Aalto University
School of Electrical
Engineering

Ambient Intelligence

Organization

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Lecture

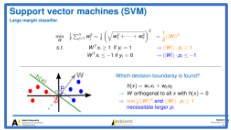
Period: III+IV

Credits: 1-8 (Modular)

MSc, PhD, PostDoc, External

Modules:

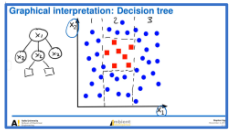
Lectures



Tutorials

Report

Video lectures



Oral exam

Expert lectures

Projects

Share your work

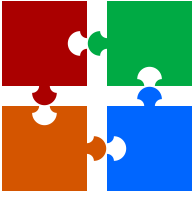
Modular structure

Lectures (1 cr) Participate in at least 10 contact sessions

Oral exam (1cr, graded) 20 minute oral exam on lecture topics

Tutorials (2cr, graded) Prepare a 30min expert tutorial (2 training sessions + 1 presentation)

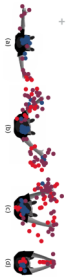
Projects (4cr, graded) Tutored groups, video reports, Poster presentation, Workshop paper

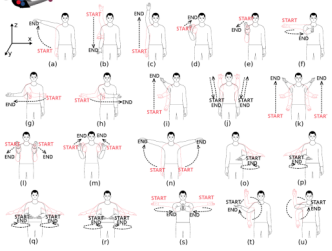


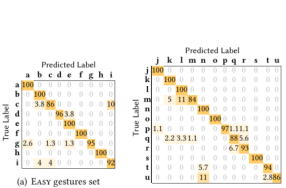
Projects

- Tutored Groups of 2–3 students
- Various topics in Ambient Intelligence (open outcome)
- 2 video reports
- Research and academic writing
- Poster presentation
- Workshop paper

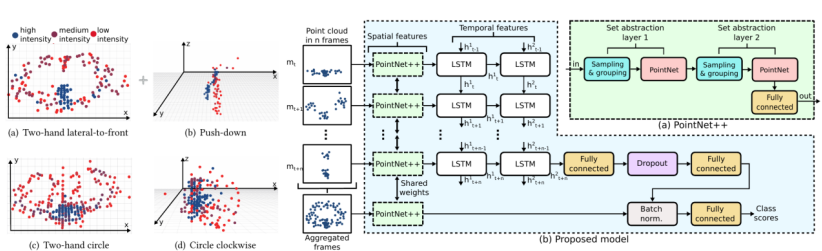
Example result







(a) Easy gestures set (b) Complex gestures set (c) All gestures set

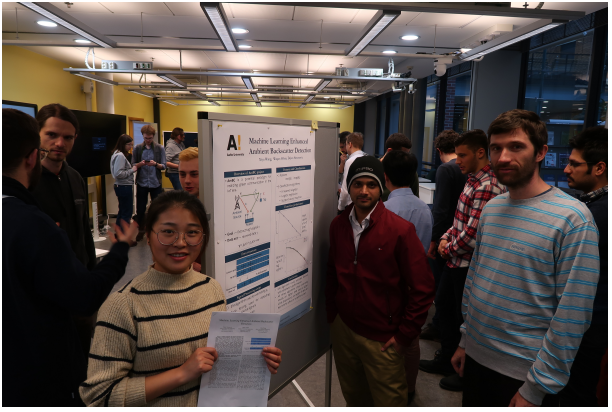


(a) Two-hand lateral-to-front (b) Push-down (c) Two-hand circle (d) Circle clockwise (a) PointNet++ (b) Proposed model

Video-reports

Report example

Poster presentations



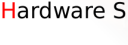
Autonomous Sailing Machine Learning Agent

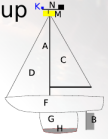
Hannes Blut, Ludwig Schneider, and Marcel Langenberg

Goals of the Project

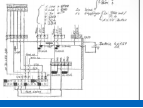
- Tack Detection
- Stay Autonomously on Tack
- Autonomous Manoeuvre

Hardware Setup



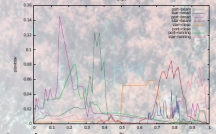


- Adafruit LSM9DS0
- Spektrum remotecontrol unit
- Rasberry Pi B
- 2 Servos
- Pi Cam

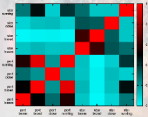


Feature Extraction

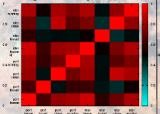
Angle propability distribution



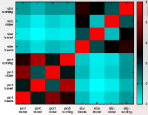
Angle



Gyroscope x



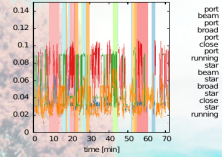
Acceleration y



$$P_{(s,t)} = \Sigma_d \, w_{s,t,d} \, p_{(s,t)}(d)$$

propability for a course (s,t) to be the actual course

Classification



Outlook

- PCA-Analysis
- Neuronal network
- Hidden Markow-Model
- Optimise training dataset
- Autonomous sailing on predefined courses/tacks

Self-criticism to Project

- We underestimated previous work
- Project is in its infancy now so the aims were too high

Reference

[1] H. Blut, M. Langenberg, S. Schneider
"Autonomous Sailing Machine Learning Agent"

Recognizing existence of human presence using RF-signal fluctuation in a cellular system

- System Setup

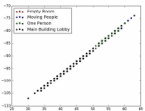
Four locations from where the data is collected

1. In an empty room
2. When one person is present in the room
3. Moving people around the room
4. Otakaari main building looby

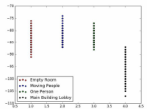
- Data Collection

PM MEAS: ARFCN=1, 54 dBm at baseband, -83 dBm at RF

- Data Visualization

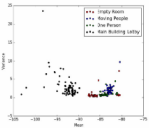


Dependencies between Baseband and RF signal strength



Plot visualising the RF strength for four different cases

- Training Model and accuracy

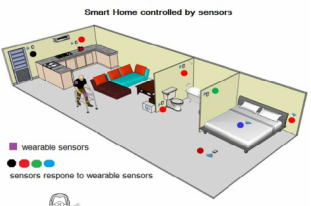


The mean variance plot of four cases.

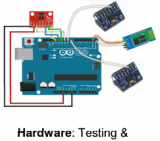
- Accuracy of the model on training data is 98% using multivariate classifier and SVM.

Emotions recognition from body gestures utilizing accelerometer data

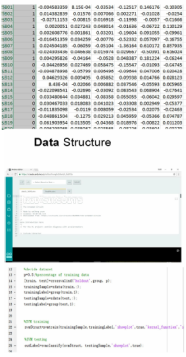
W. Yuan, S. Zuo



Layout: wearable pervasive sensor



Hardware: Testing & Monitoring system



Data Structure

Software Integration

Result: neural network model
Size of sample: 1800
(training70%, validation15%, testing15%)

Prospect:

- emotional control in private space
- emotion monitoring of specific patients
- interaction with pets

Worskhop

SMARTCOMP 2023

Tutorials

Tutorials


Literature review, learn about a concept
Feedback on Draft version (slides)
Feedback on training presentation
Feedback on revised training presentation
Expert tutorial (30 min)

Tutorials

In-depth technical, potentially hands-on training on a selected, project-specific topic

Rationale

1. Gain insight into a practical topic related to Pervasive Computing and Activity Recognition and to
2. share this with the other students in the course

Tutorials

In-depth technical, potentially hands-on training on a selected, project-specific topic

Rationale

1. Gain insight into a practical topic related to Pervasive Computing and Activity Recognition and to
2. share this with the other students in the course

Comprehensive introduction/overview

Informative understand/explain concepts

Audience other students in the class

Tutorial-style hands-on instructions and expert knowledge

- 30 minutes

Lecture

Organization

Lecture : Wed 14:15 – 15:00 & 15:15 – 16:00 (Zoom)

Tutorials training Fr 14:15 – 15:00 & 15:15 – 16:00

Tutorials : 30 min Wed 14:15 – 15:00 & 15:15 – 16:00 (Zoom)

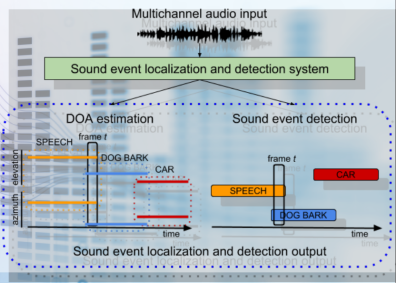
Expert presentations Wed & Fr 14:15 – 15:00 & 15:15 – 16:00 (Zoom)

Resources : myCourses

Project topics

Tutorials

Sound Event Localization and Detection (SELD)



NTNU | Norwegian University of Science and Technology

1

Tutorials

- Applications:
  - Robotics, Navigation, Smart homes, Tracking, Healthcare, etc.
- Benefits:
  - Available dataset
  - Available baseline system(Tensorflow, Pytorch)
  - Part of a challenge
  - Room for improvement
  - Available infrastructure in Finland and Aalto university
  - Dealing with State-of-the-art Machine Learning
- Source:
  - Sound Event Localization and Detection Evaluated in Real Spatial Sound Scenes
- Contact:
  - Masoud Mohtadifar, Masoud Mohtadifar

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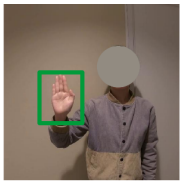
2

Tutorials

Topic: Moving body parts separation

- Separation of all moving parts related to the motion.
  - For instance, arms for doing the gesture, legs while walking.
  - Rope skipping requires the use of both hands and legs.
- Exclude other bodily activities not related to movement.

- Dataset: Video data from participants performing different gestures and motions.



Tutorials

Topic: Feature space object recognition and separation

- Object-related information localization in feature space.
- Separate/add specified objects from/to an image in feature space, with less effect on features of other objects in the image.

- Dataset:
  - CIFAR-10: single object recognition
  - PASCAL VOC: multi-object recognition

input data

possible representation in feature space

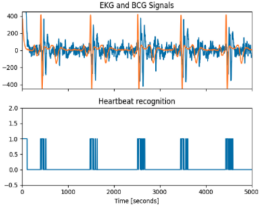
Tutorials

Background

- Movement of the heart propagates through the body and can be measured at the body surface
- Principle of ballistocardiography, measurement by precise acceleration sensors
- Since it is an acceleration signal, the signal processing is not trivial.

Topic

- Complex signals should not only be processed in the cloud
- Sensor-based data processing is a goal here, which requires lightweight processing of the data
- Embedded AI, e.g. using Tensorflow light, is a solution to perform complex data processing by pre-trained models on resource-limited hardware.



Task

- Creation of models for the detection of BCG signals, in particular the IJK complex.
- Further analyses desirable, e.g. determination of heart rate variability
- Strong focus on lightweight models that can be run on resource-limited hardware
- Real hardware (e.g. microcontrollers or FPGAs) may also be used to demonstrate the methods

Tutorials

Target:

The design and evaluation of a flexible UHF RFID **reader** using **USRP** (Universal Software Radio Peripheral) in conjunction with software that should be developed in the open-source **GNU Radio** framework

Topic 1:

Developing communication protocol between the USRP-based reader and a UHF RFID tag using Phase-shift keying (PSK) modulation

Topic 2:

Forcing several RFID tags to backscatter in carefully selected groups using the USRP-based reader

Questions?

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Literature

- C.M. Bishop: Pattern recognition and machine learning, Springer, 2007.
- R.O. Duda, P.E. Hart, D.G. Stork: Pattern Classification, Wiley, 2001.