FlexFun Design Report

A rehabilitation platform allow patients doing game-based exercise at home

1. Problem Statement

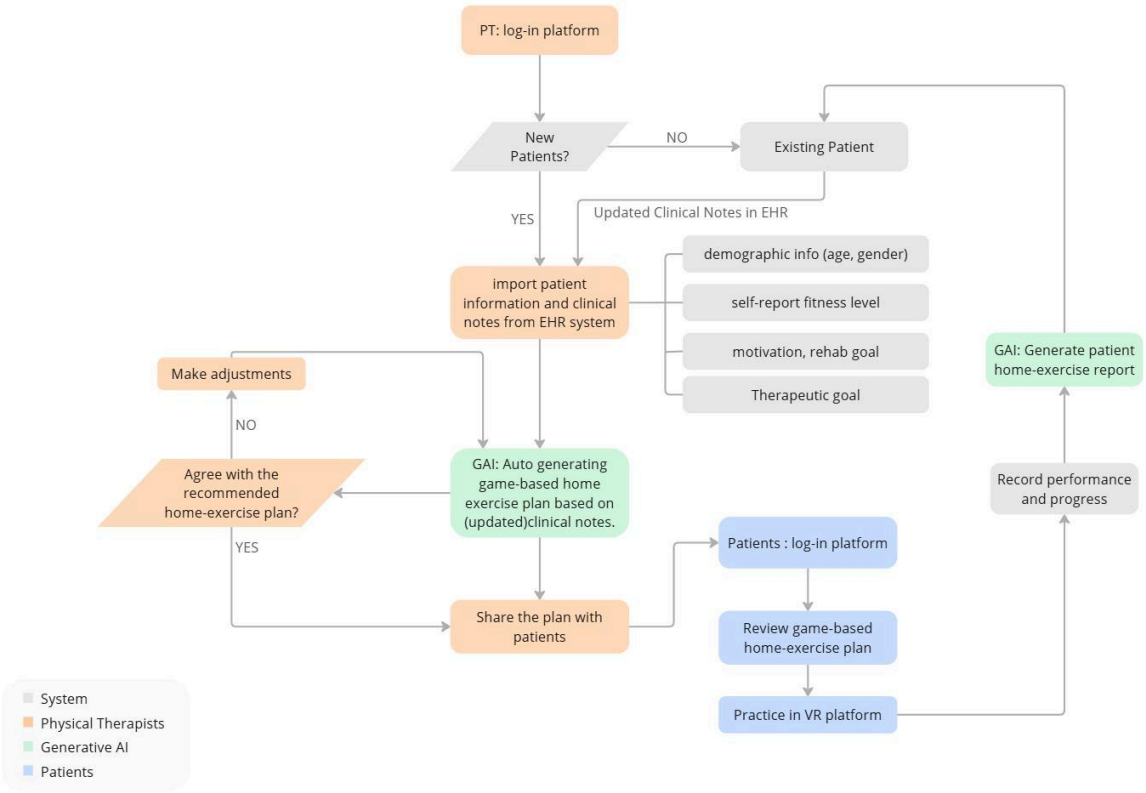
The effectiveness of rehabilitation outcomes significantly depends on patients' adherence to prescribed out-of-session exercises, such as home exercises. However, physical therapists burning out and PT shortage are not uncommon which leads to limited attention and guidance to give to both in-patients and out-patients once they are out of the sessions. Patients often need help to maintain motivation for completing prescribed exercises alone due to the absence of structured guidance, interactive support, and environmental constraints. Addressing these challenges is crucial for enhancing patient engagement and improving rehabilitation success.

2. Solution

To create a gamified home exercise platform combined with GAI to auto generate customized home exercise plans and rehabilitation games for patients based on clinicians' notes. In this way, I expect this platform can accelerate physical therapists' workflow in putting together the home-exercises that are tailored to patients and it gives physical therapists access to monitor patients' home exercise progress when out of the clinics. For patients, the gamified rehabilitation exercises are tailored to the patient's goals and interests, with the interactions and feedback from the game, all together may enhance their motivation for completing the exercises at home.

3. Platform Workflow

User Flow



3.1 Where does AI kick in Generative AI

- Auto-generate game tasks and environments
- Auto-generate rehabilitation exercise plan

4. Design Validation

4.1 Stakeholder Interview

In my initial stakeholder interview, I invited four stakeholders to join in a semi-structured in-depth interview with me separately. The interviews were conducted on Zoom, and for each interview was at least 60 mins (60 ~ 120 mins). Here are a brief background about each interviewee:

- Dr. Liu
    - Dr. Liu is a licensed physician and specializes in neurological disorders with over 15+ years of experience in China.

- Kate
    - Kate is a college senior majoring in physical therapy in the United States. She has over 50 hours in out-patient clinic practice, and she has injured twice within the last five years and ended up in 1.5 years of rehabilitation as an outpatient.
- Tong:
    - Tong is a PhD student in the Boston area, and she had a knee injury due to indoor climbing back in 2023. Tong is still actively visiting physical therapy clinics and it has been overall half of the year already.
- Grace:
    - Grace is a DPT with over 1000 hours practice in out-patient clinics, in-patient hospitals, and home programs in the United States. She is working in an outpatient clinic in Virginia.

4.2 Interview Process

There are two main goals for conducting the interview. First, I want to know what are the main challenges or problems in the rehabilitation process from both clinicians' and patients' perspectives. Second, I want to know how likely the solution (demo) I proposed could solve the challenges they mentioned. Thus, the interview process is divided into three parts:

- Part.1: Semi-structured interview (45-60 minutes)
- Part.2: Demo display (10-15 minutes)
- Part.3: Receiving feedback (20-30 minutes)

Notes: Because Dr. Liu was interviewed before the demo was developed I only had a semi-structured interview with Dr. Liu to ask about the main challenges and overall diagnosis and treatment plan process in clinics.

Depending on the role (Patient or Clinician), two different interview questionnaire sets were delivered accordingly. Because Kate is a PT and a patient, I asked about both her experiences as a PT and her experience in the rehabilitation process.

Table.1 A summary of the semi-structured interview questionnaires

#	Interview Questions for Clinicians	Interview Questions for Patients

Q1	Can you walk me through the process of prescribing exercises to a patient when they first visit?	Can you tell me about your overall physical therapy experience? - If you don't mind me asking, what was the diagnosis you got?
Q2	What factors do you consider when determining the appropriate home exercise regimen for a patient?	What specific exercises are you required to perform as part of your physical therapy routine?
Q3	Do you ensure that the home exercises prescribed align with the patient's specific needs and goals?	Can you walk me through a typical physical therapy session at home?
Q4	Do you use any tools or resources to demonstrate and explain the prescribed exercises to the patient?	How often do you perform your prescribed exercises at home, and for how long each session?
Q5	Have you observed any patterns or trends in patient compliance with their home exercise programs? If yes, what are they?	What strategies do you use to stay motivated and consistent with your home exercise routine?
Q6	How do you assess and monitor a patient's progress with their home exercises during follow-up visits?	Have you encountered any difficulties or challenges while performing your exercises at home? If so, can you describe them?
Q7	Have you encountered any common challenges or difficulties in prescribing home exercises to patients? If so, can you elaborate on them?	How do you track your progress with your home exercises?
Q8	How do you adapt or modify home exercise programs based on a patient's progress, feedback, or changing needs?	Do you use any tools or equipment to assist you with your exercises at home? If yes, which ones?
Q9	Have you encountered any barriers or limitations in implementing home exercise programs for certain patient populations? If so, how do you address them?	Do you feel confident in performing your exercises correctly at home, or do you have concerns about your technique?
Q10	What additional resources or support do you believe would enhance the effectiveness of home exercise programs for patients?	Have you received guidance and instructions from your healthcare provider on how to perform your exercises correctly at home?
Q11		Do you have any suggestions for improving the effectiveness or convenience of your home physical therapy exercises?

Q12		How do you feel about the level of support you receive from your healthcare provider or therapist regarding your home exercise program?

Here is a summary of the interview questions and because it is semi-structured, this questionnaire is only used as a start point and I always add follow-up questions based on the flow of the conversation.

4.3 Interview Insights

4.3.1 Poor Adherence in Home Exercise Program (HEP)

Physical therapists commonly agree that home exercise is important for optimized rehabilitation outcomes, and patients who complete home exercise are more likely to recover sooner. However, PTs also mentioned that most of their patients do not complete the home exercise because of lacking motivation, and this is consistent with patients' reports, all patients shared that they were less motivated to complete their home exercise. The main reasons include feeling bored with repetitive movements and lack of instruction and guidance. Here are some quotes from clinicians and patients:

4.3.2 Environment Limitation in HEP

Besides motivation, the physical space constraints and lack of equipment were also mentioned by physician therapists and patients. For special senior patients, physical therapists need to go to their residential place to deliver the exercise treatments and a lot of time, there is very limited space for patients to practice at home, and the therapist has to use whatever they have. One patient also mentioned that she was living in a college dorm, which limited the movements she could do.

4.3.3 Personal Interests and Goals are Tie to the Motivation of Doing HEP

One patient mentioned the movements that related to her athletic goal (e.g. going back to skiing and climbing) motivated her more to finish the home exercise. One PT also mentioned that she will add or create new movements or adjust the existing movements that are related to what patients want to motivate them to finish the training.

4.3.4 Feedback on Demo

Patients Feedback

- All patients like the idea of turning rehabilitation movements into a mixed-reality game and they think it is going to help with the motivation.
- They like the auto-generated planning that turns daily rehabilitation tasks into daily game missions. As they mentioned, one of the things they wished to have in their previous home rehabilitation process was to have a reminder or planner to remind them of their daily tasks
- One patient specifically likes the idea of creating themes and game tasks that are relevant to her athletic goal (e.g. practicing upper body movements in a mountain climbing theme.)

Clinicians Feedback

- Clinicians' concerns were about how much extra work they have to do in order to use the platform, thus, clinicians generally like the functions of auto-generating rehabilitation games that are relevant to the patient's therapeutic and personal goals based on the existing clinical notes.
- Additional suggestions are to add patient interest sessions in the new patient form and update the recommendation of the rehabilitation game based on updated clinical notes after the patient revisit.
- They like to have a performance report to monitor patients' processes, this can include time, completion, speed, rotation, accuracy etc.
- Suggested to have the option to adopt the game background since there are senior patients or people with vision impairment who could have a harder time concentrating on main objects from complex backgrounds.
- One clinician raised questions about how to keep the hardware safe (i.ka, VR headset) and suggested home-based rehabilitation programs (e.g. therapists go to patients' homes) and in-patient hospitals are better user scenarios.

5. Iterative Design

Based on the interview with stakeholders, the main changes I made include:

1. Add the function of updating clinical notes from the EHR system since PTs take new notes every time a patient revisit
2. Add input session for putting patients' interests and personal goals since those are related to making a home-exercise plan that is customized to patients
3. Generate a short report that includes patients' home exercise performance.

6. Challenges and Limitations

- **Easy access for senior patients.** As I am interviewing the physical therapist, the challenge includes that even VR headset seems to work well in in-patient hospital settings, but most of the in-patients are seniors with neurological disorders, and assisting patients to use the VR headset by themselves can be challenging. An on-site instruction and easy-to-follow tutorial should always be available for that population. The onsite assistance needs to coordinate with rehabilitation facilities, but the later suggestion can be made in the platform design and should be tested on senior patients.
- **Match the right level to the patients' current ability.** Physical therapists used to start the tasks from easiest and gradually become harder. How to make sure the recommended game is customized to people's current ability needs further discussion and this probably requires an accurate calibration system that allows dynamic adjustment as patients make progress.
- **Technical limitation in tracking lower body movements.** While all XR headsets with upper body tracking and hand control with accelerators to track participants' upper body movements and heights, the lower body tracking is limited. However, additional sensors can be attached to patients' lower bodies but with additional costs and the accuracy should be tested.