SGRT: Overview and New Trends

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Educational Objectives

• Discuss SI opportunities
• Review basic principles & systems
• Emerging results & applications
• New developments

Role of Imaging in RT

• Volumetric, x-ray based imaging crucial for interfraction positioning due to highly conformal deliveries
• Limitations:
  – Additional dose
  – Temporal snapshot
  – No real-time monitoring
  – Motion management
  – Patient posture visualization
Why Surface Imaging?

- Goal: Improve the overall (temporal) accuracy of radiation delivery
  - Patient positioning
    - Improve inter-fractional set-up accuracy & precision
    - Visualize patient surface changes
    - Reduce set-up time
  - Patient monitoring
    - Monitor patient intra-fractionally (assess post CBCT/planar shifts)
    - Quantify inadvertent movements
    - Minimize re-imaging needs/reduce dose
  - Motion management tool for delivery
    - Efficient gating tool without extra patient devices
    - Simultaneously monitor patient motion and acquire breathing trace

Photogrammetry

- Method of extracting three-dimensional information from data acquired by means of multiple two dimensional images
- **Stereophotogrammetry** incorporates the known spatial geometry information
- Various techniques
  - Video-based
  - Laser-based
  - Optical-based

Evolution of SGRT

OPTICAL-BASED IMAGING

Triangulation

\[ R = \frac{B \cdot \sin(\theta)}{\sin(\alpha + \theta)} \]

B and \( \alpha \) are known, How to get the value of \( \theta \)?

Structured Light Patterns

Zhang et al. 3DPVT (2002)

Selection of ROI

Courtesy of H. Al-Hallaq
Newer Generation: Systems

- VisionRT AlignRT
- C-RAD CatalystHD
- Varian IDENTIFY

SGRT Workflow Modules

Identification
- Ability to verify patients
- Identify immobilization devices

Positioning
- Use of SI to position patients in 6D
- Posture correction

Monitoring
- Use of SI to monitor patient motion relative to reference position

Gating
- Use of SI to provide breathing trace for gated deliveries

IDENTIFICATION
- Biometric identification
- Palm/RFID
- Facial
- Correct immobilization devices and location on treatment table verification
SGRT Workflow Modules

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SI: Set-up Accuracy & Efficiency

Can surface imaging improve the patient setup for proton postmastectomy chest wall irradiation?
Katia Kato PhD, Nilos Bapoo MD, Sharman Cullen MD, Jee-Hoon Lee MD

SGRT Workflow Modules

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Monitoring:
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Patient Monitoring: Lung VMAT Case

Patient Monitoring: Proton Breast Tx

SGRT Workflow Modules

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Gating:
- Use of SI to provide breathing trace for gated deliveries
Motion Management: Gating


Additional SI Opportunities

- New treatment sites
- Use to patient collision
- Use to monitor patient changes
- Use to facilitate machine QA

Evolving SI Platforms

- BrainLAB ExacTrac Dynamic
- Combining imaging systems to synergistically improve accuracy
  - Surface
  - X-ray
  - Thermal
- Thermal imaging
  - Potentially enhances accuracy for select sites by using 3D heat map

Tumor regression detected with SI


Ryan Foster, Ph.D.

Patient Collision Detection

Quality assurance of gating response times for surface guided motion management treatment delivery using an electronic portal imaging device

Ryan Foster, Ph.D.

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Coastal of BrainLAB
Conclusions

• SI technology has evolved over recent years to improve quality and delivery efficiency of patient treatments
• Increasing adoption of SI technology in recent years
• Growing data emerging on the improved accuracy of radiation delivery for a number of disease sites
• Exciting future opportunities to further the use of SI

Thank you for your attention!