



VAR Lab @ IEETA



Enhancing Stroke Rehabilitation through Virtual Reality: A Human-Centered Approach

Bernardo Marques,
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IEETA, DETI, LASI,
University of Aveiro



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01

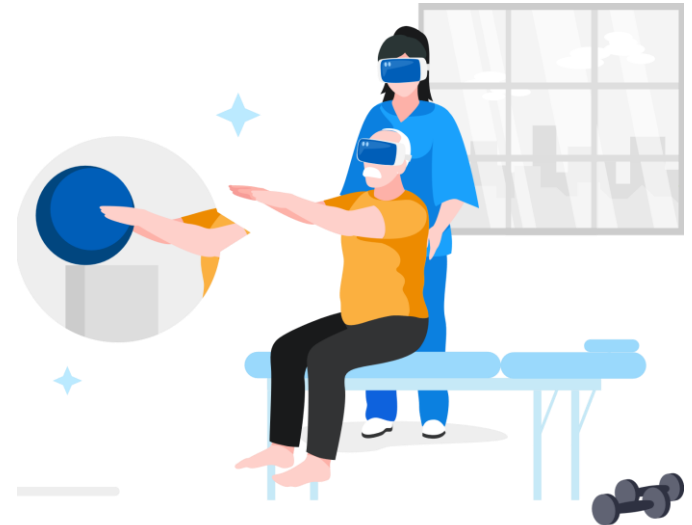
VAR Lab @ IEETA

02

Research Examples

03

Discussion Session



Feel free
to ask
questions



VAR Lab @ IEETA

Who are we?



sites.google.com/view/varlab/home



IEETA

Institute of Electronics and Informatics Engineering of Aveiro

- IRS - Intelligent Robotics and Systems
- BIT - Biomedical Informatics and Technologies
- ISP - Information Systems and Processing

VAR Lab @ IEETA - Mission

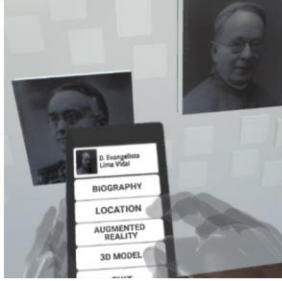
- Research new methodologies within the scope of Virtual and Augmented Reality
- Develop Systems for Human Assistance through Human-Centered Design
- Foster collaboration with society in multiple areas of application
- Support education and training at the University of Aveiro



Research Interests



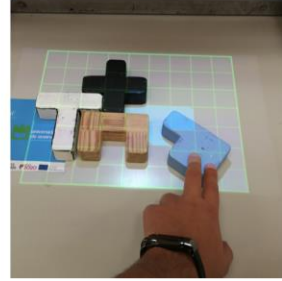
Continuous experiences



Cultural Heritage



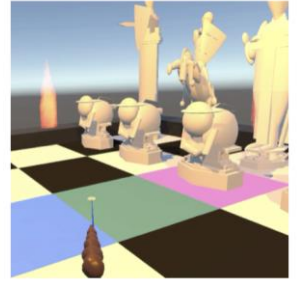
Simulation and Repair



Training and Guidance



Education



Entertainment



Maintenance Assistance



Assembly and Quality Control



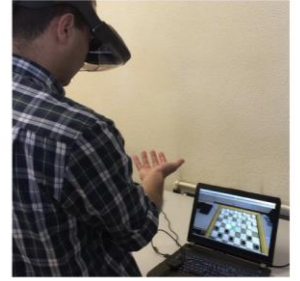
Co-located Collaboration



Remote Collaboration



Rehabilitation



Serious Games

Collaborations so far ...

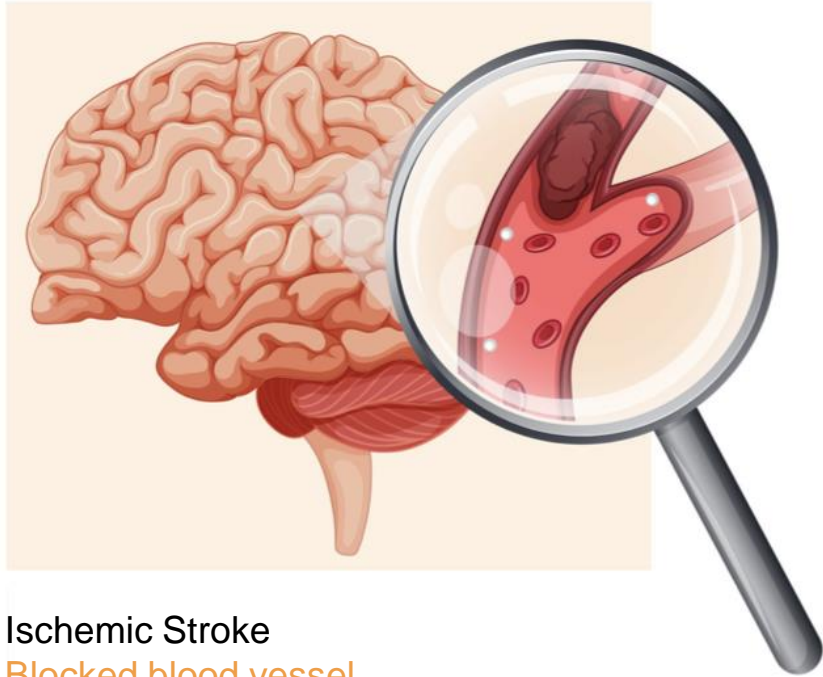


Multiple visits and presentations

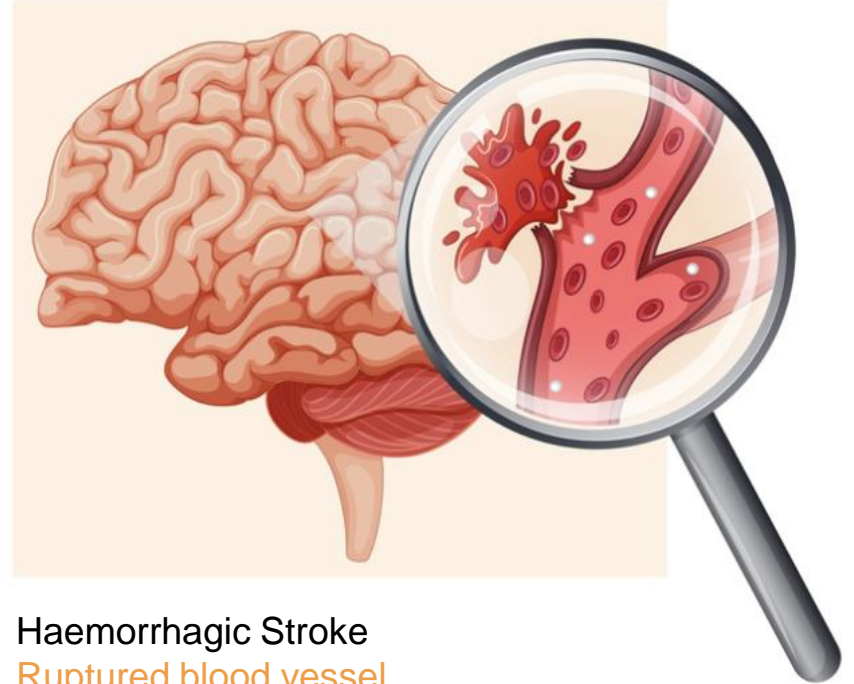


Concepts and Definitions

Stroke



Ischemic Stroke
Blocked blood vessel



Haemorrhagic Stroke
Ruptured blood vessel

Stroke Symptoms



Face
drooping



Arm
weakness

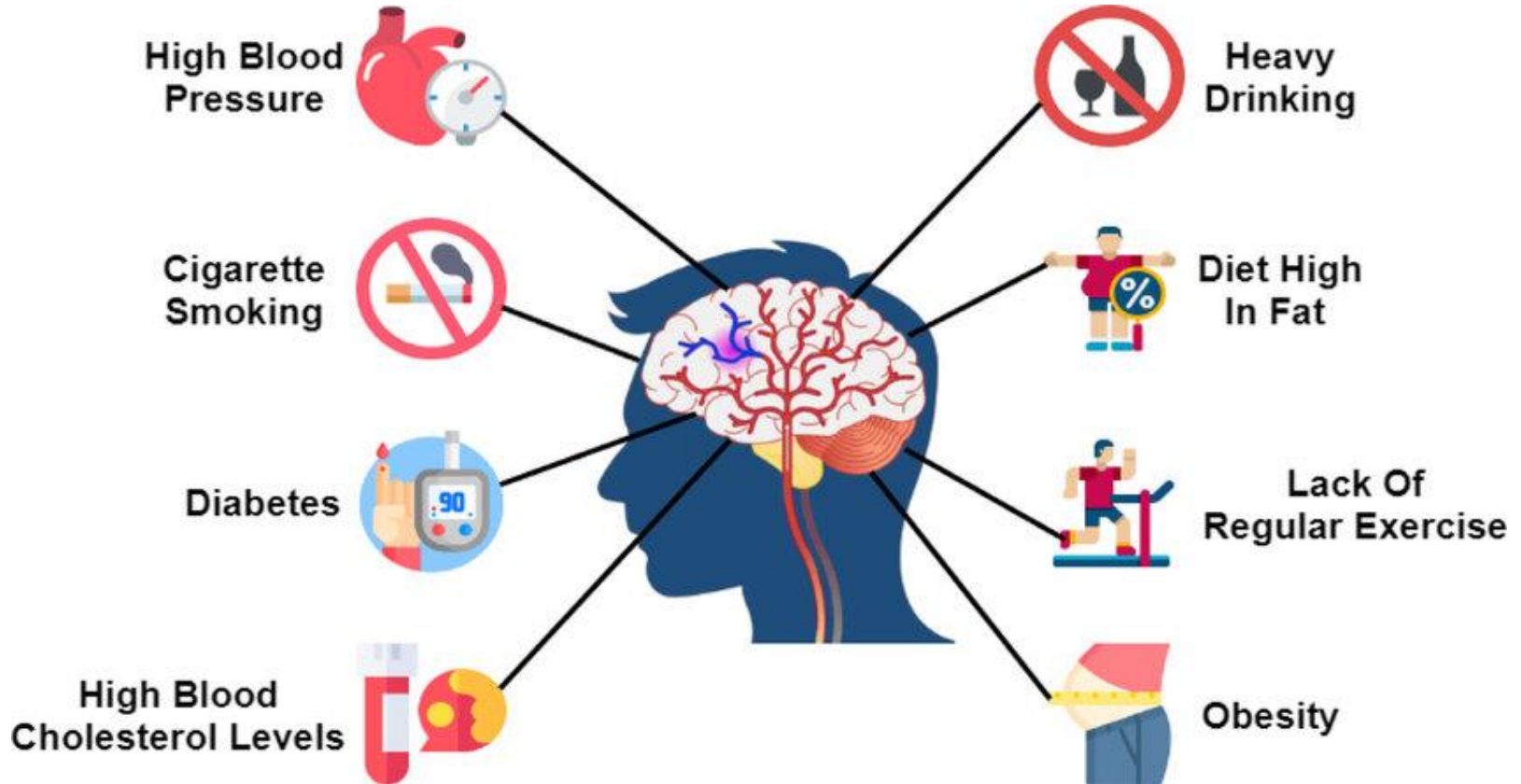


Speech
difficulties



Time
to call

Stroke Risk Factors



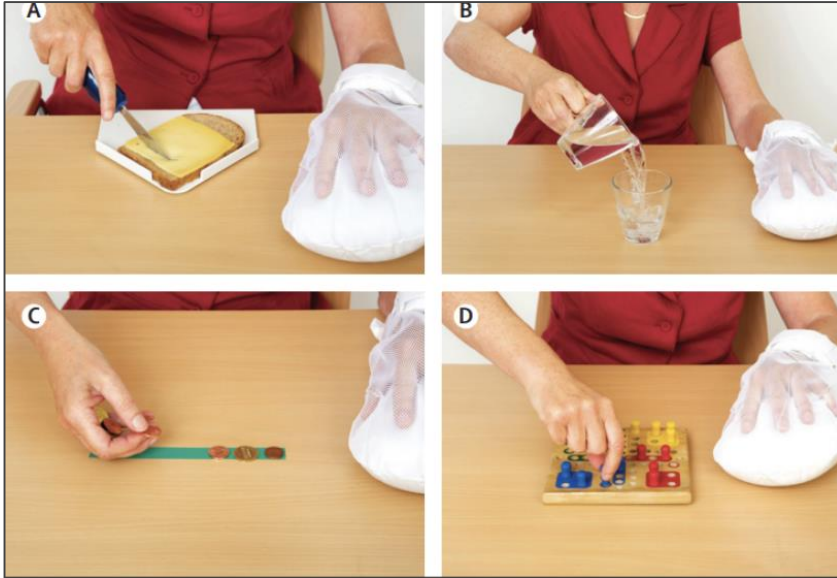
Life after a Stroke



Need for rehabilitation programs



Some Rehabilitation Methods



Constraint induced movement therapy

Blocked Restriction of the healthy limb to promote the use of the affected one



Mirror Therapy

Use a mirror to reflect the healthy limb and hide the affected one

The importance of daily activities



Existing challenges and limitations

- Repetitive exercises;
- Loss of motivation;
- Lack of personalization;
- Isolated experiences;
- Absence of social approaches.





Digital Realities and

Serious Games

Reality–virtuality continuum



AR

AUGMENTED REALITY

Digital content from virtual world on top of real environment providing information



MR

MIXED REALITY

Virtual and Real Environment mix and interact with each other

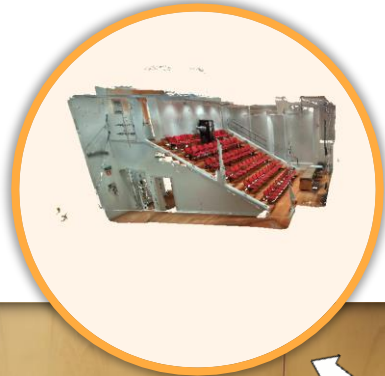
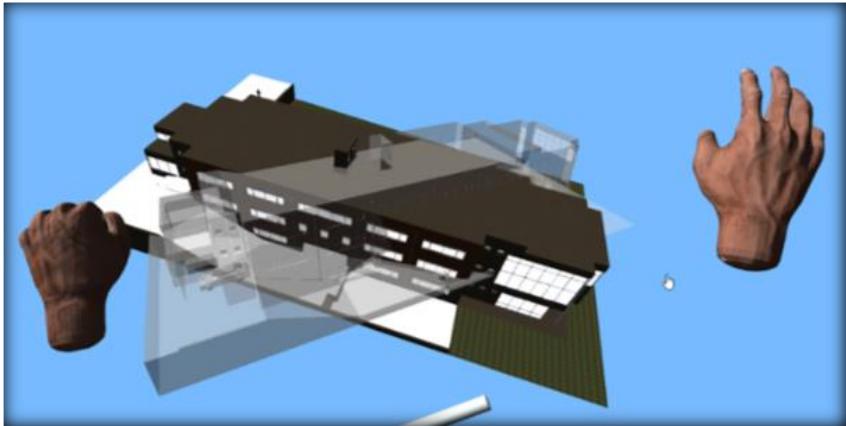


VR

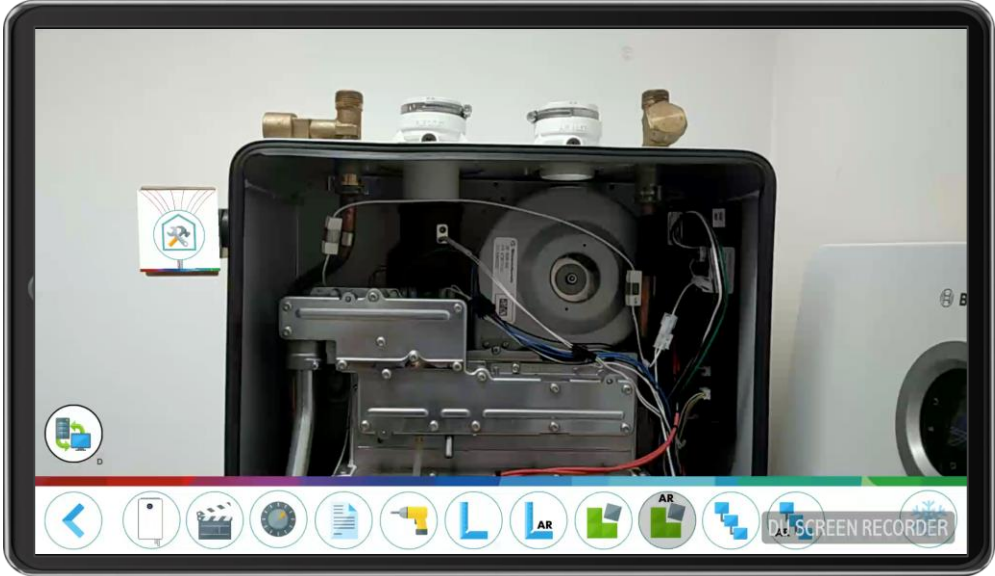
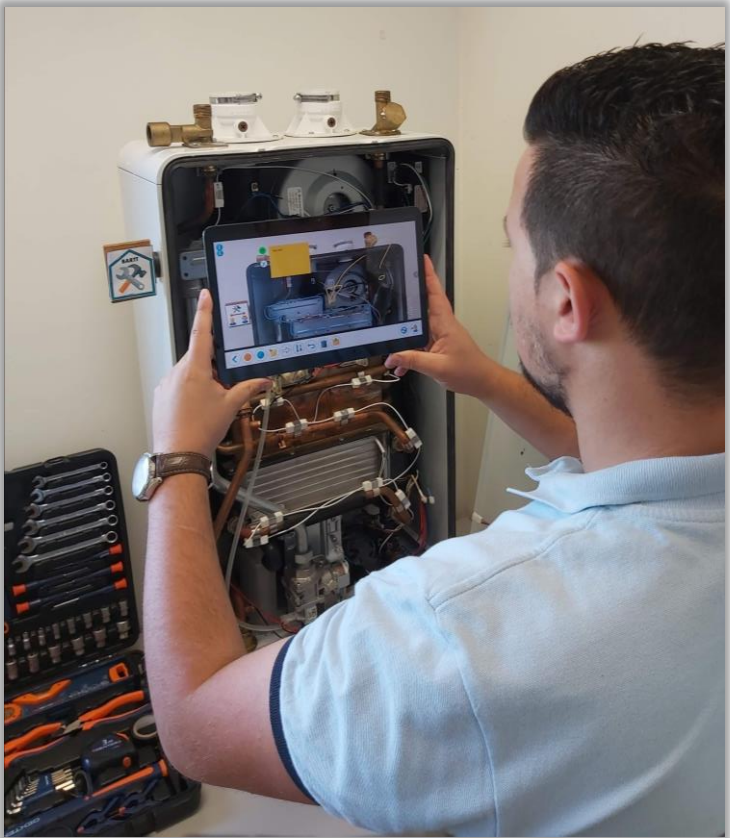
VIRTUAL REALITY

Immersive virtual environments shut out the real world

Virtual Reality (VR)



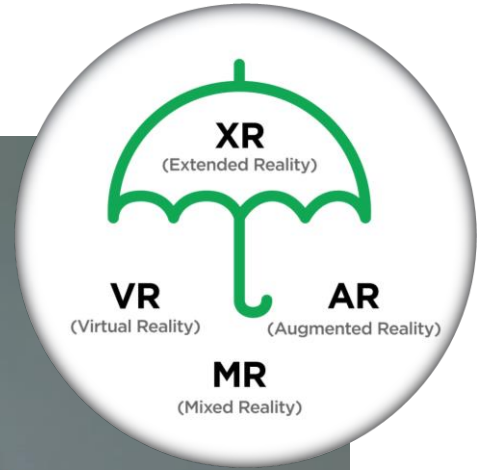
Augmented Reality (AR)



Mixed Reality (MR)



eXtended Reality (XR)



Serious Game



**How did we get into
rehabilitation?**

Medical Rehabilitation Center



Medical Rehabilitation Center

Criação do Centro de Medicina de Reabilitação da Região Centro – Rovisco Pais (Decreto-Lei nº 203/96, de 23 de Outubro) na herdade da extinta Leprosaria Nacional: Hospital-Colónia Rovisco Pais.

1996

Recebe os primeiros doentes de Medicina Física e Reabilitação, 30 camas

2002

UCC - Unidade de Cuidados Continuados de Convalescença, 30 camas

2012

Conclusão da instalação da UCC com alargamento da lotação para 60 camas

2015

<https://www.roviscopais.pt/>

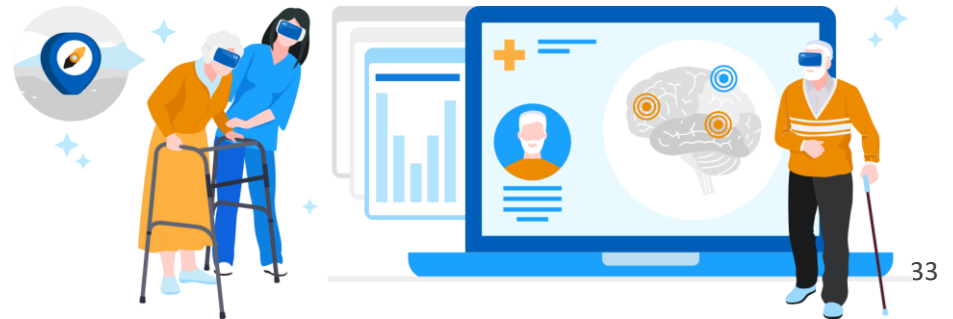


Newer experiences are emerging ...

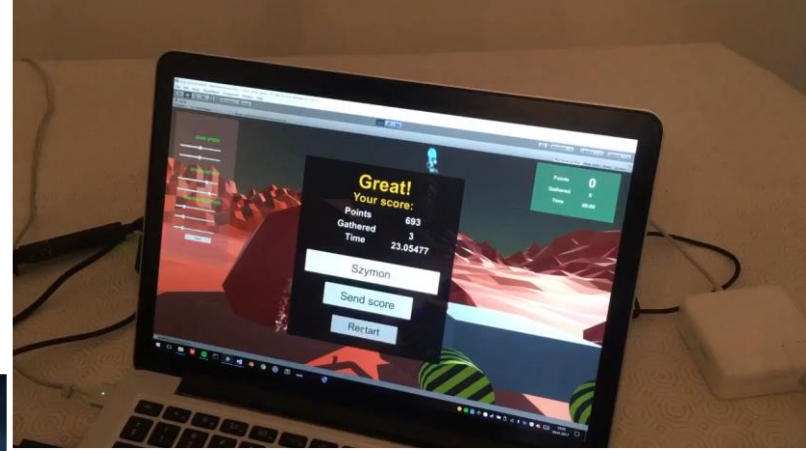


The challenge to go beyond ...

- “How can you assist our rehabilitation practices?”
- “Not to replace existing methods, but as a complement.”
- “Are you able to create more motivational/relatable methods?”
- “You must take Stroke Survivors characteristics into account!”



First prototypes – Upper Limb



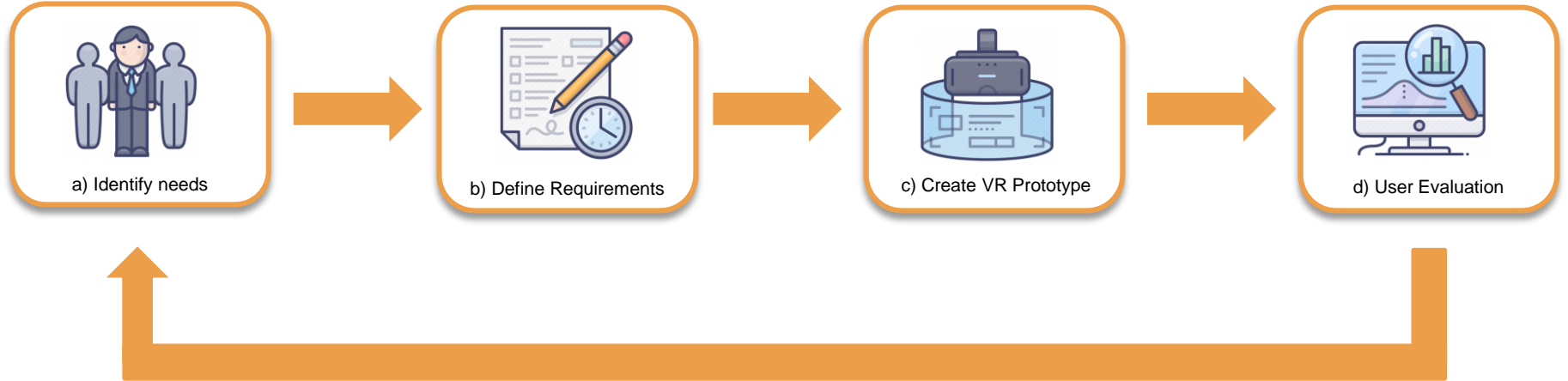
Research Examples from VAR Lab @ IEETA



Human-Centered

Design Methodology

Human-Centered Design (HCD)





First 'real' contact

with Rehabilitation

Understanding ...

- The field – first contact with rehabilitation scenarios;
- The challenges and needs of Stroke Survivors/Healthcare Professionals;
- Current rehabilitation methods and what was missing;
- The available technology (2016) – avoiding controllers;
- How to make a contribution that was relevant.



First 'Major' Contribution



Five Rehabilitation Games



Five Rehabilitation Games



Patient Tests

The mini-game prototypes were tested at the 'Centro de Medicina de Reabilitação da Região Centro – Rovisco Pais' rehab center with the help of the patients, therapists and doctors



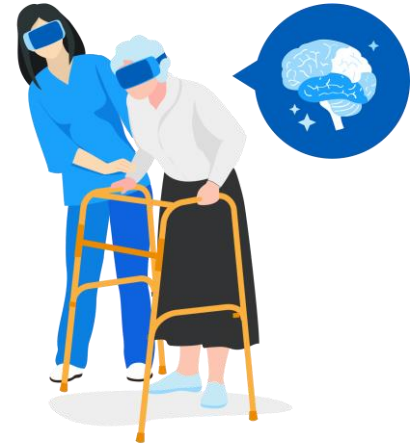
Whac-a-mole

during COVID-19

Appearance of new hardware



- Does not require a computer;
- More affordable;
- Easy to get;
- No wires;
- Hand Tracking;
- Cast to external devices.



Focus Group

- Inclusion of Stroke Survivors and Healthcare Professionals;
- Identify needs and existing challenges;
- Understand current practices;
- Verify willingness to use VR;
- Propose multiple serious games;
- Define Requirements;
- Established next steps.



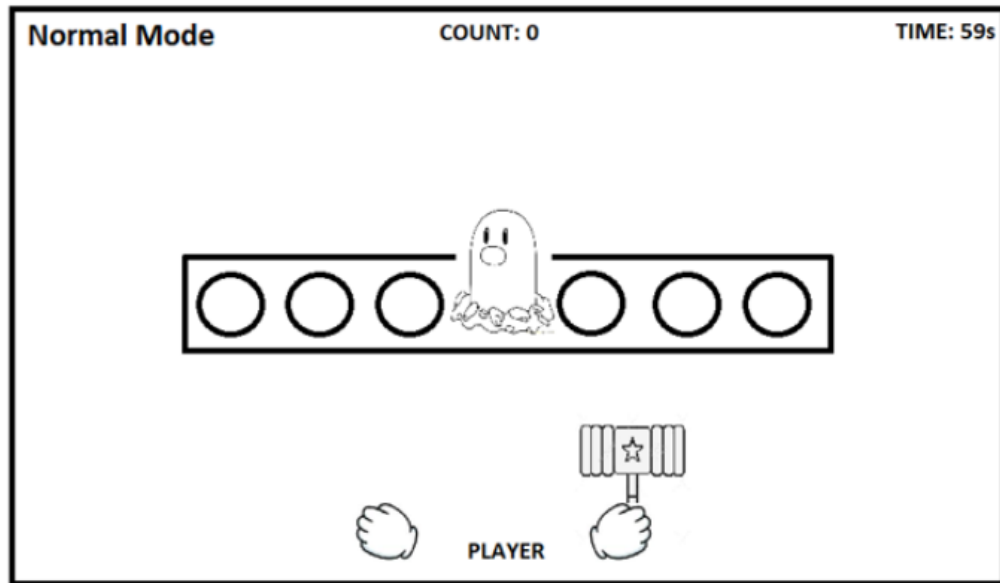
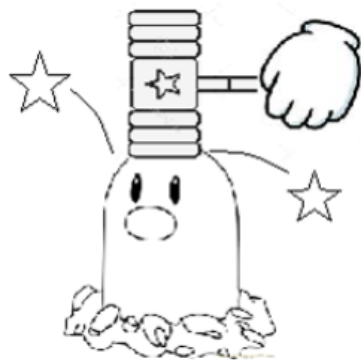
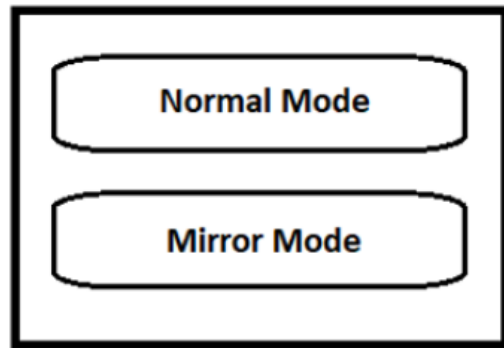
Some possibilities on the table



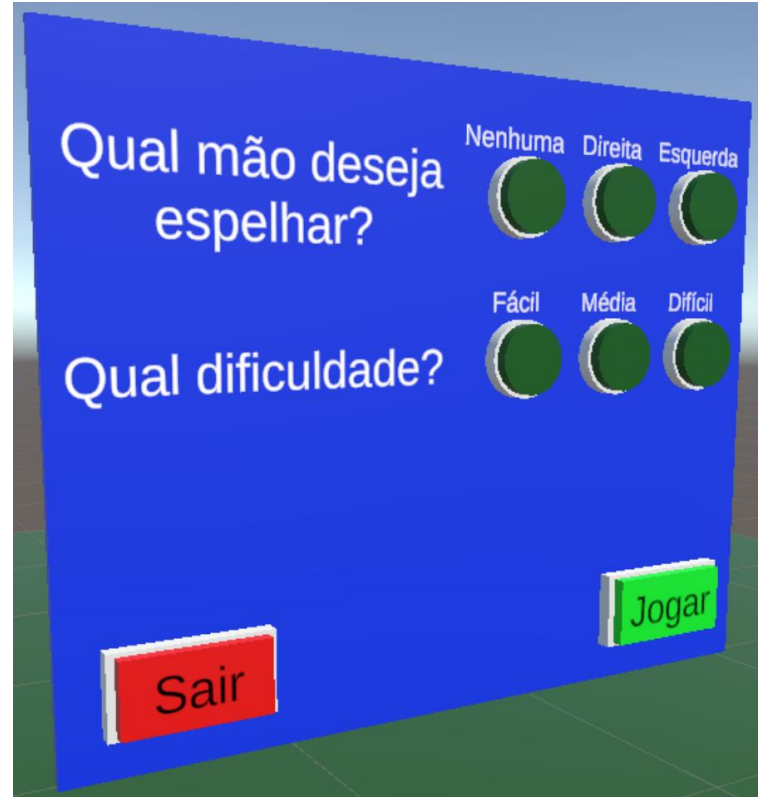
Whac-a-mole



Conceptualization



Whac-a-mole using VR



Whac-a-mole using VR



Normal Version



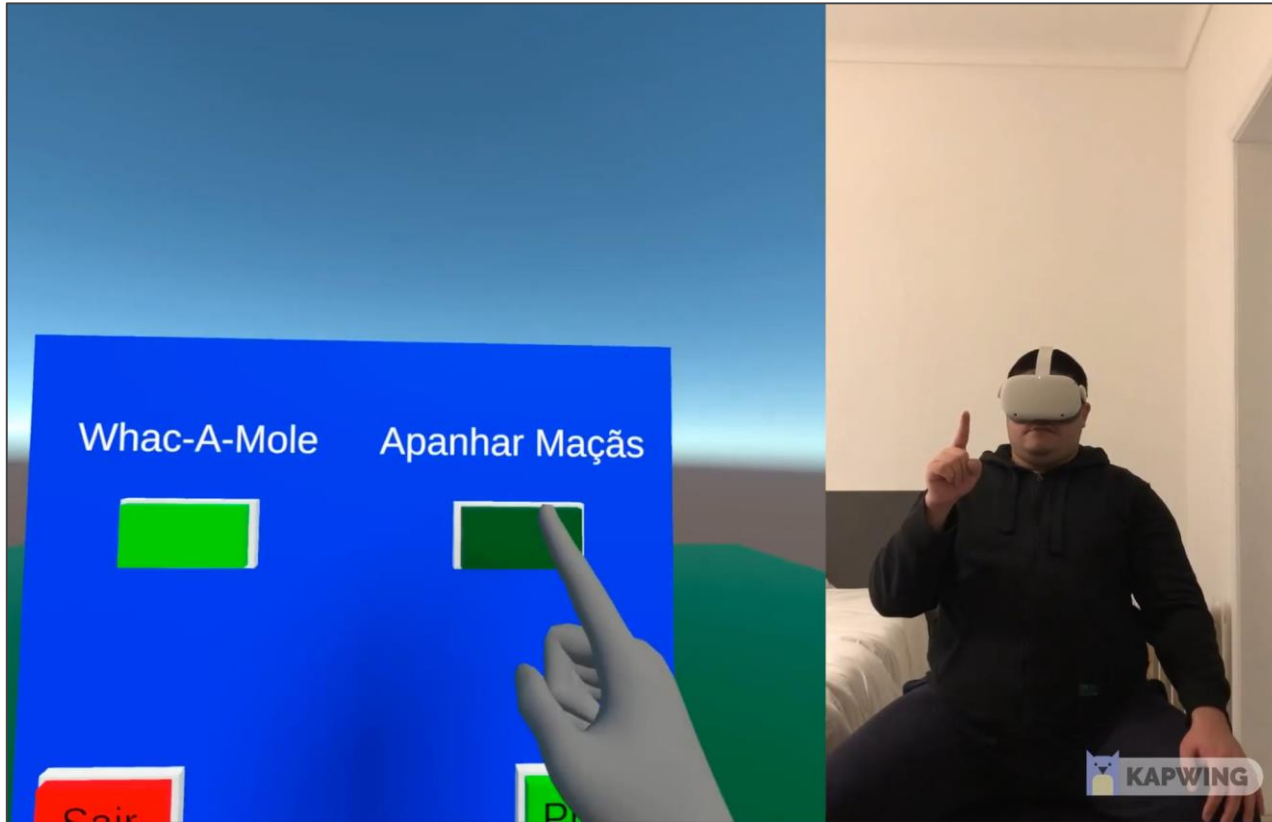
Mirror Version

Whac-a-mole using VR



- Due to COVID-19, the game was not evaluated in clinical environment;
- Despite, preliminary studies in laboratory occurred;
- Data Collected allowed to improve the game and even create a new one.

Grab the apples





The VR Supermarket

Experience

Methodology

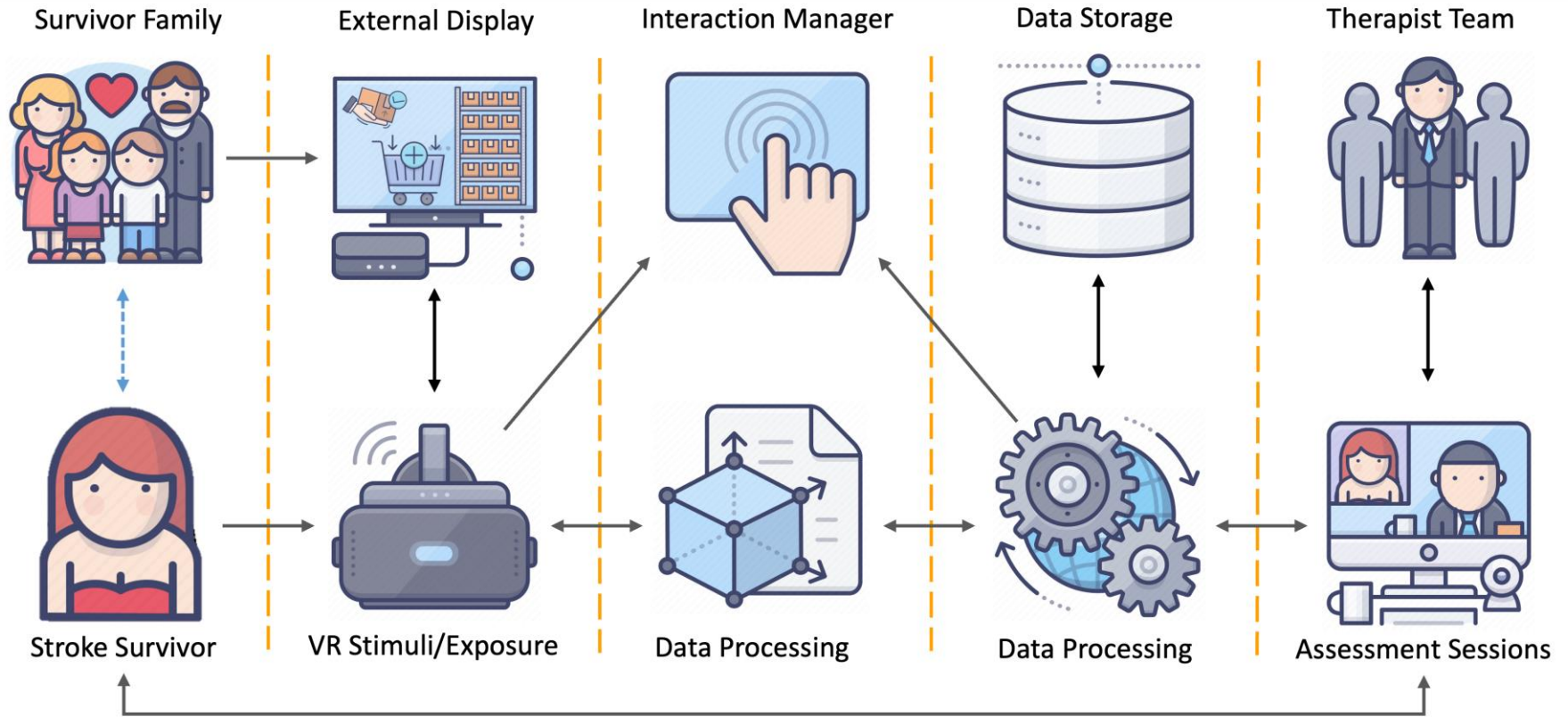
- This work was supported by the information gathered from the focus group previously mentioned;
- Recurring meetings with occupational therapists;
- Change of game to a daily activity;
- Iterative Process.



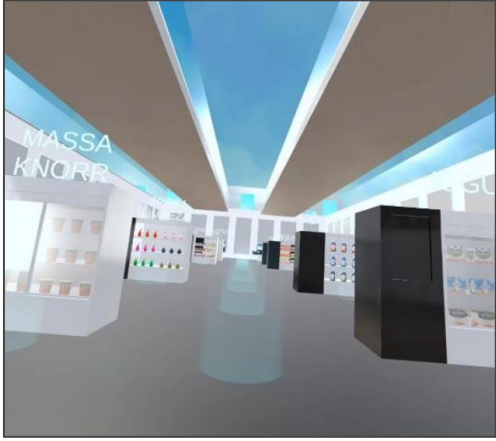
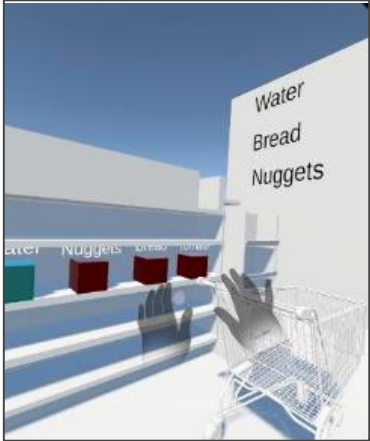
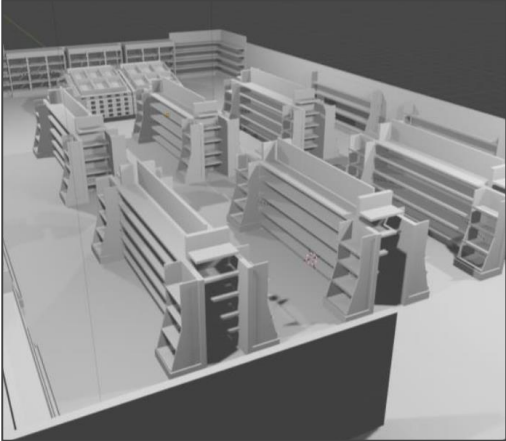
Supermarket using VR



Framework Overview



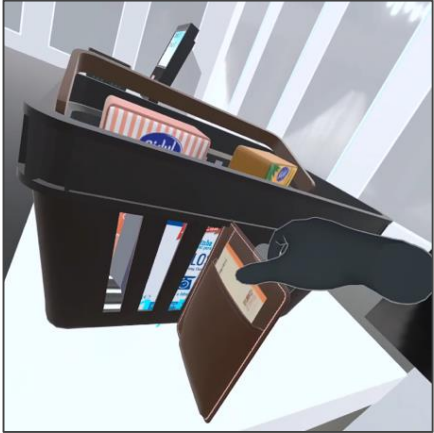
Conceptualization



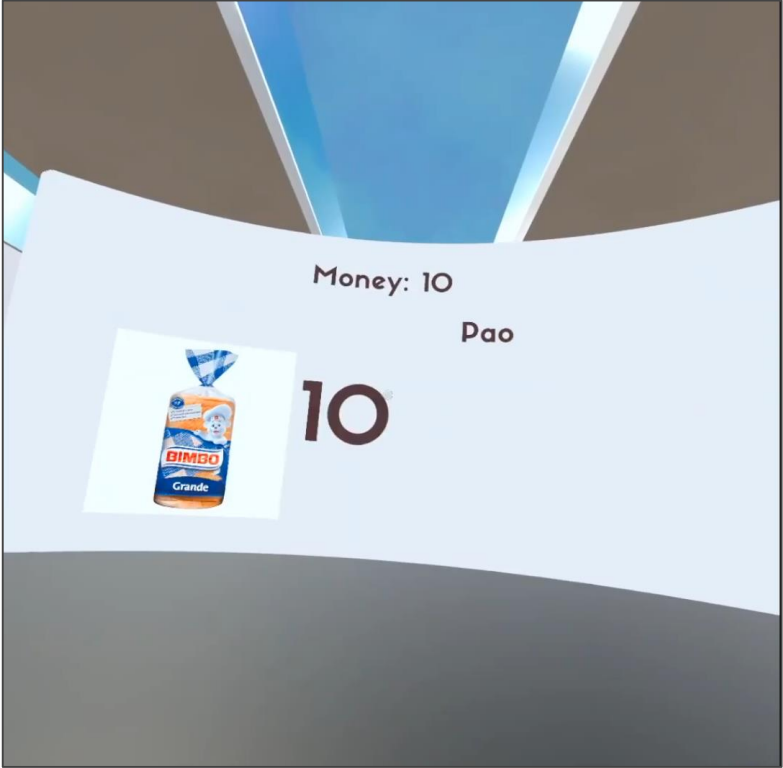
Conceptualization



Supermarket using VR



Supermarket using VR



Assessment at Academic Events



Assessment at GAM Aveiro



Assessment at the Rehabilitation Center



Assessment at the Rehabilitation Center



Assessment at the Rehabilitation Center





Subsequent

Improvements

Payment options



Payment options



Payment options

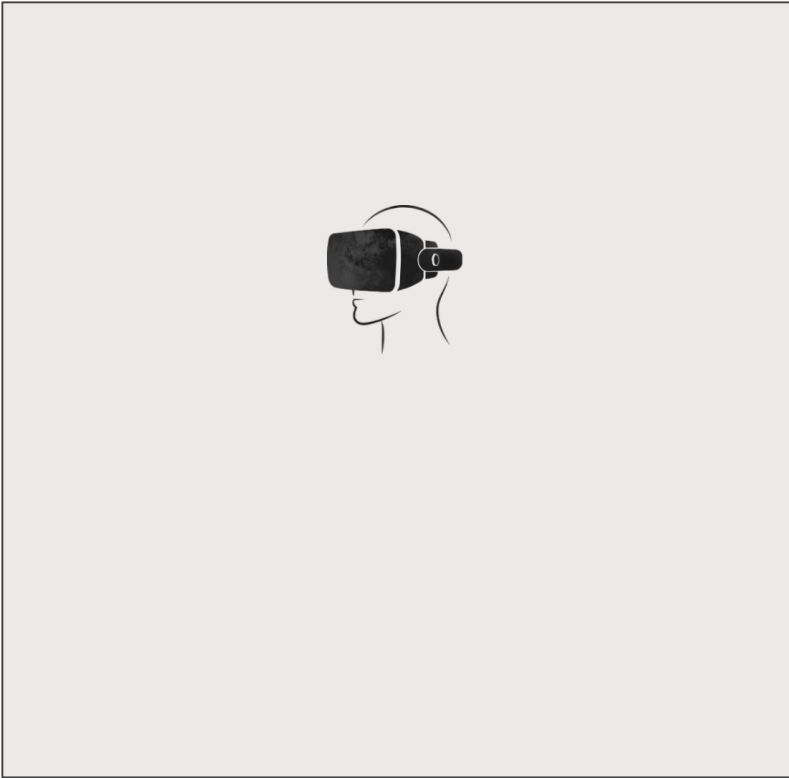


Withdraw money

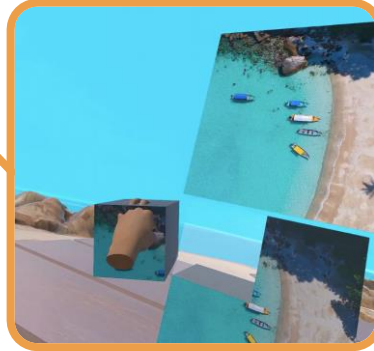


- These features avoid unnecessary travel to the closest ATM;
- It also frees occupational therapists from having to accompany Survivors to the ATM;
- Provide scenarios that are not physical available at the rehabilitation center;
- Allows trial an error as many times as necessary in a safe environment.

Other games – towards personalization



Comparison - Mirror Approach





Collaborative VR

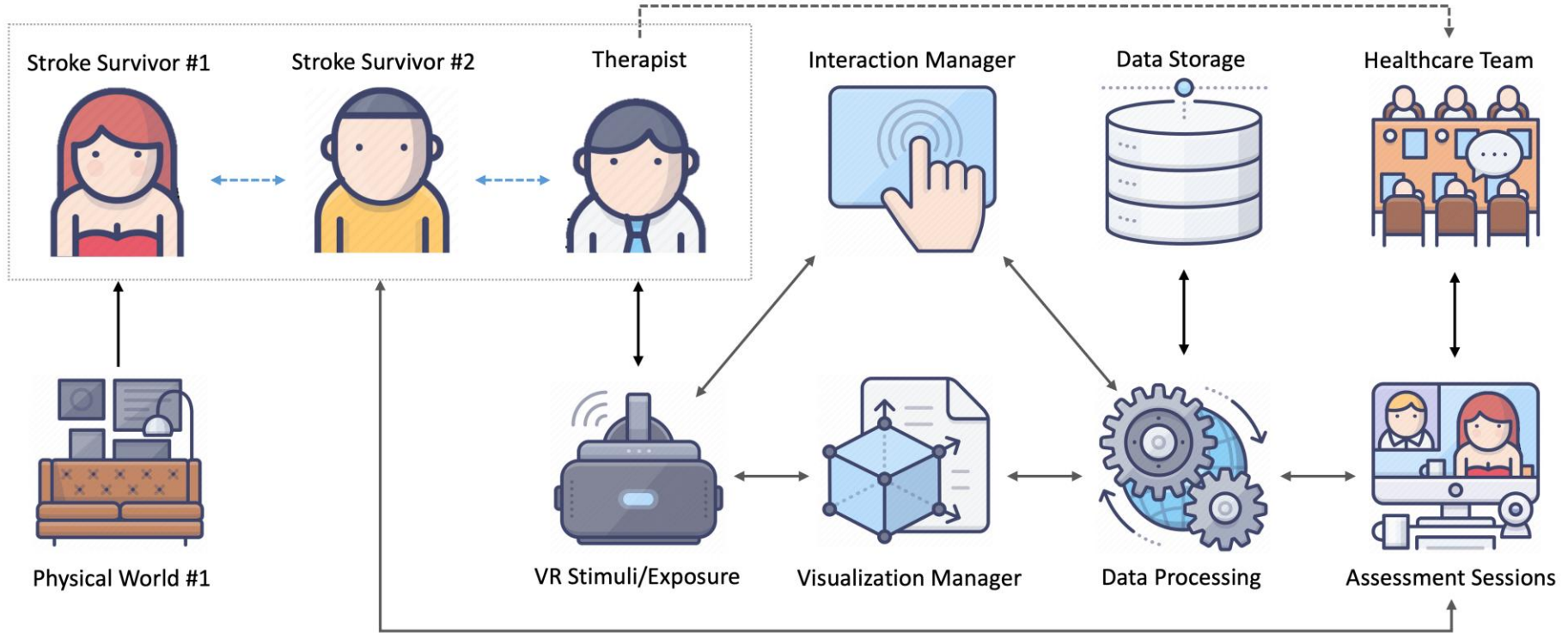
Experiences

Why collaboration?

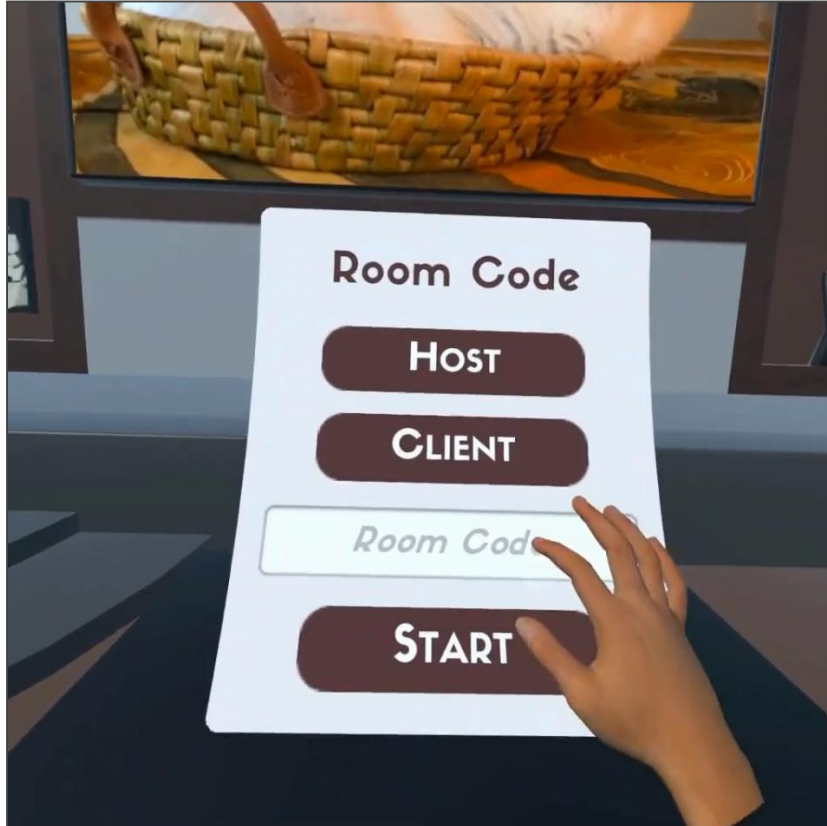
- Combine physical and cognitive rehabilitation;
- Provide a competitive nature;
- Enhance motivation and engagement;
- Boost connection with other individuals;
- May be experienced with family members – at home.



Framework Overview



Moving into collaborative settings



Moving into collaborative settings



Including the Therapist Team



Concluding Remarks

Final Remarks

- VR popularity has risen in the past few years;
- Technology is becoming more mature - hardware prices and availability enhance adoption;
- Several areas of application can benefit from these technologies;
- In rehabilitation, VR shows promising results;
- There is still much research to be made before these become commonplace.



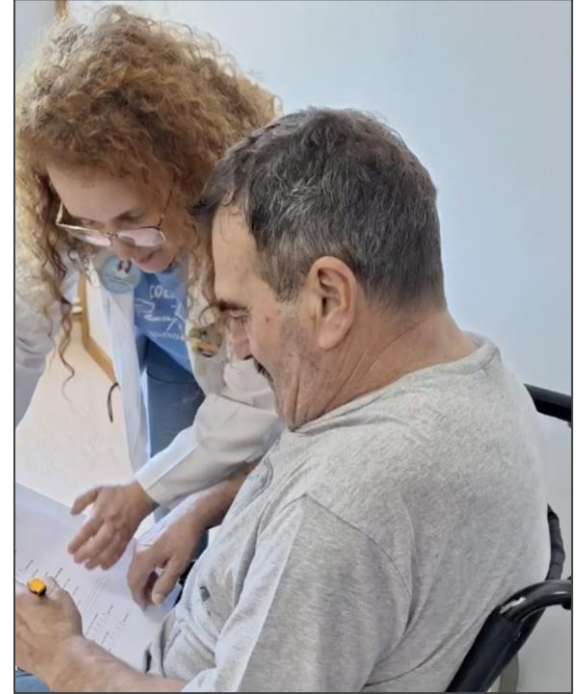
Why use VR and Serious Games?

- Immersive interactive and insightful contexts;
- Relatable tasks - multiple models & experiences;
- Individual & Collaborative features;
- Multiple benefits:
 - Increases coordination;
 - Helps increase mobility;
 - Facilitates communication.



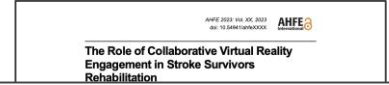
Future Work

- Maintain connection with Rovisco Pais, Portugal AVC and GAM Aveiro;
- Integrate automatic game personalization – Artificial Intelligence;
- Continue to explore collaborative (and remote) scenarios;
- Improve data collection and analysis for the Therapist team;
- Start exploring ‘rehabilitation at home’;
- Obtain financial support for conducting a research project.



Contributions

- Various small-scale prototypes in Virtual and Augmented Reality Course;
 - 4 Master Degree Dissertations (1 ERASMUS Student);
 - 1 ongoing PhD recently starting;
 - 1 PhD to start next year.
-
- Various publications in international conferences and journals;
 - Honorable Mention – Prize for Social and Human Sciences;
 - Impact in society - Big smile in most Stroke Survivors.



Distinções

Sérgio Oliveira recebe menção honrosa em Prémio para as Ciências Sociais e Humanas

21 dezembro 2023



A dissertação de Sérgio Oliveira, desenvolvida no âmbito do mestrado em Desenvolvimento de Jogos Digitais (MDJD) da Universidade de Aveiro (UA), mereceu uma menção honrosa no âmbito do Prémio para as Ciências Sociais e Humanas 2023 atribuído pelo Instituto Nacional de Reabilitação.



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The End



“Surround yourself with people who challenge you, teach you, and push you to be your best”

Discussion session



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