

Virtual Reality (VR) Technology in Physiotherapy

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Abstract- Purpose: This paper proposes a system that offers customized, immersive, virtual reality-based, full-body physical therapy and reports the progress of the patient with virtual therapy sessions. **Method:** The program uses the complete inverse kinematic technology to instantly track the upper limb motion. It enables the physiologists to manage a user's implementation and separately note down the progress according to the extent of motion, pace, and span. A connection between the program and the guru is reported. Exercises considered too energizing or too trouble-free were not considered more exciting, indicating for exercises to be individually monitored. Results show that people enjoy these immersive virtual sessions of therapy more than the real world therapy. **Conclusion:** Considering the data, it is safe to broaden the journal concerning the participants and to detect a standing and feasible study. So, VR has the potential to vary much of the planet around us, and mostly for the higher. While writing, we're within the middle of the COVID-19 pandemic. Imagine the advantages that VR would wear people's psychological state immediately while maintaining social distancing. Testing will help us to understand the level of difficulty a patient faces while doing the exercises.

Keywords — Animation technology, Inverse Kinematics, Oculus Quest 4, Three-dimensional visualization, Unreal Engine 4, VirtualReality;

I. INTRODUCTION

In traditional physiotherapy, different processes are involved: physical checking, rating, assessment, therapeutic mediation, monitoring, and changes in the therapy plan steady with patient betterment. This process is rigorous, cumbersome, hooked into the hands of the doctors, and implicates the involvement of the user who is asked to execute the treatment numerous times without any supervision.

Our solution provides physiologists to create postures and thus personalize the same as per the patient's needs. Libraries of movements are often created for effective use in new methods of healing. Therapy treatment programs are often demonstrated by a virtual figure illustrating exercises gradually, including monitoring patients' performance. Tracking the VR movements helps improve patient grasping and compliance and provides data accumulations. The sessions can be played in different environments making it alluring for the patient and improves user engagement by providing a better graphical understanding and analysis of the movements. The interaction of the application is fully immersive; thanks to Oculus Quest for captivating Virtual Reality exposure.

II. KEY BENEFITS OF VR PHYSIOTHERAPY FOR PATIENTS

Customizable: The VR Physical Therapy platform is highly tailored for each patient. It can be re-programmed as per the customers' needs and enables them to set a manual goal and personalize the exercises.

Multitasking: Patients are capable of listening to music or radio while exercising using an integrated world inside a VR at the same time. The VR system will multitask by itself and alert them about what's next.

Reminders: VR is capable of sending reminders to a patient's device when it's time for rehabilitation exercise. This way, the patient feels independent, as well as the therapist gets time to utilize and care for a lot more patients at the same time.

Trackers: VR automatically tracks the progress of the patient. It also sends messages stating all the necessary information that is necessary for further analysis. The doctor can use this data to keep track of the progress and evaluate the next step of the patient's recovery with ease.

Portability: Neither user has to go to the hospital nor the doctor needs to set up regular meets. All the check-ups, exercising, and reconstruction processes can be seen with a VR headset straight from home.

Easy To Use: As there is an in-game guide, the user does not face any difficulty while using the application. The guide shows the demo on how to perform the exercise

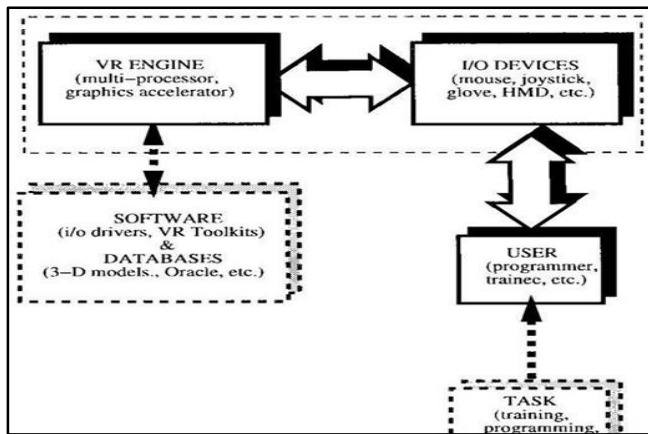


FIG.1. The Structure Of VR System.

III. VR APPLICATION IN PHYSIOTHERAPY

During the difficult time of the pandemic, people are supposed to maintain social distance and avoid being out. Hence, physiotherapy sessions are also out of the scope during such times. VR is the go-to solution during such a crisis. Our solution helps patients to perform physio exercises in a virtual environment. VR applications currently available for physiotherapy don't track the entire body. But our project overcomes that barrier. Immersive Virtual Exercising and Monitoring for better graphics and understanding of the performance of a patient. VR uses an incontinent low-cost data ; patients can indulge themselves in rigorous therapies with an application that tracks hands, fingers and body movements.

IV. GENERAL WORKING

The user wears the Oculus headset and launches the application, where the user specifies its Height and. Users can choose different types of therapy they have to perform and get trained from Guru. Users can choose Different levels from the theme (eg - earth, water, etc). After performing the exercises the user will be provided with analytics and reports.

V. FEATURES

- 1 Different Elemental Level
2. Guru to train the patient
3. Different Poses for patient
4. Reports and analytics of Exercise
5. Task and schedule

VI. PROPOSED SYSTEM

We have used the concept of a reality show called 'Hole in the wall' where the contestants have to evade the incoming wall by posing as the hole in it. Our project does the same thing but in VR. The user uses the oculus quest as a VR device. Oculus Quest has three trackers(head and both arms). With these three trackers, only upper body movement was being tracked. So we used inverse kinematics to get the

approximate tracking of the lower body. Inverse kinematics helps us to track movement by using joints as a point of reference and getting the approximate output of the movement. So this helps us track the entire body which is unique about the project. The whole point of VR is to take the user into a virtual world. So we decided to create our virtual environments. This makes the boring physio session more interactive and more fun.

Our solution allows therapists to create and change exercises for specific patient needs. Libraries of exercises are often created for effective recovery of the patient. Therapy programs are often shown by a virtual character(in our case 'Guru') explaining exercises systematically and sequentially, including monitoring patient execution. Progress tracking improves patient understanding, motivation, and provides data. The sessions can be played in different environments making it exciting for the patient and enhances user engagement allowing a better user experience and analysis of motions of the patient. The interactions are also fully immersive; thanks to Oculus Quest for captivating Virtual Reality exposure. The user chose to enter a code instead of doing a manual setup. The context of the game is set as to how one is traveling to a different realm to master how to create the 4 elements as they have depleted on her planet. While traveling they meet their guru (simulated person) who knows how each exercise is to be carried out in different elements. So the environment will turn water-based and the guru will carry out exercises to perform in that element and so forth. Once the game starts the environments get flared up and keep switching after every 30 – 40 seconds and in that 30 seconds, the walls keep coming in front of you helping you to stay in the correct position and change direction whenever needed. The game is over and the user is standing in the middle of the four elements after achieving victory. The user gets a report.

The doctor gets a report. The report is generated based on the score obtained in the game. Based on the number of hits to the wall on each side, the report data is generated.

Stimulates patients' brains and makes them imagine as if they are literally present in that pretended world.

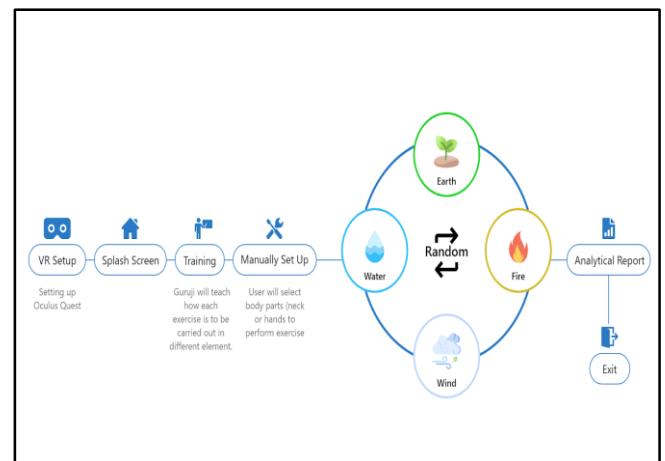


FIG.2. Proposed System Diagram

VII. METHODOLOGY

1:VR Setup: From the Unreal Engine Launcher, press the Launch button to open the Unreal Project Browser. From the New Project Categories section of the Unreal Project Browser, select Games, and click Next -One the Select Template page, choose Blank project and click Next

For Project Settings, choose:

Blueprint-Mobile / Tablet-Scalable 3D or 2D-No Starter Content

At the bottom of the screen:

- a. Set the folder location
- b. Set the project name

Press the Create Project button to create the project and load a blank project. Configure the Project for Oculus Development In this section, you will enable the Oculus plug in and modify some project settings to work with Oculus devices.: Select Edit > Plugins, choose the Virtual Reality section, and make sure that the OculusVR Plugin is enabled.

2: Training: As soon as the splash screen disappears, you will be able to notice a human avatar named Guru who would actually introduce the patient to the application. Here the patient will be given instructions as to how to move ahead in the application. The Guru will familiarize the user with exercises and how to attain that particular posture. To sum up, the user will be given a guide about the application and how to move ahead with the model.

3: Manual Set-Up: Here the user or the Physio can make the changes and program the application based on their need. The changes include : Speed , Exercises , Environment , Aiming for the targeted body part etc . After this the application will take the user into the Virtual Environment. This is where the actual exercise begins for the user. He/She has to train its body as per the wall coming towards them in the game. They are challenged because of vivid postures coming at them so they have to hold that specific position which helps them to workout without even noticing it.

To make it adventurous we have tried to indulge a real life natural surrounding to make it pleasing for the user during their workouts and not make it exhausting for them.

The different levels are the four realms of our world namely Earth, Water, Fire & Wind.

4: Analytic Report: This is the last step, once the patient is done working out, a direct report is printed and sent to the respective physio and the copy is even present in the application. The user can refer to it so as to check his/her improvement.

VIII. RESULT ANALYSIS

There are several VR applications existing in the medical sector. But none of them are much fun or they don't allow

full-body tracking with which full-body exercises can be enabled. PhysioVR uses Oculus Quest which has 3 motion sensors (head mount, left controller, and right controller) and with the use of Inverse Kinematics, we are able to track the lower body as well. This provides the user to perform full-body exercises that are possible for that particular user. Inverse Kinematics is used to create virtual bone joints between the upper and lower body. This is used to track the upper body movement of the user and tries to predict the lower body movements. Also, considering the current pandemic, people avoid going to the clinic and hence PhysioVR will help users to exercise in a fun way at home.

The following represents the working of our project:

1. The home page of the application.

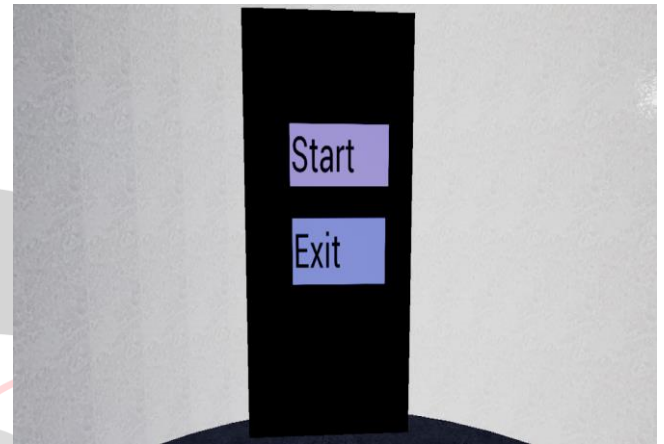


FIG.3. Fire Level Diagram

2. The user chooses to enter a code instead of doing a manual setup. (A manual setup will be where the person will be asked a few questions to set up the experience for them). The user will input the code or their option in the quiz.

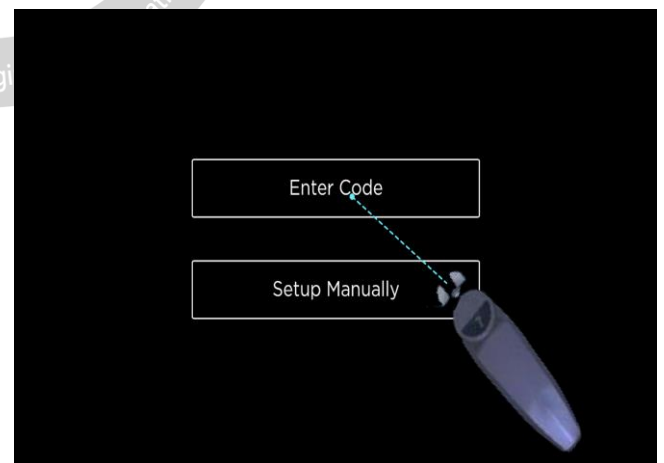


FIG.4. Log In Diagram

3. The context of the game is set as to how one is traveling to a different realm to master how to create the 4 elements as they have depleted on their planet. The main menu from where the user has to choose the realm is shown below:

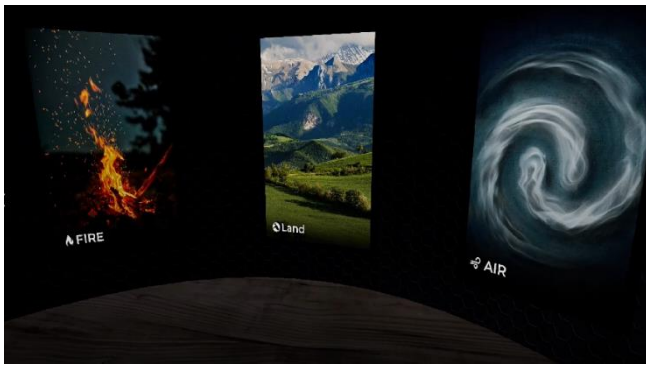


FIG..5.Main Menu Diagram

4. While traveling they meet their guru (simulated person) who knows how each exercise is to be carried out in different elements. So the environment will turn water-based and the guru will carry out exercises to perform in that element and so forth. The user has to follow the guru and perform all the exercises with her like training. Inside the spaceship, the guru trains the person to perform particular exercises and the inside of the spaceship gets simulated like it's filled with that element. If the user isn't doing it right the training will keep repeating that part



FIG.6. Fire Level Diagram

The four stages/ elemental level are:

1. FIRE

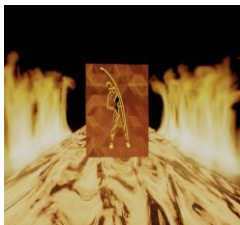

| Interactions | Animation | Storyboard |
|--|---|---|
| The user is supposed to do the exercises based on the environment around them and see to it that their posture aligns with the wall coming towards them. | The environment turns fiery and the wall which has fire comes towards the user. |  |
|  | | |

TABLE.1. Fire Realm Table

2. WATER

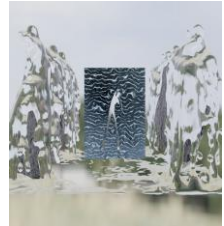

| Interactions | Animation | Storyboard |
|--|---|---|
| The user is supposed to do the exercises based on the environment around them and see to it that their posture aligns with the wall coming towards them. | The environment turns watery and watery walls start coming towards the user |  |
|  | | |

TABLE.2. Water Realm Table

3. AIR

| Interactions | Animation | Storyboard |
|--|---|------------|
| The user is supposed to do the exercises based on the environment around them and see to it that their posture aligns with the wall coming towards them. | The environment turns stormy and the wall which has fog comes towards the user. | |

TABLE.3. Air Realm Table

4. NATURE


| Interactions | Animation | Storyboard |
|--|--|---|
| The user is supposed to do the exercises based on the environment around them and see to it that their posture aligns with the wall coming towards them. | The environment turns like a forest and grassy walls start coming towards the user |  |

TABLE.4. Nature Realm Table

In the first stage, the client meets the project leader to set up the initial requirements of the application. The leader, as an expert in exercises, makes use of their experience to discuss and clarify some of the objectives, while the rest of them will need to be studied in depth.

Participants wore a VR headset, in which they saw an avatar standing approximately 3m in front of them. This distance was chosen as it was determined to be a suitable compromise

between the avatar being close enough to allow a clear view of avatar movements, but far enough away so that the whole avatar could be kept in view. The large field of view for the Head Mounted Display meant that the whole avatar, including the feet, would be visible to the participant at this distance.

Once the setup is done and the avatar is ready to begin the workout, slowly mounted walls start coming towards the avatar. The mounted walls move with the speed that is set by the patient. Sufficient amount of time needs to be taken by the user so that they can get into that posture. The user has to hold that position until the mounted wall is passed by their avatar in the VR environment. The postures change as per the body exercises chosen by the patient in the previous step. The surroundings also vary randomly.

The patient has to keep in mind that they need to restrict themselves from touching the walls. Whenever the avatar touches any edge of the wall, the avatar loses a point and it will be reflected on the analysis report. Based on the score the doctor can get an idea about the patient and their progress. This will help them to understand if any changes are required and what changes if any.

IX. SCENE

Once the game starts the environments get flared up and keep switching after every 30 – 40 seconds and in that 30 seconds, the walls keep coming in front of you helping you to stay in the correct position and change direction whenever needed. When the change in direction or position is there an intermediate pose can come from far away so the user can slowly first come to the center and then another actually changed pose can come so the user does jerk to change position and hurt themselves. The user is supposed to do the exercises based on the environment around them and see to it that their posture aligns with the wall coming towards them. The environment of the 4 elements keeps changing with the wall of that posture coming towards the user. If the posture doesn't match and they hit the wall then there is a crashing sound with a little movement in the camera.

Once the game is over and the user is standing in the middle of the four elements after achieving victory. The user gets a report.

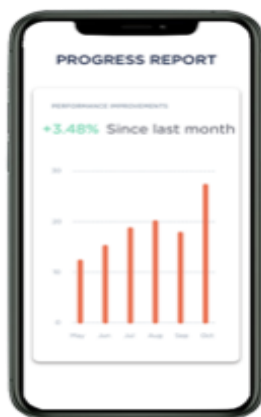


FIG.7. Progress Report Diagram

X. CONCLUSION

Therefore, the need for physiotherapy at home is necessary during times of pandemic. Adding to that, Interactive Physio sessions are what will keep the patient engaged in the sessions. Not only patients but also daily exercises can be done at home by using PhysioVR. PhysioVR uses Oculus Quest which has 3 motion sensors (head mount, left controller, and right controller) and with the use of Inverse Kinematics, we can track the lower body as well.

The current application will be used at Physio Clinics for testing and research purposes, after understanding the sustainability of the product it will be launched on Oculus Quest for a bigger user base. The application will have tutorials to guide the user for instructions. The user will be able to navigate through the application using its interactive UI design and Environment and get used to the interface in no additional time.

This provides the user to perform full-body exercises that are possible for that particular user. Inverse Kinematics is used to create virtual bone joints between the upper and lower body. This is used to track the upper body movement of the user and tries to predict the lower body movements. Also, considering the current pandemic, people avoid going to the clinic and hence PhysioVR will help users to exercise in a fun way at home. Our application strives for the better health of people and hence promotes fitness and a healthy lifestyle. As we mentioned earlier, the VR industry has boomed exponentially so eventually people are going to have VR headsets at home. Also, all the exercises and duration of each session will be well monitored and follow safety guidelines. Hence, PhysioVR is an application that has a lot of potential in the market.

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