Thematic Literature Review on the use of Motion-Sensing and Kinect technologies for Physiotherapy sessions. Also, methods to extract and manipulate video streams from a live online source.

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1.0) Introduction

As life becomes ever more virtual, improved technical solutions are being increasingly used for medical treatments. An exciting technology, rising in popularity, is the use of motion input for everyday activities, especially exercises. These ideas align with our aim to bring motion input to virtual physiotherapy sessions, to aid a patient's recovery from their own home.

Early conceptual articles on motion-sensing technology contemplated a physical device used to track motion. The device should be portable and require a variable level of effort to be moved, ranging from a gravity eliminated environment to a weighted environment. This is dependent on the patient's movement ability, with the device measuring the patient's range of motion and amount of motion during every use, then recording and storing this data [1]. However, these were merely projections and theoretical implications of motion-input within the physiotherapy practice. The status of this technology is not fully mapped yet and hence no concrete platform has been established. Therefore, this literature aims to identify gaps, as well as popular themes in existing studies.

This literature will use a raft of literature including both published and unpublished works from the last 2 decades. Our reason for utilising a vast range of literature is due to the limited amount of records relating to the topic. However, there will explicitly be no literature relating to the use of AR/VR technology for physiotherapy. From the reviews' findings, we will attain a comprehensive view of approaches and ideas behind existing motion-based solutions to physiotherapy. This will provide a window of opportunity, directions, and avenues for us to approach this project.

2.0) Literature Review – Digital Physiotherapy

2.1) Kinect-based Virtual Rehabilitation for Upper Extremity Motor Recovery in Chronic Stroke

Summary:
This work was undertaken to improve upper extremity motor function through repetitive exercises and games, several times a week. The aim was to track an increase in shoulder and elbow range of motion in a month.

Premise:
This short timeframe was chosen in an aim to find a way to accelerate motor recovery. Since most games are for 'normal' people, the movement is too extreme, so the right Kinect games need to be deciphered.

Methodology:
Therapeutic exercises for rehabilitation was chosen based on the Brunnstrom Approach. 9 physiotherapists were consulted to evaluate these choices, and then later to test the games.
The upper extremity motor recovery level was evaluated using the Fugl-Meyer assessment scale. Also goniometry was performed to measure the shoulder and elbow range of motion. A usability questionnaire was then sent out, containing both multiple choice and open ended questions.

Inconsistency & Errors:
Chose the games with the Brunnstrom Approach but looked at results based of the Fugl-Meyer assessment scale, which is a lack of consistency.
No control group was included and the sample size was extremely small. Also, there was no way for physiotherapists to measure the results and get data fed to them.
~~Relevance:~~
~~Conclusion:~~

2.2) Reliability and validity analyzes of Kinect V2 based measurement system for shoulder motions

Summary:
Aim of this study is to examine the reliability and validity analyses of the proposed shoulder measurement system. Three systems were used to evaluate validity of the Kinect V2 to measure shoulder motions: Kinect V2 based system, clinical goniometer and digital goniometer. One expert physical therapist measured shoulder abduction, flexion, external rotation, internal rotation. high ICC values show that the Kinect V2 based shoulder motion measurement system has very good intra-rater reliability for abduction, flexion, external rotation, internal rotation shoulder poses.

Conclusion:
Validity and reliability of Kinect V2 based measurement system for the shoulder motions were presented. The proposed system consists of Kinect V2 sensor and graphical user interface. The reliability test results show that Kinect V2 based measurement system is very good for abduction, flexion, internal rotation, external rotation poses, and has good reliability for extension pose.

3.0) Literature Review – Cloning Video Stream

3.1) Streaming audio and video from Teams using NDI and SDI Technology

Summary:
The technology allows you to broadcast the audio and video streams from a Teams meeting to your local network [3]. When using NewTek NDI® technology in a Teams meeting, you will have unique video streams on the network that can be used in your own production. This means video and audio streams from each individual participant can be isolated and handled individually for any production purposes.
These video and audio streams are created as unique NDI objects.

Methodology behind this is for the host/admin member of a call to local broadcast the meeting through their meeting settings which allow local broadcasting through NDI.

This technology also has an NDI-in feature. The explanation above is for NDI-out, to extract videos from a Teams call. The NDI-in feature has limited documentation; however, we believe it will allow us to ship a games app GUI into teams, with the video streams attached.

Premise:
Being a feature built into Teams, integration should be easier than other solutions. In addition there will be more documentation to follow. This solution has very low overhead and seems easy to use despite appearing to require a specific type of Microsoft account.

Conclusion:
Comprehensive guide for using NDI and SDI technology was provided and presented, as well as their potential use cases. This seems to be a very exciting and innovative approach as it will allow for remote control for member inside a teams call. However, the potential disability and blocking of NDI-In software could potentially be a big negative as it will not allow for overlays and more production capabilities. Therefore, alternative solutions must be looked into.

3.2) Stream Smart: P2P video streaming for smartphones through the cloud

Summary:
Aim is to allow someone to share their live time video with other devices through using the P2P network. This offers a scalable solution and reliable approach as it diverges away from a single point of failure. Furthermore, the device sharing the video would not be overloaded, unlike many traditional approaches. This study looks to leverage cloud technology. Each device is associated with its own personal clone in the cloud. The live video is uploaded to the cloud clone and then every other device which has a cloud clone can watch this live or store it to watch later. This takes advantage of the high-speed network as well as both computation and communication offloading

Premise:
As mentioned above, previous solutions had high computation requirements and communication requirements. Furthermore, they do not take advantage of modern high speed networks so often we are left with a lagged video stream.

Methodology:
We demonstrate our StreamSmart prototype using four Samsung Galaxy S Plus devices and 32 Android-X86 software clones deployed on Amazon's EC2 public cloud.

Conclusion:
It is not a very private approach, as the source is likely to not want their video to be shared to different Cloud Clones. And theres an issue of link creation between certain clones, if they are bootstrapped.

3.3) Development of a Remote Object Webcam Controller with COBRA and JMF

Summary:
In Java, a MediaLocator object is used to access video for a web cam on a Windows computer. Once the video feed is obtained a DataSource is created to store the live video feed. This DataSource can be fed for the user to view the live video, or it can be sent to a processor that transforms the DataSource into a different type of DataSource.
If the webcam's DataSource is to be transmitted over a network and recorded locally to file at the same time, it must be created as a cloneable DataSource. A cloneable DataSource can be clones any number of times for different uses.

Conclusion:
This is a frugal approach due to the limited compatibility as it is only available on windows. However, a similar approach can be deployed if we couple this with the cloud stored idea in 3.1). Then we can create an object to access cloud data, and this can be relayed any number of times as the object is cloneable.

4.0) Review

Despite limited availability on the use of web cam technology for digital physiotherapy, we have evaluated multiple studies on related areas.

The first part of research was to gage an idea of different studies relating to using Kinect-based technology for physiotherapy. From these studies we were able to decipher the initial ideas, approach used, and the findings from the study. This helped us identify gaps that we can bear in mind when planning our project. From the approach and findings, we also identified useful data-gathering methodologies, like the Brunnstrom Approach and the Fugl-Meyer Assessment Scale. Gathering data to satisfy these approaches would be much more beneficial to the physiotherapist than simply gathering the repetitions and total time moved, as was previously discussed in our team. Furthermore, looking into these approaches provided a streamlined vision to the exercises and games that could be played to effectively target each part of the body.

The second part of research consisted of viewing different video stream cloning techniques, as we aim to have a video stream on the teams call, but also a video stream to feed into the UCL motion input library. Our primary aim is to implement the NDI solution within MotionInput/OBS. This will allow us to handle and maintain every members audio and video stream individually. This can then be used to run Motioninput, as well as create a graphic overlay to send back into Teams using OBS. Therefore, we can render the graphics overlay in OBS, with live NDI video streams on the overlay back into Teams. The graphic overlay element of this solution may be hampered by the potential blocking of NDI-In Software by Microsoft. There are back-up 2 approaches we have found out from our research, and they would be compatible with both windows and mac and would work efficiently on most devices due to the reduced overhead.

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