TEC2014-53176-R HAVideo (2015-2017)

High Availability Video Analysis for People Behaviour Understanding

D4.3 v3

Results Report

Video Processing and Understanding Lab

Escuela Politécnica Superior

Universidad Autónoma de Madrid

AUTHORS LIST

José M. Martínez	josem.martinez@uam.es
Fulgencio Navarro	fulgencio.navarro@uam.es
Diego Ortego	diego.ortego@uam.es
Rafael Martín	rafael.martinn@uam.es
Álvaro Martín	alvaro.martin@uam.es
Juan Carlos San Miguel	juancarlos.sanmiguel@uam.es
Marcos Escudero Viñolo	marcos.escudero@uam.es
Jesús Bescós	j.bescos@uam.es

HISTORY

Version	Date	Editor	Description
0.1	1 December 2015	José M. Martínez	First Draft version for contributions
0.2	2 December 2015	Fulgencio Navarro	Contributions
0.3	2 December 2015	Diego Ortego	Contributions
0.4	3 December 2015	Rafael Martin	Contributions
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0.6	10 December 2015	Juan Carlos San Miguel	Contributions
0.7	10 December 2015	Marcos Escudero	Contributions
0.8	12 December 2015	Jesús Bescós	Contributions
0.9	14 December 2015	José M. Martínez	Working Draft edition
0.10	15 December 2015	Álvaro García	Working Draft comments
0.11	16 December 2015	Juan Carlos San Miguel	Working Draft comments
0.12	17 December 2015	Marcos Escudero	Working Draft comments
0.13	18 December 2015	Diego Ortego	Working Draft comments
0.14	18 December 2015	Fulgencio Navarro	Working Draft comments
0.15	19 December 2015	Rafael Martín	Working Draft comments
0.16	22 December 2015	José M. Martínez	Final Working Draft
1.0	22 December 2015	José M. Martínez	Editorial checking
1.1	13 June 2016	José M. Martínez	First Draft version for contributions (version 3)

1.2	15 June 2016	Juan Carlos San Miguel	Contributions
1.3	16 June 2016	Diego Ortego	Contributions
1.4	18 June 2016	Álvaro García Martín	Contributions
1.5	18 June 2016	Rafael Martín	Contributions
1.6	19 June 2016	Marcos Escudero	Contributions
1.7	20 June 2016	Fulgencio Navarro	Contributions
1.9	21 June 2016	José M: Martínez	Working Draft edition
1.10	22 June 2016	Álvaro García Martín	Working Draft comments
1.11	23 June 2016	Juan Carlos San Miguel	Working Draft comments
1.12	24 June 2016	Rafael Martín	Working Draft comments
1.13	25 June 2016	Marcos Escudero	Working Draft comments
1.14	27 June 2016	Diego Ortego	Working Draft comments
1.15	27 June 2016	Jesús Bescós	Working Draft comments
1.16	29 June 2016	José M. Martínez	Final Working Draft
2.0	30 June 2016	José M. Martínez	Editorial checking

CONTENTS:

1.   Introduction

This *report* recapitulates the results obtained within the HAVideo project. The results are announced as they are obtained both at the Web site (http://www-vpu.eps.uam.es/HAvideo).

The HAVideo project started officially January 2015, nevertheless the official grant notification arrived in September. Nevertheless, Video Processing and Understanding Lab (VPULab) has been working during 2015 in the research lines proposed in the project. Therefore, the project started to produce results before the official announcement of the project start.
Nevertheless, the publication dates of all the deliverables of the project have been rescheduled to December 2015. This decision implied a delay, not affecting the project work planning, of deliverables D1.1, D1.2, D4.1 and D4.3v1 (edited together with v2 – this document-). Also the HAVi Newsletters of year 2015 were published together December 2015 (numbers 1-3).

During the third semester the workplan has been slightly modified:
- January 2016 we decided to delay the start of Tasks 3.1 (till June 2016, to synchronize WP3 tasks) and 4.2 (till January 2017 to focus on applications during the last year).
- June 2016 we have decided to extend Task 2.2 till month 30 (June 2017) in order to further work on context in multi-camera setups.

HAVi Newsletter #4 was published April 2016. With respect to deliverables, D2.2v1 and D2.3v1 were published June 2016, as well as D4.3v3 (this document). D3.1v1 was cancelled as a consequence of the delay in the start of Tasks 3.1; also, accordingly to the delay in the start of Tasks 4.2, all the related deliverables of this task planned for 2016 have been rescheduled.

1.1. Document structure

This document contains the following chapters:

- Chapter 1: Introduction to this document

- Chapter 2: Publications

- Chapter 3: Project Documents

- Chapter 4: Content Sets

- Chapter 5: Workshops and Seminars

- Chapter 6: Main achievements of the project

2. Publications

2.1. Journals

[1] Álvaro García, Juan Carlos San Miguel, **"Context-aware part-based people detection for video monitoring**", Electronic Letters, 51(23):1865:1867, Nov. 2015, IET, ISSN 0013-5194 (DOI 10.1049/el.2015.3099)

[2] Diego Ortego, Juan Carlos San Miguel, José M. Martínez, **"Long-Term Stationary Object Detection Based on Spatio-Temporal Change Detection**", IEEE Signal Processing Letters, 22(12):2368:2372, Dec. 2015, IEEE, ISSN 1070-9908 (DOI 10.1109/LSP.2015.2482598)

[3] ObaidUllah Khalid, Juan C. SanMiguel, Andrea Cavallaro, **"Multi-tracker Partition Fusion"**, IEEE Transactions on Circuits and Systems for Video Technology, (online March 2016), IEEE, ISSN 1051-8215 (DOI 10.1109/TCSVT.2016.2542699)

[4] Diego Ortego, Juan Carlos San Miguel, José M. Martínez, **"Rejection based Multipath Reconstruction for Background estimation in Video Sequences with Stationary Objects"**, Computer Vision and Image Understanding, 147:2337, Jun. 2016, Elsevier, ISSN 1077-3142 (DOI 10.1016/j.cviu.2016.03.012).

[5] Víctor Fernández-Carbajales, Miguel Ángel García, José M. Martínez, **"Visual Attention Based on a Joint Perceptual Space of Color and Brightness for Improved Video Tracking"**, Pattern Recognition, (online June 2016), Elsevier, ISSN 0031-3203 (DOI 10.1016/j.patcog.2016.06.007).

2.2. Book Chapters

2.3. Conferences

[6] Matej Kristan et al., **"The Visual Object Tracking VOT2015 challenge results"**, Proc. of 3rd Visual Object Tracking Challenge Workshop at International Conference on Computer Vision, Santiago, Chile, December 2015, pp.564-586.

[7] Michael Felsberg et al., **"The Visual Object Tracking VOT-TIR2015 challenge results"**, Proc. of 3rd Visual Object Tracking Challenge Workshop at International Conference on Computer Vision, Santiago, Chile, December 2015, pp.639-651.

2.4. PhD Thesis

[8] **Contributions to region-based image and video analysis: feature aggregation, background subtraction and description constraining,** Marcos Escudero Viñolo (advisor: Jesús Bescós Cano), Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jan. 2016

2.5. Master Thesis

[9] **Estimación de la densidad de personas en entornos densamente poblados (People density estimation in crowded environments)**, Rosely Sánchez (advisor: Álvaro García-Martín), Proyecto Fin de Carrera (Master Thesis), Ingeniería de Telecomunicación, Escuela Politécnica Superior, Univ. Autónoma de Madrid, May 2015.

[10] **Detección de personas en presencia de grupos (People detection in presence of groups)**, Sergio Merino Martínez, (advisor: Álvaro García Martín), Trabajo Fin de Máster (Master Thesis), Master en Investigación e Innovación en TIC, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Sep. 2015.

[11] **Preservación de privacidad de personas en vídeo-seguridad (People privacy preservation in video-surveillance)**, Jaime Mateo Herrero (advisor: José M. Martínez), Proyecto Fin de Carrera (Master Thesis), Ingeniería de Telecomunicación, Universidad Autónoma de Madrid, Escuela Politécnica Superior, Oct. 2015.

[12] **Detección de caídas mediante vídeo-monitorización (Fall detection using video)**, David Dean Pulido (advisor: José M. Martínez), Proyecto Fin de Carrera (Master Thesis), Ingeniería de Telecomunicación, Universidad Autónoma de Madrid, Escuela Politécnica Superior, Mar. 2016.

[13] **Análisis de actividad en vídeos deportivos multicámara (Activity analysis in multicamera sports videos)**, Ángel Mora Sánchez (advisor: Rafael Martín), Proyecto Fin de Carrera (Master Thesis), Ingeniería de Telecomunicación, Universidad Autónoma de Madrid, Escuela Politécnica Superior, Mar. 2016.

[14] **Estimación de fondo de escena en secuencias de vídeo**, Jaime Gallo de Cal, (advisor: Diego Ortego Hernández), Proyecto fin de Carrera, en Ingeniería de Telecomunicación, Jul. 2016.

[15] **Evaluación comparativa de técnicas de detección y descripción de puntos de interés en imágenes**, Miguel Martín Redondo, (advisor: Fulgencio Navarro Fajardo), Proyecto fin de Carrera, en Ingeniería de Telecomunicación, Jul. 2016.

[16] **Automatización de funciones en el seguimiento del profesor para la emisión de clases presenciales**, Alberto Palero Almazán, (advisor: Jesús Bescós Cano), Trabajo Fin de Máster (Master Thesis),), Master en Ingeniería de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

2.6. Graduate Thesis

[17] **Detección de ritmo cardíaco mediante vídeo (Heart rate detection using video)**, Erik Velasco Salido (advisor: José M. Martínez), Trabajo Fin de Grado (Graduate Thesis), Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jun. 2015.

[18] **Identificación automática de materiales usando el sensor Kinect (Material identification through the Kinect technology)**, Alejandro López

Cifuentes (advisor: Marcos Escudero Viñolo), Trabajo Fin de Grado (Graduate Thesis), Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jun. 2015.

[19] **Detección de la posición relativa de una cámara en situaciones de grandes desplazamientos (Detection of camera relative position in wide-baseline scenarios)**, María Narváez Encinal (advisor: Marcos Escudero Viñolo), Trabajo Fin de Grado (Graduate Thesis), Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jun. 2015.

[20] **Detección de vehículos mediante el análisis de imágenes (Image-based vehicle detection)**, Juan Ignacio Bravo (advisor: Luis Salgado), Trabajo Fin de Grado (Graduate Thesis), Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jun. 2015.

[21] **Simulador virtual para sistemas multi-cámara distribuidos (Distributed multicamera systems virtual simualtor),** Luis Pérez Llorente (advisor: Juan C. San Miguel), Trabajo Fin de Grado (Graduate Thesis), Grado en Ingeniería Informática, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2015.

[22] **Desarrollo de herramienta para la anotación manual de secuencias de vídeo (Developemt of a video sequences manual annotation tool),** Yoel Witmaar (advisor: Juan C. San Miguel), Trabajo Fin de Grado (Graduate Thesis), Grado en Ingeniería Informática, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2015.

[23] **Detección de Personas en Grupos (People detection in groups),** Marta Villanueva Torres (advisor: Álvaro García), Trabajo Fin de Grado (Graduate Thesis), Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2015.

[24] **Detección de personas en entornos multicámara utilizando información contextual**, Alejandro Miguélez Sierra (advisor: Rafael Martín), Trabajo Fin de Grado, Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Ene. 2016.

[25] **Detección de personas en entornos residenciales y hospitalarios**, Jesús Molina Merchán (advisor: Rafael Martín), Trabajo Fin de Grado, Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jun. 2016.

[26] **Detección de objetos abandonados para vídeo-vigilancia a largo plazo**, Sergio López Álvarez (advisor: Diego Ortego), Trabajo Fin de Grado, Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jun. 2016.

[27] **Reconstrucción de fondo de escena a partir de secuencias de vídeo**, Carolina Fernández-Pedraza (advisor: Diego Ortego), Trabajo Fin de Grado, Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

[28] **Detección de personas utilizando contexto de la escena**, Carlos Chaparro Pozo (advisor: Álvaro García), Trabajo Fin de Grado, Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

[29]   **Seguimiento de objetos mediante constricción espacial de puntos TILDE**, César Augusto Betancur Cruz (advisor: Marcos Escudero Viñolo), Trabajo Fin de Grado, Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jun. 2016.

[30]   **Diseño y desarrollo de una herramienta para la extracción semi-supervisada de la información de contexto**, Raúl García Jiménez (advisor: Marcos Escudero Viñolo), Trabajo Fin de Grado, Grado en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

[31]   **Diseño de herramientas de apoyo para la detección de logotipos en secuencias de video**, Efrén Martín García (advisor: Marcos Escudero Viñolo), Trabajo Fin de Grado, Grado en Ingeniería Informática, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

[32]   **Seguimiento automático de objetivos con Drones mediante algoritmos de tracking**, Roi Rico Díaz (advisor: Fulgencio Navarro Fajardo), Trabajo Fin de Grado, en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

[33]   **Control de cámaras PTZ para la reconstrucción de escena basada en puntos de interés**, Elisa Martín Pérez (advisor: Fulgencio Navarro Fajardo), Trabajo Fin de Grado, en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

[34]   **Seguimiento de objetos basado en múltiples algoritmos**, Eduardo Moreno de Pablos, (advisor: Juan C. SanMiguel Avedillo), Trabajo Fin de Grado, en Ingeniería de Tecnologías y Servicios de Telecomunicación, Escuela Politécnica Superior, Universidad Autónoma de Madrid, Jul. 2016.

3. Project Documents

3.1. Deliverables

3.2. First year Deliverables

3.2.1. D1.1 "System Infrastructure" version 1 (December 2015)

This deliverable describes the current infrastructure and purchase plans for the second year, as due to budget constraints and grant notification delay, the originally planned acquisitions have been postponed to the beginning of the second year. This delayed purchase allows to define priorities over the acquisitions in the proposal by discussing the needs with the package leaders. As a result, additional equipment is going to be purchased: a new server with GPU support and laptops for the research team. The acquisition of battery-powered cameras will be considered during the third year subject to budget availability. The second year report will contain the planned milestones and deliverables corresponding to the acquisition of portable equipment (to be performed in the third year).

3.2.2. D1.2 "DiVA documentation" version 1 (December 2015)

This deliverable describes the activities performed for the task T.1.2: Update and maintenance of the Distributed Video Analysis (DiVA) software architecture. During the first year, an existing annotation tool has been improved to provide semiautomatic information which will be integrated in DiVA. Due to the low priority of this task (no dependencies exist during the first year), project resources have been reassigned to more critical tasks and therefore, the completion of the developments for the contextual information management have been postponed to the second and third year, where integration of new sensors, reliability testing and improvements of the annotation tools will be explored. For the second year, the deliverable D1.2 will be updated with the planned improvements of the employed annotation tool in the project.

3.2.3. D1.3 "Simulator documentation: description, programmer manual and user guide" version 1 (December 2015)

This deliverable describes the activities performed for the task T.1.3: Development and maintenance of a camera network simulator. During the first year, two multi-camera simulators have been developed for virtual data and for network conditions. The former allows to repeatedly visualize the same activities with a network of cameras whereas the latter provides features to simulate real networks (communication protocols, wireless/wired channels, transmission delays/errors, …). Proper documentation has been generated for both simulators. For the second year, the objective is twofold: improve the virtual simulator and integrate with the network simulator.

3.2.4. D2.1 "People Behaviour understanding in single and multiple camera settings" version 1 (December 2015)

This deliverable describes the work related with the task T.2.1 Analysis Tools for human behavior understanding. The people behavior understanding in this project has been already designed as a sequential combination of object segmentation, people

detection, object tracking and behavior recognition. In particular, during the first part of the project there have been a focus on developing different approaches for segmentation, people detection and tracking in single camera.

In relation with segmentation, a long-term stationary object detection based on spatio-temporal change detection has been implemented and evaluated, as a result a publication in an international journal has been presented ([2]).

In relation with people detection several approaches have been implemented and tested in relation with people behavior understanding: people density estimation in crowded scenarios and people detection in groups (Master theses [9][10] and Graduate Thesis [23]). There is also an ongoing work related with integrating wheelchair users in people detection.

In relation with tracking, we have presented a tracker to an international tracking challenge (VOT challenge), as a result two publications [6][7] in an international conference have been presented. In addition, there is an ongoing work on high-precision shape tracking.

3.2.5. D2.4 "Exploration and viability studies for people behaviour understanding" version 1 (December 2015)

This deliverable describes the work related with the task T2.4, exploration and viability studies. Three main works has been developed and are presented below.

The first work is related to heart rate detection using video, and the developed system is explained in graduate thesis [17].

The second work focuses on people privacy preservation in video-surveillance. This work is contained in master thesis [11].

The third work combines colour, texture and depth information to identify materials in a Kinect-like controlled scenario. This work is contained in master thesis [18].

3.2.6. D4.1 "Evaluation methodology and datasets" version 1 (June 2015) [cancelled]

This deliverable was cancelled.

3.2.7. D4.1 "Evaluation methodology and datasets" version 1 (December 2015)

In relation with people detection, a new people detection dataset has been recorded and evaluated, in particular, multiple camera video sequences has been recorded in a real in-door senior residence environment containing wheelchairs users and standing people and it has been released together with the associated ground-truth.

In relation with tracking, we have presented a tracker to an international tracking challenge (VOT challenge). The VOT challenges provide the visual tracking community with a precisely defined and repeatable way of comparing trackers as well as a common platform for discussing the evaluation and advancements made in the field of visual tracking. This deliverable includes a description of the proposed methodology and dataset presented in the VOT challenge.

3.2.8. D4.3 "Results Report" version 1 (June 2015) [delayed]

This deliverable was delayed and merged with December's version (this document).

3.2.9. D4.3 "Results Report" version 1&2 (December 2015)

This *report* recapitulates the results obtained within the HAVideo project during 2015. The results are announced as they are obtained both at the Web site (http://www-vpu.eps.uam.es/HAvideo).

3.3. Third semester Deliverables

3.3.1. D2.2 "Contextual modelling and extraction for people behaviour understanding" version 1 (June 2016)

This deliverable describes the work related with the task T2.2, context modelling and extraction. Eight main works have been developed and are presented below.

The first approach is related to the development of semi-automatic annotation tools [22] based on image and video processing algorithms. The objective is to reduce the effort and time required to annotate video sequences.

The second approach aims to design and develop a set of algorithms able to cope with the problem of modelling the epipolar geometry between two widely separated cameras capturing the same scene [19].

The third approach is focused on the implementation of a system able to segment a video flow generated by a forward looking camera placed in the frontal of a vehicle, with the aim of detecting vehicles, pavement and lane marks. The system handles contextual information of the scene to generate statistical models of the regions of interest [20].

The fourth approach is related to include context information to people detection and combine information obtained from different cameras [24].

The fifth approach proposes an approach for part-based people detection in images that uses pre-annotated contextual information to weight the contribution of each model part [1]. An upgrade of this approach is also developed in [28].

The sixth approach enhances [19] by designing and developing strategies to propagate the user annotation of contextual objects from the first frame to the rest of the video. The main objective is to provide tight-to-object annotation masks of dynamic contextual objects while further reducing the required amount of user interactions [30].

The seventh approach [33] aims to generate the scene panoramic using a PTZ-recording camera.

Finally, in the eighth approach [8], regions are used to constrain the descriptions of singular points. The advantages of this scheme are illustrated by means of a method for object identification in cluttered scenarios.

3.3.2. D2.3 "Online quality analysis of people behaviour understanding" version 1 (June 2016)

This deliverable describes the work related with the task T2.3, quality analysis. Various activities have been undertaken and are presented below.

The first activity considers a video tracking application where multiple algorithms are employed to track a single target [3]. Tracker's quality is estimated to cluster trackers over time in order to identify the ones following the right target. Intra-tracker and inter-tracker spatio-temporal measures are proposed to estimate the quality of each algorithm.

The second activity is related to the study of good object properties to estimate the quality of Background Subtraction algorithms without using ground-truth. A set of 21 measures is analysed in a heterogeneous dataset using four algorithms, demonstrating that fitness between objects and segmented image regions has a great potential to replicate performance.

The third activity consists in the development of a Background Estimation algorithm for video sequences [4] robust to stationary objects. The main novelty consists in a multipath reconstruction scheme that allows improving performance compared to related literature.

The fourth activity involves the implementation of two algorithms for Background estimation in video sequences [27] from the literature. The experiments carried out demonstrates superior capabilities of block-wise approaches against pixel-wise ones in challenging scenarios.

3.3.3. D4.3 "Results Report" version 3 (June 2016)

This *report* recapitulates the results obtained within the HAVideo project during the first semester of 2016. The results are announced as they are obtained both at the Web site (http://www-vpu.eps.uam.es/HAvideo).

3.4. Fourth semester Deliverables (planned)

3.4.1. D1.1 "System Infrastructure" version 2 (December 2016)

3.4.2. D1.3 "Simulator documentation: description, programmer manual and user guide" version 2 (December 2016)

3.4.3. D2.1 "People Behaviour understanding in single and multiple camera settings" version 2 (December 2016)

3.4.4. D2.2 "Contextual modelling and extraction for people behaviour understanding" version 2 (December 2016)

3.4.5. D2.4 "Exploration and viability studies for people behaviour understanding" version 2 (December 2016)

3.4.6. D3.1 "Online adaptive people behaviour understanding based on contextual and quality information" version 1 (December 2016)

3.4.7. D3.2 "Collaborative approaches for people behaviour understanding" version 1 (December 2016)

3.4.8. D4.1 "Evaluation methodology and datasets" version 2 (December 2016)

3.4.9. D4.3 "Results Report" version 4 (December 2016)

3.5. Technical Reports

4. Content Sets

4.1.1. Wheelchair Users dataset - WUds

http://www-vpu.eps.uam.es/DS/WUds/

5. Workshops and Seminars

5.1. Workshops

5.1.1. 1st Workshop

The first workshop was held May 2015 at the Escuela Politécnica Superior of the Universidad Autónoma de Madrid.

It was not announced as HAVideo Workshops as the project proposal approval notification was not received at that time.

The Workshop consisted of two parts:

- Dissemination Day (May 25th 2015): Video Analysis Technologies and applications for Computer Vision.
- Short course: (May 26th-28th 2015): Introduction to Computer Vision applications programming with OpenCV

5.1.2. 2016 Developers Workshop

The 2016 Developers Workshop was held May 2016 at the Escuela Politécnica Superior of the Universidad Autónoma de Madrid.

The Workshop consisted of two parts:

- Dissemination Day (May 23rd 2016): Video Analysis Technologies and applications for Computer Vision.
- Short course: (May 24th-26th 2016): Introduction to Computer Vision applications programming with OpenCV

There were 16 participants.

5.2. Seminars

6. Main Achievements of the Project

6.1. First year main achievements

For workpackage WP.1: Video Analysis Framework, the main achievements are:
- Task 1.3: Update and maintenance of a camera network simulator
    - o Development of a virtual camera network simulator [21]
    - o Improvement of an existing camera network simulator to include embedded hardware modelling, sensor models and real communication protocols

For workpackage WP.2: Video analysis tools, models and performance indicators, the main achievements are:
- Task 2.1: Analysis Tools for human behaviour understanding
    - o Development of a long-term stationary object detection based on spatio-temporal change detection [2].
    - o Development of a people density estimation in crowded scenarios [9] and a people detection in groups [10][23].
- Task 2.2: Contextual modeling and extraction
    - o Development of a context-aware people detector [1][28] which uses static contextual annotation to integrate and weight partial evidences from a part-based people detector algorithm.
    - o Improvement of an existing manual annotation tool, to provide semiautomatic tools that speed up the annotation process.
    - o Development of a camera calibration algorithm [19] to detect the relative position of a camera respect to another in wide-baseline scenarios.
    - o Development of a vehicle detection algorithm [20] that uses on-line generated context to separate between object classes.
    - o Development of a tool and of its associated user interface to annotate static contextual objects in video sequences [22].
- Task 2.4: Exploration and viability studies
    - o Implementation of a privacy preserving module for existing video surveillance systems [11].
    - o Development of a heart rate detector using video [17].
    - o Development of a system for material identification through the Kinect technology [18].

For workpackage WP.4: Evaluation framework, demonstrators and dissemination, the main achievements are:
- Task 4.1: Evaluation framework
    - o International tracking challenge (VOT challenge) evaluation [6][7].
    - o Development of a new dataset for wheelchairs users and standing people detection in a real in-door senior residence environment.
- Task 4.3: Dissemination
    - o The web page has been created
    - o The first workshop was held May 2015 at the Escuela Politécnica Superior of the Universidad Autónoma de Madrid (see 5.1.1)

6.2. Third semester main achievements

For workpackage WP.1: Video Analysis Framework, the work on the third semester has been focused on improving the virtual camera network simulator using the Unity tool. This work is expected to be completed in the fourth semester (Task 1.3: Update and maintenance of a camera network simulator)

For workpackage WP.2: Video analysis tools, models and performance indicators, the main achievements are:
- Task 2.1: Analysis Tools for human behaviour understanding
    o Development of a measure to estimate tracking quality based on reverse trajectory analysis employed for combining multiple algorithms [3]
    o Development of a new Visual Attention Model enhancing discrimination among objects and its application to tracking [5]
    o Development of a fail detection algorithm [12]
    o Development of two applications for sport analysis of multicamera sports videos [13].
    o Enhancements to a long-term teacher-tracking system for the real-time distribution of classroom activities [16].
    o Compiled and generated training image sets (real and synthetical) to train people detectors adapted to hospitalary environments and nursing homes [25].
    o Development of a robust to appearance changes tracker based on the use of a state-of-the-art point-of-interest detector [29].
    o Development of an adaptation of state of the art tracking algorithms to perform long-term on UAVs sequences in a Graduate Thesis [32].
- Task 2.2: Contextual modeling and extraction
    o Study to include context information to people detection and combine information obtained from different cameras [24].
    o Improvement of an existing tool and of its associated user interface to propagate the annotation of static and dynamic contextual objects in video sequences [30].
    o Development of an online panoramic background initialization algorithm for PTZ cameras in a Graduate Thesis [33].
- Task 2.3: Quality Analysis
    o Study of good object properties for stand-alone evaluation of Background Subtraction algorithms.
    o Study of online people detection algorithms quality analysis using correlation metrics.
    o Development of a Background Estimation algorithm for video sequences robust to stationary objects [4].
    o Development of a Background Estimation algorithm for video sequences in a Master Thesis [14].
    o Development of a long-term abandoned object detector robust against sudden illumination changes and stationary pedestrians [26].
    o Implementation of two algorithms for Background Estimation from the literature [27].

     o Considering the potential of measures based on fitness to regions, new measures for evaluation of Background Subtraction without ground-truth are being developed.
- Task 2.4: Exploration and viability studies
     o Development of pre-processing algorithms to constrain logo detection [31].

Workpackage WP.3: Self-configurable approaches for long-term analysis, has been delayed till the second semester of 2016.

For workpackage WP.4: Evaluation framework, demonstrators and dissemination, the main achievements are:
- Task 4.1: Evaluation Framework
     o Development of an evaluation framework and a comparative analysis of state of the art local features detection and description algorithms in a Master Thesis [15]
     o Generation of a dataset containing 4 categories or challenges with 10 video sequences for the task of Background Estimation [27].
     o International tracking challenge (VOT challenge) evaluation (results will be available in the next months).
- Task 4.3: Dissemination
     o The 2016 HAVideo Developers workshop was held May 2016 at the Escuela Politécnica Superior of the Universidad Autónoma de Madrid (see 5.1.2)