $H$ knowing $s$

Passive
1. Water column temperature estimate $H$ assuming $s$
2. Bottom seagrass health statistical analysis of $y$
3. Shipping noise estimate $y$, assuming $s$ and $H$

$y = Hs + n$

$s$ known, unknown deterministic, random
Challenges

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time-variable environment
Challenges

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- time-variable environment

  \( s \) known, unknown

  deterministic, random
Challenges

Complex underwater operations

Refractions and Reflections

Useful equipment

~10cm
Application 1: deep sea communications

Physical model-based Comms

OceanTech project (2018-2020)

STRONGMAR project (2016-2019)

Exploration

Caiti et. al., "Linking Acoustic Communications and network performance:...", IEEE JOE, 38(4), 2013
Maia et. al., "A perspective for time-varying channel compensation...", Sensors & Transducers, 189(6), 2015

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Application 2: bottom exploration

WiMUST project (2015-2018)

- reducing the complexity and cost of geophysical surveys
- operation in sensitive areas (coastal)
- optimal array configurations

Vector sensor

- measure pressure and particle velocity (field directivity)
- spatial filtering capabilities (deghosting, directional noise)
- large spatial discrimination with short arrays

Application 3: ocean observatories

listening to the ocean
- understand biological, environmental and seismic processes
- estimating ocean properties from sources of opportunity
- integration with non-acoustical sensors

EMSODEV (2015-2019)


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European multisensory seabed and water column observatory
Application 4: littoral monitoring

- **Seagrass meadows**
  - O2 production, fish habitat, shore line stabilization

- **Active acoustics**
  - Bubbles assessment (not readily assessed by conventional methods → underestimation of O2 production)

- **Passive acoustics**
  - Biological noise → to estimate populations (species, abundance, behavior)
  - Link between O2 production and noise variability

**SEAOX project** (FCT - PTDC/EEI-PRO/2598/2014) focus on the “Ria Formosa” Lagoon ecosystem


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Challenges in the recognition of activities of daily living anywhere at anytime without special requirements using mobile devices

The Assisted Living Computing and Telecommunications Laboratory (ALLab) is a research group created within the Network Architectures and Protocols Research Group of the Instituto de Telecomunicações pole at the University of Beira Inteiror, Covilhã, Portugal. In the context of IT@UBI, the Assisted Living Computing and Telecommunications Laboratory is focused on research on Biosignal algorithms, Ambient Assisted Living, Biosignal acquisition and transmission, and Quality of Experience has been created.

Research staff has experience on development of Intelectual Property. We have also connections to other research groups in in the USA (Prof. Madalena Costa, Beth Israel Deaconess Medical Center, Harvard Medical School) and in Portugal (Polythecnique Institute of Castelo Branco, Superior Health School Dr. Lopes Dias, University of Trás-os-Montes and Alto-Douro, Center for Research in Sport, Health and Human Development, Lusophone University of Humanities and Technologies), and to QoE research groups in Europe through the IC0703 COST Action. Research cooperation with private companies is also implemented, either following a model of "research per request" or a "shared risk model".
One of our research studies is related to the research and development of a Personal Digital Life Coach (PDLC). It includes different components, including the recognition of Activities of Daily Living (ADL), recognition of environments, recognition of emotions and integration of all modules with Big Data. The recognition of ADL and environments is now finished with success, reporting the recognition of 16 events (ADL and environments) with more 2.97% of accuracy than the average accuracy reported in the literature.

The recognition of the emotions is now in the phase related to the research about the state-of-the-art, which should be finished in the next years. After that, the integration with Big Data will be performed. There are other ongoing projects related to the use of other sensors, including Electrocardiography and others, using the Bitalino sensors.
Development of a Personal Digital Life Coach using Mobile devices’ Sensors

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Altranportugal – Lisbon, Portugal
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September 2018
Agenda

• Background of Ambient Assisted Living Computing and Telecommunications Laboratory

• Development of a Personal Digital Life Coach – Concepts

• Framework for the Recognition of Activities of Daily Living using Mobile Devices’ Sensors

• Limiting Resources for the Recognition of Activities of Daily Living

• Directions for Lightweight Data Fusion Methods

• Future Improvements for the Classification Methodologies

• Insights Development for the Personal Digital Life Coach
Background of Ambient Assisted Living Computing and Telecommunications Laboratory

- Different research studies related to the Mobile Health
- Different studies related to the development of a Personal Digital Life Coach
- Different studies related to the networking concepts
- We are placed in University of Beira Interior, Covilhã, Portugal
Development of a Personal Digital Life Coach

Integration of all concepts with Big Data

Recognition of Emotions

Personnal Digital Life Coach

Recognition of Activities of Daily Living

Recognition of Environments

- Development of an Android Library using a Smartphone

- Components of the Framework:
  - Sensors
  - Data Acquisition
  - Data Processing
    - Data Cleaning
    - Data Imputation
    - Feature Extraction
  - Data Fusion
  - Classification

- First Proposal ➔ 2015

- Second Proposal ⇒ 2

• Third Proposal ➔ 2017

- Final Proposal ➔ 2018
Limiting Resources for the Recognition of Activities of Daily Living

• Sensors - Minimalistic Approach

• Futuristic Active/Passive Devices for IoT

• Sequentiation of Concepts for the Recognition of Activities of Daily Living

• Ubiquitous Computing for Huge Data Processing
Directions for Lightweight Data Fusion Methods

• Data Fusion Methods - Cutting Edge

• Performance Indicators Improvement using Data Fusion Methods

• Heavyweight Algorithms Beaten by Lightweight

• Future of the Data Fusion using On-going Development Devices
Future Improvements for the Classification Methodologies

- Existing Classification Methodologies
- Different Approaches for Limited Resources
- Use of Cloud Computing Off-Load Techniques
- Knowledge Refinement using the Results Obtained with Different Techniques
Insights Development for the Personal Digital Life Coach

- Personalized methods for the Daily Activity Assistant
- Individualized Smart-Home Insight
- Importance of the Emotional Intelligence for the Personal Digital Life Coach
- Big Data for the Personal Digital Life Coach
Development for the Personal Digital Life Coach – Current State

• Studies Completed:
  • Recognition of Activities of Daily Living
  • Recognition of Environments

• Ongoing Research:
  • Recognition of Emotions

• Future Research:
  • Integration of all concepts with Big Data
Thank you!!!
Huge Data and IoT Applications in Precision Agriculture

Sensing Huge Data and IoT Systems

Precision agriculture (PA) is an approach to farm management that uses information technology to ensure that the crops and soil receive exactly what they need for optimum health and productivity. The goal of PA is to ensure profitability, sustainability and protection of the environment.

In this context, PA is a development that emphasizes the use of sensors, information and communication technology in the farm management cycle. New technologies such as the Internet of Things (IoT) and cloud computing are expected to leverage this development and introduce more automation based on robots and artificial intelligence in farming.

This is encompassed by the phenomenon of huge data, massive volumes of data with a wide variety that can be captured, analyzed and used for decision-making. Based on the concept of supply chain, huge data are being used to provide predictive insights in farming operations, drive real-time operational decisions, and redesign business processes for food production.

In the Panel it is discussed the present and the future of sensing huge data and IoT in PA based on scenarios. Also, further development of sensor’s networks, data quality, and application platforms are both presented together with models for data sharing and decision making processes.
Panel

Sensing Huge Data and IoT Systems

Huge Data and IoT Applications in Precision Agriculture

Paulo E. Cruvinel
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Needs for knowledge, science, industry & innovation in food safety?

As defined by the Food and Agriculture Organization (FAO) of the United Nations:

- Food safety “exists when all people at all times have both physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs for an active and healthy life.”

Challenges

- An increasing global population, in combination with climate change, poses a threat to food safety as arable land becomes less available;
- **Global population**: Projected to be approaching 12 Billion People in the 2050s;
- **Food production**: needs to increase more than 60% in food production;
- **Degradation, Water use, Resilience of natural resources, Pest Control**: needs for sustainability;
- **Risk Control**: Biggest challenge, demanding huge data sensing and IoT systems to support decision making.
Technology roadmap: The Internet of Things

Source: SRI Consulting Business Intelligence, In: 3rd International Conference on Networks, Applications, protocols and Service (NetAPPS), Sept, 2012. Date retrieved: August 10, 2018
Huge Data Landscape...
Food Safety....but also Food Security

Analysis of the international food-trade network shows great vulnerability to the fast spread of contaminants.
Sensing Huge Data (Spatial Database & Text)

Topographic map archive, Habitat, Boundaries, Business entities, Geomatics & methods, Statistics & Analytics, License & public policy, logistics...

WEB Enabled Access based on IoT

Location Based Platforms

Spatial Data Infrastructures

Enabling Technology
Converting Data into Information

Supported Functions
For Governance and Agricultural Industry

Farming, resource & inputs management; Land valuation & taxation; Agricultural risk monitoring (climatic risk, agro-ecological zone, crop forecast...); Transport & access (logistics); Traceability; Transactions & management; Disclosure of restrictions; Emergency management; Policy making...
Sensing huge data & data quality

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<th>Data Quality System</th>
<th>Auditable System &amp; Serviceability</th>
<th>Risk Verification</th>
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Food Industry based on Huge Data, IoT Applications and Precision Agriculture

Zoning of Climatic Risks
Regionalization of climatic claims to minimize losses in agricultural production, risks reducing from the rainfall regimes

Agroecological Zoning of Sugarcane
It defines suitable areas and exclusion zones for the cultivation of sugar cane in Brazil. Directs the policy of expansion and bioethanol production

Low Carbon Agriculture ABC Plan
Decarbonization of the agriculture processes by the incorporation of practices of low emission of greenhouse gases
Conclusions

There are many challenges in ongoing sensing huge data and IoT systems related with processes for decision making in agriculture. So far, the approach depends on the complex scenarios related to agriculture and food production, as well as from the level of data with quality required to support the value chain and the biomes diversity.
Thanks for your attention!
Today, there are many needs to generate, organize and use huge data and the internet of things (IoT) related with processes for decision making. Such processes are related with environment, industry, defense, automation, robotics, storage, logistics, traceability, and agriculture, among others.

The approach used to tackle each one of these issues depends on the application scenario, as well as from the amount of data and quality required for the intended use, and of course due the sensors, IoT, and their performances. Therefore, in such scenario, there are needs for digital development associated with huge amount of data, interpretation, sensors’ network, intelligence, and the IoT, which are now playing an important role, i.e., not only to find opportunities for business but also to allow sustainability to life quality for the world population.

Furthermore, in such realistic scenario the information retrieval and the decision making based on sensing huge data and IoT systems are still a big challenge and lead to opportunities at national, regional and global level.