032 ASMTB: AN EXTENSIBLE DEVELOPMENT ENVIRONMENT FOR 3D SEGMENTATIONS BASED ON ACTIVE SHAPE MODELS

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Background: Segmentation approaches based on statistical shape models (SSM), such as the Active Shape Model (ASM) framework, are a family of powerful methods for image segmentation [1]. The general idea of these methods is that a weak contrast at object boundaries, partial occlusions or high noise that make a proper segmentation very difficult can be compensated by employing a-priori knowledge of the shapes of the structures that are to be segmented.
However, deploying SSMs for practical image segmentation tasks is non-trivial, as a vast amount of configurations of the algorithm has to be chosen, such as shape representation, appearance descriptor, model fitting method, etc., each having a substantial impact on segmentation quality.

Aims: The objective is to simplify the application and evaluation of ASMs for tackling individual segmentation tasks and to provide an extensible framework including a graphical user interface (GUI) for the efficient exploration of various parametrisations and alterations (such as in [1,2]) of the ASM method.

Methods: A prototype of a development environment (DE) for the application of ASM-based segmentation methods has been developed in MATLAB.
As a particular segmentation task has its individual requirements and peculiarities it is not possible to provide a general framework that is suitable to all thinkable scenarios. Thus, our focus lies on providing a robust object-oriented (OO) software architecture that can easily be tailored to specific tasks.
Core components of this architecture, which directly translate to OO classes, are: *training set*, *shape representation*, *image representation*, *active shape model* (comprising a *point distribution model* and an *appearance/profile model*), *search method*, *segmentation result* and *cross-validation setting*. Customisations of these components are enabled by class inheritance. A simplified UML class diagram including some provided customisations is shown in Fig (a).
On top of this OO framework a GUI has been developed in order to interact with the core components. It comprises four modules (*training* module, *ASM inspection* module, *search* module and *evaluation* module).

Results: The developed software is currently used for applying ASMs for the 3D segmentation of deep brain structures [3] and has proven to be a highly valuable tool for evaluating various ASM configurations.

Conclusions: Due to the large number of improvements of the ASM framework proposed in the literature it is non-trivial to find the appropriate alterations including their optimal parametrisations for a given segmentation task. Thus, finding a good configuration is in general tackled manually by a combination of heuristics and trial-and-error. In order to improve the efficiency of this procedure the proposed prototype DE for ASM-based segmentation has been developed.
The extension of the proposed DE to other approaches based on SSM, such as the Active Appearance Model, is straightforward and can be implemented by class inheritance.

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References: [1] T. Heimann, H.-P. Meinzer, "Statistical shape models for 3D medical image segmentation: A review" Medical Image Analysis 13, 4: 543–563, 2009.
[2] B. van Ginneken, A.F. Frangi, R.F. Frangi, J.J. Staal, B.M. Haar Romeny, M.A. Viergever, "Active Shape Model Segmentation with Optimal Features" IEEE Transactions on Medical Imaging 21:924–933, 2002.
[3] F. Bernard, A. Husch, F. Hertel, P. Gemmar, "Patient-specific Modelling of the Subthalamic Nucleus for Deep Brain Stimulation Targeting" International Neuromodulation Society World Congress, Berlin, Germany, Jun 2013.

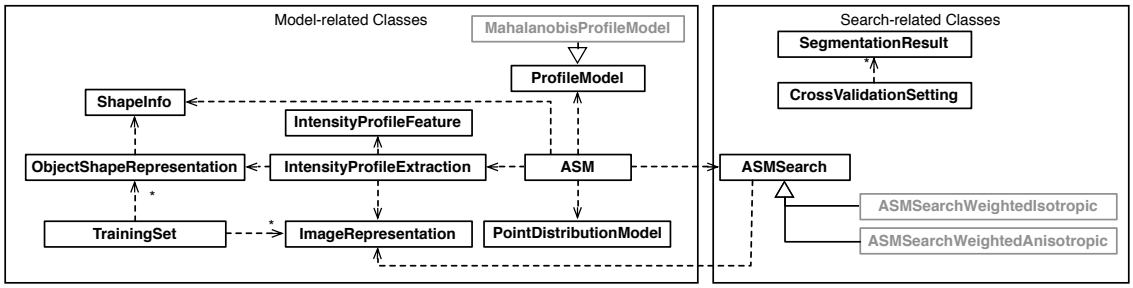

Figure: (a) Simplified class diagram of the core components (black) and example customisations (grey).