UNIVERSITI PUTRA MALAYSIA

VISION-BASED HUMAN ACTION RECOGNITION USING TIME DELAY INPUT RADIAL BASIS FUNCTION NETWORKS

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By

DAVOOD KALHOR

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Master of Science

December 2011

DEDICATION

This thesis is dedicated to my beloved wife, Trifa, for all her support and patience during my research, and also to our darling daughter Viana.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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December 2011

Chairman: Professor Ishak Aris, PhD

Faculty: Engineering

Understanding human actions from video sequences is one of the most active and challenging research topics in computer vision. In spite of several promising works, particularly in recent years, to achieve high accuracy, there is still a lack of efficient systems for real-time applications, thereby increasing demand for faster systems. In other words, when addressing high performance systems for real-time applications both accuracy and speed should be considered. In practice, however, concurrently achieving high accuracy and high speed is very challenging. This thesis is motivated to deal with this problem and proposes a method, which is sufficiently fast for real-time human action recognition at 10 frames per second (fps).

The proposed method consists of two main parts. In the first part, a feature vector is extracted for each frame, and then an action descriptor is constructed from a concatenation of these vectors. The choice of appropriate features is of vital importance to successful design of a high-performance system. This thesis, unlike

most of the previous works in which very complex and high dimensional feature vectors have been used to describe actions, proposes a new descriptor with low dimensionality and complexity while preserving required power of discrimination. The feature vector is built by merging three information channels from grid-based shape features, bounding box, and the mass center of silhouettes. In the second part, these feature vectors are classified utilizing a Time Delay Input Radial Basis Function Network (TDIRBFN). This network has no integration layer and therefore a smaller number of model parameters and less computation during model selection. A growing-cell approach is suggested to train this network.

This work is evaluated using leave-one-actor-out protocol and a human action dataset (provided by University of Illinois at Urbana-Champaign) containing 14 actions. Based on experimental results, implemented in MATLAB environment, the average execution time for constructing feature vectors is almost 20 ms (50 fps), significantly smaller than the literature. The proposed method can be trained to meet two different objectives, high speed (the main requirement of real-time systems) and high accuracy (the main requirement of non-real-time systems). The achieved results are 15.5 fps (classifier speed) and 90.66% (accuracy), for the first objective, and 94.52% (accuracy) and 2.37 fps (classifier speed), for the second objective. A comparative analysis demonstrates that the proposed system, in addition to comparable accuracy with the literature, outperforms state-of-the-art methods in terms of both speed and overall performance. The findings of this work are significant in that they offer simpler descriptors as well as the TDIRBFN as an alternative method for classification of human actions, particularly for real-time applications.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENGECAMAN AKSI MANUSIA BERASASKAN PENGLIHATAN MENGGUNAKAN RANGKAIAN MASUKAN MASA LENGAHAN FUNGSI BERASASKAN JEJARIAN

Oleh

DAVOOD KALHOR

Disember 2011

Pengerusi: Profesor Ishak Aris, PhD

Fakulti: Kejuruteraan

Memahami aksi-aksi manusia dari turutan video adalah salah satu topik yang aktif dan mencabar di dalam bidang penglihatan komputer. Di samping beberapa hasil kerja yang terdahulu yang menunjukkan ketepatan yang tinggi, masih terdapat sistem yang kurang cekap terutama bagi aplikasi masa sebenar, ini menyebabkan permintaan yang meningkat kepada sistem yang lebih pantas. Dengan perkataan yang lain, apabila berurusan dengan sistem berkeupayaan tinggi untuk aplikasi masa sebenar, kedua-dua ketepatan dan kepantasan perlu dipertimbangkan. Di dalam praktis yang sebenar, untuk mencapai ketepatan dan kepantasan yang tinggi secara serentak adalah mencabar. Tesis ini bermotivasi untuk menyelesaikan masalah ini dan mencadangkan satu kaedah yang cukup pantas untuk pengenalan aksi manusia masa nyata pada kadar 10 kerangka sesaat (fps).

Kaedah yang dicadangkan mempunyai dua bahagian. Pada bahagian pertama, vektor ciri dikeluarkan dari setiap rangka dan pengecam aksi dibina dari turutan vektor –

vektor ini. Pemilihan vektor yang sesuai adalah penting bagi memastikan kejayaan untuk merekacipta sistem yang berkeupayaan tinggi. Tesis ini tidak seperti kerja yang terdahulu yang komplek dan menggunakan vektor yang bercirikan dimensi tinggi untuk menerangkan aksi, ia sebaliknya mencadangkan satu pengecam yang mempunyai dimensi yang rendah dan mudah disamping mengekalkan kuasa diskriminasi. Vektor ciri dibina dengan menggabungkan tiga saluran informasi iaitu dari bentuk ciri berasaskan grid, kotak kawasan dan pusat jisim bayang. Pada bahagian kedua vektor ciri – vektor ciri ini diklasifikasikan dengan menggunakan rangkaian masukan masa lengah fungsi asas jejari (TDIRBFN). Rangkaian ini tidak mempunyai lapisan integrasi di mana bilangan parameter model adalah lebih kecil dan kompleksiti pengiraan semasa pemilihan model adalah lebih rendah. Pendekatan pembiakkan sel dicadangkan untuk melatih rangkaian ini.

Kerja ini dinilai dengan menggunakan protokol tinggalkan-satu-pelakon-keluar dan set data pergerakan manusia (disediakan oleh University Illinois di Urbana-Champaign) yang mengandungi 14 aksi. Berdasarkan kepada keputusan amali yang dibuat dengan menggunakan persekitaran MATLAB, purata masa perlaksanaan untuk membentuk vektor ciri adalah 20 ms (50 fps), di mana ianya adalah lebih kecil berbanding dengan data yang telah diterbitkan sebelum ini. Kaedah yang dicadangkan boleh dilatih untuk memenuhi dua tujuan yang berbeza iaitu kelajuan yang tinggi (keperluan utama bagi sistem masa nyata) dan ketepatan yang tinggi (keperluan utama bagi sistem bukan masa nyata). Keputusan yang diperolehi ialah 15.5 fps (kelajuan pengkelas) dan 90.66% (ketepatan), untuk tujuan pertama dan 94.52% (ketepatan) dan 2.37 fps (kelajuan pengkelas), untuk tujuan kedua. Analisis perbandingan menunjukkan sistem yang dicadangkan selain mempunyai kecekapan

yang standing dengan sistem yang terdapat pada sorotan ilmiah, ianya juga mempunyai kelajuan dan prestasi keseluruhan yang lebih baik berbanding dengan kaedah – kaedah yang lain. Hasil kajian ini adalah ketara kerana ianya menawarkan pengecam yang lebih mudah dan menawarkan TDIRBFN sebagai kaedah pilihan untuk mengklasifikasikan aksi – aksi manusia terutama untuk aplikasi masa nyata.

ACKNOWLEDGEMENTS

To be blunt about it, obstacles and challenges confronting a postgraduate student are formidable. Successfully riding the roller coaster of a postgraduate degree would only be possible with the help of scholars, family, and friends; making commitment and great effort; and also these factors and several others should be in harmony with each other. The following is a few words in appreciation of the help and support that I have received during my study.

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I certify that a Thesis Examination Committee has met on 27 December 2011 to conduct the final examination of Davood Kalhor on his thesis entitled "Vision-Based Human Action Recognition Using Time Delay Input Radial Basis Function Networks" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

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Date: 2 March 2012

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

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DAVOOD KALHOR

Date: 27 December 2011

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