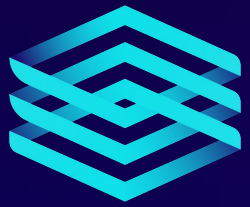
EXO-AI

Redefining Physiotherapy

INNOLYMPICS

Team Poggers


Reinforcement learning for customized routines and recommendations



Exoskeleton AI-Enabled Physiotherapy

INNOLYMPICS

Team Poggers

27 March 2021

Team Poggers

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Problem Statement

Physiotherapy is recommended for many injured athletes and military personnel by their doctors. However, it has low attendance and recovery rates, due to many reasons like cost and effectiveness of their treatments.

How can we aim to improve the recovery rate for injured patients while increasing retention rates for physiotherapy?

Joey’s Experience

You Sheng's Experience

Table of Content

Limitations of Physiotherapists

Solution

Low frequency

Once per month sessions due to limited physiotherapists and clinics

Short duration

30 mins per session, may not be sufficient to run through all the exercises

Inflexible scheduling

Typically during working hours & subjected to tight schedules of physiotherapists

Our Solution

Solution

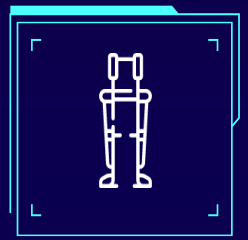
EXO-AI

Exoskeleton AI-Enabled Physiotherapy

Using AI-enabled systems, integrated with Smart Mirror technology and Exoskeleton Robotics capabilities, we aim for remote physiotherapy sessions to be more convenient and effective for patients. **EXO-AI** can be placed at any military medical center or hospital, allowing for remote and flexible physiotherapy while promoting recovery at a faster and more flexible pace.

Our Solution

Solution



EXO-S
EXOSKELETON

Wearable robotics to accurately evaluate form and guide users in form correction performing physical therapy

EXO-M
SMART MIRROR

Interactive user interface to visually provide users with comprehensive and immediate feedback

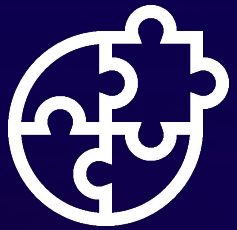
Overview of EXO-S Exoskeleton

EXO-S

IOT-actuated wearable robotic exoskeleton

Active posture repositioning via physical pressure

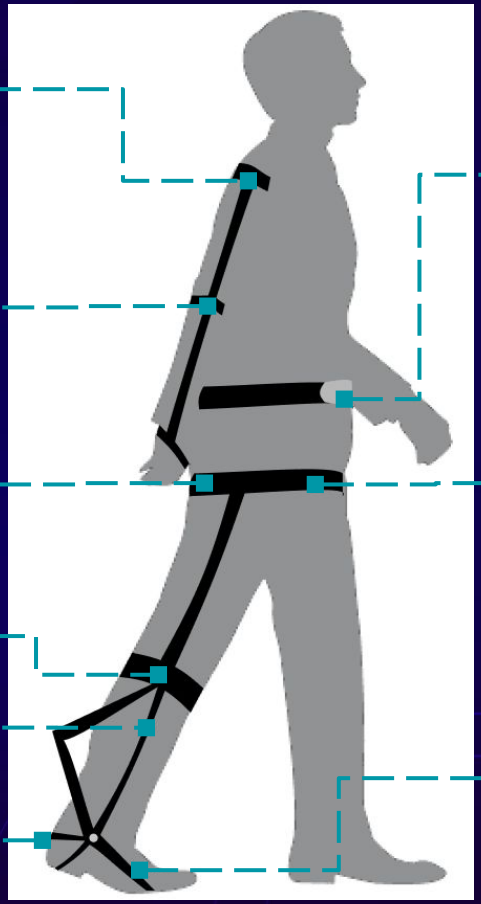
Gait training and mobility via powered motion



Synergized and integrated with EXO-Mirror

Blueprint of EXO-S Exoskeleton

EXO-S



Shoulder goniometer and actuator

Arm attachment

Sciatica goniometer and actuator

Knee goniometer and actuator

Shank attachment

Ankle goniometer

Control buttons:
- *Power button*
- *Bluetooth connection*

Anterior hip goniometer

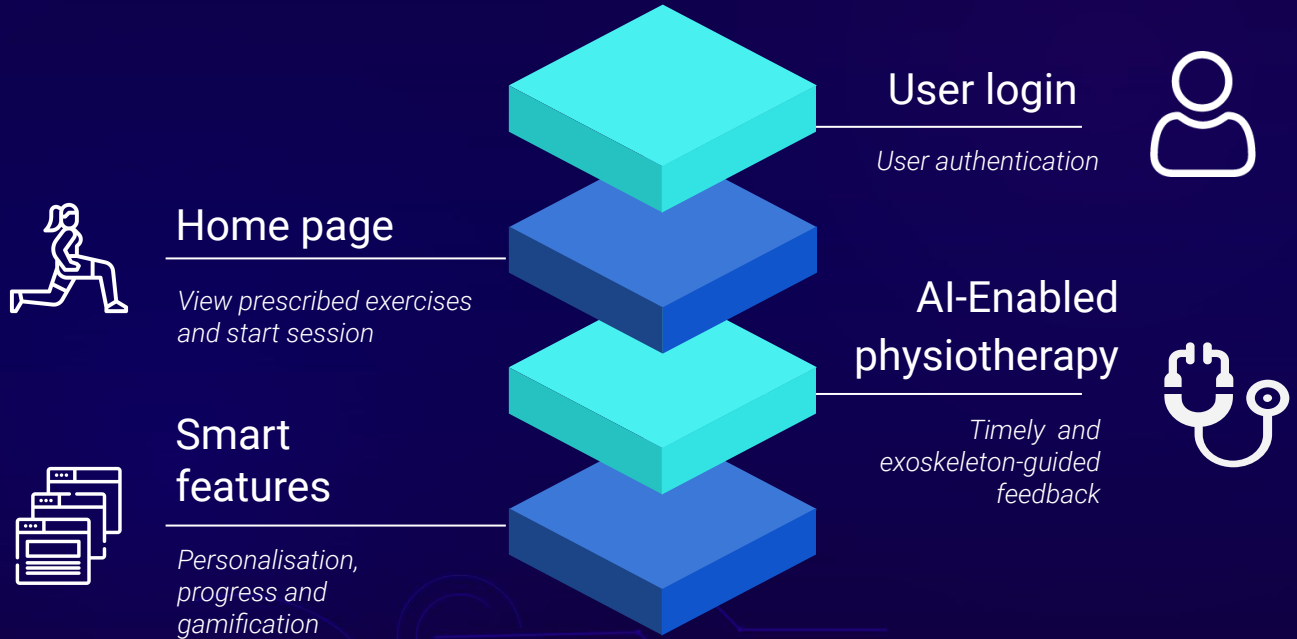
Foot attachment

Goniometer: To measure angles and rotate body parts to a precise angular position. Useful for pose estimation and mobility.

Actuator: Applies slight pressure to specific joints to correct posture. Pressure values to be applied will be based on reinforcement learning AI techniques to gradually improve the user's form.

Overview of EXO-M Smart Mirror

EXO-M



User login

User authentication

Home page

View prescribed exercises and start session

AI-Enabled physiotherapy

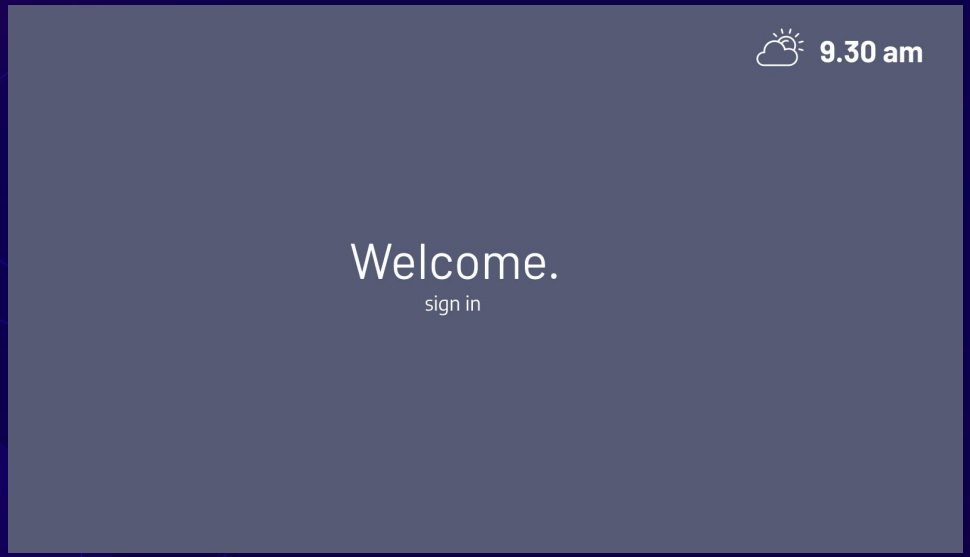
Timely and exoskeleton-guided feedback

Smart features

Personalisation, progress and gamification

User Login

EXO-M
User login



User Authentication

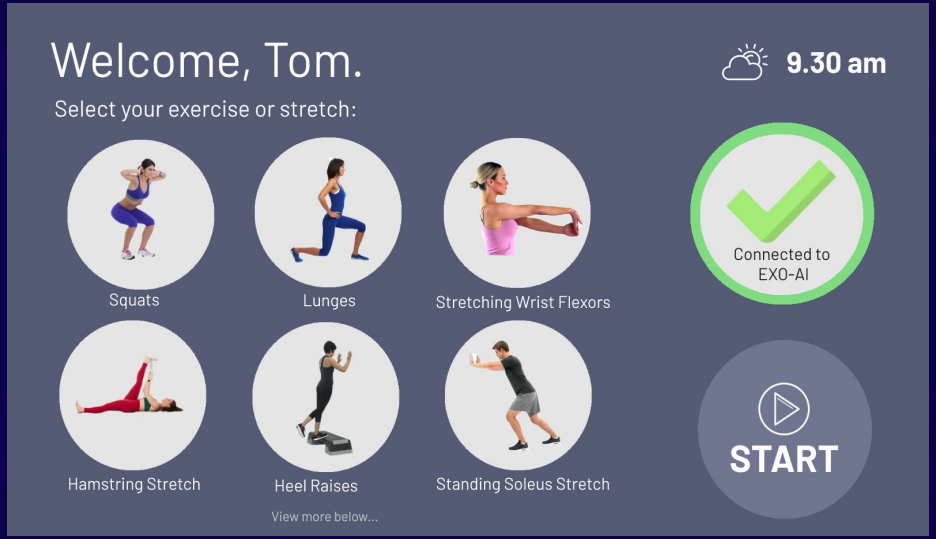
User is able to log into the system using various methods such as using the fingerprint scanner found on the wearable exoskeleton and facial recognition technology and camera of the mirror

Home Page

EXO-M
Home page

Prescribed exercises

Latest list of exercises as prescribed by the physiotherapist.



Connection Status

Wireless 5-GHz connection with exoskeleton, which will auto-calibrate to user's body fit on connection.

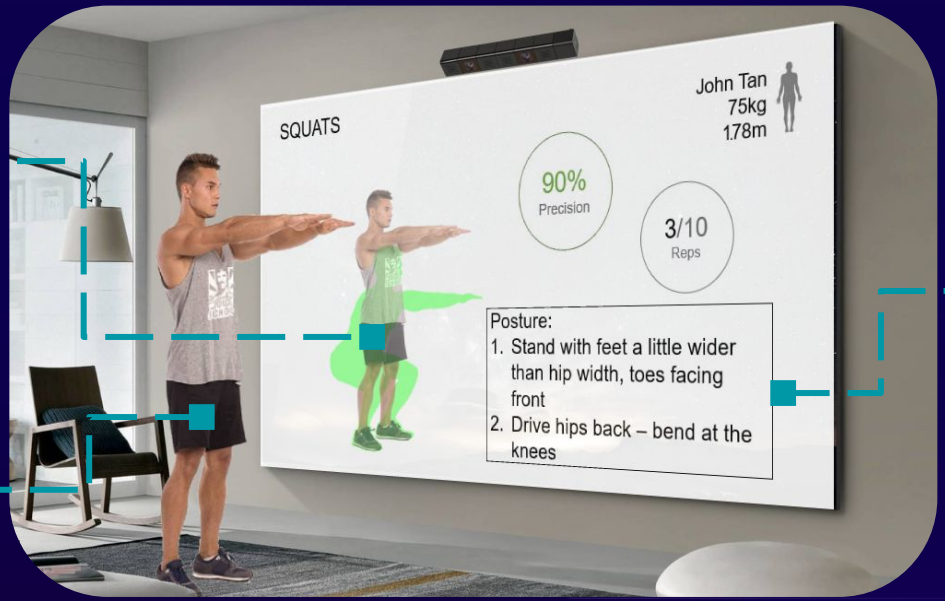
AI-Enabled Physiotherapy

EXO-M
Physiotherapy

Intuitive usage of mirror

Correct demonstration displayed in green

User to complete actions by matching his form using his mirror image to the demo display



Clear instructions of exercises given

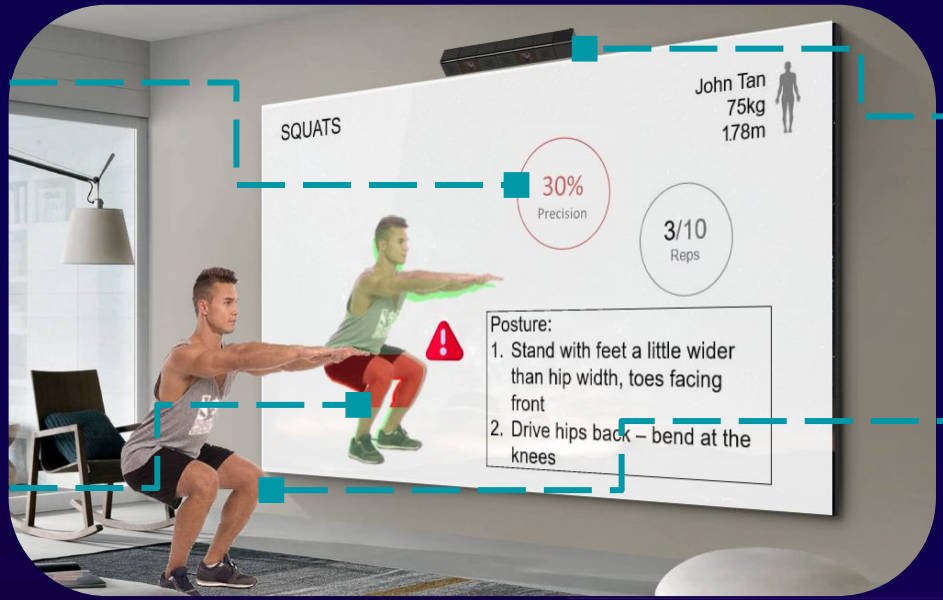
AI-Enabled Physiotherapy

EXO-M
Physiotherapy

Immediate & accurate feedback

Highly accurate form evaluation through exoskeleton sensors

Red zones in demonstration to highlight area where the user's posture is undesirable



Camera records sessions for review by physiotherapists

Pose estimation AI technologies (e.g. OpenPose) compares demo and user and performs form correction

Overview of Smart Features

EXO-M
Features

1. Personalised Exercise Plan

2. Progress/ Analysis Report

3. Augmented Reality Gamification

Personalised Exercise Plan

PROBLEM

Exercises assigned to the user are **not ideal** for their **current level** or progress.

EXO-M
Features: Personalised Plan

SOLUTION

Personalised Exercise Plan
Customised for the user using **machine learning** based on past records and analysis of their data.

Personalised Exercise Plan

Input

Progress

Medical History

User's Details

Use **Machine Learning** to craft an exercise plan **customised** to the user.

Output

10x

Number of Repetitions

Type of Exercise

Difficulty of Exercise

Personalised Routine

Progress/Analysis Report

EXO-M
Features: Progress/Analysis Report

PROBLEM

Users are often **unaware of their progress** in treatment and can only find out by asking their physiotherapists

SOLUTION

Progress/Analysis Reports
Use easily accessible and comprehensive visualisations to show user's progress in treatment

Progress/Analysis Report

PROGRESS REPORT

User will be provided a **time-based progress visualisation** of their improvement. This allows them to keep track of their progress over time which provides a sense of **positive feedback**.

IN-DEPTH REPORT

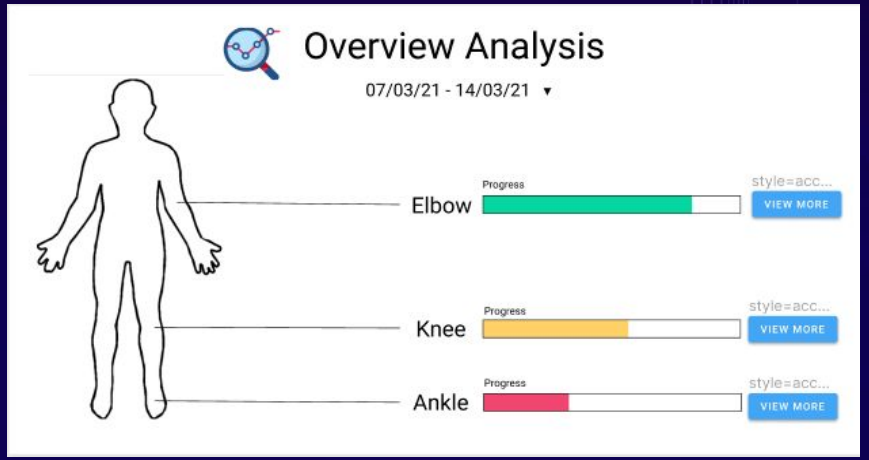
User will be presented with a recap of specific exercise session with regards to **certain metrics** such as *positional accuracy* or *speed of repetitions*.

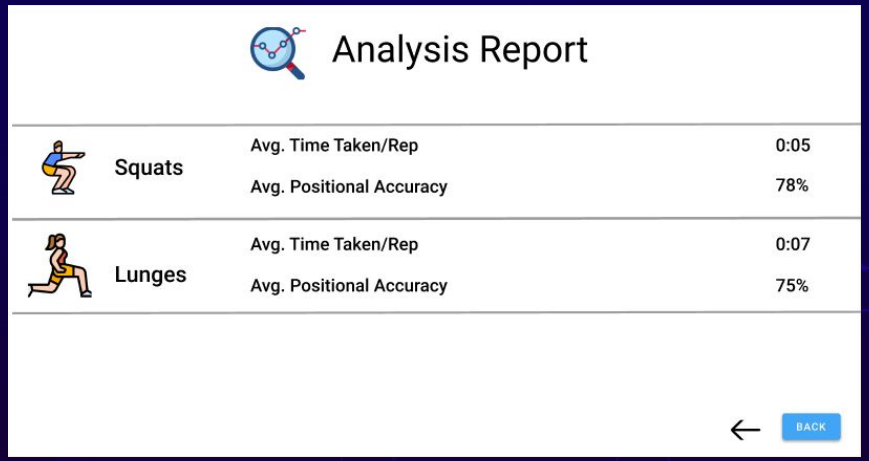
They will also be able to view their performance during their exercise session via a **video playback** (provided by the camera).

Progress/Analysis Report

PROGRESS OVERVIEW

Physiotherapist will get an overview of the extent to which the patient have **recovered motor functions**. This allows the physiotherapist to tweak and adjust the exercises based on the patient's mobility to **prevent overuse or overstrain of** the affected muscle groups or even to **speed up the recovery process**.





EXERCISE SESSION REVIEW

Physiotherapist are able to **analyse progress** of patients by inputting metrics such as *positional accuracy* into a machine learning model. This also allows them to give **more accurate feedback** to the patient in terms of their form to prevent the injury from aggravating.

Augmented Reality Gamification

PROBLEM

Rehabilitation exercises are often **repetitive** and **mundane**, hence patients are **not motivated** to perform them regularly on their own, **impeding** their recovery rate

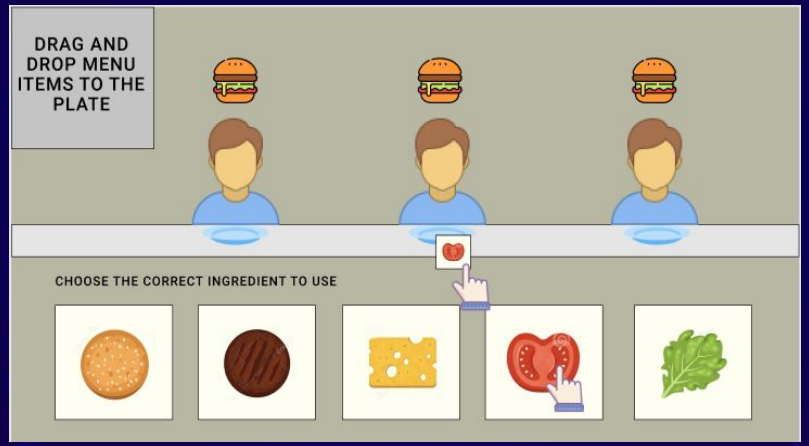
EXO-M
Features:
Gamification

SOLUTION

Augmented Reality-Based Gamification

Simulate everyday items into a virtual environment for the user to interact with in a fun and enjoyable manner.

Augmented Reality Gamification



AUGMENTED REALITY

AR Markers are placed on physical objects to represent ingredients. This enables the user to handle a realistic weight. We use AR to be able to represent objects in a virtual environment with a different appearance.

GAMIFICATION

This gamifies the exercise. An example of a game would be to move ingredients to create a meal for customers.

User Journey

User journey

STEP 1

User schedules free slots with EXO-AI, at any location.

Flexible in regards to the amount of time they can spend per day on EXO-AI

STEP 2

Physiotherapist will pre-plan exercise routine depending on user's specific requirements (E.g. recovery for military activity).

Can be done before the user's timeslot, or in real-time

User Journey

User journey

STEP 3

Putting on EXO-S and activating EXO-M, user can access the step-by-step routine, with visual demos shown on EXO-M and active physical corrective action by EXO-S

STEP 4

EXO-M will record the participant's treatment, which can be viewed by the physiotherapist at another time or location.

Provides in-depth analysis of posture better feedback for recovery.

Competitive Matrix

Business Value

EXO-AI Strengths

Flexible Schedule

Exoskeleton-only companies have very specific time slots and locations, resulting in lower flexibility in schedule while we aim to achieve **high flexibility in schedule** by providing more time slots and locations.

Exercise Variety

Physiotherapists are able to **customise** each routine to every patient to their needs, which is not possible with traditional exoskeleton-only companies, as their exoskeletons only cater to a few specific movements (e.g. Walking). Preventing future repeat injuries requires **posture/form correction** on the more advanced exercises which can be achieved with EXO-AI to **further improve recovery rates** in the long run.

Business Value

Musculoskeletal Disorders (MSDs) in the Military

Business Value

65% **Of all soldiers**

70% **Overuse / Poor Form**

44% Of all **permanent disability compensation**

Overuse injuries, like stress fractures, can be **prevented** in future injuries with **proper form, technique and exercise**.

https://academic.oup.com/milmed/article/185/9-10/e1461/5805225

Patient Care Cost per year in the U.S. Military

Business Value

$434 Million

https://academic.oup.com/milmed/article/185/9-10/e1461/5805225

Business Value

Business Value

Amount Spent Per Year On Recovery Treatments For Military Personnel In The U.S.

$ 434,000,000 / Year

Average Spending Per Customer On Traditional Physiotherapy

$85 - $320 / Session

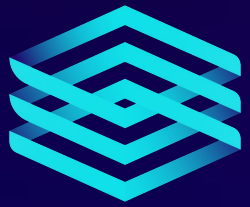
Total Spending Per Customer On Traditional Physiotherapy

$680 - $2560 / Injury

*8 Sessions Average per injury

80/20

Over the course of 2 months for injury recovery, there is an average of 8 visits to a physiotherapist and 2 visits to a medical doctor, making physiotherapy a **larger medical expense** as compared to doctor consultations.



EXO-AI

Redefining Physiotherapy

THANK YOU

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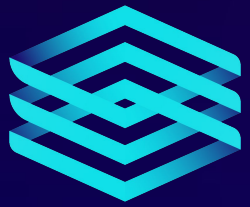
A peer-reviewed **statistical explanation** on YS’s attractiveness

= Poggers?



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