IN PARTNERSHIP WITH:
CNRS

Institut polytechnique de Grenoble

Université Joseph Fourier (Grenoble)

Activity Report 2014

Project-Team MORPHEO

Capture and Analysis of Shapes in Motion

IN COLLABORATION WITH: Laboratoire Jean Kuntzmann (LJK)

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
Vision, perception and multimedia interpretation

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Project-Team MORPHEO

Keywords: Computer Vision, Computer Graphics, 3d Modeling, Geometry Processing, Video

Creation of the Team: 2011 March 01*, updated into Project-Team:* 2014 January 01.

1. Members

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Lionel Reveret [Inria, Researcher, HdR]

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Franck Hétroy-Wheeler [INP Grenoble, Associate Professor]

Engineers

Abdelaziz Djelouah [Inria, until Sep 2014, granted by Technicolor]
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2. Overall Objectives

2.1. Overall Objectives

Morpheo's main objective is the ability to perceive and to interpret moving shapes using systems of multiple cameras for the analysis of animal motion, animation synthesis and immersive and interactive environments. Multiple camera systems allow dense information on both shapes and their motion to be recovered from visual cues. Such ability to perceive shapes in motion brings a rich domain for research investigations on how to model, understand and animate real dynamic shapes. In order to reach this objective, several scientific and technological challenges must be faced:

A first challenge is to be able to recover shape information from videos. Multiple camera setups allow to acquire shapes as well as their appearances with a reasonable level of precision. However most effective current approaches estimate static 3D shapes and the recovery of temporal information, such as motion, remains a challenging task. Another challenge in the acquisition process is the ability to handle heterogeneous sensors with different modalities as available nowadays: color cameras, time of flight cameras, stereo cameras and structured light scanners, etc.

A second challenge is the analysis of shapes. Few tools have been proposed for that purpose and recovering the intrinsic nature of shapes is an actual and active research domain. Of particular interest is the study of animal shapes and of their associated articulated structures. An important task is to automatically infer such properties from temporal sequences of 3D models as obtained with the previously mentioned acquisition systems. Another task is to build models for classes of shapes, such as animal species, that allow for both shape and pose variations.

A third challenge concerns the analysis of the motion of shapes that move and evolve, typically humans. This has been an area of interest for decades and the challenging innovation is to consider for this purpose dense motion fields, obtained from temporally consistent 3D models, instead of traditional sparse point trajectories obtained by tracking particular features on shapes, e.g. motion capture systems. The interest is to provide full information on both motions and shapes and the ability to correlate these information.The main tasks that arise in this context are first to find relevant indices to describe the dynamic evolutions of shapes and second to build compact representations for classes of movements.

A fourth challenge tackled by Morpheo is immersive and interactive systems. Such systems rely on real time modeling, either for shapes, motion or actions. Most methods of shape and motion retrieval turn out to be fairly complex, and quickly topple hardware processing or bandwidth limitations, even with a limited number of cameras. Achieving interactivity thus calls for scalable methods and research of specific distribution and parallelization strategies.

3. Research Program

3.1. Shape Acquisition

Multiple camera setups allow to acquire shapes, i.e. geometry, as well as their appearances, i.e. photometry, with a reasonable level of precision. However fundamental limitations still exist, in particular today's state-of-the-art approaches do not fully exploit the redundancy of information over temporal sequences of visual observations. Despite an increasing interest of the computer vision communities in the past years, the problem is still far from solved other than in specific situations with restrictive assumptions and configurations. Our goal in this research axis is to open the acquisition process to more general assumptions, e.g. no specific lighting or background conditions, scenes with evolving topologies, , and fully leverage temporal aspects of the acquisition process.

3.2. Bayesian Inference

Acquisition of 4D Models can often be conveniently formulated as a Bayesian estimation or learning problem. Various generative and graphical models can be proposed for the problems of occupancy estimation, 3D surface tracking in a time sequence, and motion segmentation. The idea of these generative models is to predict the noisy measurements (e.g. pixel values, measured 3D points or speed quantities) from a set of parameters describing the unobserved scene state, which in turn can be estimated using Bayes' rule to solve the inverse problem. The advantages of this type of modeling are numerous, as they enable to model the noisy relationships between observed and unknown quantities specific to the problem, deal with outliers, and allow to efficiently account for various types of priors about the scene and its semantics. Sensor models for different modalities can also easily be seamlessly integrated and jointly used, which remains central to our goals.

Since the acquisition problems often involve a large number of variables, a key challenge is to exhibit models which correctly account for the observed phenoma, while keeping reasonable estimation times, sometimes with a real-time objective. Maximum likelihood / maximum a posteriori estimation and approximate inference techniques, such as Expectation Maximization, Variational Bayesian inference, or Belief Propagation, are useful tools to keep the estimation tractable. While 3D acquisition has been extensively explored, the research community faces many open challenges in how to model and specify more efficient priors for 4D acquisition and temporal evolution.

3.3. Shape Analysis

Shape analysis has received much attention from the scientific community and recovering the intrinsic nature of shapes is currently an active research domain. Of particular interest is the study of human and animal shapes and their associated articulated underlying structures, i.e. skeletons, since applications are numerous, either in the entertainment industry or for medical applications, among others. Our main goals in this research axis are : the understanding of a shape's global structure, and a pose-independent classification of shapes.

3.4. Shape Tracking

Recovering the temporal evolution of a deformable surface is a fundamental task in computer vision, with a large variety of applications ranging from the motion capture of articulated shapes, such as human bodies, to the deformation of complex surfaces such as clothes. Methods that solve for this problem usually infer surface evolutions from motion or geometric cues. This information can be provided by motion capture systems or one of the numerous available static 3D acquisition modalities. In this inference, methods are faced with the challenging estimation of the time-consistent deformation of a surface from cues that can be sparse and noisy. Such an estimation is an ill posed problem that requires prior knowledge on the deformation to be introduced in order to limit the range of possible solutions. Our goal is to devise robust and accurate solutions based on new deformation models that fully exploit the geometric and photometric information available.

3.5. Motion Modeling

Multiple views systems can significantly change the paradigm of motion capture. Traditional motion capture systems provide 3D trajectories of a sparse set of markers fixed on the subject. These trajectories can be transformed into motion parameters on articulated limbs with the help of prior models of the skeletal structure. However, such skeletal models are mainly robotical abstractions that do not describe the true morphology and anatomical motions of humans and animals. On the other hand, 4D models (temporally consistent mesh sequences) provide dense motion information on body's shape while requiring less prior assumption. They represent therefore a new rich source of information on human and animal shape movements. The analysis of such data has nevertheless received few attention yet and tools still need to be developed which is our objective.

4. Application Domains

4.1. 4D modeling

Modeling shapes that evolve over time, analyzing and interpreting their motion has been a subject of increasing interest of many research communities including the computer vision, the computer graphics and the medical imaging communities. Recent evolutions in acquisition technologies including 3D depth cameras (Time-of-Flight and Kinect), multi-camera systems, marker based motion capture systems, ultrasound and CT scans have made those communities consider capturing the real scene and their dynamics, create 4D spatio-temporal models, analyze and interpret them. A number of applications including dense motion capture, dynamic shape modeling and animation, temporally consistent 3D reconstruction, motion analyzes and interpretation have therefore emerged.

4.2. Shape Analysis

Most existing shape analysis tools are local, in the sense that they give local insight about an object's geometry or purpose. The use of both geometry and motion cues makes it possible to recover more global information, in order to get extensive knowledge about a shape. For instance, motion can help to decompose a 3D model of a character into semantically significant parts, such as legs, arms, torso and head. Possible applications of such high-level shape understanding include accurate feature computation, comparison between models to detect defects or medical pathologies, and the design of new biometric models or new anthropometric datasets.

4.3. Human Motion Analysis

The recovery of dense motion information enables the combined analyses of shapes and their motions. Typical examples include the estimation of mean shapes given a set of 3D models or the identification of abnormal deformations of a shape given its typical evolutions. The interest arises in several application domains where temporal surface deformations need to be captured and analysed. It includes human body analyses for which potential applications are anyway numerous and important, from the identification of pathologies to the design of new prostheses.

4.4. Interaction

The ability to build models of humans in real time allows to develop interactive applications where users interact with virtual worlds. The recent Kinect proposed by Microsoft illustrates this principle with game applications using human inputs perceived with a depth camera. Other examples include gesture interfaces using visual inputs. A challenging issue in this domain is the ability to capture complex scenes in natural environments. Multi-modal visual perception, e.g. depth and color cameras, is one objective in that respect.

5. New Software and Platforms

5.1. Software packages

5.1.1. Shape Tracking

We are developing a software suite to track shapes over temporal sequences. The motivation is to provide temporally coherent 4D Models, i.e. 3D models and their evolutions over time , as required by motion related applications such as motion analysis. This software takes as input a temporal sequence of 3D models in addition to a template and estimate the template deformations over the sequence that fit the observed 3D models. This software is particularly developed in the context of the FUI project Creamove.

5.1.2. LucyViewer

Lucy Viewer http://4drepository.inrialpes.fr/lucy_viewer/ is an interactive viewing software for 4D models, i.e, dynamic three-dimensional scenes that evolve over time. Each 4D model is a sequence of meshes with associated texture information, in terms of images captured from multiple cameras at each frame. Such data is available from various websites over the world including the 4D repository website hosted by Inria Grenoble http://4drepository.inrialpes.fr/. The software was developed in the context of the European project iGlance, it is available as an open source software under the GNU LGP Licence.

5.1.3. Ethomice

Ethomice http://morpheo.inrialpes.fr/people/reveret/ethomice/ is a motion analysis software to characterize motor behavior of small vertebrates such as mice or rats. From a multiple views video input, a biomechanical model of the skeleton is registered. Study on animal model is the first important step in Biology and Clinical research. In this context, the analysis of the neuro-motor behaviour is a frequent cue to test the effect of a gene or a drug. Ethomice is a platform for simulation and analysis of the small laboratory animal, such as rat or mouse. This platform links the internal skeletal structure with 3D measurements of the external appearance of the animal under study. From a stream of multiple views video, the platform aims at delivering a three dimensional analysis of the body posture and the behaviour of the animal. The software was developed by Lionel Reveret and Estelle Duveau. An official APP repository has been issued this year.

5.2. Databases

5.2.1. 4D repository (http://4drepository.inrialpes.fr/)

This website hosts dynamic mesh sequences reconstructed from images captured using a multi-camera set up. Such mesh-sequences offer a new promising vision of virtual reality, by capturing real actors and their interactions. The texture information is trivially mapped to the reconstructed geometry, by back-projecting from the images. These sequences can be seen from arbitrary viewing angles as the user navigates in 4D (3D geometry + time) . Different sequences of human / non-human interaction can be browsed and downloaded from the data section. A software to visualize and navigate these sequences is also available for download.

5.3. Platforms

5.3.1. Platform Grimage

The Grimage platform is an experimental multi-camera platform dedicated to spatio-temporal modeling including immersive and interactive applications. It hosts a multiple-camera system connected to a PC cluster, as well as visualization facilities including head mounted displays. This platform is shared by several research groups, most proeminently Moais, Morpheo and Perception. In particular, Grimage allows challenging real-time immersive applications based on computer vision and interactions between real and virtual objects, Figure 1. Note that the Grimage platform, while still active in 2014, is now replaced by the Kinovis platform that exhibit a larger acquisition space and better acquisition facilities.

Figure 1. Platform: the Grimage acquisition.

5.3.2. Platform Kinovis

Kinovis (http://kinovis.inrialpes.fr/) is a new multi-camera acquisition project that was was selected within the call for proposals ”Equipements d’Excellence” of the program “Investissement d’Avenir˝ funded by the French government. The project involves 2 institutes: the Inria Grenoble Rhône-Alpes, the université Joseph Fourier and 4 laboratories: the LJK(laboratoire Jean Kuntzmann - applied mathematics), the LIG (laboratoire d’informatique de Grenoble - Computer Science), the Gipsa lab (Signal, Speech and Image processing) and the LADAF (Grenoble Hospitals - Anatomy). The Kinovis environment will be composed of 2 complementary platforms. A first platform located at the Inria Grenoble will have a 10mx10m acquisition surface and will be equipped with 60 cameras. It is the evolution of the Grimage platform previously described towards the production of better models of more complex dynamic scenes. A second platforms located at Grenoble Hospitals, within the LADAF anatomy laboratory, will be equipped with both color and X-ray cameras to enable combined analysis of internal and external shape structures, typically skeleton and bodies of animals. Installation works of both platforms started in 2013 and are now finished. Members of Morpheo are highly involved in this project. Edmond Boyer is coordinating this project and Lionel Reveret is in charge of the LADAF platform. Thomas Pasquier and Julien Pansiot are managing the technical resources of both platforms.

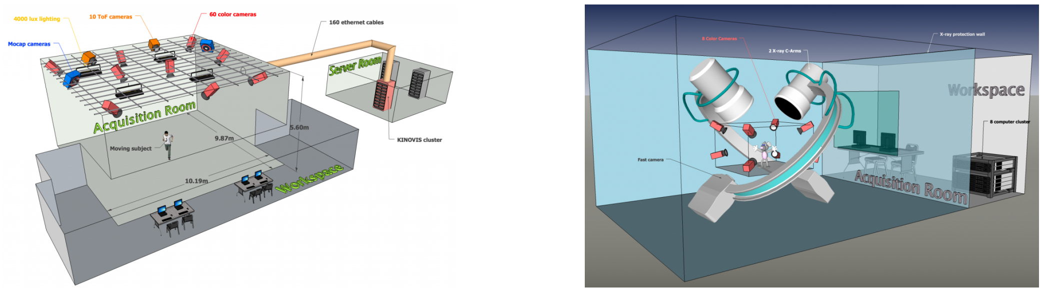

Figure 2. Kinovis platforms: on the left the Inria platform; on the right Grenoble Hospital platform.

5.3.3. *Multicamera platform for video analysis of mice behavior*

This project is a follow-up of the experimental set-up developed for a CNES project with Mathieu Beraneck from the CESeM laboratory (centre for the study of sensorimotor control, CNRS UMR 8194) at the Paris-Descartes University. The goal of this project was to analyze the 3D body postures of mice with various vestibular deficiencies in low gravity condition (3D posturography) during a parabolic flight campaign. The set-up has been now adapted for new experiments on motor-control disorders for other mice models. This experimental platform is currently under development for a broader deployment for high throughput phenotyping with the technology transfer project ETHOMICE. This project involves a close relationship with the CESeM laboratory and the European Mouse Clinical Institute in Strasbourg (Institut Clinique de la Souris, ICS).

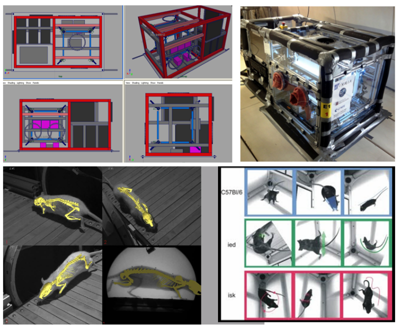

Figure 3. Ethomice: Experimental platform for video analysis of mice behavior.

6. New Results

6.1. Human Shape and Pose Tracking Using Keyframes

In this work we consider human tracking in multi-view set-ups and investigates a robust strategy that learns online key poses to drive a shape tracking method. The interest arises in realistic dynamic scenes where occlusions or segmentation errors occur. The corrupted observations present missing data and outliers that deteriorate tracking results. We propose to use key poses of the tracked person as multiple reference models. In contrast to many existing approaches that rely on a single reference model, multiple templates represent a larger variability of human poses. They provide therefore better initial hypotheses when tracking with noisy data. Our approach identifies these reference models online as distinctive keyframes during tracking. The most suitable one is then chosen as the reference at each frame. In addition, taking advantage of the proximity between successive frames, an efficient outlier handling technique is proposed to prevent from associating the model to irrelevant outliers. The two strategies are successfully experimented with a surface deformation framework that recovers both the pose and the shape. Evaluations on existing datasets also demonstrate their benefits with respect to the state of the art. This work was presented at CVPR'14 [5].

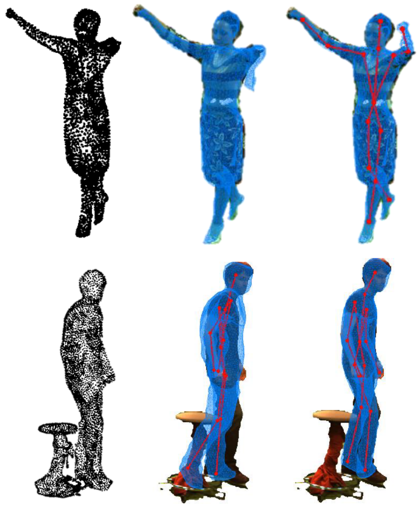

Figure 4. Shape tracking with keframes[5]

6.2. On Mean Pose and Variability of 3D Deformable Models

We present a novel methodology for the analysis of complex object shapes in motion observed by multiple video cameras. In particular, we propose to learn local surface rigidity probabilities (i.e., deformations), and to estimate a mean pose over a temporal sequence. Local deformations can be used for rigidity-based dynamic surface segmentation, while a mean pose can be used as a sequence keyframe or a cluster prototype and has therefore numerous applications, such as motion synthesis or sequential alignment for compression or morphing. We take advantage of recent advances in surface tracking techniques to formulate a generative model of 3D temporal sequences using a probabilistic framework, which conditions shape fitting over all frames to a simple set of intrinsic surface rigidity properties. Surface tracking and rigidity variable estimation can then be formulated as an Expectation-Maximization inference problem and solved by alternatively minimizing two nested fixed point iterations. We show that this framework provides a new fundamental building block for various applications of shape analysis, and achieves comparable tracking performance to state of the art surface tracking techniques on real datasets, even compared to approaches using strong kinematic priors such as rigid skeletons.

Figure 5. Rigidity probability of the shape tracked with mean pose [4]

6.3. Segmentation multi-vues par coupure de graphes

In this paper, we address the problem of object segmentation in multiple views when two or more viewpoints of the same scene are available. We propose a new approach that propagates segmentation coherence information in space, hence allowing evidence in one image to be shared over the complete set. To this aim the segmentation is cast as a single efficient labeling problem over space and time with graph cuts. In contrast to most existing multi-view segmentation methods that rely on some form of dense reconstruction, ours only requires a sparse 3D sampling to propagate information between viewpoints. The approach is thoroughly evaluated on standard multi-view datasets. The obtained results compete with state of the art methods but they are achieved with significantly fewer viewpoints.

Figure 6. Results of our multi-view segmentation approach over 3 input views, with no user interaction (completely automated). [9]

6.4. Combined Visible and X-Ray 3D Imaging

This work considers 3D imaging of moving objects and introduces a technique that exploits visible and x-ray images to recover dense 3D models. While recent methods such as tomography from cone-beam x-ray can advantageously replace more expensive and higher-dose CT scanners, they still require specific equipment and immobilised patients. We investigate an alternative strategy that combines a single x-ray source and a set of colour cameras to capture rigidly moving samples. The colour cameras allow for coarse marklerless motion tracking, which is further refined with the x-ray information. Once the sample poses are correctly estimated, a dense 3D attenuation model is reconstructed from the set of x-ray frames. Preliminary results on simulated data compared to ground-truth as well as actual in-vivo experiments were presented at the conference MIUA'14 [6].

6.5. Non-Rigid Registration meets Surface Reconstruction

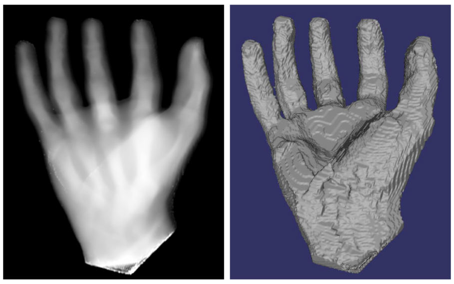

Figure 7. Human hand reconstruction with a combined visible and x-ray system [6]

Non rigid registration is an important task in computer vision with many applications in shape and motion modeling. A fundamental step of the registration is the data association between the source and the target sets. Such association proves difficult in practice, due to the discrete nature of the information and its corruption by various types of noise, e.g. outliers and missing data. In this work we investigate the benefit of the implicit representations for the non-rigid registration of 3D point clouds. First, the target points are described with small quadratic patches that are blended through partition of unity weighting. Then, the discrete association between the source and the target can be replaced by a continuous distance field induced by the interface. By combining this distance field with a proper deformation term, the registration energy can be expressed in a linear least square form that is easy and fast to solve. This significantly eases the registration by avoiding direct association between points. Moreover, a hierarchical approach can be easily implemented by employing coarse-to-fine representations. Experimental results were conducted with point clouds from multi-view data sets. The qualitative and quantitative comparisons show the outperformance and robustness of our framework. This work was presented at 3DV'14[7].

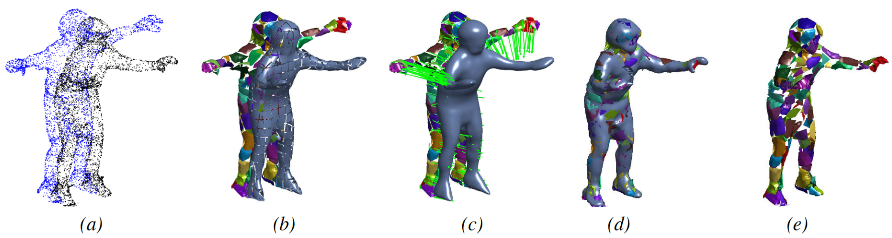

Figure 8. Using implicit interface for registration: (a) initial pose of the source and target sets; (b) source patches and the local quadrics representing the target; (c) the implicit interface induces a gradient field; (d) deformed source patches fitting the interface; a coarse-to-fine interface has been used in (c) - (d); (e) the final deformation of the template [7].

6.6. High Resolution 3D Shape Texture from Multiple Videos

We examine the problem of retrieving high resolution textures of objects observed in multiple videos under small object deformations. In the monocular case, the data redundancy necessary to reconstruct a high-resolution image stems from temporal accumulation. This has been vastly explored and is known as super-resolution. On the other hand, a handful of methods have considered the texture of a static 3D object observed from several cameras, where the data redundancy is obtained through the different viewpoints. We introduce a unified framework to leverage both possibilities for the estimation of a high resolution texture of an object. This framework uniformly deals with any related geometric variability introduced by the acquisition chain or by the evolution over time. To this goal we use 2D warps for all viewpoints and all temporal frames and a linear projection model from texture to image space. Despite its simplicity, the method is able to successfully handle different views over space and time. As shown experimentally, it demonstrates the interest of temporal information that improves the texture quality. Additionally, we also show that our method outperforms state of the art multi-view super-resolution methods that exist for the static case. This work was presented at CPVR'14 [8].

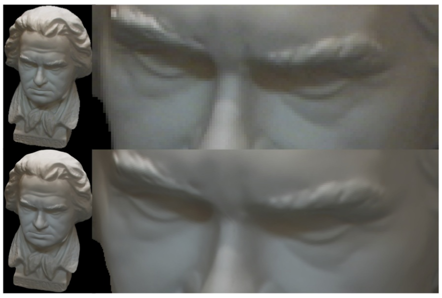

Figure 9. Input view 768 × 576 resolution with up-sampling by factor of three, BEETHOVEN dataset. Super-resolved 2304×1728 output of our algorithm rendered from identical viewpoint [8].

7. Bilateral Contracts and Grants with Industry

7.1. Contract with Technicolor

A three year collaboration with Technicolor has started in 2011 and ended in 2014. The objective of this collaboration was to consider the capture and the interpretation of complex dynamic scenes in uncontrolled environments. A co- supervised PhD student (Abdelaziz Djelouah) was working on this subject and will defend his PhD in March 2015.

8. Partnerships and Cooperations

8.1. ARC6 project PADME – Perceptual quality Assessment of Dynamic MEshes and its applications

In this project, we propose to use a new and experimental "bottom-up" approach to study an interdisciplinary problem, namely the objective perceptual quality assessment of 3D dynamic meshes (i.e., shapes in motion with temporal coherence). The objectives of the proposed project are threefold:

1. to understand the HVS (human visual system) features when observing 3D animated meshes, through a series of psychophysical experiments;
2. to develop an efficient and open-source objective quality metric for dynamic meshes based on the results of the above experiments;
3. to apply the learned HVS features and the derived metric to the application of compression and/or watermarking of animated meshes.

This work is funded by the Rhône-Alpes région through an ARC6 grant for the period 2013-2016. The three partners are LIRIS (University Lyon 1, Florent Dupont), GIPSA-Lab (CNRS, Kai Wang) and LJK (University of Grenoble, Franck Hétroy-Wheeler). A PhD student, Georges Nader, is working on this project.

8.2. National Initiatives

8.2.1. Motion analysis of laboratory rodents

In order to evaluate the scalabililty of previous work on motion analysis of laboratory rodents, a collaboration has been initiated with the Institut Clinique de la Souris (ICS), in Institut de Génétique et de Biologie Moléculaire et Cellulaire (IGBMC). This institute is dedicated to phenotypying of mice and requires reliable motion analysis tools. A multicamera plateform has been deployed at ICS and will be exploited next year for tests ranging from one to two hundreds mice.

8.2.2. ANR

8.2.2.1. ANR project Morpho – Analysis of Human Shapes and Motions

Morpho is aimed at designing new technologies for the measure and for the analysis of dynamic surface evolutions using visual data. Optical systems and digital cameras provide a simple and non invasive mean to observe shapes that evolve and deform and we propose to study the associated computing tools that allow for the combined analysis of shapes and motions. Typical examples include the estimation of mean shapes given a set of 3D models or the identification of abnormal deformations of a shape given its typical evolutions. Therefore this does not only include static shape models but also the way they deform with respect to typical motions. It brings a new research area on how motions relate to shapes where the relationships can be represented through various models that include traditional underlying structures, such as parametric shape models, but are not limited to them. The interest arises in several application domains where temporal surface deformations need to be captured and analyzed. It includes human body analyses but also extends to other deforming objects, sails for instance. Potential applications with human bodies are anyway numerous and important, from the identification of pathologies to the design of new prostheses. The project focus is therefore on human body shapes and their motions and on how to characterize them through new biometric models for analysis purposes. 3 academic partners will collaborate on this project: the Inria Rhône-Alpes with the Morpheo team, the GIPSA-lab Grenoble and the Inria Lorraine with the Alice team. Website: http://morpho.inrialpes.fr/.

8.2.3. Competitivity Clusters

8.2.3.1. FUI project Creamove

Creamove is a collaboration between the Morpheo team of the Inria Grenoble Rhône-Alpes, the 4D View Solution company specialised in multi-camera acquisition systems, the SIP company specialised in multi-media and interactive applications and a choreographer. The objective is to develop new interactive and artistic applications where humans can interact in 3D with virtual characters built from real videos. Dancer performances will be pre-recorded in 3D and used on-line to design new movement sequences based on inputs coming from human bodies captured in real time. Website: http://www.creamove.fr.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. Re@ct

Type: FP7 COOPERATION

Defi: IMMERSIVE PRODUCTION AND DELIVERY OF INTERACTIVE 3D CONTENT

Instrument: Specific Targeted Research Project

Objectif: Networked Media ans Search Systems

Duration: December 2011 - November 2014

Coordinator: BBC (UK)

Partner: BBC (UK), Fraunhofer HHI (Germany), University of Surrey (UK), Artefacto (France), OMG (UK).

Inria contact: Jean-Se´bastien Franco, Edmond Boyer

Abstract:RE@CT will introduce a new production methodology to create film-quality interactive characters from 3D video capture of actor performance. Recent advances in graphics hardware have produced interactive video games with photo-realistic scenes. However, interactive characters still lack the visual appeal and subtle details of real actor performance as captured on film. In addition, existing production pipelines for authoring animated characters are highly labour intensive. RE@CT aims to revolutionise the production of realistic characters and significantly reduce costs by developing an automated process to extract and represent animated characters from actor performance capture in a multiple camera studio. The key innovation is the development of methods for analysis and representation of 3D video to allow reuse for real-time interactive animation. This will enable efficient authoring of interactive characters with video quality appearance and motion. The project builds on the latest advances in 3D and free-viewpoint video from the contributing project partners. For interactive applications, the technical challenges are to achieve another step change in visual quality and to transform captured 3D video data into a representation that can be used to synthesise new actions and is compatible with current gaming technology.

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Declared Inria International Partners

8.4.1.1.1. Joint project with Forest Research, UK

A common work with an ecophysiologist from Forest Research, Eric Casella, is currently carried out to detect, analyse and correct acquisition noise from terrestrial laser scans (t-LiDAR) of trees. This project is funded by Grenoble university, through the AGIR framework. First results have been presented during the 5th French-Canadian workshop “Use of t-LiDAR systems in forest ecology”.

8.4.1.2. Informal International Partners

8.4.1.2.1. Collaboration with TU Munich

The long term collaboration with TU Munich and Slobodan Ilic on human motion capture is ongoing with the work of Paul Huang [5] that was published atCVPR this year. The work contributes with an approach that identifies and takes benefit of key poses when tracking shapes.

8.5. International Research Visitors

8.5.1. Visits to International Teams

8.5.1.1. Sabbatical programme

Reveret Lionel

Date: Jul 2014 - June 2015

Institution: Brown University (USA)

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific events selection

9.1.1.1. Member of the conference program committee

- Edmond Boyer was area chair for BMVC, ICPR and RFIA.

9.1.1.2. Reviewer

- Edmond Boyer has reviewed for: CVPR, ECCV, 3DV, ACCV, CVMP, ORASIS
- Jean-Sébastien Franco has reviewed for: CVPR 2014, ECCV 2014, 3DV 2014.
- Franck Hétroy-Wheeler has reviewed for SIGGRAPH Asia (course).
- Lionel Reveret has reviewed for: ACM SIGGRAPH, Eurographics, BMVC, Pacific Graphics (committee member), Motion in Games (committee member).

9.1.2. Journal

9.1.2.1. Member of the editorial board

- Edmond Boyer is associate editor of IJCV.

9.1.2.2. Reviewer

- Edmond Boyer has reviewed for: Eurographics, IEEE PAMI.
- Jean-Sébastien Franco has reviewed for: PAMI, Refig.
- Franck Hétroy-Wheeler has reviewed for: IJCV, Graphical Models, ReFIG.
- Lionel Reveret has reviewed for: ACM Transactions on Graphics, Computer Graphics Forum.

9.1.3. Invited talks

- Edmond Boyer gave invited talks at: MPI Tubingen, AC3D'14 conference, Gratz University, Reims Image conference.

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

Licence: J.S. Franco, Algorithmics, 60h, Ensimag 1st year, Grenoble INP

License: J.S. Franco, C Project, 30h, Ensimag 1st year, Grenoble INP

Master: J.S. Franco, End of study project (PFE) Project Tutoring, 18h, Ensimag 2nd year, Grenoble INP

Master: J.S. Franco, Projet de Specialité - Project Tutoring, 14h, Ensimag 2nd year, Grenoble INP

Master: J.S. Franco, 3D Graphics, 50h, Ensimag 2nd year, Grenoble INP

Master: J.S. Franco, Modelisation et programmation C++, 9h, Ensimag 2nd year, Grenoble INP

Master: J.S. Franco, Introduction to Computer Vision, 27h, Ensimag 1st year, Grenoble INP

Master: J.S. Franco, co-responsability of the Graphics, Vision, Robotics specialty of the Mosig Masters program, Second year Masters, Grenoble INP, Université Joseph Fourier

Master: Edmond Boyer, 3D Modeling, 9h, M2R GVR, Université Joseph Fourier Grenoble, France.

Master: Edmond Boyer, projet de programmation, 30h, M1 informatique - M1 MoSig, Université Joseph Fourier Grenoble, France.

Master: Edmond Boyer, Introduction to Image Analysis, 15h, M1 MoSig, Université Joseph Fourier Grenoble, France.

9.2.2. Supervision

PhD in progress : Benjamin Allain, Geometry and Appearance Analysis of Deformable 3D shapes, Université de Grenoble, started 01/10/2012, supervised by J.S. Franco and E. Boyer.

PhD in progress: Adnane Boukhayma, 4D model synthesis, Universiteé de Grenoble, started 01/10/2013, supervised by Edmond Boyer.

PhD in progress: Georges Nader, Evaluation de la qualité perceptuelle de maillages dynamiques et ses applications, Université Claude Bernard - Lyon 1, started 01/10/2013, supervised by Florent Dupont, Kai Wang and Franck Hétroy-Wheeler.

PhD in progress: Li Wang, Transport optimal pour l'analyse de formes en mouvement, Université de Grenoble, started 01/10/2013, supervised by Edmond Boyer and Franck Hétroy-Wheeler.

PhD in progress : Vagia Tsiminaki, Appearance Modelling and Time Refinement in 3D Videos, Université de Grenoble, started 01/10/2012, supervised by J.S. Franco and E. Boyer.

9.2.3. Juries

- Edmond Boyer was reviewer of two PhD thesis (Rim Slama, Lille University, Christian Reinbacher Graz University) and president of one PhD committee (Eva Mavridou, Grenoble University).

9.3. Popularization

- Franck Hétroy-Wheeler gave a talk to high school math teachers entitled: “Digital geometry: from real to virtual worlds”. This talk has then been adapted and given to a 11th grade class.

10. Bibliography

Publications of the year

Doctoral Dissertations and Habilitation Theses

[1] L. Reveret. *Measurements and models for motion capture*, Institut National Polytechnique de Grenoble - INPG, May 2014, Habilitation à diriger des recherches, https://tel.archives-ouvertes.fr/tel-01064134

Articles in International Peer-Reviewed Journals

[2] A. Barbacci, J. Diener, P. Hémon, A. Adam, N. Donès, L. Reveret, B. Moulia. *A robust videogrametric method for the velocimetry of wind-induced motion in trees*, in "Agricultural and Forest Meteorology", January 2014, vol. 184, pp. 220-229 [*DOI :* 10.1016/j.agrformet.2013.10.003], https://hal.inria.fr/hal-00915106

[3] M. Rouhani, A. D. Sappa, E. Boyer. *Implicit B-Spline Surface Reconstruction*, in "IEEE Transactions on Image Processing", January 2015, vol. 24, n^{o} 1, pp. 22 - 32 [*DOI :* 10.1109/TIP.2014.2366374], https://hal.inria.fr/hal-01101037

International Conferences with Proceedings

[4] B. Allain, J.-S. Franco, E. Boyer, T. Tung. *On Mean Pose and Variability of 3D Deformable Models*, in "ECCV 2014 - European Conference on Computer Vision", Zurich, Switzerland, Springer, September 2014, https://hal.inria.fr/hal-01016981

[5] C. H. Huang, E. Boyer, N. Navab, S. Ilic. *Human Shape and Pose Tracking Using Keyframes*, in "CVPR 2014 - IEEE International Conference on Computer Vision and Pattern Recognition", Columbus, United States, IEEE, June 2014, pp. 3446-3453 [*DOI :* 10.1109/CVPR.2014.440], https://hal.inria.fr/hal-00995681

[6] J. Pansiot, L. Reveret, E. Boyer. *Combined Visible and X-Ray 3D Imaging*, in "Medical Image Understanding and Analysis", London, United Kingdom, July 2014, pp. 13-18, https://hal.inria.fr/hal-00994974

[7] M. ROUHANI, E. BOYER, A. D. SAPPA. *Non-Rigid Registration meets Surface Reconstruction*, in "3DV 2014 - International Conference on 3D Vision", Tokyo, Japan, December 2014, https://hal.inria.fr/hal-01063513

[8] V. TSIMINAKI, J.-S. FRANCO, E. BOYER. *High Resolution 3D Shape Texture from Multiple Videos*, in "CVPR 2014 - IEEE International Conference on Computer Vision and Pattern Recognition", Columbus, OH, United States, June 2014, https://hal.inria.fr/hal-00977755

National Conferences with Proceedings

[9] A. DJELOUAH, J.-S. FRANCO, E. BOYER, F. LE CLERC, P. PÉREZ. *Segmentation multi-vues par coupure de graphes*, in "RFIA 2014 - Reconnaissance de Formes et Intelligence Artificielle", Rouen, France, June 2014, https://hal.archives-ouvertes.fr/hal-00988772