Machine learning for biomedical image visualization

IMI Research Seminar, June 8, 2018

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Agenda

– Intro to Biomedical and Multimedia Information Technology (BMIT) Research Group
– Biomedical Image Visualisation Examples
  – Saliency-based volume rendering
  – fMRI (4D spatial-temporal data)
  – Musculoskeletal visualisation
  – Nasal Analysis
http://bmit-network.org/
Biomedical and Multimedia Information Technology

http://bmit-network.org/
BMIT Research Themes

Theme: Biomedical Data Augmentation and Visualization; Telehealth
Theme Leader: Jinman Kim

Theme: Data Fusion, Registration and Segmentation
Theme Leader: Xiuying Wang

Theme: Multimedia Computing
Theme Leader: Zhiyong Wang

http://bmit-network.org/
Hospitals as Partners

Royal Prince Alfred

Westmead

Nepean
Machine learning for biomedical image visualization
BMIT Research on Medical Image Analysis

Deep Learning driven Imaging Processing

Integrated data processing

Visualization
1. AI-based Image Analysis
2. Integrated Data Processing; Image+

- Image + Image (e.g., Pre/Post surgery)
- Image + Video (e.g., image annotations during surgical)
- Image + Omics (e.g., image-genomics and survival)
- Image + Tissue …
- Image + Implantable Devices …
- …
3. Visualisation + Mixed Biomedical Reality
Ensemble of Networks

Kumar et al., IEEE JBHI’16
PERCIST Full Body Segmentation

Lei et al., CMIG’16
Dual-path adversarial learning (DAL) method for FCN segmentation

Lei et al., TVCJ 2018
Saliency-based Detection and Segmentation

Bi et al., TBE, 2017
Ahn et al., JBHI 2017
Yuan et al., TIP, 2018
Yuan et al., TCSVT

Figure 2: Flow diagram of our proposed multi-stage fully convolutional networks with parallel integration (mFCN-PI) method.
Saliency-based Volume Rendering
Object Detection and Visualization using Contextual Saliency

<table>
<thead>
<tr>
<th>(a) User-defined Ray</th>
<th>(b) SDRPA</th>
<th>(c) Saliency-driven DVR</th>
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<tbody>
<tr>
<td><img src="image1" alt="DVR" /></td>
<td><img src="image2" alt="SDRPA" /></td>
<td><img src="image3" alt="Saliency-driven DVR" /></td>
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<tr>
<td>(i) Saliency computation</td>
<td>(ii) Feature identification</td>
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<tr>
<td>2D ray-aligned intensity image slice</td>
<td>Ray profile analysis</td>
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<tr>
<td>Color mapping</td>
<td>Default DVR</td>
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<tr>
<td>Saliency map</td>
<td>Default TF</td>
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<tr>
<td>Gray-level ramp TF</td>
<td>Saliency-driven TF</td>
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<td>x-axis: intensity y-axis: opacity</td>
<td>x-axis: intensity y-axis: opacity</td>
<td>x-axis: ray y-axis: intensity</td>
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</tbody>
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Feature of Interest based Direct Volume Rendering using Contextual Saliency-driven Ray Profile Analysis, CGF
Interactive Demo

Initial DVR (intensity windowing)
Application Example I: Single Click Interaction

(a) (b) (c) (d)
Application Example II: MR Volume Visualization

(a) 2D MR image
(b) Saliency map of (b)
(c) Saliency-driven DVR
Occlusion and Slice-based Volume Rendering Augmentation for PET-CT

Jung et al., IEEE JBHI 2016
**Multi-modality PET-CT Visualization**

- Improve PET-CT image interpretation.
  - Quickly identify parts of PET images, such as cancers.
  - Depicts the accurate localization of PET abnormality.
- Improve communication among clinicians.
  - Presentation to other clinicians, e.g., Multi-Disciplinary Team (MDT) meeting.
- Clinical Trial
  - 6 clinicians (evaluators) are involved. 2 clinicians per site: Usyd (Royal Prince Alfred hospital) and Shanghai Jiatong (Renji and Ruijin hospital).
Multi-modality TF Parameter Optimization

Jung et al., TVCJ, 2013

- Use of spatial relationships among features from multiple modalities.
Nasal Cavity for Airflow Visual Analysis
Nasal Cavity for Airflow Visual Analysis

Huang et al., ISBI 2016
fMRI Analysis Pipeline and Uncertainties – opportunities for visual analytics and computer graphics
fMRI Viewer - CereVA

deRidder et al., BDVA, EMBC, etc.
Musculoskeletal Image Analysis and Visualisation
Modelling of Pre-surgical and Post-surgical Total Knee CT Scans

- Deep learning to automatically segment pre- and post-surgical total knee CT scans
  - Deep learning based statistical shape model / synthetics
  - Simulate gate and derive clinical measurements e.g., relative angles
Machine Learning for Automated Personalized Orthotic Therapy of the Children

– Use of machine learning to create personalized AFOs for children with MSK problems directly from 3D scans
– Challenges in 3D scanned object refinements