# Realtime Physiotherapy and Fitness Assistant

CSE3043: Video Analytics

Review 1

# Team Members

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# Abstract


- We aim to create an automated system for tracking the physiotherapy poses of an individual which are then juxtaposed with the correct postures of the corresponding exercises.

- The system will offer suggestions on how to improve on the exercises as well as score them.

- We propose enhanced error identification by monitoring the speed and body parts of the person and will perform these tasks on a live video feed in real time.

# Motivation

- The pandemic has incentivized innovation that utilizes remote technology to achieve communication between people. Hospitals are often full, and as result, online consultations have seen a rise in preference.

- However, due to the limited availability of professionals, there is a difficulty in providing at home services for patients that require physiotherapy.

- These individuals may be recovering from an operation or require such exercises to maintain their muscular and physical health.

# Literature Survey

# Literature Survey

## Automatic Feedback For Physiotherapy Exercises Based On PoseNet

Hassan, H.A.; Abdallah, B.H.; Abdallah, A.A.; Abdel-Aal, R.O.; Numan, R.R.; Darwish, A.K.; El-Behaidy, W.H. Automatic Feedback For Physiotherapy Exercises Based On PoseNet. FCAI-Inform. Bull. 2020, 2, 10–14.

## Gesture Recognition in RGB Videos Using Human Body Keypoints and Dynamic Time Warping

Schneider, Pascal, Raphael Memmesheimer, Ivanna Kramer, and Dietrich Paulus. "Gesture recognition in RGB videos using human body keypoints and dynamic time warping." In *Robot World Cup*, pp. 281-293. Springer, Cham, 2019.

## Musculoskeletal Physiotherapy using Artificial Intelligence and Machine Learning

Godse, Sachin P., Shalini Singh, Sonal Khule, Vedant Yadav, and Shubham Wakhare. "Musculoskeletal physiotherapy using artificial intelligence and machine learning." *Int. J. Innov. Sci. Res. Technol.* 4, no. 11 (2019): 592-598.

# Automatic Feedback For Physiotherapy Exercises Based On PoseNet

- Utilizes the PoseNet model to assess a video input of a person performing an exercise, and analyse it to provide corrective feedback
- Home Based Physiotherapy Exercise (HPTE) dataset is used. It consists of 240 exercises, with 480 videos available in both RGB and grayscale.
- Applied L2 normalization on the key points estimated by PoseNet, to accommodate users of all shapes and sizes.
- In order to perform the comparison, two methods are implemented. In the first, a pickled version of keypoints in the HPTE dataset was created and used. This method is more accurate but slower.
- The second methodology involves Dynamic Time Warping (DTW) which is used to measure non linear similarity between two time series. This technique is faster but slightly less accurate.

# Gesture Recognition in RGB Videos Using Human Body Keypoints and Dynamic Time Warping

- Human gestures in RGB videos are classified using a deep learning pipeline consisting of a real-time human pose extraction and processing system called OpenPose, and time series classification using Dynamic Time Warping and One-Nearest Neighbor.

- The approach is flexible and hardware-independent, and new gestures can be taught to the classifier using only a small amount of training data.

- As compared to the existing literature, they did not achieve higher accuracy. However, the ability of their model to work on less training data is a noteworthy result.

# Musculoskeletal Physiotherapy using Artificial Intelligence and Machine Learning

- Proposes an end-to-end computer vision based model for rating postures.
  Each frame of video is resized to a fixed form factor and converted to minimum data loss format.
- Open Source posture detection model OpenPose is used to detect various joints and important points in the body and estimate measurement between them.
- A normalized error value is created based on difference in distance of these points against previously fed values. The persons heights, weight and size are included in the calculations to improve performance and efficiency.

# Project Design

- The basic hardware requirements include a laptop with a camera, and CPU powerful enough to perform pose estimation and real time video processing.
- The models will be created and trained in the Python programming language. PoseNet is a pre-existing realtime pose estimation library complete with limb identification and tracking. This will be used to perform track the user's body movements.
- A reference video containing the correct method of performing the exercise will be required. This will allow us to perform a similarity comparison between the user and the professional, when they perform the exercise.
- Evaluation will be done based on the similarity between the videos, ensuring that certain differences such as length differences between the limbs and speed of motion are accounted for. Corrective feedback will be provided in real time as well to allow users to adjust accordingly.

# Project Flow

## First

We obtain the video feed from both the user as well as the reference video that contains the correct performance of the exercise

## Second

Both the videos are then compared side by side in real time. The user performs the exercise as done in the video and the model tracks their limbs to evaluate the technique

## Last

Based on the similarity comparison, the model evaluates the exercise done by the user. Corrective feedback is provided, and the user may continue to perform the exercise as many times as required

# Module Description

# Real time Video Processing

- Ensuring that the user can use our application in real-time to help better understand the correct technique to perform the exercise
- Takes in video input from a camera source such as the laptop camera, and outputs the processed frames as a video stream onto the display
- Module Incharge: Subramanian Venkittanarayan

# Pose Estimation

- From the processed video we make use of pose estimation libraries such as OpenPose and PoseNet to get the positions of different points across the body.

- Take in individual video frames and return an associated json object containing the coordinates of each of the points

- Module Incharge: Subramanian Venkittanarayan

# Limb Tracking

- This module will help identify the individual body parts of the user.
- It is necessary to monitor them as it is possible that the user may be performing the exercise using an incorrect body part.
- That may deter the very purpose of the exercise and increase complications.
- Module incharge: Ritika Sarkar

# Realtime Overlay and Correction

- The correct poses will be overlaid on top of the user's poses in real-time.
- Also, correcting information like by how much angle the user needs to move their arms and in which direction, will be displayed.
- This will enable the user to correct their poses.
- Module incharge: Ritika Sarkar

# 4 Pose Evaluation and Scoring

- Done based on the video feed containing the correct performance of the exercise
- Users will be encouraged to follow along with the sample video, to ensure the exercise is performed with the appropriate technique and speed.
- Based on the similarities between the user performing the exercise from reference data, an evaluation will be provided, distance between points, angles betweens limbs and range of motion achieved and other data extracted from the points will be used to provide feedback to the user.
- Module Incharge: Aaditya Hemant

# 5 Reference Data generation

- Collect reference images and videos for multiple preset configurations.
- Extract pose information and motion ranges for each exercise and store it in a database for comparisons.
- Module incharge:  Aaditya Hemant

# Research Paper Possibility

Currently we do not have plans for a research paper, as we are yet to understand the effectiveness of our final implementation. However we hope that towards the end of the semester, we can reevaluate our project and finalize whether a research paper is viable or not.

# Conclusion

Our project aims to improve the process of postoperative recovery/ general physiotherapy by ensuring that patients everywhere have an easy, simple and accessible way of performing self evaluation. With the pandemic still affecting our lives, and changing the future as well, it is important to innovate with the idea of remote/at home services in mind.

# Thanks!