Overview of the 2013 Workshop on Medical Computer Vision (MCV 2013)

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Abstract. The 2013 workshop in medical computer vision (MCV) took place in Nagoya, Japan in connection with MICCAI (Medical Image Computing for Computer Assisted Intervention). It is the third MICCAI MCV workshop after 2011 and 2012. This workshop aims at exploring the use of modern computer vision technology in tasks such as automatic segmentation and registration, localisation of anatomical features and detection of anomalies. It emphasises questions of harvesting, organising and learning from large–scale medical imaging data sets and general–purpose automatic understanding of medical images. We are especially interested in modern, scalable and efficient algorithms which generalise well to previously unseen images. The strong participation in the workshop of over 70 persons shows the importance of and interest in Medical Computer Vision. This overview article describes the papers presented in the workshop as either oral presentations or short presentations and posters. It also describes the invited talks and the results of the VISCERAL session in the workshop on the use of big data in medical imaging.

Keywords: medical image analysis, medical computer vision, segmentation, detection

1 Introduction

The workshop MCV (Medical Computer Vision) took place in connection with MICCAI (Medical Image Computing for Computer–Assisted Interventions) on September 26, 2013 in Nagoya, Japan. This is the third workshop on medical computer vision organised in connection with MICCAI after the workshops in 2011 [] and 2012 []. The workshop received 25 high quality paper submissions.

All papers were reviewed by at least three external reviewers of the scientific committee of the workshop. Then, all borderline papers were reviewed in addition by at least one member of the workshop organisers. The seven best papers were presented as long papers and another twelve papers were accepted as short papers and posters. With the increasing importance of large datasets it was also decided to add a session on an evaluation campaign called VISCERAL[1] (VISual Concept ExtRaction challenge in RAdioLogy) in 2013. The VISCERAL project [15] is indeed manually annotating large amounts of 3D medical data to make them available in two benchmarks for research. The first benchmark is on the automatic detection of organs in the body and includes over 20 organs and more than 50 landmarks in the body. The second benchmark will be on the retrieval of similar cases in very large data sets. Two papers in this volume also present preliminary work on the VISCERAL data set and the discussion at the workshop on the important parts of the benchmark and the challenges.

This text also gives an overview of the most important discussions that took place during the medical computer vision workshop and the challenges that were identified in the field.

2 Papers presented at the workshop

The workshop presents several categories of papers that are described in more detail in the following sections. *Long papers* include the papers with clearly the best review scores that were presented as long papers at the MCV workshop. The *short papers* were high quality papers accepted for a short presentation at the workshop and a poster. Then, the two *invited talks* are described. The last section finally describes the VISCERAL session of the workshop and the two preliminary papers that were presented by participants in the organ detection challenge. This section also describes the discussions at the VISCERAL session.

2.1 Long papers

The presented long papers were separated into three topic areas, papers on registration techniques, segmentations techniques and a last section on localisation and detection.

Registration Chou et al. [4] describe a 2D/3D deformable registration approach

Local regression learning via forest classification for 2D/3D deformable registration Chen-Rui Chou and Stephen Pizer (UNC) [4]

Semi-supervised learning of nonrigid deformations for image registration John Onofrey, Lawrence Staib and Xenophon Papademetris (Yale) [17]

[1] `http://viscerl.eu/`

Segmentation White matter supervoxel segmentation by axial DP-means clustering Ryan Cabeen, and David Laidlaw (Brown) [3]

Integrated spatio-temporal segmentation of longitudinal brain tumor imaging studies Stefan Bauer, Jean Tessier, Oliver Krieter, Lutz-P. Nolte and Mauricio Reyes (Bern U) [2] This paper won the price for the best paper sponsored by Siemens. Indeed, the paper included the longitudinal analysis of medical images of the brain with a fully automatic segmentation. This allows the disease grading.

Semantic context forests for learning-based knee cartilage segmentation in 3D MR image Quan Wang, Dijia Wu, Le Lu, Meizhu Liu, Kim Boyery and Kevin Zhou (Rensselaer / Siemens) [20]

Detection and Localization Class-specific regression random forest for accurate extraction of standard planes from 3D echocardiography Kiryl Chykeyuk and Alison Noble (Oxford) [5]

Organ localization using joint AP/LAT view landmark consensus detection and hierarchical active appearance models Qi Song, Albert Montillo, Roshni Bhagalia and Srikrishnan (GE) [18]

2.2 Short papers

The short papers are grouped into the topics of Detection, Visualization, Segmentation and Features and Retrieval.

Detection Pectoral muscle detection in digital breast tomosynthesis and mammography Florin Ghesu, Michael Wels, Anna Jerebko, Michael Suhling, Joachim Hornegger and Michael Kelm (Siemens / Erlangen U) [11]

Automatic aorta detection in 3D cardiac CT images using Bayesian tracking method Mingna Zheng, Jeffery Carr and Yaorong Ge (Virginia Tech / Wake Forest / UNC) [22]

Local phase-based fast ray features for automatic left ventricle apical view detection in 3D echocardiography Joao Domingos, Eduardo Lima, Paul Leeson and Alison Noble (Oxford) [7] *Visualization* Flexible architecture for streaming and visualization of large virtual microscopy images German Corredor, Marcela Iregui, Viviana Arias and Eduardo Romero (U National Colombia / U Militar Bogota) [6]

2D-PCA shape models: application to 3D reconstruction of the human teeth from a single image Aly Abdelrehim, Aly Farag, Ahmed Shalaby and Moumen El-Melegy (U Louisville / Assiut U) [1]

Segmentation Robust mixture-parameter estimation for unsupervised segmentation of brain MR images Alfiia Galimzianova, Tiga Spiclin, Bostjan Likar and Franjo Pernus (U Ljubljana) [10]

Accurate whole-brain segmentation for Alzheimers disease combining an adaptive statistical atlas and multi-atlas Zhennan Yan, Shaoting Zhang, Xiaofeng Liu, Dimitris Metaxas, Albert Montillo and AIBL (Rutgers / GE) [21]

Features and Retrieval Computer aided diagnosis using multilevel image features on large-scale evaluation Le Lu, Pandu Devarakota, Siddharth Vikal, Dijia Wu, Yefeng Zheng and Matthias Wolf (Siemens) [16]

2D-based 3D volume retrieval using singular value decomposition of detected regions Alba Seco de Herrera, Antonio Foncubierta Rodriguez, Emanuele Schiavi and Henning Muller (HES-SO/ Rey Juan Carlos) [13]

A novel shape feature descriptor for the classification of polyps in HD colonoscopy Michael Hafner, Andreas Uhl and Georg Wimmer (Salzburg U / Vienna Hospital) [12]

Shape Curvature Histogram: a shape feature for celiac disease diagnosis Michael Gadermayr, Michael Liedlgruber, Andreas Uhl and Andreas Vecsei (Salzburg U / Vienna Hospital) [8]

Feature extraction with intrinsic distortion correction in celiac disease imagery: no need for rasterization Michael Gadermayr, Andreas Uhl and Andreas Vecsei (Salzburg U / Vienna Hospital) [9]

2.3 Invited papers

The first invited speaker was *Leo Grady* of Healthflow Inc., USA. His invited talk focused on the remaining challenges in image segmentation for real clinical applications. Very small differences in the final label can determine the decisions that the health providers will take for a specific patient. He encouraged the audience to not be satisfied with the evluation scores accepted by the community but to aim at a clinical implementation of their methods. He also described the business model used in his company that originated from a method proposed in one of the previous MICCAI conferences.

The second invited talk was give by *Ron Kikinis* of Harvard Medical School, Cambridge, MA, USA. He called for a more continuos development in the medical image computing community by using the research time more efficiently. He mentioned that the methods that are accepted by other researchers are fast and are able work on a different environment than the one were they were developed. He presented some of the features introduced in Slicer based on the feedback by both developers and researchers. Methods that are adaptable and allow improvements in the coding by other users tend to have a higher impact in the community.

2.4 VISCERAL section

The VISCERAL session at the MCV workshop had the goals to inform about the whole–body annotation benchmark that is developed in the VISCERAL project. Another goal was also to include the entire medical imaging community into the discussion of how things should be analysed and what the main challenges in terms of research are. The discussions thus addressed some of the obstacles of doing a multi–organ segmentation like overcoming normal anatomical variability. Many showed an interest in sharing a large dataset to compare their own

approaches. Three approaches for organ segmentation and landmark detection were presented by HES–SO and Toshiba Medical Visualization Systems Europe who are registered participants of Benchmark 1.

In [14], the manually annotated volumes are registered to a new volume. This registration of several manually annotated volumes to a new volume allows to create probability maps for each of the organ in a flexible approach that does not use any a priori information. Such probability maps can then also be used for finding seed points for other segmentation algorithms.

In [19] a quite different approach is described by Jimenez et at.. The presented work uses atlases for segmentation and can potentially be complementary to the text of Joyseeree et al With atlases a priori information can be integrated into the segmentation process and thus relations between several organs.

Toshiba research then presented their approach that included mainly the detectin of landmarks and not organ segmentation.

3 Discussions at the workshop

The large number of over 70 participants at the workshop also led to a large number of very interesting discussions during the workshop and also the lunch and coffee breaks.

4 Conclusions

The third edition of the workshop on medical computer vision at MICCAI was a clear success. High quality papers and posters were presented and many discussions on challenges and techniques used emerged. The domain also still has many research challenges that are currently being tackles. The use of large amounts of data such as in the VISCERAL project requires several changes for researchers in terms of validating approaches and developing computationally quick approaches. Many of the more complex approaches can be very well used on small–scale and specific problems but might never work on extremely big data sets.

Also the

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