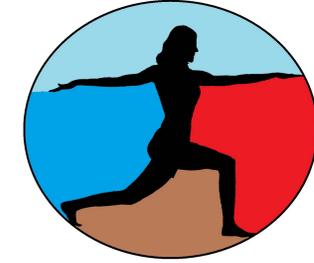# Elemental Kinection

Telerehabilitation Utilizing Microsoft Kinect v2

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Project Overview

According to the World Health Organization Media Centre over 15% of the world's population suffers from some type of disability. Therapists work to help people overcome these disabilities; however, to be effective therapy often needs to be continued at home. These prescribed exercises may be monotonous for the patient and may not be performed correctly or at all. Elemental Kinection provides for telerehabilitation (rehabilitation provided over the internet), which is an inexpensive and engaging alternative for at-home therapy.

Using the motion sensing capabilities of the Microsoft Kinect v2, our application tracks a patient's movements while the patient performs exercises and provides real-time feedback. Patients may also view their prior therapy history through the Elemental Kinection application or the accompanying web application. Elemental Kinection differs from similar Kinect therapy applications in that it utilizes machine learning, instead of heuristics, to allow therapists to easily add exercises to the system. Utilizing the capabilities of the Kinect v2 and Unity 3D, we believe Elemental Kinection provides a fun and engaging alternative to traditional at-home treatment.

Goals

- Create an application that allows a therapy patient to retrieve at-home therapy sessions over the web.

- Provide the patient with an engaging and responsive application to help score and record exercise data from therapy sessions.

- Allow a therapist to assign and view the results of patient sessions via a web portal.

- Enable a therapist to dynamically define new exercises and add them to the application without the need for programmer intervention.

- Utilize current technologies to accomplish these goals, such as the Microsoft Kinect v2, Microsoft Gesture Builder, Unity 3D, and various web technologies.
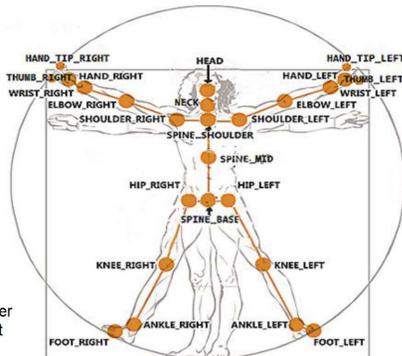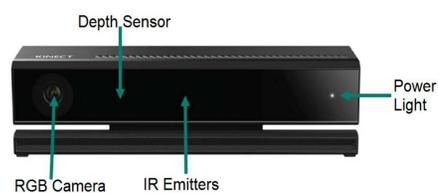
Microsoft Kinect v2

- The Microsoft Kinect v2 is a package of sensing equipment designed for the purpose of motion and audio tracking in a 3 dimensional environment.

- The Kinect serves a dual purpose in this project. The first is to track the exercises of patients at home and the second is to allow a therapist to dynamically create new exercises that the patient can perform.
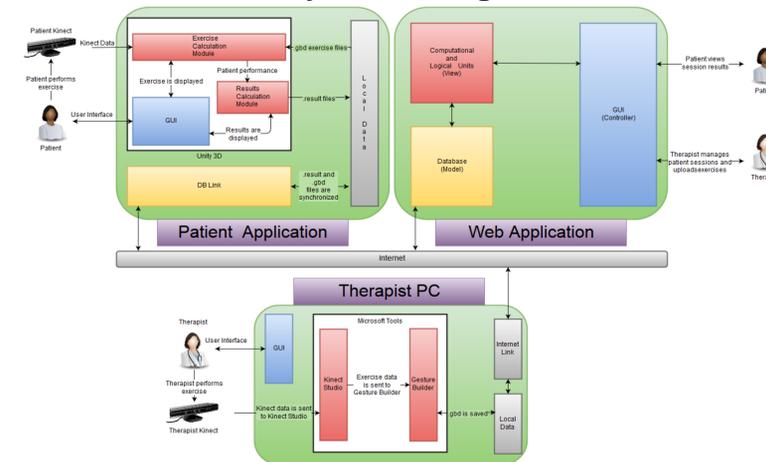
- The Kinect can track up to 25 joints on the human body.

- Kinect sensors used in Elemental Kinection:
  - 1080x1920 color video camera.
  - 512x424 infrared camera.
  - 3 infrared transmitters.

System Design

Patient Application

Exercise Screen   **Exercise Selection Screen**

Therapist Web Portal

Home Screen   **Add Exercises**

View Statistics

Microsoft Visual Gesture Builder

- Microsoft Visual Gesture Builder (VGB) is a tool included in the Kinect SDK that allows the user to create gesture recognition files simply by recording and tagging clips.

- By recording several clips of a single gesture, an exercise in this instance, VGB uses machine learning to pick out key joints and movements that constitute that exercise.

- Visual Gesture Builder's usage of machine learning solves the difficult problem of generating new exercises. Whereas heuristics requires direct programmer intervention, machine learning allows therapists to easily create new exercises on their own.

Unity 3D

- Unity is a game development engine that allows us to create the patient's application UI and environment.

- There are packages for Unity that allow the Kinect and Gesture Builder to be integrated directly into Unity.

- Built-in Unity packages allow us to easily create unique terrain to act as a background for the application.

Web Technologies

- The web application consists of 3 different parts: Django, MySQL, and Nginx, and is hosted on Amazon Web Services (AWS).

- Django is a Python based MVC web framework used to design the app's functionality.

- MySQL is the database used to store the collected data from therapists and patients.

- Nginx is the web server used to serve the files and provide load-balancing for various protocols.

- Amazon Web Services is a collection of cloud computing services that make up the on-demand computing platform offered by Amazon.com.

Results and Conclusions

- Utilizing Visual Gesture Builder, therapists are able to easily add new exercises to the application after it has already been deployed.

- A web portal allows physical therapists to upload these new exercises, assign therapy sessions to patients, and view patient results.

- Patients are able to download therapy sessions remotely and perform the exercises with real-time feedback. Exercise results are both stored locally and uploaded to the web application.

- Learning new technologies – particularly game engines – can have a significant learning curve.

Acknowledgments

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References

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AWS - https://aws.amazon.com/
Django - https://www.djangoproject.com/
Kinect - https://dev.windows.com/en-us/kinect/hardware
Unity - https://unity3d.com/5
VGB - https://channel9.msdn.com/Blogs/k4wdev