Development of AI-Powered Digital Therapeutics For Personalized and Fun-Filled Exercise-Based Therapies.

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DEEP LEARNING INDABA

MOTIVATION.

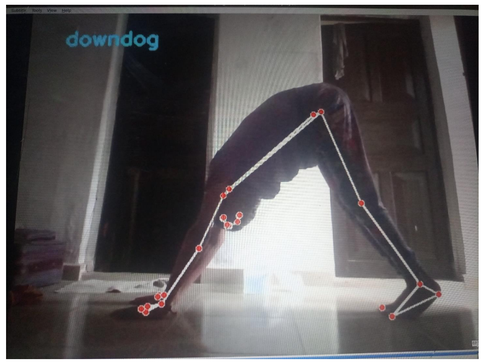
- Approximately 1.71 billion people suffered from musculoskeletal conditions worldwide.
- The rate of evidence of people with acute and chronic musculoskeletal conditions such as (neck, shoulder, chronic back, hip and knee pain) is on the increase in Africa.
- The prevalence of incidence of chronic musculoskeletal conditions every year leading to disability worldwide implies the need to diagnose and treat chronic musculoskeletal conditions on time, to stem its tide.
- The diagnosis and treatment of chronic musculoskeletal conditions by conventional medical techniques may not be enough. Hence, the machine learning technique is needed to diagnose and treat chronic musculoskeletal conditions.

OBJECTIVE.

Development of AI-powered digital therapeutics for personalized and fun-filled exercise-based therapies to people with chronic musculoskeletal conditions by calculating normal degree joints of the body and track movement patterns possible in each Joint as well as their normal ranges for easy diagnosis and treatment.

METHOD.

- A collected local data of 280 pictures of single people in different background while performing 5 different major activities e.g., scout, push up, jogging, down-dog , stretching.
- Training of Machine Learning model on the 5 classes to be detected.
- Testing the performances of the trained models and calculating angle using goniometry
- Performing pose estimation on videos from the pi camera using Media Pipe algorithm.
- Measuring the performance of the pose estimation algorithm on the processor in terms of number of processed frames per seconds (FPS). i.e., Models evaluation.



Sample tracking during an exercise

DATA ANALYSIS

After detailed image preprocessing of the datasets. The angle information was collected from 280 images in the datasets and was put into an excel sheet and analysis using Jupyter Notebook..

RESULT

MODELS	ACCURACY	F1-SCORE
SVM	0.95	0.97
LOGISTIC REGRESSION	0.97	0.97
CATBOOST	0.85	0.83
RANDOM FOREST	0.83	0.90
ADABOOST	0.56	0.51
MULTILAYER PERCEPTION	0.94	0.91

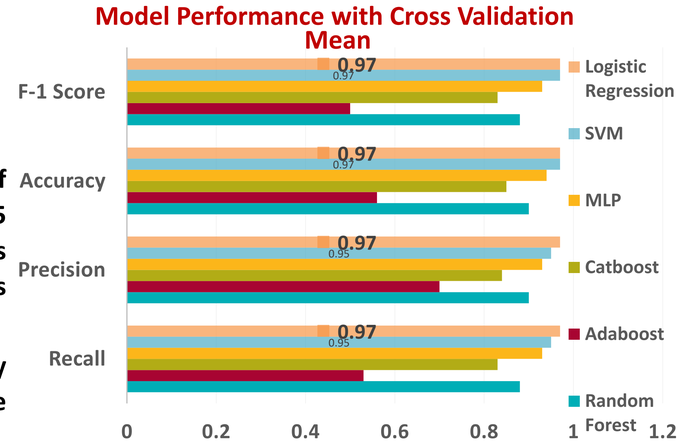
DISCUSSION

Simple distance measurements on the axes of the body can be used to classify postures into 5 classes. After running the script on 56 pictures (20% of our dataset), following results was obtained:

- When the entire body can be seen all key points were detected, the typical exercise undergoing by the user is easily classified.
- Despite presence of transparent barrier in the background, all major key points were still detected and classified correctly.
- Six ML algorithms was used to perform classification and results was compared.
- SVM had the highest F-1 score
- Accuracy wasn't a good measure of the model's algorithm because it is simple and misused metric .

CONCLUSION

- Pose classification into 5 categories can be done using angle information collected from the key points of a person in the scene which then allows physiotherapist/ medical rehab to diagnose and treat their patient.
- Machine learning algorithms using pose estimation and classification are significant in medical domain for diagnosis of chronic musculoskeletal conditions.
- The pose estimation and classification system developed is computationally intensive and would require to be deploy on a cloud e.g., AWS, MICROSOFT AZURE.



RECOMMENDATION

A machine learning API can be integrated with the system to analyze and perform predictions in real time. Also, more robust datasets than my local dataset can be developed to handle limitations of wrongly labelled key points in strongly occluded scenes with unseen poses. More feature engineering should be done on the data to improve accuracy of the algorithm in classifying exercise accurately and for angle measurements.

REFERENCE

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ACKNOWLEDGEMENT

Special thanks to Deep Leaning Indaba who organized and sponsored the conference.