UNIVERSITY OF OTTAWA

DOCTORAL THESIS

Efficient Intermediate Representations for Pose-Based Action Recognition

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Department of Computer Science

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UNIVERSITY OF OTTAWA

Abstract

Faculty of Engineering

Department of Computer Science

Master of Computer Science

Efficient Intermediate Representations for Pose-Based Action Recognition

by Nicolas FLEECE

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...

"Thanks to my solid academic training, today I can write hundreds of words on virtually any topic without possessing a shred of information, which is how I got a good job in journalism."

Dave Barry

Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor. . .

Contents

List of Figures

List of Tables

List of Abbreviations

LAH   List Abbreviations Here

WSF   What (it) Stands For

Physical Constants

Speed of Light $\quad c_0 = 2.997\,924\,58 \times 10^8\,\mathrm{m\,s^{-1}}$ (exact)

List of Symbols

a	distance	m
P	power	$\mathrm{W}\,(\mathrm{J}\,\mathrm{s}^{-1})$
ω	angular frequency	rad

For/Dedicated to/To my…

Chapter 1

Literature Review

1.1 Classical Action Recognition

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1.2 Deep Learning Action Recognition

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1.2.1 3D-CNN

ResNet

MoveNet

1.3 Optical Flow

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1.4 Person-Based Action Recognition

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1.5 Pose-Based Action Recognition

Pose involves extracting the skeleton of the person and using this data over multiple frames of a video to classify an action. Pose is a common addition used in action recognition as it relates most to how humans view actions and the movement of different bones.

1.5.1 Intermediate Representations

The approach of the majority of this thesis involves creating intermediate representations for pose data over multiple frames. This typically has the aim of creating some

kind of image that represents either the motion of the persons bones and/or joints through the image at different points in the video. These images can then be used either by the model independently or added to traditional two-stream architectures.

The advantage of these types of representations is that the model can quite often be a small CNN that can be trained end-to-end very quickly and with little memory. This quite often allows for real-time evaluation and in some cases mobile-capable models.

PoTion

Pose motion representation for action recognition [1] was largely the inspiration for the work that was done within this thesis. This approach aims to take the joints extracted from the pose representation and use the movement over f frames, creating j images where j is the number of joints.

The approach begins by extracting j joint heatmaps from each frame of the video, these individual frames are then combines using their colour coding where depending on what time t the frame is at in the video, the joint heatmap is made to be that colour. They then perform their temporal aggregation where for each joint j, they combine all frames together into one image, perfoming a simple addition through all frames. This leaves an image that demonstrates the movement of one joint through all frames of a video.

PA3D

Pose action 3D [2] is a similar approach to PoTion, where it involves the use of the generated joint heatmaps from pose estimation models. The difference is that instead of using the color coding similar to potion, PA3D stacks the joint heatmaps such that they create j cubes of every heatmap frame.

Simple yet efficient real-time pose-based action recognition

Appendix A

Frequently Asked Questions

A.1 How do I change the colors of links?

The color of links can be changed to your liking using:

`\hypersetup{urlcolor=red}`, or

`\hypersetup{citecolor=green}`, or

`\hypersetup{allcolor=blue}`.

If you want to completely hide the links, you can use:

`\hypersetup{allcolors=.}`, or even better:

`\hypersetup{hidelinks}`.

If you want to have obvious links in the PDF but not the printed text, use:

`\hypersetup{colorlinks=false}`.

Bibliography

[1] V. Choutas, P. Weinzaepfel, J. Revaud, and C. Schmid, "Potion: Pose motion representation for action recognition," Jun. 2018, pp. 7024–7033. DOI: 10.1109/CVPR.2018.00734.

[2] A. Yan, Y. Wang, Z. Li, and Y. Qiao, "Pa3d: Pose-action 3d machine for video recognition," in *2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2019, pp. 7914–7923. DOI: 10.1109/CVPR.2019.00811.