PhD Open Days

A Low-Cost System to Assist Stroke Rehabilitation

PhD in Electrical and Computer Engineering

Ana Rita Mendes Cóias (ana.coias@tecnico.ulisboa.pt)

Introduction

The need for accessible assistive systems has been growing to answer the main barriers to stroke rehabilitation, e.g. reduced patient engagement in therapy. An assistive system should objectively assess patients' exercise performance and provide stimulating and appropriate real time feedback, enabling movement pattern correction (e.g., diminish compensatory motions). Additionally, a therapist can track patients' progress by accessing objective data about their performance.

Proposed Research

### The Virtual Coach

System Setup
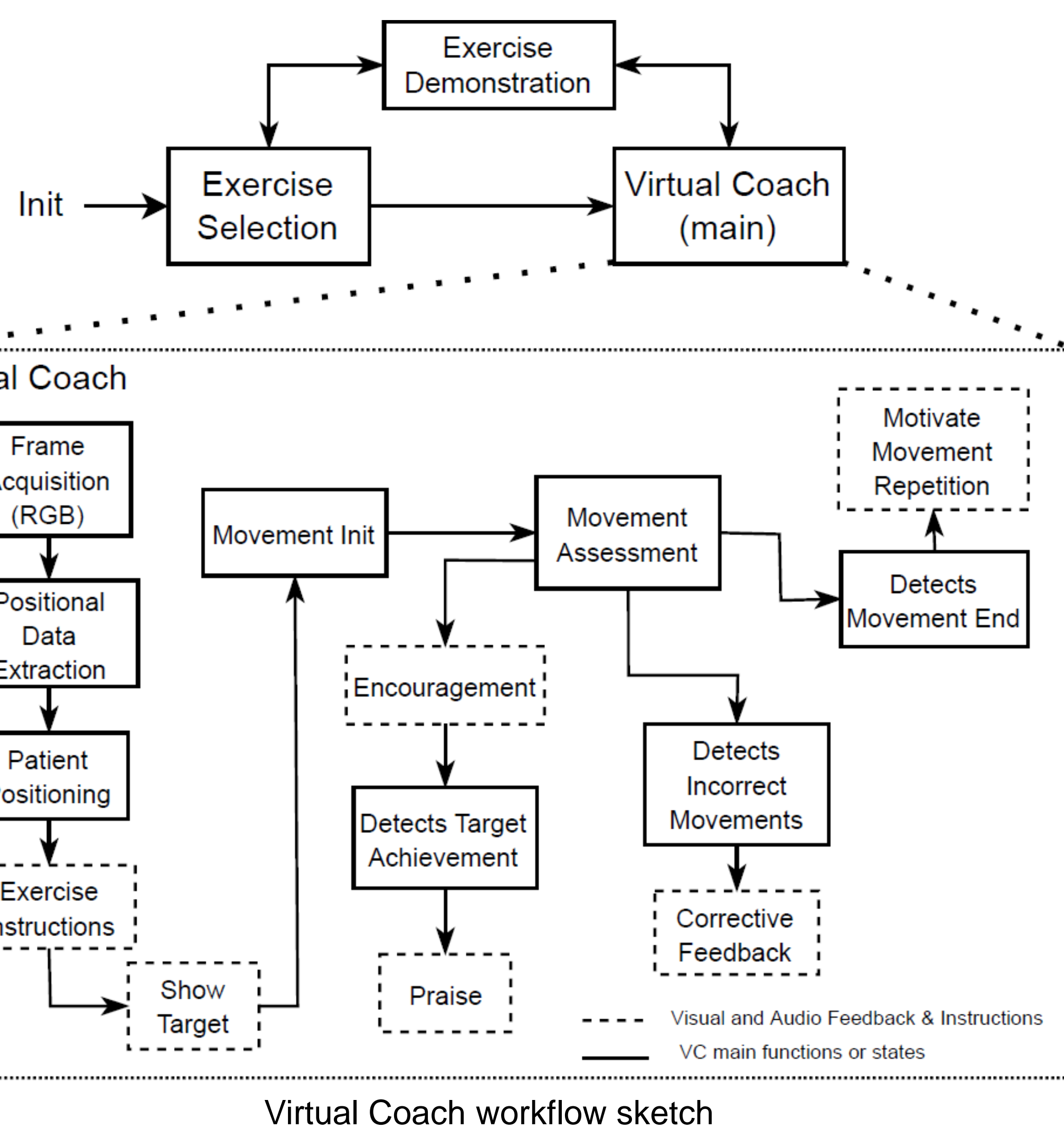
Virtual Coach workflow sketch

The Virtual Coach: Figure – Virtual Coach setup & workflow sketch.

Exercises & Performance Components

We explore three upper extremity exercises and three performance components to evaluate exercise performance ('*compensation*', '*smoothness*', and '*range of motion*'), previously identified. Additionally, we identified five new rehabilitation exercises.
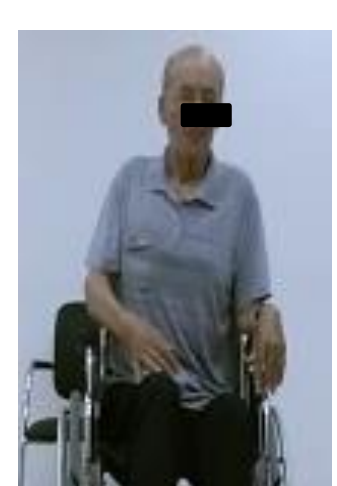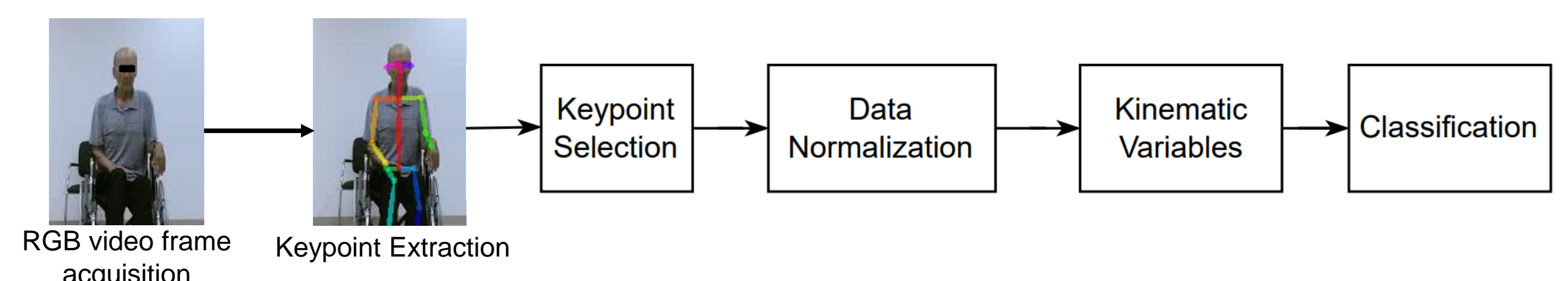

Shoulder Elevation   *Trunk Rotation*   *Trunk Displacement*

Exercises & Performance Components : Figure – Compensatory movement patterns.

E1 – '*Bring a cup to the mouth*'   E2 – '*Switch a light on*'   E3 – '*Move a cane forward*'   E4 – '*Brush the hair*'   E5 – '*Brush the teeth*'

E6 – '*Wash the face*'   E7 – '*Put on socks*'   E8 – '*Hip flexion*'

Exercises & Performance Components: Figure – Rehabilitation exercises.

Exercise Performance Assessment

RGB video frame acquisition   Keypoint Extraction   Keypoint Selection → Data Normalization → Kinematic Variables → Classification
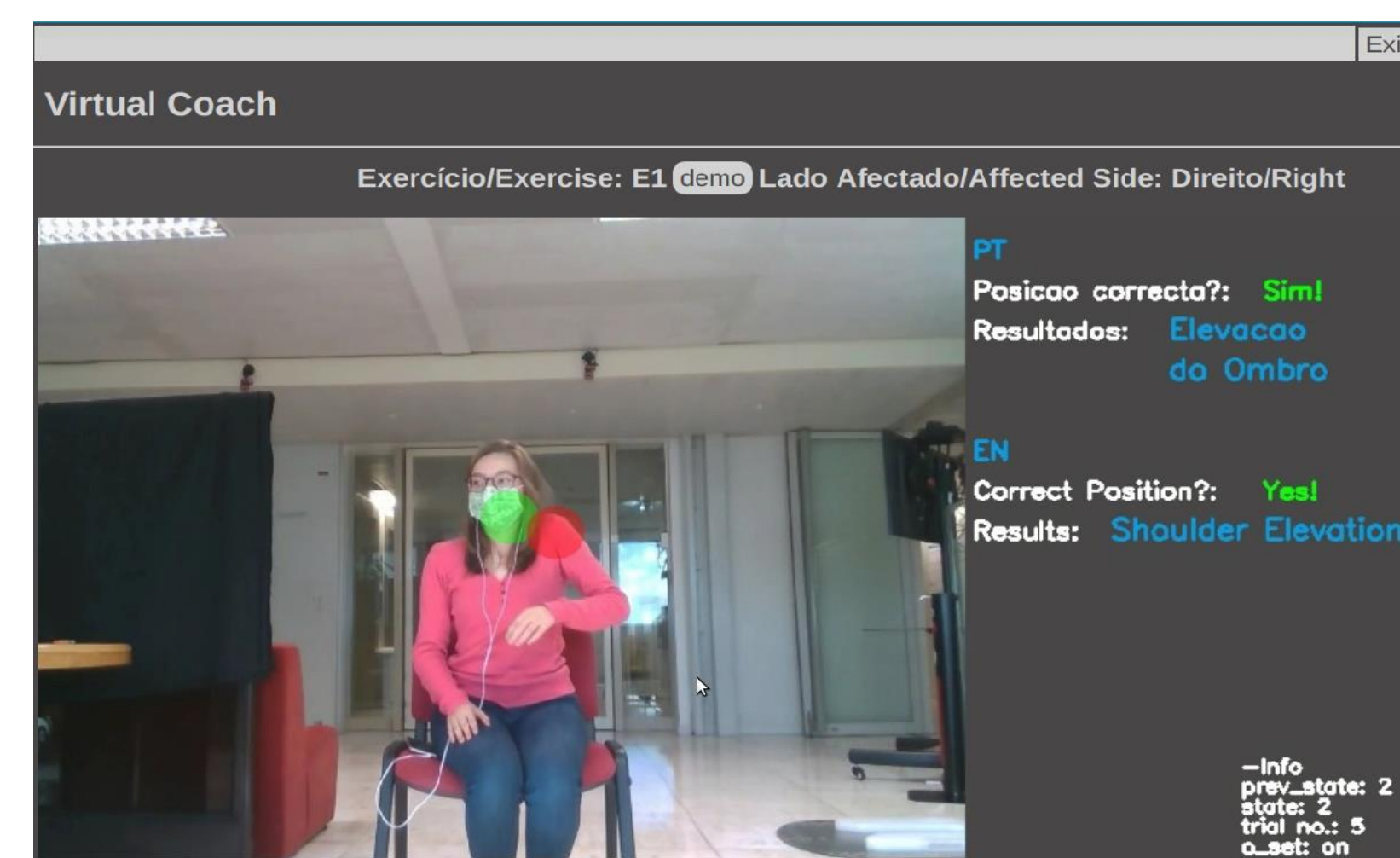
Preliminary Virtual Coach & Compensatory Assessment: Figure – Performance assessment approach.

Current Progress & Future Plan

Preliminary Virtual Coach & Compensatory Movements Assessment

We developed a prototype of a Virtual Coach to support the performance of the three exercises and assess compensatory patterns in real time. We developed Rule-Based and Neural Network Based classification approaches to identify distinct compensation patterns.

Virtual Coach prototype main screen

Compensation assessment performance

	Rule-Based $(f_1 - score)$	Neural Network Based $(f_1 - score)$
E1	$\mathbf{0.76 \pm 0.12}$	0.70 ± 0.24
E2	0.59 ± 0.16	$\mathbf{0.73 \pm 0.19}$
E3	0.70 ± 0.26	$\mathbf{0.80 \pm 0.22}$

Preliminary Virtual Coach & Compensatory Assessment: Figure – Virtual Coach 1st prototype & classification results.

Next Steps

- New exercises' data acquisition;
- Exploration and development of new approaches to evaluate performance and new performance components;
- Development of an improved prototype;
- Prototype testing.

Acknowledgements
The authors would like to thank the NeuroSer rehabilitation center team.

TÉCNICO LISBOA

Prof. Alexandre Bernardino

PhD in Electrical and Computer Engineering

phdopendays.tecnico.ulisboa.pt