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Automatic monitoring and detection of activities of daily living (ADLs) within Home Environments

Anastasios Vafeiadis (ESR 13)

Center for Research & Technology Hellas / Information Technologies Institute (CERTH/ITI)

Advisors: Prof. Liming Chen, Prof. Raouf Hamzaoui

Supervisors: Dr. Konstantinos Votis, Dr. Dimitrios Giakoumis, Dr. Dimitrios Tzovaras

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ESR 13 Background

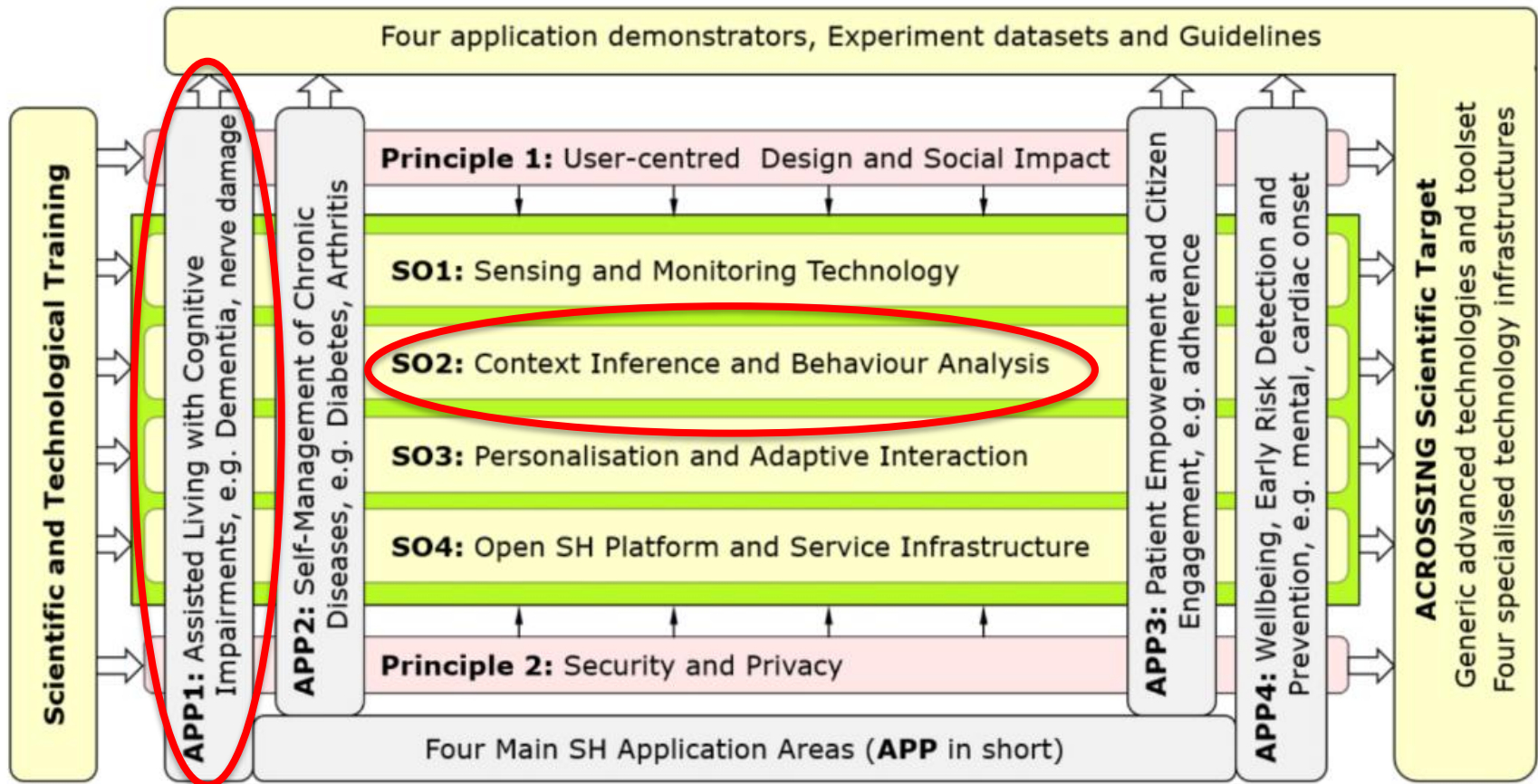
- Joined ACROSSING in October 2016
 - Affiliation CERTH/ITI; Academic Affiliation: DMU
- Educational Experience:
 - BSc in Electrical & Computer Engineering, Mathematics – Worcester Polytechnic Institute, Worcester, MA, USA (May 2012)
 - MSc. in Electrical & Computer Engineering – Northeastern University, Boston, MA, USA (June 2014)
- Working Experience:
 - Worcester Polytechnic Institute - Research Assistant (May 2010 – November 2012)
 - Vehicular communication prototype using Software Defined Radios (SDRs)
 - Advanced Development Digital Signal Processing (DSP) Engineer – Bose Corp., Framingham, MA, USA (June – September 2014)
 - Algorithm development for noise cancellation and enhancement in a vehicle
- Research Areas: Digital Signal Processing, Audio Signal Processing, Wireless Communications

Research Project Objectives

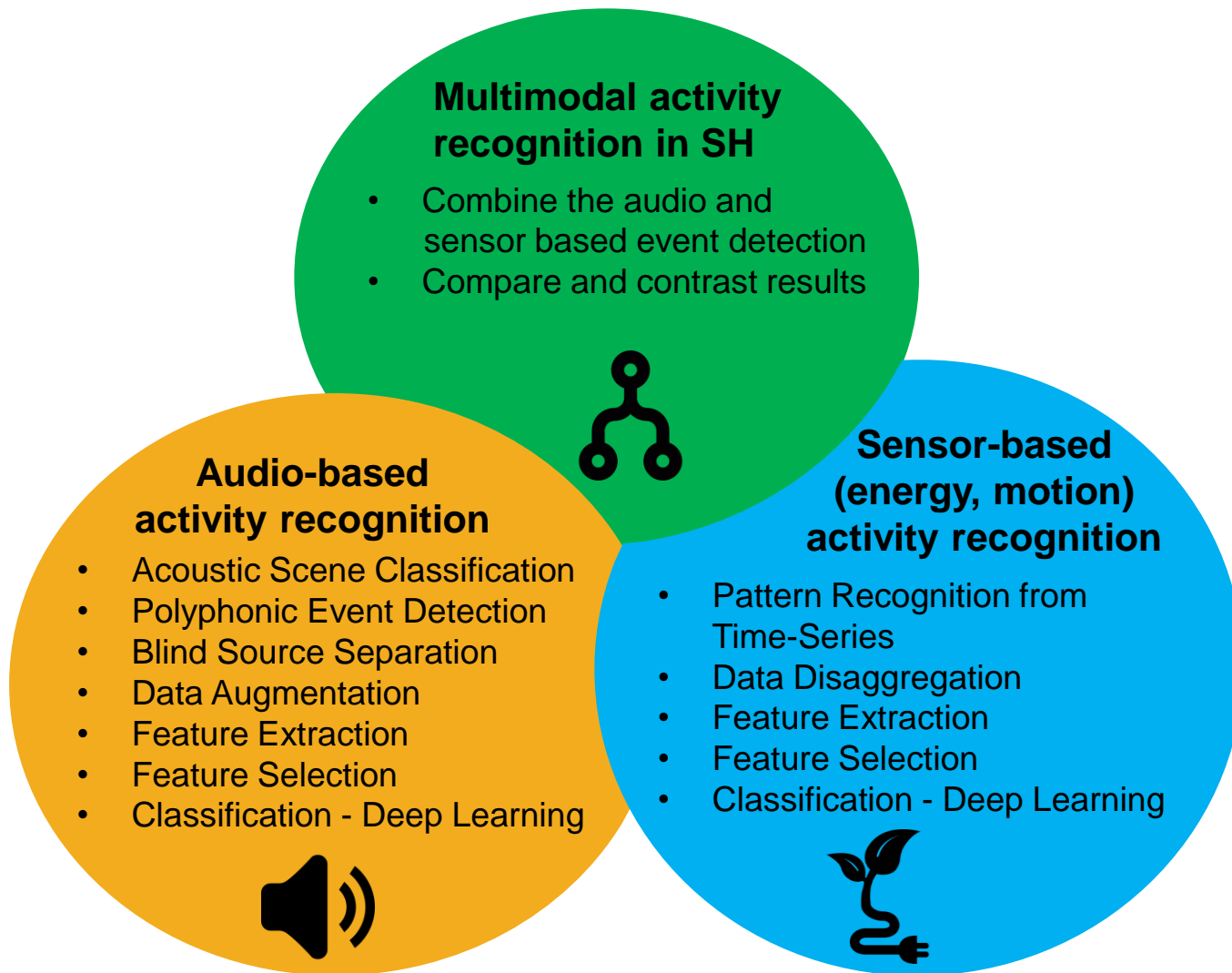
- Title: **Automatic monitoring** and **detection** of activities of daily living (ADLs) within Home Environments
- Perform **unobtrusive** activity recognition and **context inference** in a Smart Home (SH) environment of older adults and patients
- Main novelty:
 - Use a multimodal approach
 - Acoustic sensors
 - Motion, RFID, energy consumption of electrical appliances



Relation with ACROSSING Working Groups



Research Methodologies



Research Achievements (1/2)

- Audio-based activity detection
 - Hybrid features in the field of environmental sound classification (MFCCs, GFCCs, ZCR, SR, SC, DWT)
 - Comparison of SoA classifiers performance with the collected dataset
 - Development of a Convolutional Neural Network (CNN) preserving spatio-temporal structure
 - Comparison of the developed algorithm with public datasets
 - Created toolbox for audio classification
- Energy-based activity detection
 - Preliminary rule-based activity recognition method
- Data Collection & Annotation
 - Data collection and annotation from CERTH/ITI Smart-home (power consumption from fridge, oven, cooking hood, dishwasher, mains)
 - Data collection and methods testing in a real-life environment (AKTIOS S.A.)

Research Achievements (2/2)

■ Papers

- Published at Ubiquitous Intelligence and Computing Conference in San Francisco
 - A. Vafeiadis, K. Votis, D. Tzovaras, L. Chen, R. Hamzaoui, Audio-based event recognition system for smart homes, in: Proc. 14th IEEE International Conference on Ubiquitous Intelligence and Computing, San Francisco, Aug. 2017.
- An extended version of the paper was invited to the IEEE Transactions on Big Data

■ Participation at DCASE official IEEE ASSP Challenge

- Acoustic event detection of 15 acoustic scenes
 - Achieved 31st place among 51 teams (ranked higher than Carnegie Mellon University, Imperial College)
 - The report was accepted as a publication to the workshop (acceptance rate 35%)
 - A. Vafeiadis, D. Kalatzis, K. Votis, D. Giakoumis, D. Tzovaras, L. Chen, R. Hamzaoui, Acoustic scene classification: from a hybrid classifier to deep learning, in: Proc. DCASE2017 Workshop on Detection and Classification of Acoustic Scenes and Events, Munich, Nov. 2017.

ACROSSING Training Experiences

- 1st Secondment at De Montfort University (10th – 17th January 2017)
 - Discussion with the PhD supervisors on the methodology and the framework of the project
 - Courses on ethics, data management, literature searching
- 2nd Secondment at AKTIOS Elderly Care Units – Athens, Greece (3rd – 8th July 2017)
 - Data collection under realistic scenarios
 - Tested the audio event recognition framework in a real-life kitchen environment (detected activities: dishwasher, mixer, cutting bread)
- ACROSSING Training Events (1-3)
 - SoA on assisted living
 - Sensor network and monitoring techniques
 - Context inference and activity recognition
 - Ethics
- Collaboration with other projects (APP1, SO2)
 - Key elements of the Scientific Objective (SO), demonstrator architecture and use cases
- DCASE IEEE Audio and Acoustic Signal Processing Challenge

Future Work

- Data collection from different home environments to increase classification accuracy
 - Make data (annotated audio and power consumption readings) publically available
 - Contribute to the “Home environment” class in the DCASE dataset
 - Continuous evaluation of the framework with public datasets (ExtraSensory, DCASE, UrbanSound, ESC-50)
- Time-series clustering and classification using Conditional Random Fields (CRFs)
- Collaboration with the SO2 group
 - Using the derived behavioral models
 - Aim: to improve the multi-modal activity recognition
- Collaboration with the APP1 group
 - VAE, RCN, GAN architecture for environmental sound data augmentation, dialogue manager based on input from activity recognition
 - Towards the creation of the virtual assistant

Future Secondments

June 2018, 2019
December 2017, 2018



October 2018, 2019



POLITÉCNICA

January 2018, 2019



- Data collection from real-life environments
- Evaluation of the methodological approach in real smart home conditions
- PhD progress assessment


Impact on Future Career

- Extend background knowledge into expertise in Ambient Assisted Living (AAL) and Internet of Things (IoT)
 - Development of skills in:
 - Audio signal processing
 - Deep learning
 - Pattern recognition
 - Time-series analysis and forecasting
- Knowledge exchange through collaboration between ESRs
- Knowledge gained on real needs, technologies, applications and challenges through training events and secondments
- Establish network with experts in the same field

Thank you!

Any Questions?

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10/20/2017