ASPiDA

Study, Design, Development and Implementation of a Holistic System for Upgrading the Quality of Life and Activity of Seniors (ASPiDA)

Duration: 34 Months

Aging Population

01 Life Expectancy

Steep increase in life expectancy due to better living conditions and improved quality of life

02 Birth deficit

Intense low birth rate in mainly developed countries

03 Aging Increase

For the first half of the 21st century the total population is expected to increase 3 times and reach 2 billion people by 2050

04 Aging in Greece

Greece presents one of the oldest populations in the European Union (2nd after Italy and 5th worldwide, showing a strong upward trend in terms of aging)

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The Challenge

how will we manage to adequately care for our fellow human beings, who are aging by offering a holistic system to upgrade their quality of life and activities?

The ASPiDA program includes a series of innovative technologies that are able to assess potential health risks as well as predict unpleasant situations in time during the activity of the elderly in a smart home environment

Thanks to the use of IoT sensors and the development of sophisticated artificial intelligence technological tools, ASPiDA evaluates the motor health problems of the elderly and examines their connection with other health issues that will be possible to prevent in time.

A special basis is given to **falls**, which occupy the first position of mortality from accidents, while they are responsible for more than 40% of deaths from injuries in people of the 3rd age.

Objectives

1. Autonomous living

ASPiDA includes risk assessment & prevention, cooperation of mechanisms for assessing the physical-kinetic/biometric state of the individual with optimal decision-making mechanisms, optimization of the physical strengthening routine

2. Improving quality of life

With the help of ASPiDA technology & automation, the elderly will feel safe in a space that will automatically adapt to their needs and work with them and for them. particularly friendly interaction environment that helps the elderly discover technology & use it to their advantage

3. Reduction of hospitalization costs

Detecting problems early avoids referral to medical rehabilitation centers. Cases requiring observation during recovery can be replaced by the system

4. Commercial retirement system production

ASPiDA presupposes the use of smart homes that are friendly to the elderly and the environment - the system is an economical solution by limiting unnecessary expenses and situations that burden the psychology

5. Decongestion & strengthening of health services

The ASPiDA includes a library of data, for the effective treatment & prevention of falls for future generations of elderly people. Decongesting the existing health system from events that require simple monitoring

6. Reduction of Mortality from Falls

The ASPiDA program includes early fall detection tools. Presupposes Immediate provision of first aid using a robotic assistant in the home environment.

ASPiDA's Main Impact

The individual's autonomous action & self-service within a smart home environment

MEMBERS OF ASPiDA CONSORTIUM

Dept ECE
Programming & Information Processing Laboratory

Dept ECE
Microwaves Laboratory

Dept ECE
Laboratory of Electrical Machines

Dept ECE
Laboratory of Electric Power Systems

Dept ECE
Laboratory of Microtechnology & Nanotechnology Systems

Dept ECE
Laboratory of Automatic Control Systems and Robotics

Dept ECE
Integrated Circuits Laboratory

Dept ECE
Laboratory of Electrical Circuits, Signal Processing, and Image Processing

Dept PME
Laboratory of Robotics and Automation

Dept PESS
Department of Physical Education and Sports Science

DEMOCRITUS UNIVERSITY OF THRACE

Coordinator
Electronics Laboratory - Department of ECE (DUTH) Coordinator Prof. Georgios Syrakoulis

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Activities

In this context, the proposed system will be able to integrate-synthesize and co-operate innovative technologies from the field of electronics, the internet of things, IT, communications, robotics, optimal control, etc. such as:

01 Vital Measurements of the Elderly

wearables for real-time physical data retrieval, system development for inadvertent vital readings.

02 Kinesiology Assessment

fall prediction system which will be based on real-time & historical data, fall assessment system, image processing techniques to detect activities, site risk assessment, etc.

03 Rehabilitation of the Elderly

optimized physical rehabilitation & strengthening as well as development of an optimal decision-making system for autonomous physical rehabilitation houses.

04 Infrastructure development

creation of a "smart home" adapted to the needs of the elderly: sensors for monitoring, electrical networks for seamless power supply, sensor network for IoT in health, smart power supply system for electronic devices & devices, efficient and robust mobile communications

05 Specialized robotic assistants

assistance in case of emergency (e.g. fall), ascertaining the situation by sending high-quality audio-visual material to the monitoring center, providing first aid

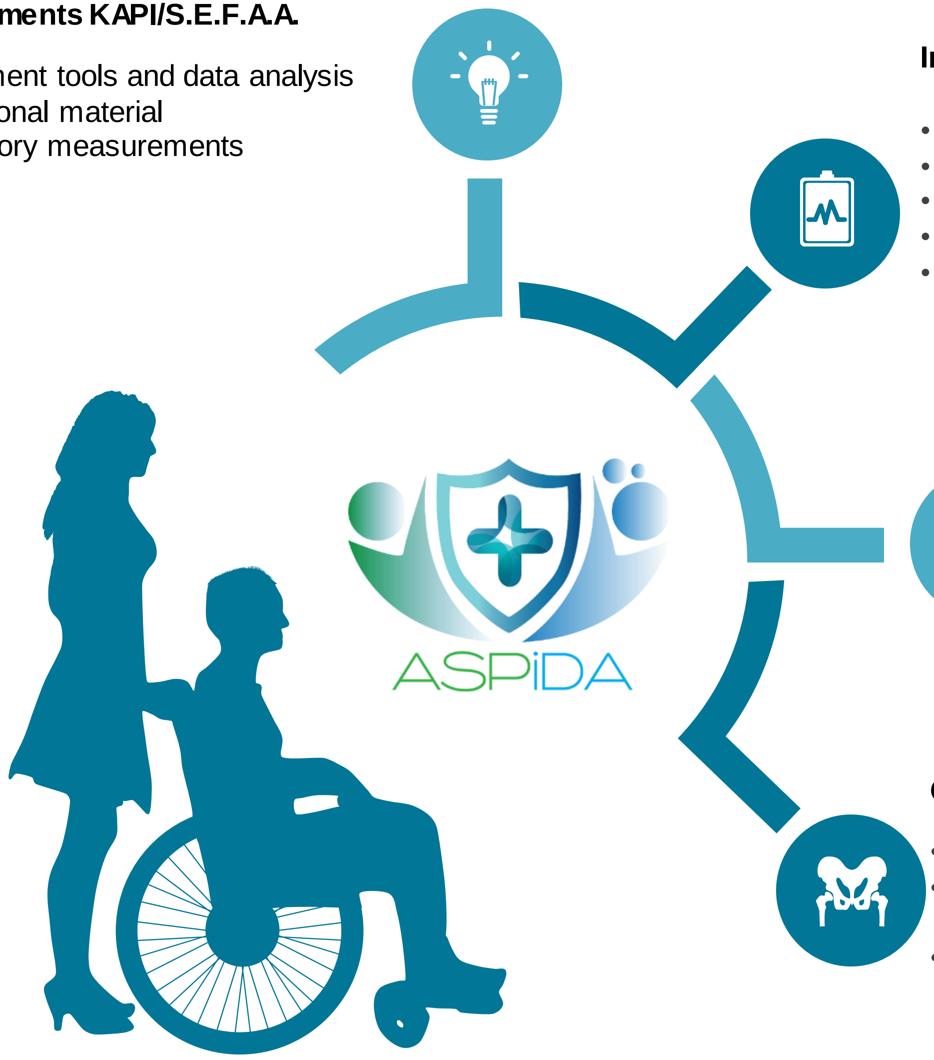
06 User-Friendly Interface

adapted according to the user (elderly/health specialist) & will provide the possibility of displaying the situation (viewing the elderly, viewing real-time measurements, direct communication, viewing historical time statistics, etc.).

Actions and Technologies developed

Promotion - Laboratory Measurements KAPI/S.E.F.A.A.

- Training researchers - Measurement tools and data analysis
- Promotional actions and promotional material
- Measurements at KAPI / Laboratory measurements at S.E.F.A.A.
- Training programs at KAPI



Innovative ASPiDA Robotic Assistant technologies

- Skeleton extraction and elderly activity recognition using cameras
- Automated Robotic Emergency Response System and Fall Assistance Tool
- Robotic navigation and mapping using RGB camera
- Energy-efficient robotic manipulation
- Continuous emotion recognition and long-behavior modeling

Kinesiology assessment tool

- Development of algorithms
- Ambient Physiological Measurements using conventional cameras
- Elderly Activity Recognition Tool

Optimal Decision Making and Reaction in the Smart Home Environment

- Tool for optimal management of lighting in the home environment of the elderly
- Tool for the optimal management of air conditioning in the home environment of the elderly
- Electricity Demand Backup Tool

ΑΣΠiΔΑ in numbers

ΑΣΠiΔΑ in numbers...

Participating Faculty Members: **25 (17 Professors, 6 Associate Professors, 2 Assistant Professors)**

Postdoctoral Researchers: 20 (14 Postdocs E.C.E. and P.M.E., 6 Postdocs S.E.F.A.A.)

PhD Candidates: 39 (28 Ph.D. of E.C.E. and 2 Ph.D. of P.M.E., 7 Ph.D. of S.E.F.A.A., 2 Ph.D. Doctors of Medicine).

Laboratories of DUTh.: **13** (11 E.C.E. Laboratories, 1 S.E.F.A.A. Laboratory, 1 P.M.E. Laboratory)

Participating Seniors: **>300**

Participants KAPI and KEFO: **>5**

Deliverables: **44**

Aspida Site: aspida.ee.duth.gr (video: https://www.ee.duth.gr/wp-content/uploads/ee_duth_gr-1.mp4)

Publications: >70

ASPiDA duration: **34** months

Laboratory Measurements KAPI/S EFAA

Researcher Training & Data Analysis

Training of researchers

- In field measurements: fitness tests and interviews
- Biomechanical analysis of movement through VICON
- Musculoskeletal modeling through OpenSim
- Code generation and algorithms development in Python

Measurement tools and data analysis

- Translation and cross-cultural adaptation of questionnaires
- Pilot measurements: field tests and interviews
- Creating algorithms for data analysis
- Analysis of self-report and accelerometry data
- Creating protocols
- Laboratory pilot measurements
- Analysis of data from laboratory measurements and from measurements at KAPIs

ASPiDA promotional/informative material and participant feedback

Poster

Brochure

Fall Prevention Guide

Individual results from the accelerometer and recommendations from W.H.O.

ASPiDA promotional actions

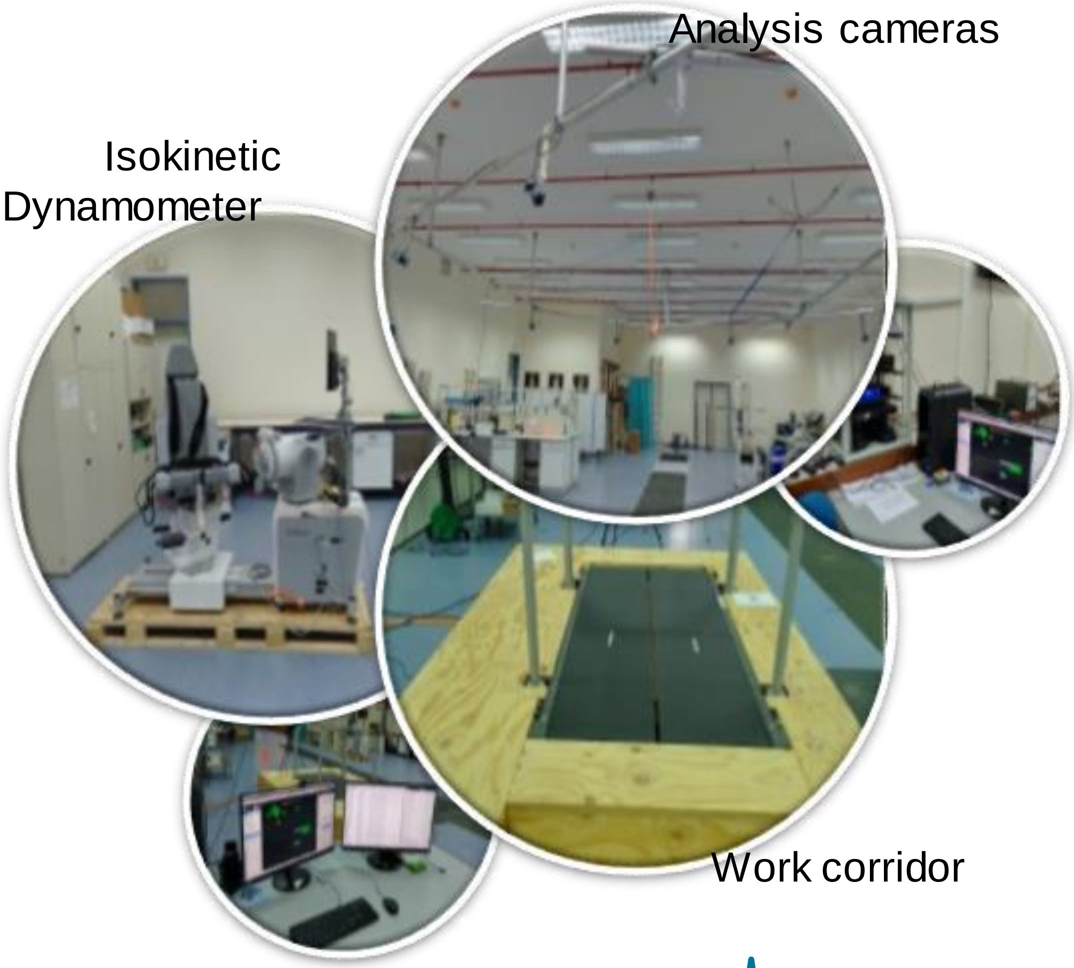
- Interview on Radio CHRONOS
- Interview at ERT Komotini
- Interview with local newspaper
- Meeting with the representatives of KAPI
- Meeting with the Deputy Mayor of Social Policy
- Meeting with the Mayor of Maroneia - Sapon

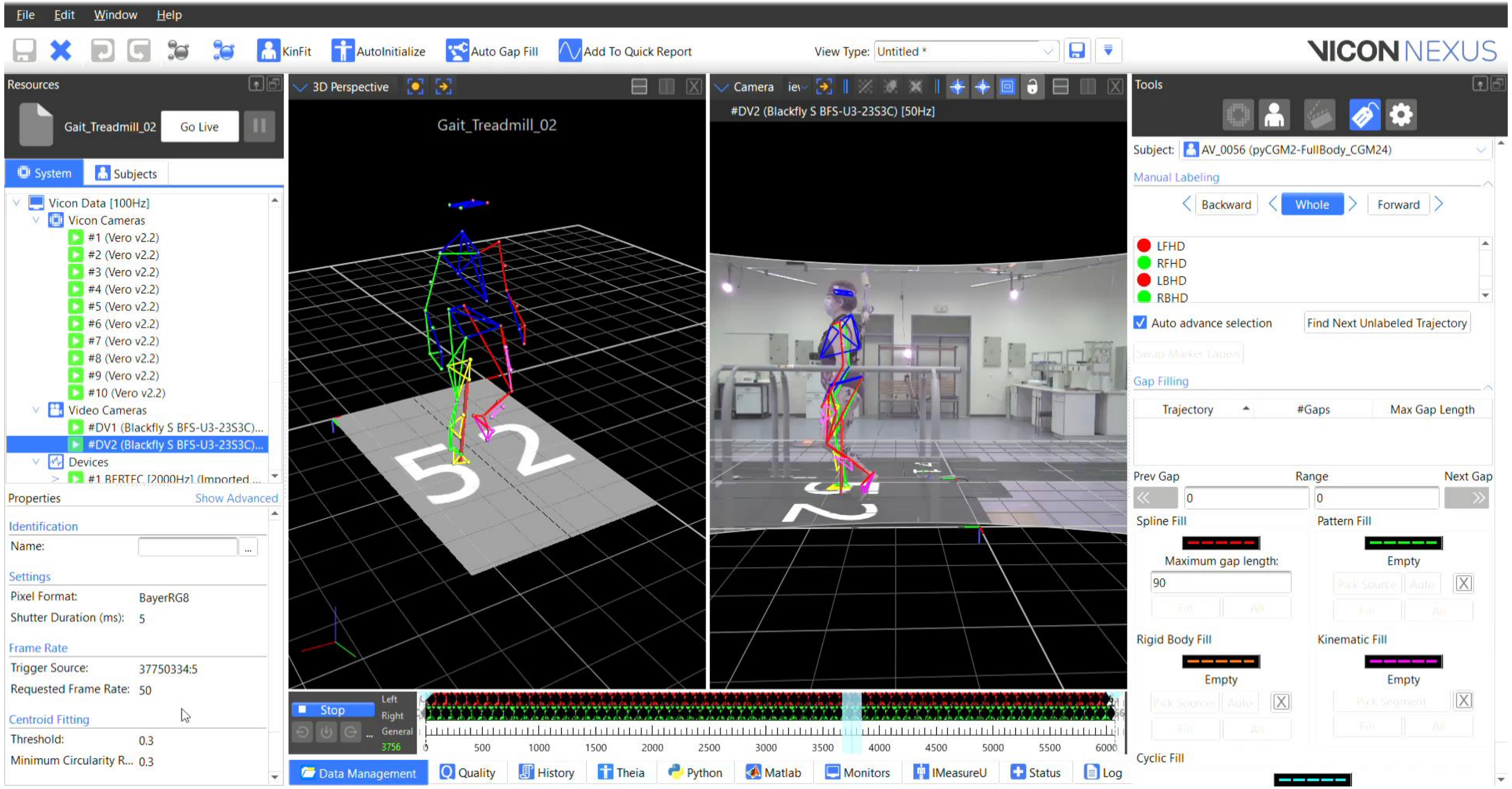
Measurements at KAPI

Laboratory measurements at T.E.F.A.A.

Recording of movement, forces and muscle activity:

- walking
- static balance on each leg
- reactive balance with increasing weight
- changes of direction while walking
- standing and sitting (chair).





Video Preview

Robotic Assistant

Main Functionalities

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Collection of functional requirements and platform technical specifications

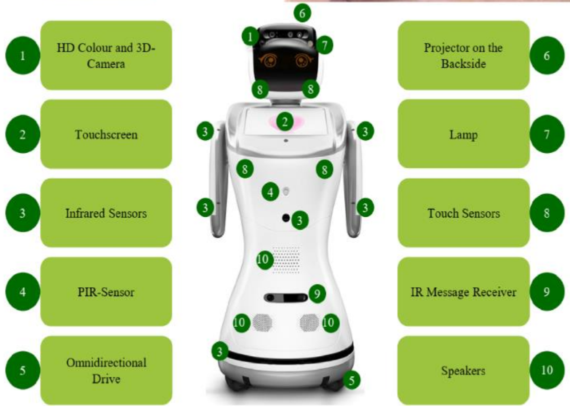
1)

2)

3)

4)

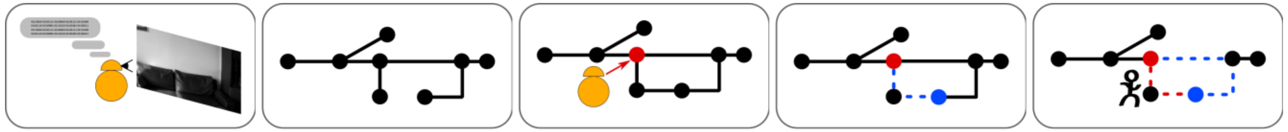
5)



Robotic Platforms: 1) YUJIN, 2) HOBBIT, 3) Mobile Robot+ Kinect Sensor (MRKS), 4) Omni-directional mobile base (OMB), 5) SANBOT ELF.

Basic robotic assistant configuration sub-tasks

1. **Human-aware robot navigation**



(α) (β) (γ) (δ) (ε)

- *(α) Perception*
- *(β) Mapping*
- *(γ) Localization*
- *(δ) Path planning*
- *(ε) Human-awareness*

2. **Energy-efficient robotic manipulation**

3. **Human body pose estimation through camera**

The ASPiDA robotic assistant

Synthesis of ASPIDA robotic assistant	
ClearPath Robotics Ridgeback	Robotic mobile base
ClearPath Robotics tower for arms	Trunk
UR-3e Remote Integration Kit with tower	UR3 robotic arm installation kit
Universal Robots UR3cb	Robotic arm
On Robot RG2	2-finger gripper
LiDAR SICK TIM551	Laser scanner
Flir Camera Flea3	RGB Camera
Dell - Intel RealSense D435	Stereo Camera

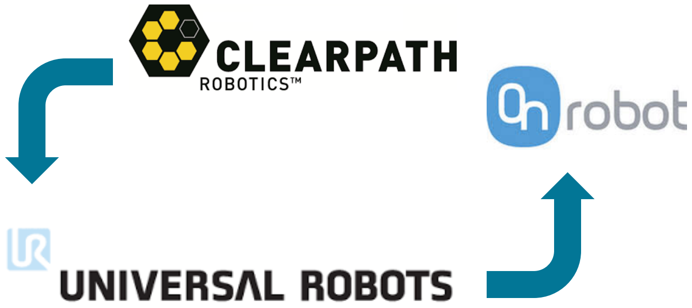
The ASPiDA robotic assistant

Platform Setup

Assembly of robotic system components

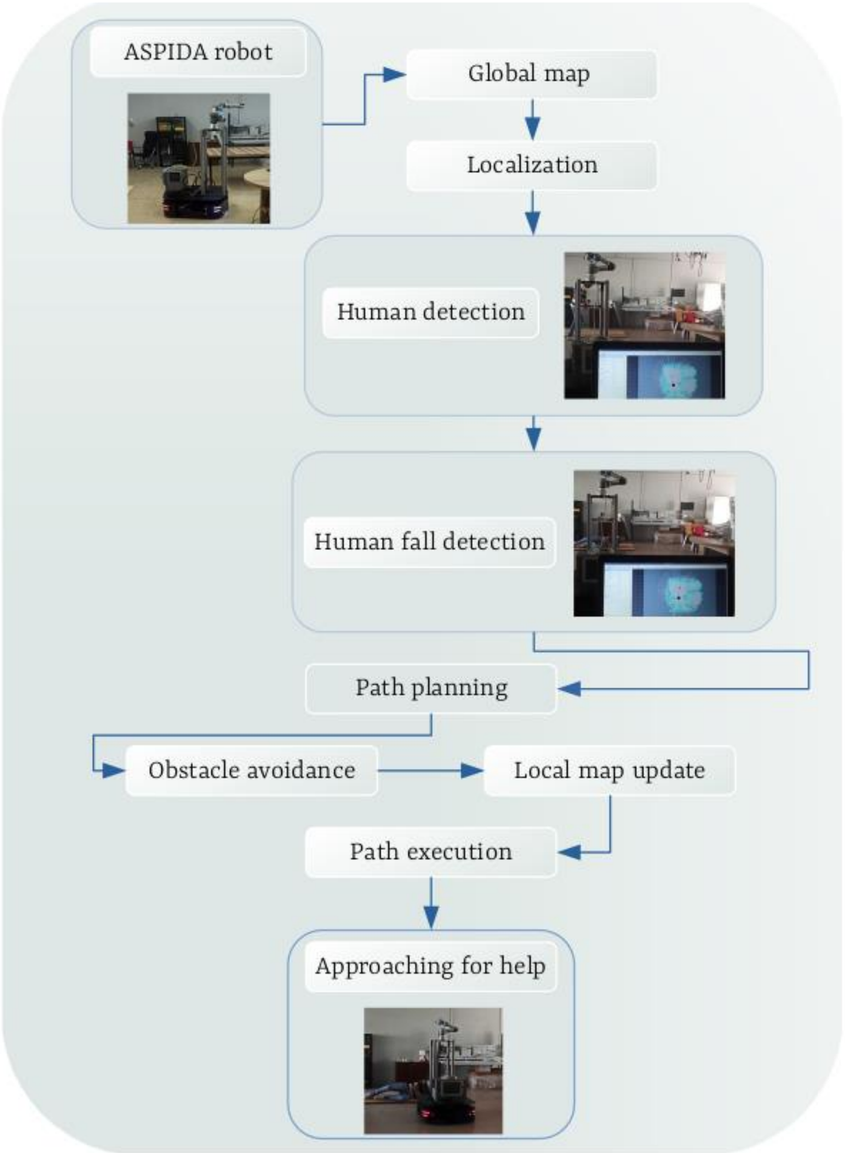
Installation of ROS operating system as well as the operating and handling packages of the robotic platform

Tests of sensors (LIDAR, stereo camera and FLIR camera) and actuators (robotic base and arm)



The ASPiDA robotic assistant

Fall Assist Emergency Algorithm



The ASPiDA robotic assistant

Global map creation

Description: The robotic assistant navigates the space and with the help of the cloud of points from the laserscan creates a map (global map) of the area of interest.
Objective: To create the map of the area in the knowledge base of the robotic assistant, so that the positioning, navigation and obstacle avoidance algorithms can be based along the way.

The ASPiDA robotic assistant

Localization

<u>Description:</u> The robotic assistant can and does locate its exact pose (position and orientation) at any time within the knowledge map it has created.
<u>Objective:</u> The robotic assistant has a precise awareness of its position and orientation, so that it can accurately and safely execute any future navigation or object avoidance scenario or even placement of dynamic obstacles (as well as the presence of a human) that can to occur in the environment.

The ASPiDA robotic assistant

Obstacle and dynamic entities modelling

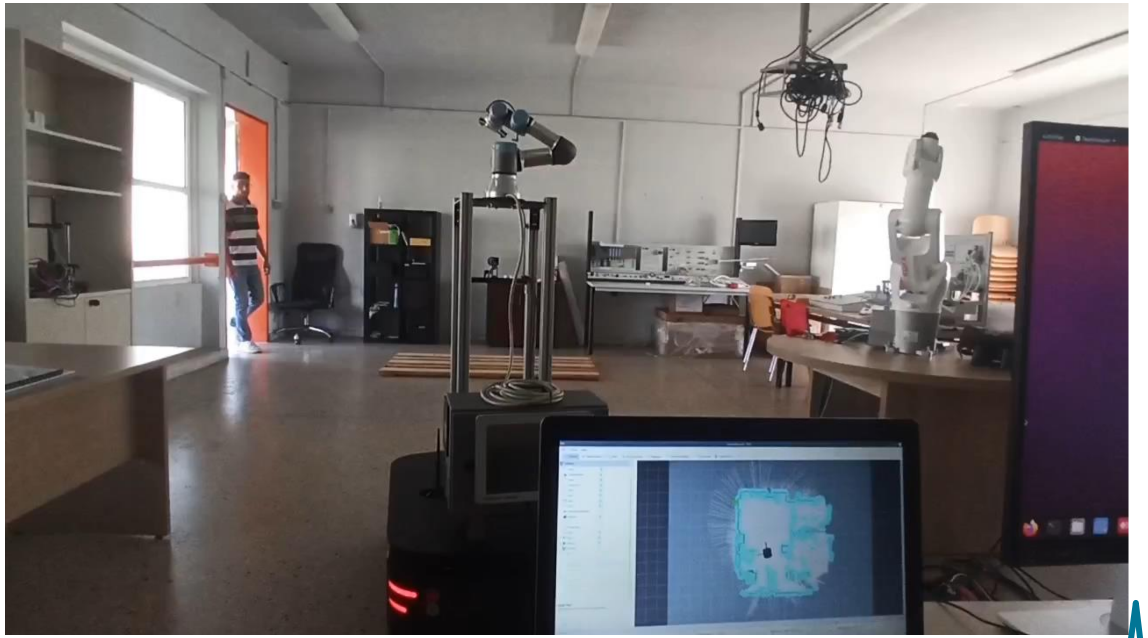
Description: The robotic assistant models the obstacles of the global map and adjusts a safety distance radius from each of them. In addition, using its sensors it constantly monitors for new obstacles and dynamic entities which it adds in real time to its map.
Objective: The robotic assistant has an accurate awareness of the location of all obstacles and safety distances to model a cost function with respect to the environment in which it is located. In this way, navigation is an optimization of the following cost function with the robot's pose as the starting point, given by the positioning function above, and a point on the map given by the user or some algorithm as the final point robot automation (e.g. emergency fall support algorithm described above).

The ASPiDA robotic assistant

Fall Assist Emergency Algorithm

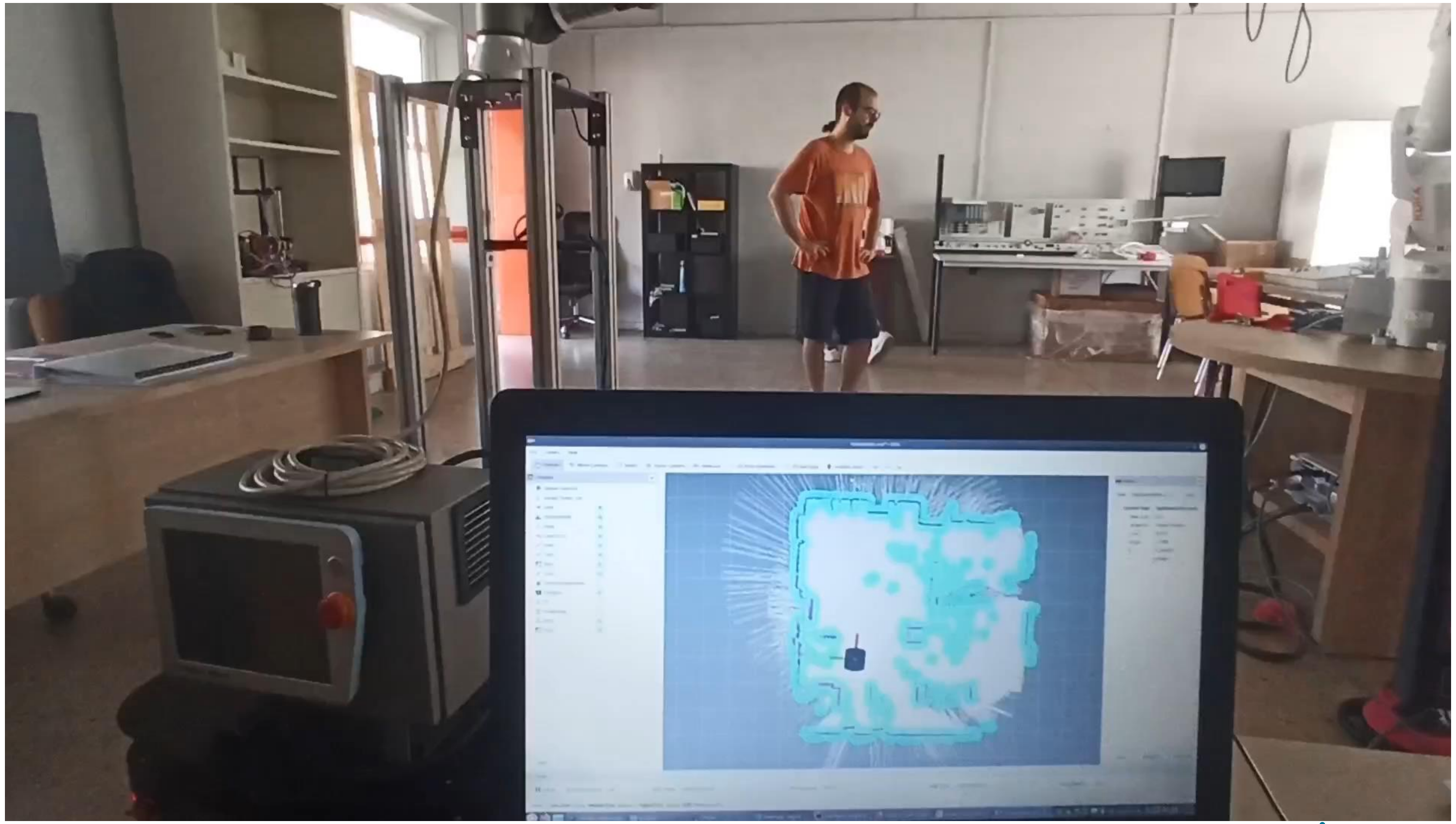
Description: The robotic assistant observes and locates people moving in space using the Real Sense camera. The position of moving people is calculated in real time, recorded and displayed on the map of the robotic assistant with a green dot. If a fall is detected, the dot turns red and the emergency algorithm is activated, alerting the robotic assistant to approach the fallen human at a safe distance.

Objective: The immediate approach of the person who fell by the robotic assistant, in order to support him (e.g. by informing the doctor in charge, assessing the situation, collecting photos after the person's consent, etc.).



The ASPiDA robotic assistant

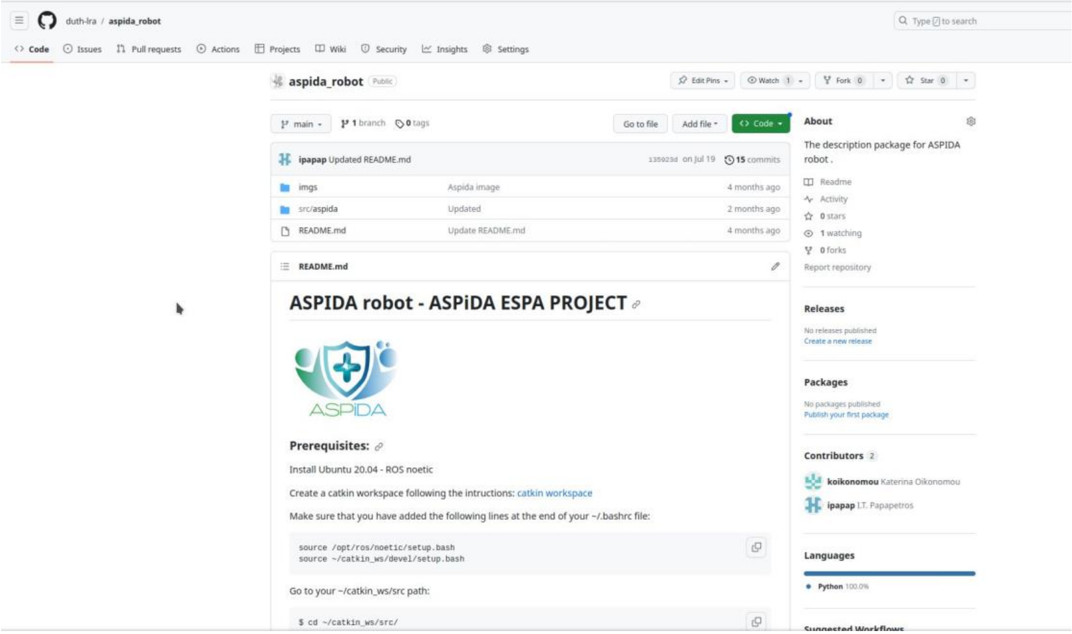
Human-aware navigation scenarios



Main Outcomes

The ASPiDA assistive robot deploys algorithms that:

- work in real-time to promote independence and safety in ambient assisted living scenarios;
- provides a realistic action plan in the emergency case of human fall;
- provides the full open-source implementation code is provided in Github.



As part of future work

- The incorporation of additional data analysis and machine learning models holds the potential to further refine the fall detection
- Increase robustness in more severe conditions, i.e., low lighting, multi-person fall detection, occlusions etc.

Robotic Assistant

Advanced research outcomes

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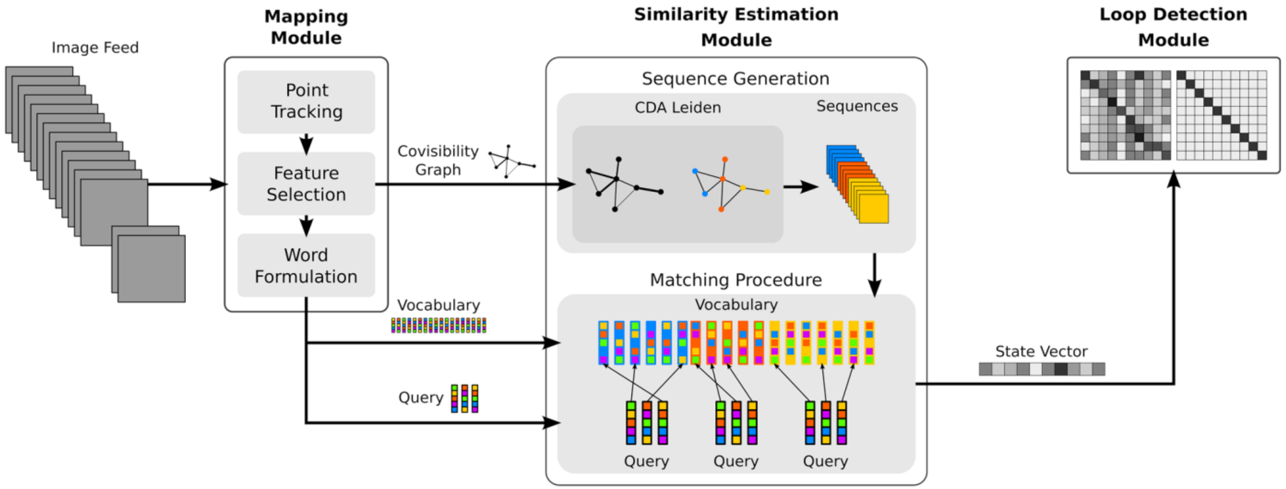
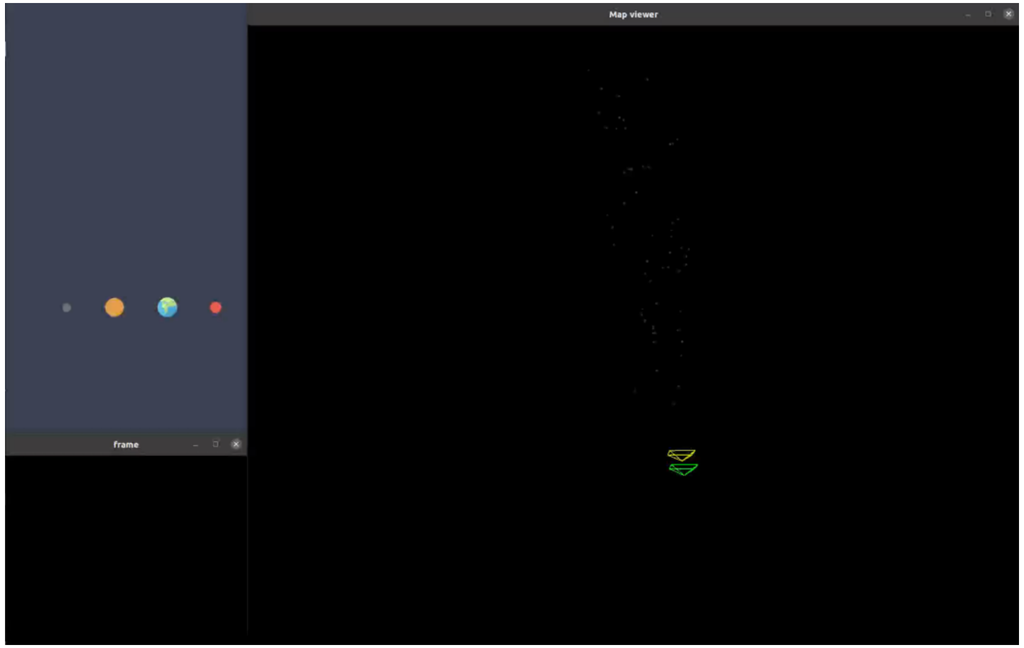
Robotic navigation and mapping

- Real-time processing of camera readings and detection of points of interest
- Creation of a knowledge base by the robotic assistant in the form of a map,
- Identifying known areas, checking and re-tracking.



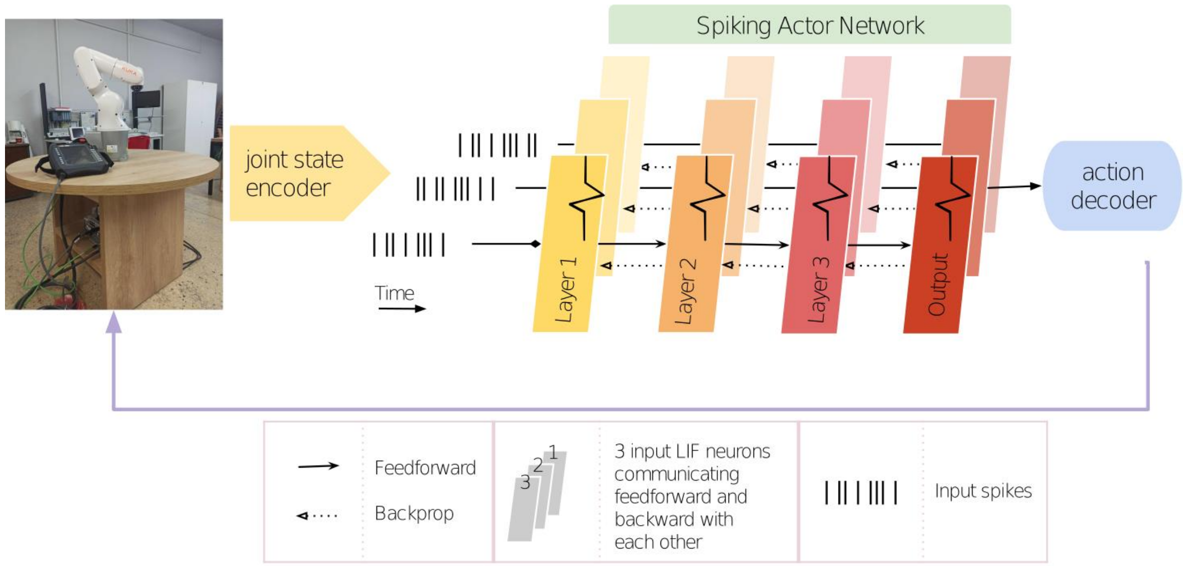


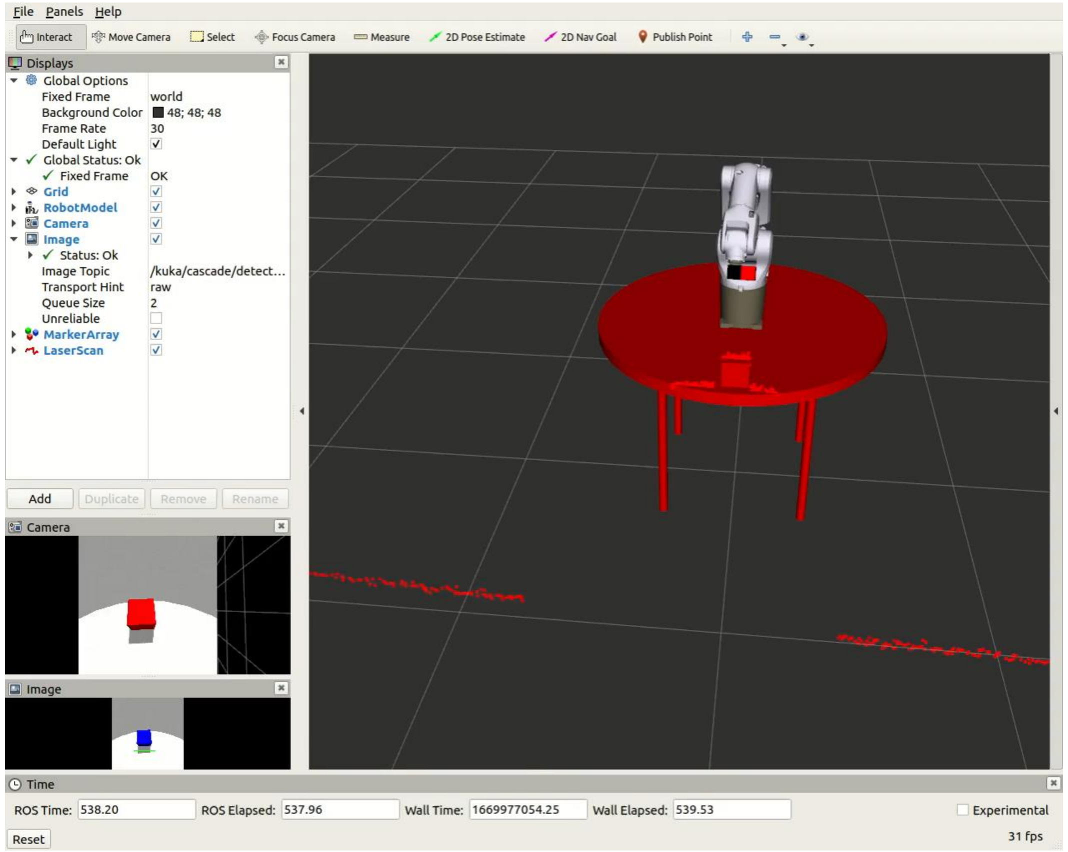
Video Preview

Energy-efficient robotic manipulation

Key characteristics

- Object detection and approach using a camera,
- 6 DoF robotic arm manipulation using reinforcement learning,
- utilization of state-of-the-art Spiking Neural Networks for the development of energy-efficient models.

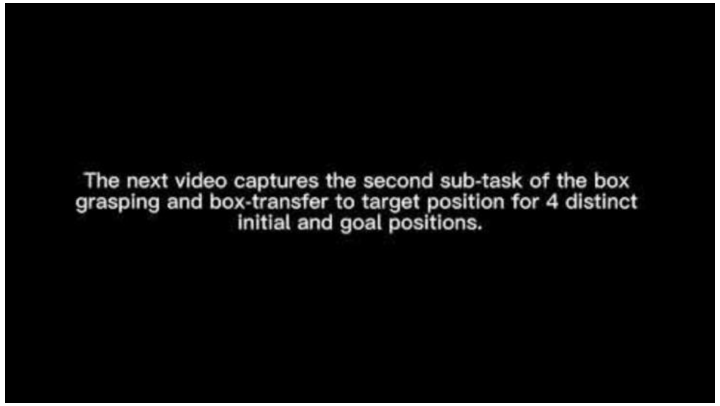




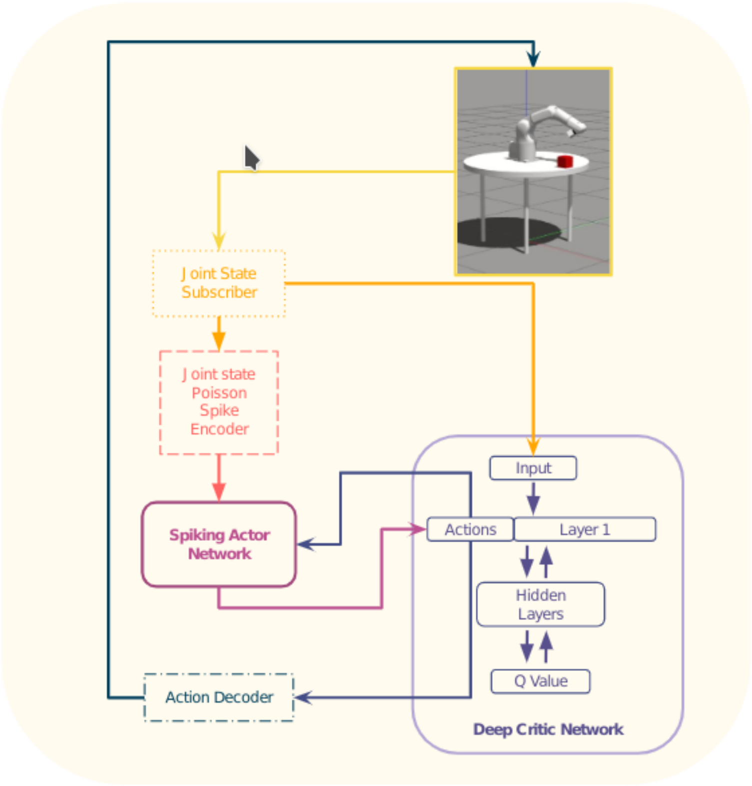
Video Preview

Energy-efficient robotic manipulation

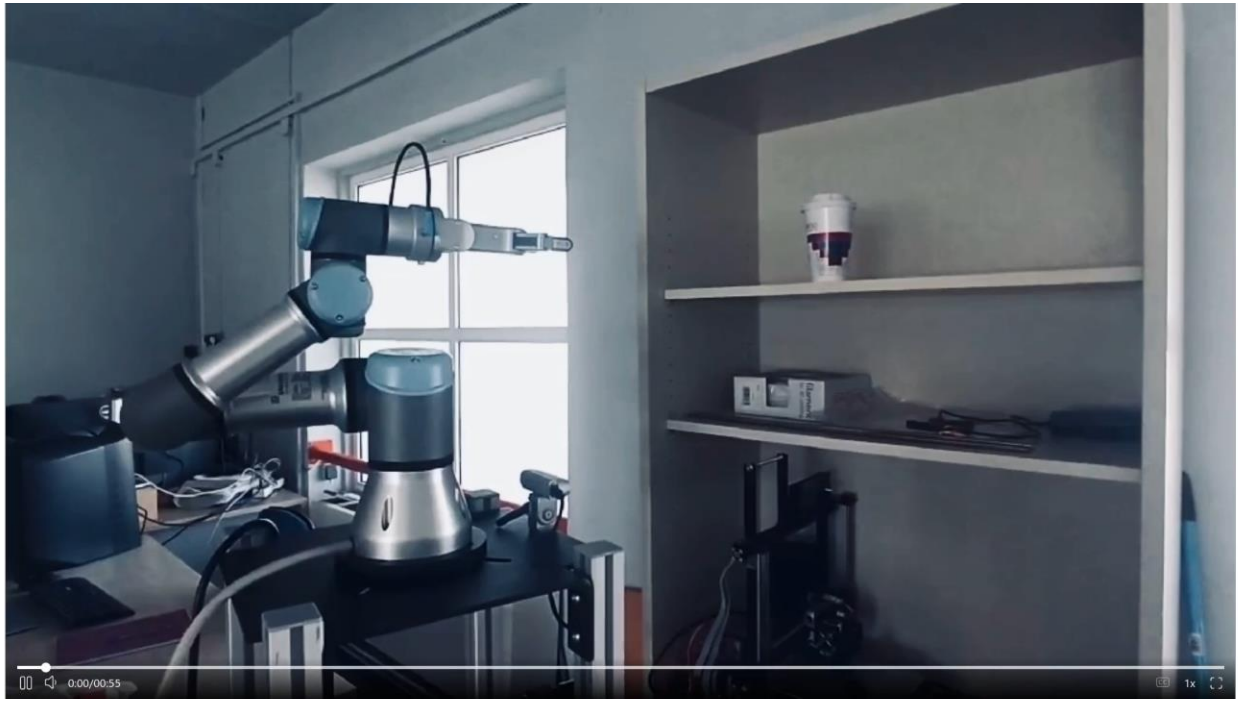
- An actor-critic reinforcement learning algorithm is employed to train the robotic arm,
- The **actor** is a Spiking Neural Network exploring the right joints' actions, in order to reach the target,
- The **critic** is a Deep Neural Network penalizing/rewarding the actor based on the results of each episode,
- After the training procedure the critic is discarded, thus leaving only the energy-efficient SNN actor during inference.
- Simulations have been conducted both for 2-DoF and 6-DoF robotic arms, before final testing.



Video Preview



Energy-efficient robotic manipulation



Skeleton extraction and elderly activity recognition using cameras

The aging of the global population poses significant challenges in providing adequate care and support for elderly individuals.

Technological developments -> address the needs of elderly people
- maintain their independence
- quality of life.

Methods :
- wearable sensors
- sophisticated ambient sensors
- interconnected devices

} **expensive and/or intrusive systems**

Domestic environments require **real-time** and **power efficient** models.

Contributions

- Complete **bioinspired ambient and low-cost** elderly action recognition system using only a **non-intrusive RGB** camera;

- **Training on time-series data** extracted from the RGB sensor, providing valuable insights into their capabilities to handle human data;

- The investigation of the **effectiveness of the energy efficient HTM and SNN bio-inspired architectures** in accurately recognizing and classifying actions;

- The illustration of a comprehensive **comparative** analysis between the **bio-inspired networks** and the **SVM**, proving their efficiency both in terms of recognition performance and execution time

Data Acquisition

Elderly individuals may exhibit unique characteristics

- different movement patterns
- mobility limitations
- gestures

We exploited a **custom dataset** of 8 elderly individuals performing daily tasks.

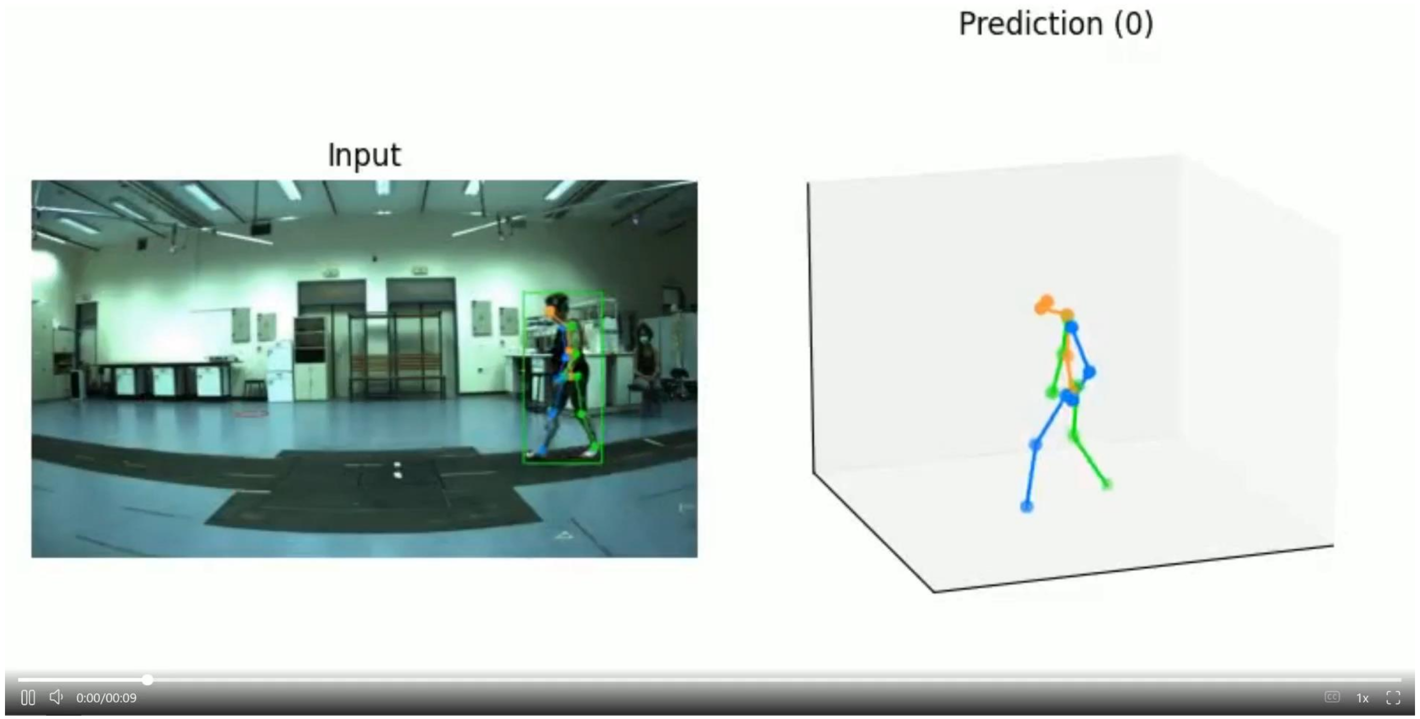
5 particular action scenarios while an RGB camera recorded the execution.

Human body pose extratcion

MMPose is an open-source toolbox for pose estimation based on PyTorch. It is a part of the OpenMMLab project.

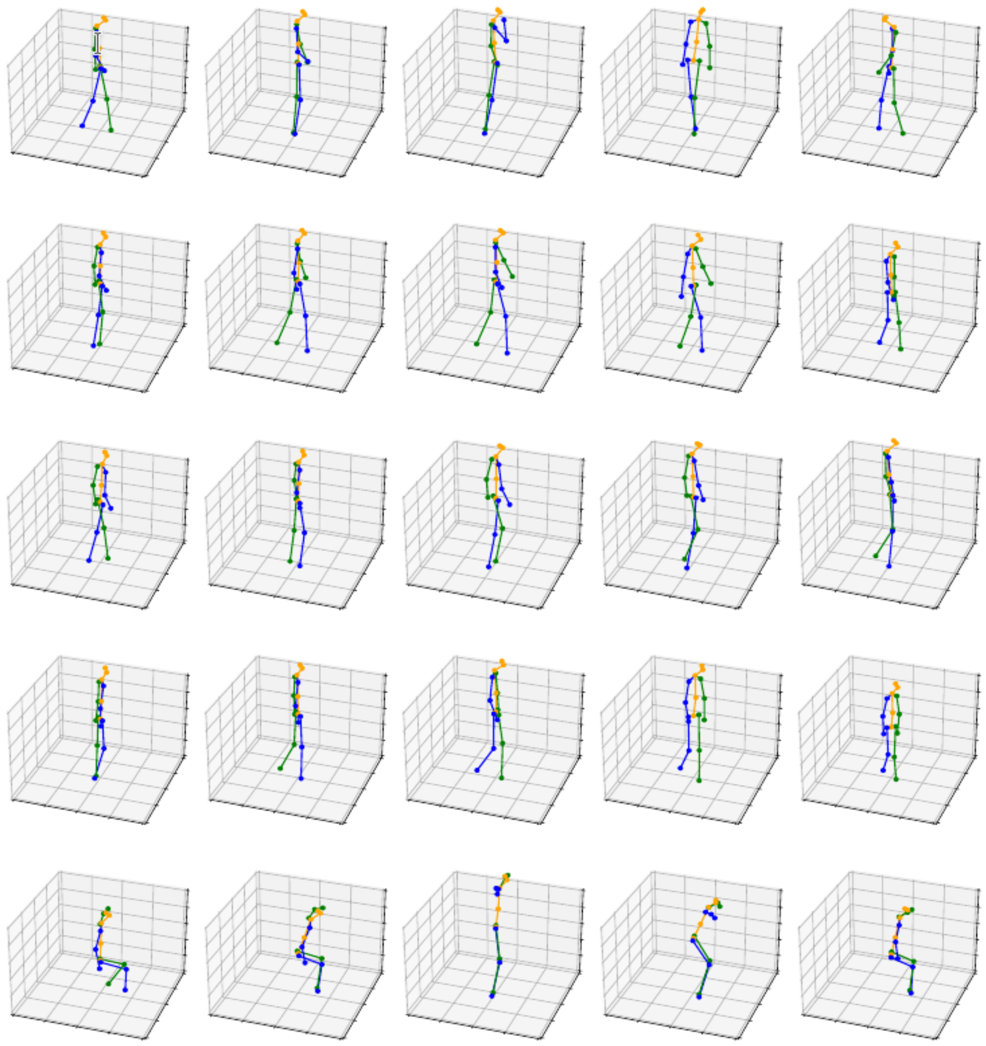
RGB Videos/Images -> 3-dimensional position of joints

Human body pose extraction



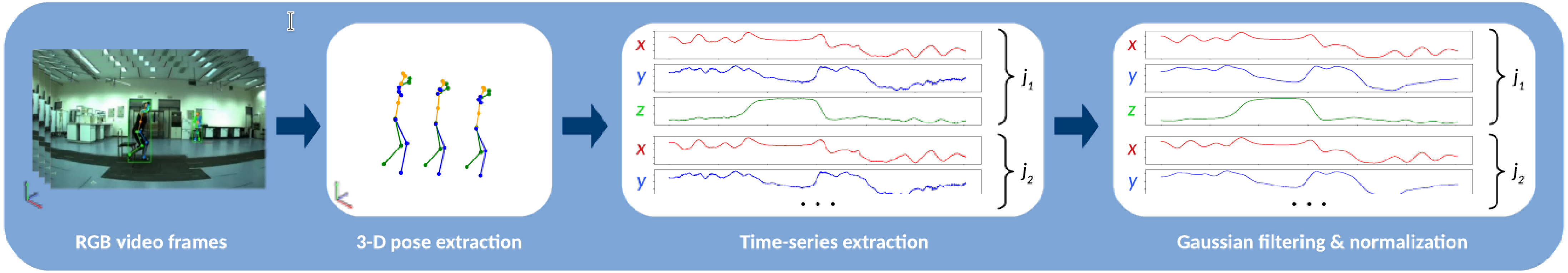
Action scenarios

1. Drink,
2. Gait,
3. Turn left,
4. Turn right,
5. Sit to stand and sit



Data pre-processing

- RGB video streams capturing multiple iterations of 5 action scenarios performed by 8 subjects;
- mmpose model is employed to extract the 3-D human skeletal posture captured RGB video frame;
- the output of the pose extraction subsystem was a skeleton matrix $S \in R^{(17\times3)}$. By processing all the frames of a video clip and focusing on a single joint and coordinate, let us assume the x-axis of the j-th joint with j = {1, 2, ..., 17},we end up with a time-series $s_{\{j,x\}}$

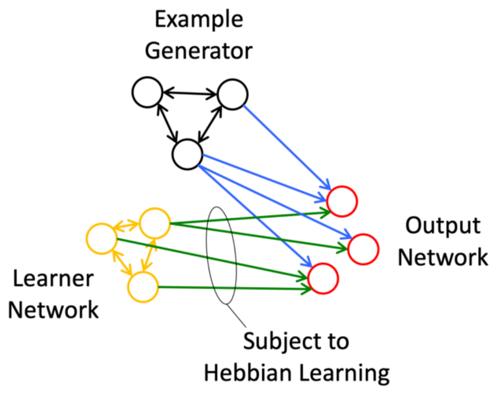


Hierarchical Temporal Memory (HTM)

HTM theoretical framework introduced by Numenta and was implemented using the Nupic open-source software platform

WHY HTM ?

- emulate the neocortex’s functioning;
- focusing on its ability to process sensory data;
- identify patterns;
- make predictions in real-time;
- Based on ***hebbian learning*.**



Hebbian learning is a model for long-term potentiation in neurons, in which weights are increased when the input and output are simultaneously active.

HTM architecture

• 2 hidden layers consisting of a SparseWeights format followed by a linear transformation;

• KWinners layer is then applied, selecting the top-k winners among the neurons based on their activation values;

• the output layer (linear transformation), maps the hidden layer's activations to the desired output $o \in R^5$.

Spiking Neural Networks (SNNs)

SNN model implemented using the Nengo library

WHY SNN with NENGO ?

• the construction of complex biologically realistic models of the brain circuits enabling users to define neural populations & their connectivity rules;

• supports the integration of external libraries, such as TensorFlow and Keras, for incorporating deep learning technique.

SNN architecture

- Consists of an input layer with an input size equal to 51 × 200 followed by a hidden and an output layer;
- The hidden layer is a single dense layer followed by an activation function, utilizing the Leaky Integrate-and-Fire (LIF) neuron model;
- The input data is fed into the dense layer, which serves as a feature extractor;
- The output layer comprises a dense layer with five units, i.e., the different action classes.

Support Vector Machines (SVMs)

WHY SVM?

- Well-established non-neural classifier;
- Compare the performance of the introduced bio-inspired network.

We utilized a Euclidean space SVM classifier with a radial basis function (RBF) kernel, given that it ensured optimal results compared to other versions of SVM and types of the kernel;

- the input of the SVM was a 1-D feature vector of length 51×200.

Evaluation strategy

Leave-one-subject-out (LOSO) cross-validation procedure to evaluate all three models.

TABLE I: Accuracy results of HTM, SNN and SVM for all 8 subjects and 5 action scenarios

	HTM					**SNN**					**SVM**				
	drink	*gait*	*turn_l*	*turn_r*	*sit2std*	*drink*	*gait*	*turn_l*	*turn_r*	*sit2std*	*drink*	*gait*	*turn_l*	*turn_r*	*sit2std*
S_1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.8	1.00	0.86	1.00	1.00
S_2	1.00	1.00	1.00	1.00	1.00	0.71	1.00	1.00	1.00	1.00	0.86	1.00	1.00	1.00	1.00
S_3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	1.00	0.71	0.86	1.00
S_4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.71	1.00
S_5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	1.00	1.00	1.00	1.00
S_6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S_7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.40
S_8	1.00	1.00	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Evaluation strategy

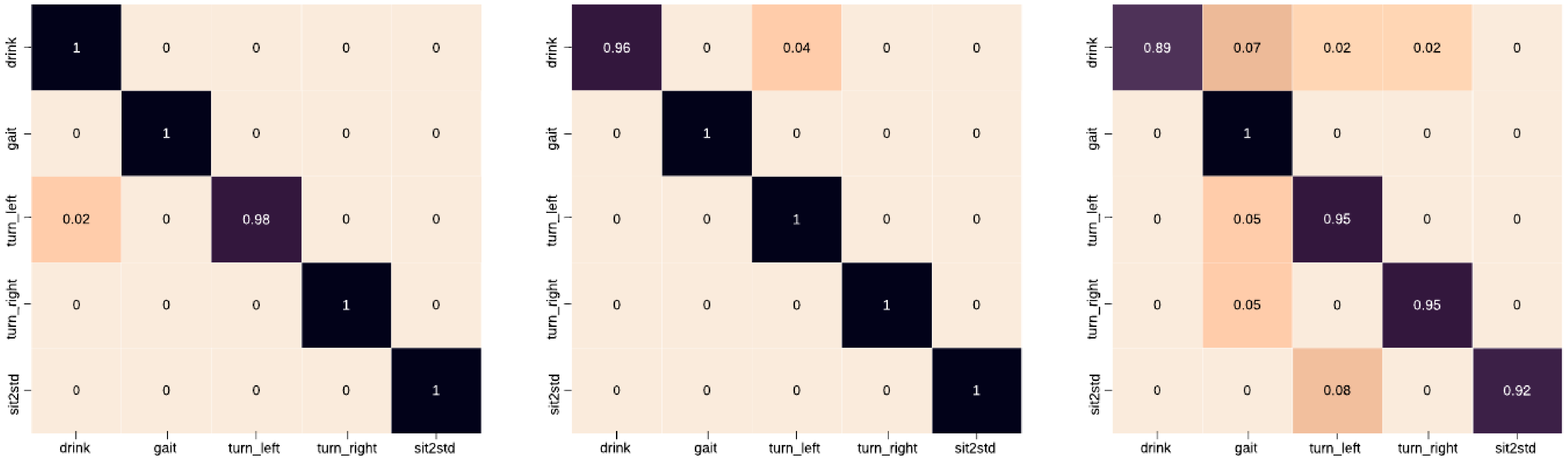
TABLE II: Overall mean and standard deviation classification performance (%)

	HTM	SNN	SVM
$\mu \pm Z(\sigma/\sqrt{n})$	99.49 ± 1.35	99.36 ± 1.70	95.47 ± 3.57

TABLE III: Time efficiency in *sec*

	HTM	SNN	SVM
$\mu \pm Z(\sigma/\sqrt{n})$	0.11 ± 0.07	0.36 ± 0.003	0.22 ± 0.29

Confusion matrix resulted from HTM, SNN and SVM on the eight subjects.



(a) HTM (b) SNN (c) SVM

Conclusions

- an end-to-end ambient solution for elderly action recognition from RGB data using bio-inspired classifiers;

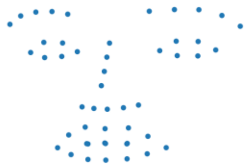
- the efficacy of both investigated bio-inspired networks, viz., HTM and SNN, in recognizing the seniors' actions;

- time efficiency is evaluated on a conventional CPU module, highlighting the ability of lightweight processing by the HTM model

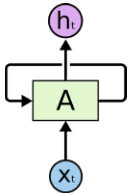
Thank you for your attention

ASPiDA

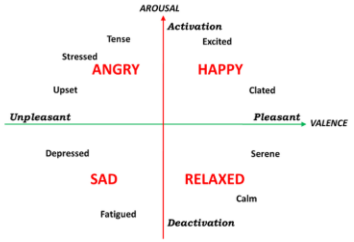
Continuous emotion recognition and long-term behavior modelling



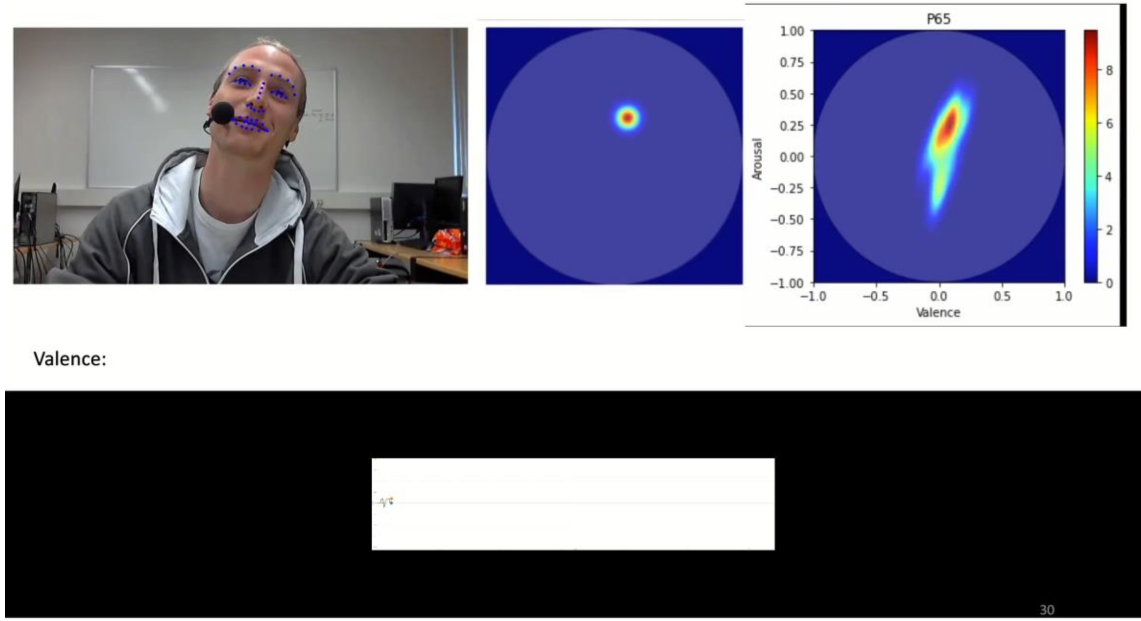
Facial Features



Recurrent Neural Network



Russel Model



Video Preview

- Russel Model: Vector Representation of emotion,
- Arousal and valence coefficients
- Continuous estimation and long-behavior modelling

Data set taken with Kinect v2 (SEFAA-DUTH).

- Total number of action = 2.139:
  1) Left and right turn = 33.6% (720)
  2) Gait = 26.6% (569)
  3) Treadmill = 2% (43)
  4) Sit = 12.6% (270)
  5) Stand = 12.7% (267)
  6) Drink water and turn = 12.6% (270)

- Total number of subjects = 51
- Minimum number of frames: ~30 (gait),
- Maximum number of frames: ~550 (Drink water and turn)

Ανάπτυξη Αλγορίθμων – Μοντέλων

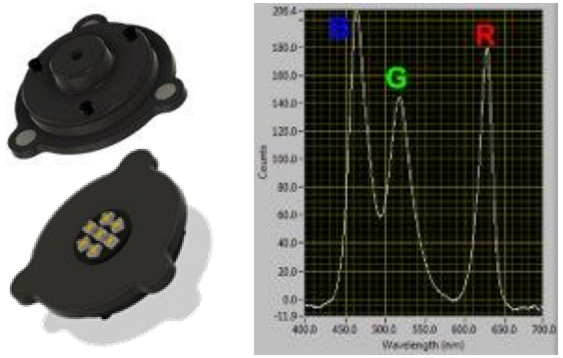
- Το κύριο έργο της ερευνητικής δραστηριότητας αφορά την βελτίωση αλγορίθμων-μοντέλων για αναγνώριση ενέργειων.
- Τα μοντέλα αυτά ανήκουν στην κατηγορίας νευρωνικών δικτύων επεξεργασίας γραφών (GNN).
- Δοκιμαστήκαν τα state-of-the-art μοντέλα με παραλλαγές τους για βελτίωση της απόδοσης τους.
- Για παράδειγμα η δοκιμή του CTR-GCNN με πρόσθετη είσοδό γωνίες είχε τα εξής αποτελέσματα στο σύνολο δεδομένων ΤΕΦΑΑ-ΔΠΘ:
  - Ακρίβεια αναγνώρισης στο σύνολο δεδομένων επαλήθευσης= **100%**
  - Ακρίβεια αναγνώρισης στο σύνολο δεδομένων ελέγχου = **98.88%**
- Η ίδια προτεινόμενη μέθοδος αυξάνει την απόδοση και σε εργασία πάνω σε δημόσια δεδομένα

Ανέπαφες Φυσιολογικές Μετρήσεις με την χρήσης απλής κάμερας

- Αντικείμενο αυτής της ενότητας είναι η λήψη κρίσιμων μεγεθών, που αφορούν την υγεία των ηλικιωμένων ανέπαφα.
- Η ανέπαφη εκτίμηση προσφέρει μια εναλλακτική μέτρηση μεγεθών, ώστε οι ηλικιωμένοι να μη φέρουν πάνω τους συσκευές μετρήσεων, τις οποίες θα πρέπει να χειρίζονται (π.χ. φορτίζουν).
- Συγκεκριμένα, επιδιώκουμε την ανέπαφη εκτίμηση των ακόλουθων μεγεθών:
    - **Καρδιακός ρυθμός (HR)**
    - **Κορεσμός Οξυγόνου (SpO2)**
    - **Συστολική και Διαστολική Πίεση**
- Επιμέρους στόχοι είναι:
    - η λήψη δεδομένων με κανονική RGB κάμερα και με υπέρυθρη (για νυχτερινή χρήση), σε συνδυασμό με τις μετρήσεις SpO2 , HR, πίεσης.
    - Η βελτίωση τεχνικών ανέπαφης εκτίμησης.

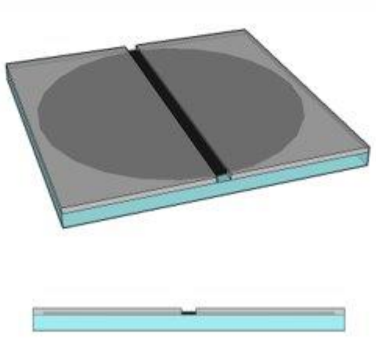
Αισθητήρες

- ✓ Ανάπτυξη ηλεκτρικών επαφών
- ✓ Κατασκευή πειραματικών διατάξεων για χαρακτηρισμό αισθητήρων
- ✓ Κατασκευή και μελέτη αισθητήρων θερμοκρασίας, ατμών ακετόνης και καρδιακών παλμών φωτός

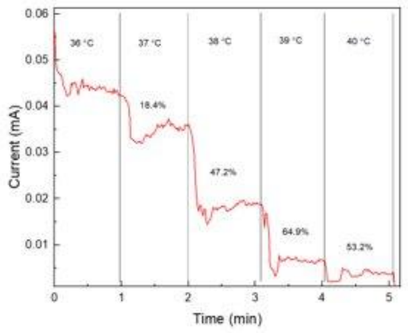


Σύστημα ελεγχόμενου φωτισμού οπτικών αισθητήρων

Σχηματική αναπαράσταση αισθητήρα γραφενίου-πυριτίου



Σχηματική αναπαράσταση αισθητήρα θερμοκρασίας

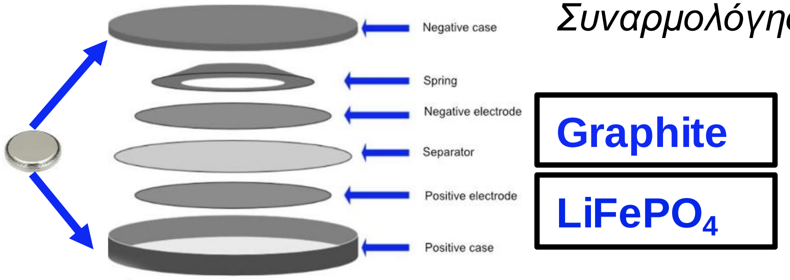


Απόκριση αισθητήρα θερμοκρασίας

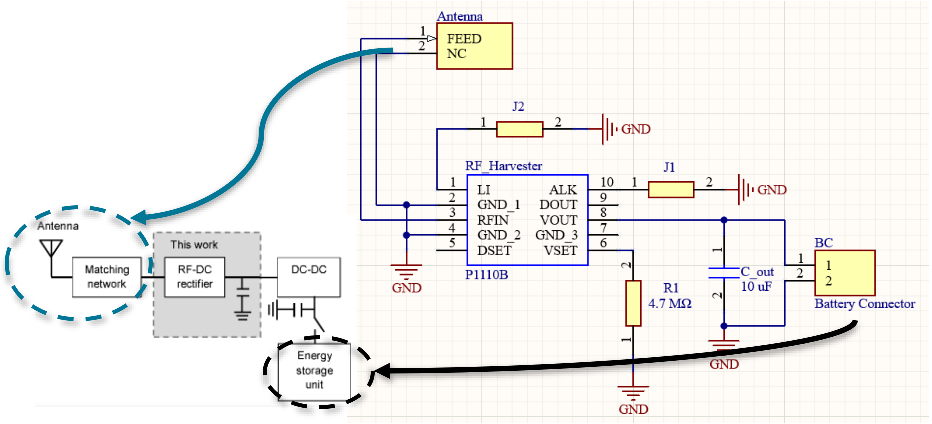
Διάφοροι τύποι μηχανικών μασκών για κατασκευή επαφών

Εξοπλισμός Glove Box στο MNTLab@DUTH

Συναρμολόγηση ενός κελιού ιόντων λιθίου

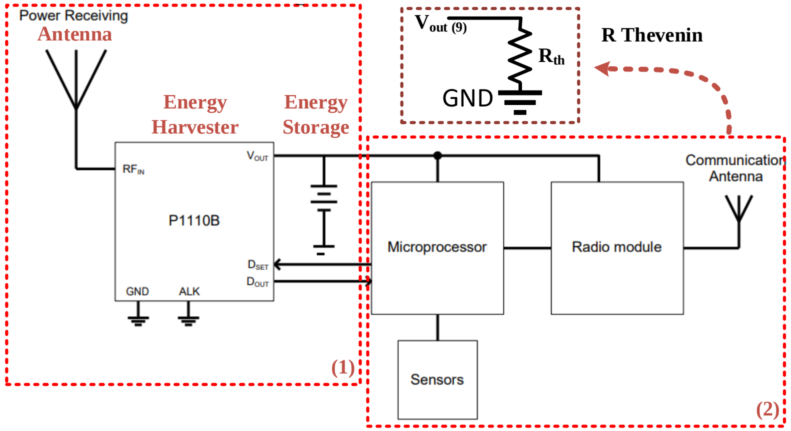


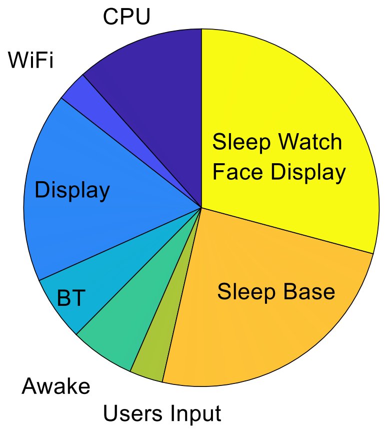
Energy Harvesters – Σχηματικά Διαγράμματα και Πλακέτα



Πρότυπο κύκλωμα RF energy harvester

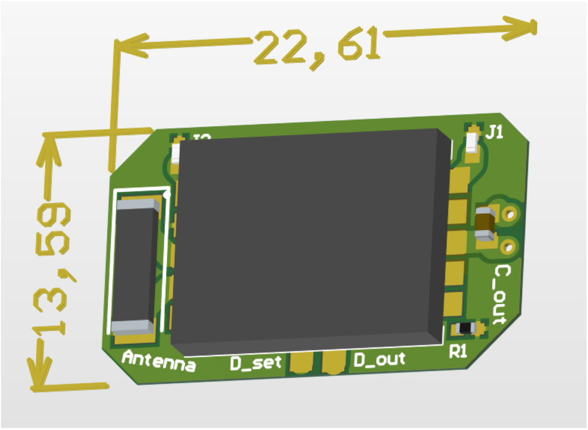
Σχηματικό διάγραμμα κυκλώματος iPowerKit

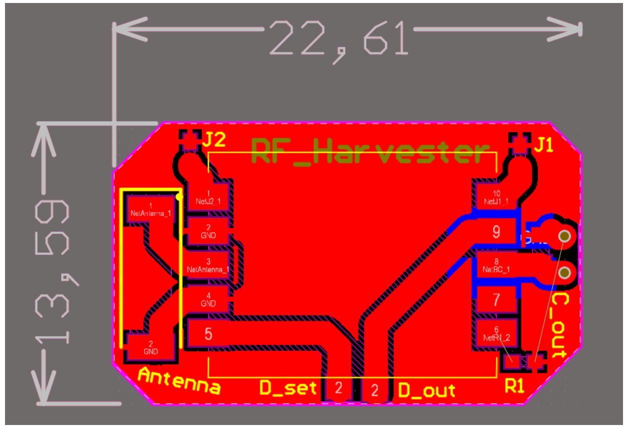




CPU	WiFi	Display	BT	Awake	Users In.	Sleep Base	Sleep Watch F.D.	Συν.
11,5	2,8	17,7	5,8	5,8	0,3	26,1	30,1	100 (%)
9,62	2,34	14,22	4,85	4,85	2,51	20,16	25,1	86,68 mW

Προσεγγιστική Κατανάλωση ανά μονάδα του συνολικού συστήματος





Διαστάσεις (mm)
22,61 x 13,59 x 5,1

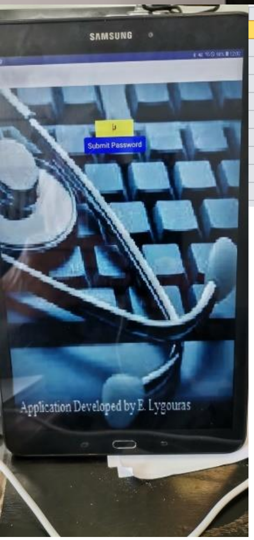
Top layer
Bottom layer

Εφαρμογή σε Wearable για Συλλογή Δεδομένων

Εισαγωγή Password

Εισαγωγή Χρόνου μεταξύ και Αριθμού των Μετρήσεων

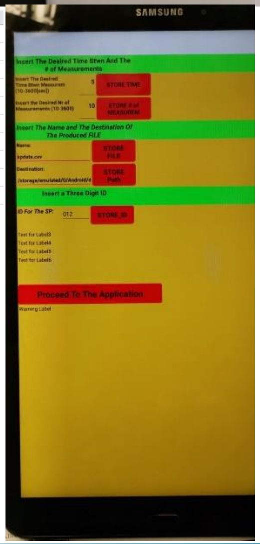
Εισαγωγή τριψήφιου αναγνωριστικού ID για κάθε επιτηρούμενο άτομο



	A	B	C	D	E	F	G	H	I	J
1	26/10/2022	18:20:07:	0	0	0	-1,3216	4,69264	9,25119	0	0
2	26/10/2022	18:20:18:	41,13901	24,91432	0	0,40223	-0,42138	9,99819	0	0
3	26/10/2022	18:20:28:	41,13901	24,91432	0	0,36392	-0,40223	9,94073	0	0
4	26/10/2022	18:20:38:	41,13901	24,91432	0	0,40223	-0,40223	9,95988	0	0
5	26/10/2022	18:22:43:	41,13901	24,91432	0	0,07661	3,9648	9,30866	0	0
6	26/10/2022	18:22:53:	41,13906	24,91426	0	0,13408	-0,09577	9,97903	0	0
7	26/10/2022	18:23:03:	41,13906	24,91426	0	0,11492	-0,07661	9,95988	0	0
8	26/10/2022	18:23:13:	41,13906	24,91426	0	0,11492	-0,07661	9,92157	0	0
9	26/10/2022	18:23:23:	41,13906	24,91426	0	-2,68151	-1,89621	10,0748	0	0
10	26/10/2022	18:23:33:	41,13906	24,91426	0	-2,45166	8,23605	4,71179	0	0

Κατέβασμα αρχείου μετρήσεων σε μορφή .xlsx

Εισαγωγή Password



Εισαγωγή ονόματος και διαδρομής (path) δημιουργούμενου αρχείου

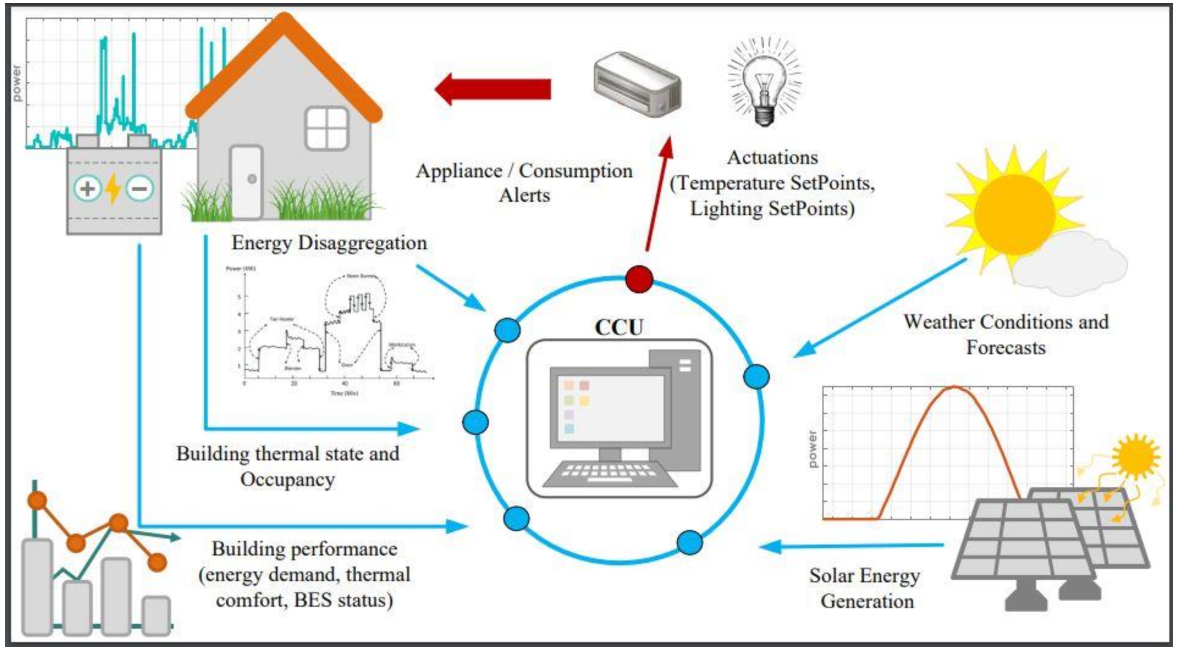
Εισαγωγή Παραμέτρων

Εκτέλεση εφαρμογής

Πλήρης και βέλτιστη διαχείριση κατοικίας ηλικιωμένων

Χαρακτηριστικά

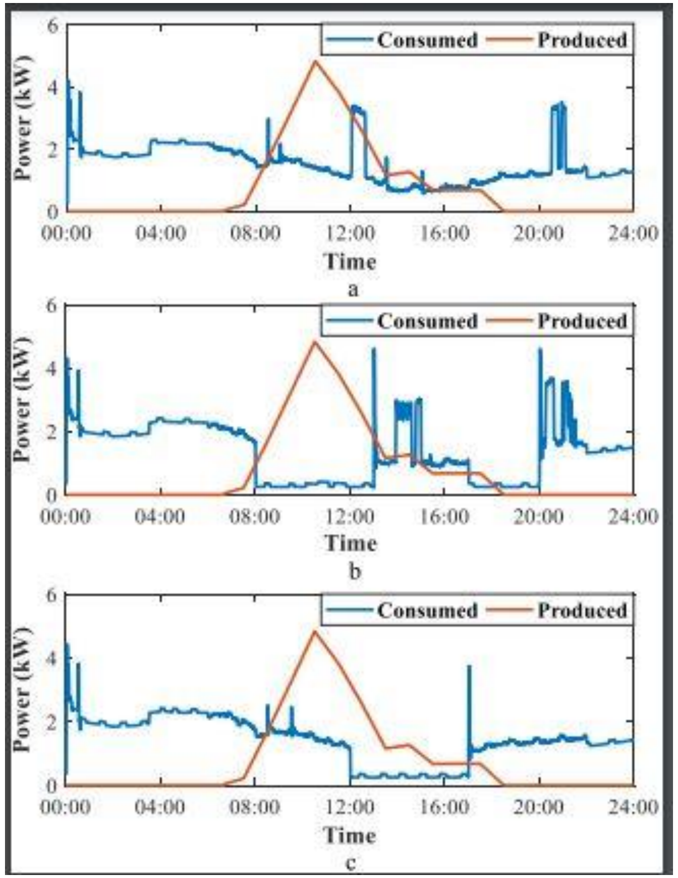
- ✓ Κτίρια διασυνδεδεμένα με το δίκτυο
- ✓ Τα κτίρια αποτελούνται από τουλάχιστον 3 δωμάτια
- ✓ Έλεγχος θερμικών φορτίων σε κάθε δωμάτιο
- ✓ Τα κτίρια είναι εξοπλισμένα με φωτοβολταϊκά πάνελ και μπαταρίες
- ✓ Χρήση του Net-Metering
- ✓ Χρήση Οικιακών Συσκευών στην διάρκεια της ημέρας

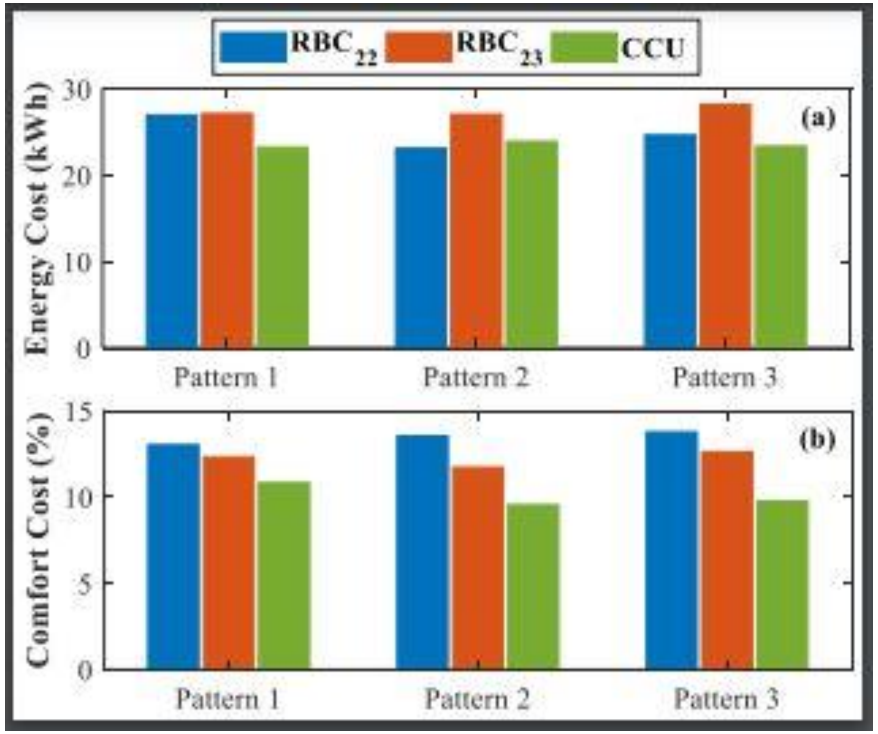


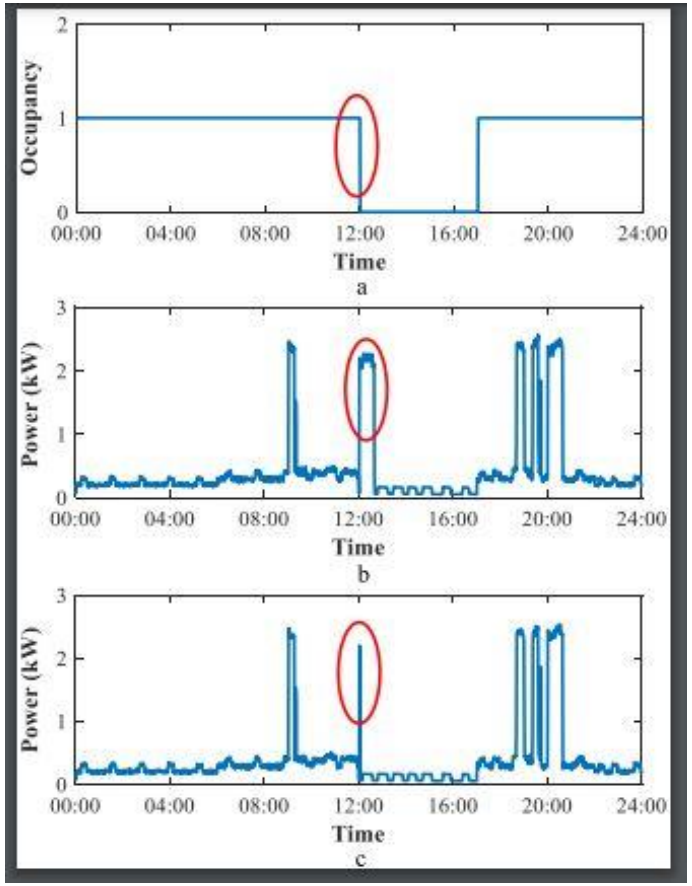
Στόχοι συστήματος διαχείρισης

- ❑ Μείωση κατανάλωσης ενέργειας
- ❑ Μείωση κόστους θέρμανσης
- ❑ Ιδανικές θερμικές συνθήκες
- ❑ Βέλτιστες συνθήκες φωτισμού
- ❑ Εξασφάλιση αποθηκευμένης ενέργειας
- ❑ Επόπτευση δυνητικά επικίνδυνων φορτίων

Αποτελέσματα συστήματος διαχείρισης







Αποτελέσματα συστήματος διαχείρισης

	RBC_{22}	RBC_{23}	CCU	Improvement wrt to R BC
Occupancy Schedule 1	1383	1919	1201	14% - 38%
Occupancy Schedule 2	1189	1374	1007	16% - 27%
Occupancy Schedule 3	1384	1705	1233	11%- 25%

Αποτελέσματα Ενεργειακής Αναβάθμισης

Αρχικό κτήριο

End-use	Annual electricity energy consumption (kWh_e/m^2year)		
	Dynamic simulation tool	*Quasi steady-state simulation tool*	
Heating	106.6	97.8	9%
Cooling	6.1	7.1	14%
DHW	17.3	31.3	**44%**
Total	**130**	**136.2**	4,5%

Σενάριο ενεργειακής αναβάθμισης

End-use	Annual electricity energy consumption (kWh_e/m^2year)		
	Dynamic simulation tool	*Quasi steady-state simulation tool*	
Heating	14.2	19.3	26%
Cooling	5.3	7.7	31%
DHW	9.1	35.4	**74%**
PV production	37.4	34.9	7%
Total	**28.6**	**62.4**	**54%**

Thank You

Συνοπτική Παρουσίαση του έργου ΑΣΠiΔΑ

Conferences

- Archontissa Kanavaki, Maria Michalopoulou, Nikolaos Aggelousis, **“The ASPIDA project: Physical activity, physical function, falls and quality of life in older adults”**, 36th Annual Conference of the European Health Psychology Society
- Michael Georgas, George Zardalidis, Filippos Farmakis, **“Ethanol Effect on Graphene Drop Casting for Acetone Vapor Sensors Operating at Room Temperature”**, 9th Micro Nano International Conference
- Archontissa Kanavaki, Maria Michalopoulou, Nikolaos Aggelousis, **“Risk of falls and physical activity behaviour in community-dwelling older adults. A cross-sectional analysis.”**, 26th Annual Conference of European College of Sport Science
- Kalliopi D. Pippi, Evangelos D. Kyriakopoulos, Theofilos A. Papadopoulos, Georgios C. Kryonidis, **“Systematic Techno-Economic Analysis of Medium-Voltage PV-BES Prosumers Operating Under NEM Policy”**, 2nd International Conference on Energy Transition in the Mediterranean Area
- Christos Athanasiadis, Kalliopi Pippi, Theofilos Papadopoulos, Christos Korkas, Christos Tsaknakis, Vasiliki Alexopoulou, Vasileios Nikolaidis, Elias Kosmatopoulos, **“A Smart Energy Management System for Elderly Households”**, 57th International Universities Power Engineering Conference
- Katerina Maria Oikonomou, Ioannis Kansizoglou, Antonios Gasteratos, **“A Framework for Active Vision-Based Robot Planning using Spiking Neural Networks”**, 30th Mediterranean Conference on Control and Automation
- Theodoros Panagiotis Chatzinikolaou, Iosif-Angelos Fyrigos, Georgios Sirakoulis, **“Image Shifting Tracking Leveraging Memristive Devices”**, 2022 11th International Conference on Modern Circuits and Systems Technologies (MOCAST)
- Katerina Maria Oikonomou, Ioannis Kansizoglou, Pelagia Manaveli, Athanasios Grekidis, Dimitrios Menychtas, Nikolaos Aggelousis, Georgios Sirakoulis, Antonios Gasteratos, **“Joint-Aware Action Recognition for Ambient Assisted Living”**, 2022 IEEE International Conference on Imaging Systems and Techniques
- Konstantinos Tsintotas, Shan An, Ioannis Tsampikos Papapetros, Fotios Konstantinidis, Georgios Sirakoulis, Antonios Gasteratos, **“Dimensionality reduction through visual data resampling for low-storage loop-closure detection”**, 2022 IEEE International Conference on Imaging Systems and Techniques
- Ioannis K. Chatzipaschalis, Karolos-Alexandros Tsakalos, Georgios Ch. Sirakoulis, Antonio Rubio, “**Parkinson’s Treatment Emulation Using Asynchronous Cel lular Neural Networks**”, LASCAS 2023
- Ioannis K. Chatzipaschalis, Evangelos Tsipas, Karolos-Alexandros Tsakalos and Georgios Ch. Sirakoulis, Antonio Rubio “Hardware Design of Memristor-based Oscillators for Emulation of Neurological Diseases, ISCAS 2023

Journal Publications

- Katerina Maria Oikonomou, Ioannis Kansizoglou, Antonios Gasteratos, **“A Hybrid Spiking Neural Network Reinforcement Learning Agent for Energy-Efficient Object Manipulation”**, Machines (2023)
- Michael Georgas, Petros Selinis, George Zardalidis, Filippos Farmakis, **“Temperature Sensors by Inkjet-Printing Compatible with Flexible Substrates: A Review”**, IEEE Sensors Journal (2022)
- Georgios Varsamis, Ioannis Karafyllidis, Georgios Sirakoulis, **“Hitting times of quantum and classical random walks in potential spaces”**, Physica A: Statistical Mechanics and its Applications (2022)
- Ioannis Kansizoglou, Evangelos Misirlis, Konstantinos Tsintotas, Antonios Gasteratos, **“Continuous Emotion Recognition for Long-Term Behavior Modeling through Recurrent Neural Networks”**, Technologies (2022)
- Georgios Varsamis, Ioannis Karafyllidis, **“Computing the lowest eigenstate of tight-binding Hamiltonians using quantum walks”**, International Journal of Quantum Information (2022)
- Ioannis Tsampikos Papapetros, Vasiliki Balaska, Antonios Gasteratos, **“Visual Loop-Closure Detection via Prominent Feature Tracking”**, Journal of Intelligent & Robotic Systems (2022)
- Ioannis Kansizoglou, Loukas Bampis, Antonios Gasteratos, “**Do Neural Network Weights Account for Classes Centers?”**, IEEE Transactions on Neural Networks and Learning Systems (2022)

Journal Publications

- F. Kotarela, A. Kyritsis, R. Agathokleous, N. Papanikolaou, **“On the exploitation of dynamic simulations for the design of buildings energy systems”**, Energy
- A. Kanavaki, M. Michalopoulou, N. Ntoumanis, I. Smilios, E. Douda, P. Manaveli, A. Gkrekidis, E. Kouli, N. Aggelousis, **“Accelerometer-assessed physical activity, balance, falls and quality of life in community-dwelling older adults. Protoc ol for a longitudinal observational study.”**, PlosOne
- Ch. Tsaknakis, Ch. Korkas, K. Pippi, Ch. Athanasiadis, V. Alexopoulou, E. Kosmatopoulos, V. Nikolaidis, Th. Papadopoulos. **“Nearly-Optimal control for energy, thermal and storage loads with energy disaggregation monitoring: A case of residential management for the elderly”**, IET Smart Cities
- Ch. Tsaknakis, Ch. Korkas, E. Kosmatopoulos. **“Multi-Agent RL framework for EV charging scheduling driven by energy costs and user preferences”**, 2023 Mediterranean Conference on Control and Automation – MED 2023
- Ch. Tsaknakis, Ch. Korkas, E. Kosmatopoulos. **“Distributed and Multi-Agent RL Framework for Optimal EV Charging Scheduling”**, IEEE Transactions on Intelligent Transportation Systems
- **“Visual Place Recognition with Sequence Representations on the Distance-Space Domain”**, Robotics and Autonomous Systems
- **“A Hybrid Reinforcement Learning Approach with a Spiking Actor Network for Efficient Robotic Arm Target Reaching”**, IEEE Robotics and Automation Letters