Exercise Perspective Detection For Push-Up Counter And Human Activity Estimation Using Open Pose

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Abstract- *Artificial intelligence technology has created its prominent importance in several fields including the fitness field. Human pose estimation is one of the significant fields of research in Computer Vision for the past several years. In this project, pose estimation and machine learning approaches are merged to examine the functioning and convey a feedback on the repetitions of performed exercises in real time. Involving machine learning technology in fitness industry could help the judges to count repetitions of any exercise during Weightlifting or Cross Fit competitions. In this project, we mainly focus on push-ups. This project presents a real-time approach to count push-ups using 2D video imagery. The proposed method uses Open Pose in each frame to extract multiple joints and links of a human body. Then, it examines key motion features related to counting the push-ups. Taking in consideration the push-up rules and criteria are defined and used parametrically to count successive push-ups. Further the clapping criteria was defined and the indication will be displayed on the screen as "person is clapping", whenever the pre-mentioned conditions were satisfied. Finally, the result shows 96.54% for accuracy, precision, recall, and F-measure, respectively, demonstrating its reliability in physical tests and trainings.*

Keywords- artificial intelligence, fitness industry, human pose estimation, computer vision, push-ups, open pose.

I. INTRODUCTION

Push-ups, as part of the physical fitness exercises, are used to assess and to build upper body strength. In the push-up test, a person performs as many push-ups as possible in two minutes, while a supervisor either it may be a physiotherapist or trainer counts the number of repetitions. In conventional methods, during testing, numerous test inspectors need to be present to count and record the pushup scores. Also, it can be difficult for one instructor to accurately judge the scores of several examinees at the same time.

The trend of human activity monitoring using extensively accessible technology is one of the most flourishing ideas in the current years. It assists many innovative applications, such as fitness games or health monitoring systems. In these situations, activity recognition tries to differentiate between dissimilar kinds of activities. Yet, only small work has engaged on qualitative recognition so far: How exactly is the activity carried out. In this project, an approach for supervising activities, i.e. qualitative recognition, is proposed. The attention lied on push-ups as a verification of concept. Thus our project concentrates on counting the number of push-ups performed by a person using real-time camera and open pose estimation. In addition, our technique detects human activities like clapping by applying specific conditions of clapping using mathematical formulae.

OBJECTIVE

- Proposing a whole system to re-identify and trace persons, identify the performed exercises, and count each person's repetitions in real time.
- Evaluating the performed exercises without the necessity of recording the video from a certain unique perspective.
- Count exercises in an automated manner with high level of accuracy.

II. LITERATURE SURVEY

[1] A. Muzakir and C. D. Kusmindari, "Push -Up Detector Applications Using Quality Function Development and Anthropometry for Movement Error Detection".

In Another approach, they developed a pushup detector application using Arduino-based microcontroller to detect nonstandard movement of push-ups, and to prevent injury by alarming mistaken push-up habits to users.

[2] D. Morris, T. S. Saponas, A. Guillory, and I. Kelner, "RecoFit: using a wearable sensor to find, recognize, and count repetitive exercises".

In this work, wearable devices were developed to automatically track and share exercise routines including

push-ups. Users were equipped with the wearable device and simply conducted repetitive exercises. In addition, the device recognized and showed which exercises the users conducted and how many counts were valid using arm-worn inertial sensors.

[3] Z. Cao, G. Hidalgo, T. Simon, S. -E. Wei, and Y. Sheikh, "OpenPose: realtime multi -person 2D pose estimation using Part Affinity Fields".

The pose of the examinee is estimated by categorizing human body into several key parts such as head, shoulder, arm, feet, etc. To capture and examine motions during the push-ups, each joint of the human body is identified by applying OpenPose. OpenPose is an algorithm for assessing 2D human poses.

[4] Soro, A., Brunner, G., Tanner, S., &Wattenhofer, R. Recognition and Repetition Counting for Complex Physical Exercises with Deep Learning.

In this work, a deep learning method is structured for exercise identification and repetition counting. The method utilizes an unprocessed sensor data obtained from a smart watch to train a neural network. It attains a classification accuracy of 99.96% and counting appropriately within an error of ± 1 repetition in 91% of the accomplished sets. In order to apply the method, every athlete must have a smart watch, which requires a large budget. Further, the method is unable to specify correct/incorrect repetitions.

[5] Hanczar, B & Dougherty, E., Classification with reject option in gene expression data.

To detect the identified and unidentified pose/motion, the model categorizes pose with reject choice using confidence interval thresholds. The mean of the Softmax probabilities from the test set of each class was collected and the 90% confidence interval was estimated to be a reference on final model. The forecast probabilities for every class of the exercise identification network must be bounded between these predictable confidence intervals to verify the forecasted label or will label as an unidentified.

III. EXISTING METHOD & PROPOSED METHOD

EXISTING METHOD:

In Existing methods, sensor-based counting devices were used. A primitive form of the device was to count pushup numbers when a part of body touched the target object; for instance, a count was alarmed when the chest of an examinee touched a button on the push-up tool. A commercial sensor-based push-up counter was also used. In another method, a push-up counting device was studied to increase the count accuracy by fusing multiple sensors. Other push-up tracking method was established through accelerometers and gyroscope data obtained from smartphone sensors by machine learning algorithms.

DISADVANTAGES:

- This kind of sensor-based push-up counters may be misused at the time of standardized push-up tests by deliberately overstating movements in ways for the sensors to admit them as valid.
- A correct push-up can be accidentally miscounted by failure of the sensor.
- Such imprecisions that can develop from this kind of push-up counters can extremely degrade the fairness of tests.

PROPOSED SYSTEM:

Lately, vision-based technologies have developed on numerous applications and they employ extremely improved computing abilities and artificial intelligence to improve their performance. In this project, a real-time approach for counting push-ups using video imagery is introduced. OpenPose is applied in each frame to extract 15 key points of a human body, and then key motion features related to the push-ups are analyzed. The performance of the technique is analyzed in terms of accuracy, precision recall and F-measure. Besides counting the push-ups, this proposed method will also detect the type of human activity that present in the image like clapping by using mathematical formulae. After detection, it will indicate us as “person is clapping”.

ADVANTAGES:

- Cost-effective (only cost of cameras),
- Instantaneous counting system, and
- No time gap for previous groundwork of device attachment.

IV. SYSTEM FUNCTION

ARCHITECTURE DESIGN:

Firstly, the camera is initialized and the real-time video of the person who is doing exercise will be captured and the video will be processed. The processed video will be segmented and frames will be extracted. Each extracted frame will be processed and pose of the person will be estimated

using open pose. Here, we are using 15 key points model (MPI), and using that model all the required key points will be detected. Then the skeleton will be formed by drawing lines with the detected key points. Then, the exercise perspective detection starts and when the conditions for push-up are satisfied, the count will be added for push-up count, otherwise it continues to monitor. At the same time, the clapping criteria will be checked and if it was satisfied, the indication will be displayed on the screen, otherwise it will keep monitor. The Architecture Design was represented as below:

Fig.no:1 Architecture Design

V. OPEN POSE ESTIMATION

Open Pose is a popular multi-person system for identifying the human body, hand, face, and foot (135 points overall) in a single image. Researchers at Carnegie Mellon University have been prioritized. Publish in the form of Python code, C ++ launch and Unity Plugin.

In the initial step the image is handed through baseline CNN network to obtain the feature maps of the input. Here, three authors used first 10 layers of VGG-19 network. The feature map is then handled in a multi-stage CNN pipeline to produce the Part Confidence Maps and Part Affinity Field

- Part Confidence Maps
- Part Affinity Field

In the final step, the Confidence Maps and Part Affinity Fields that are created above are handled by a greedy bipartite matching algorithm to acquire the poses for every person in the image.

Fig.no:2 input image

Fig.no:3 parsing results

VI. SYSTEM SPECIFICATION

HARDWARE SPECIFICATION

Processor : INTEL I5 (7th generation)
RAM : 4 GB RAM
Hard disk : 1TB
Monitor : 20’ color monitor

SOFTWARE SPECIFICATION

Language used : python
Software tool used : PyCharm
Platform : Windows 8

VII. SYSTEM SOFTWARE

PYCHARM

PyCharm is the very prevalent IDE used for Python scripting language. PyCharm gives some of the greatest features to its users and developers in the following aspects.

- Code completion and inspection
- Advanced debugging

- Assistance for web programming and frameworks such as Django and Flask

Features of PyCharm

Furthermore, a developer will find PyCharm more convenient to work with, due to the features stated below

Code Completion

PyCharm supports easier code completion whether it is for built in or for an external package.

SQL Alchemy as Debugger

You can fix a breakpoint, wait in the debugger and can see the SQL interpretation of the user expression for SQL Language code.

Git Visualization in Editor

When coding in Python, doubts are usual for a developer. You can confirm the final commit effortlessly in PyCharm as it has the blue sections that can explain the dissimilarity between the final commit and the present one.

Code Coverage in Editor

You can run **.py** files outside the PyCharm Editor as well denoting it as code coverage particulars somewhere else in the project tree, in the summary section etc.

Package Management

All the installed packages are shown with suitable visual depiction. This comprises record of installed packages and the capability to seek and include further packages.

Local History

Local History is constantly following the changes in a way that counterparts like Git. Local history in PyCharm provides full particulars of what is essential to rollback and what is to be included.

Refactoring

Refactoring is the procedure of changing name of one or more files at a time and PyCharm comprises several shortcuts for an easy refactoring procedure.

User Interface of PyCharm Editor

Note that the editor comprises several features to generate a fresh project or import from an already generated project.

VIII. HARDWARE REQUIERMENTS & SPECIFICATIONS

I5 PROCESSOR

Intel core is the processors I5 family which is well-known for its state-of-the-art innovative construction and integrated structural design which also gives the benefit of the parallel computing. It's also great in offering the users with the outstanding graphical user interfaces.

Basic Features of the I5

The basic feature of the I5 features are highly improved as compared to previous version of the processor by Intel. Some of the popular and leading features of I4 processors are listed below.

- I5 processors proposes the flawless precision and extraordinary functioning and response rate which in turn, give the users with the elevated throughput rates, and also decreased time in executing the programs by the processor.
- The Intel I5 processor is fully equipped by the latest HD graphics with powerful and advanced video engine that provides smooth high quality display along with the 3d graphics capabilities. On the whole I4 processors can be considered as the high graphical and multimedia display processors for daily computing.

More advantages of the I5

I5 processors have remarkable advantages that are of great use in the field of computers and technology. Some of them are listed below.

- Dual core processing has the capability to run two independent programs with one hardware.
- I5 processors have improved Pentium base, they have totally new architecture with more integrations and high-speed performance structure.

IX. RESULTS

The approach was implemented and results were observed as shown below:

Fig.no:4 output-skeleton

The above figure shows the result in which pose was estimated and the angles which are all required for the etection of push-up were measured. Also the count was added, as the condition for push-up is satisfied.

Fig.no: 5 output-key points

The above figure shows only the detected key points without skeleton with numberings.

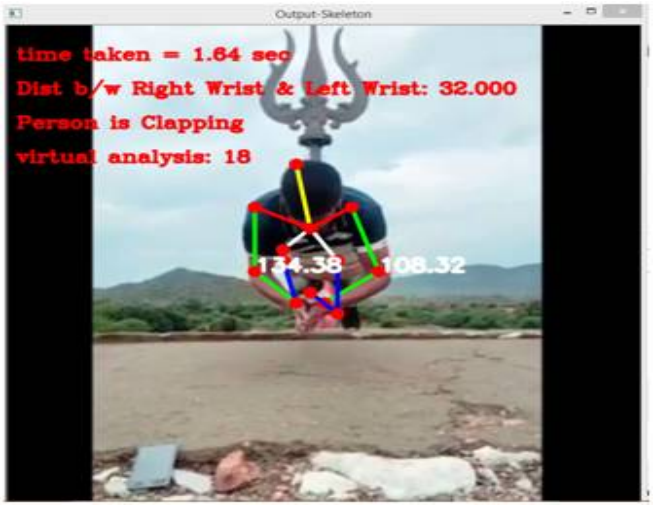

Fig.no: 6 clapping indicated

The above figure shows that the human activity is detected and indicated as “person is clapping”.

X. CONCLUSION

In this project, a real -time push -up count technique was implemented by using real-time video to count push - ups. OpenPose was applied to extract multiple joints and links of the human body in 2D image, and then analyzed the key body parts that influenced the push -ups. Based on the push –up condition, several criteria were defined and the angles of elbows were parameterized to detect the presence of exact push-up in the video. Further, the clapping criteria was defined like distance between two wrists will be minimum certain value and whenever such condition is satisfied, the indication will be displayed on the screen as “person is clapping”. Thus our approach performed well and successfully detected push-up and count was added and also the clap was detected and indication was displayed. The performance of the proposed method was 96.54% in accuracy, precision, recall and F -measure, respectively. For future study, 3D analysis of the human body and Deep learning approach will be further researched to improve its reliability in physical fitness tests.

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