CADIPT

3D depth-resolved imaging using Enhanced Truncated Correlation Photothermal Coherence Tomography (eTC-PCT)

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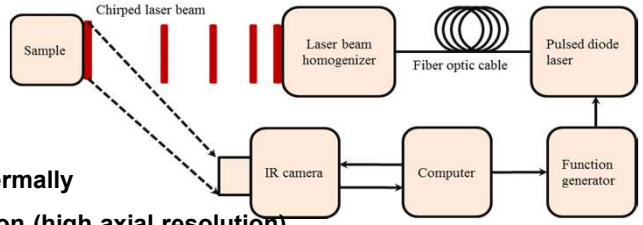
Introduction / Overview

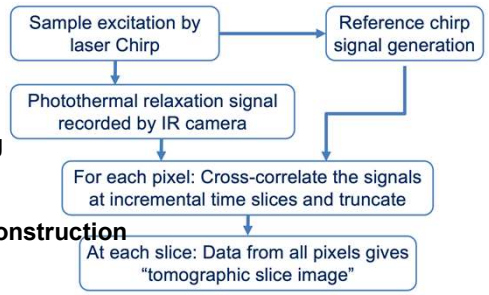
- **Photothermal effect:** Optical-to-thermal energy conversion (radiative and non-radiative), following light interaction with material.
- **Active thermography**: Light source generates photothermal response within sample, which is recorded by IR detector and correlated with material composition / structure.
- At ***CADIPT***, we have developed the **first bespoke signal-processing algorithm (*eTC-PCT*) for depth-resolved 3D image reconstruction from photothermal data**.
- eTC-PCT **detects sub-surface cracks and defects** in industrial materials.
- In **medical applications**, eTC-PCT can **reconstruct tissue structures in 3D**, and detect and **monitor lesion progression**.
- eTC-PCT is **safe** to use on human tissue, has **no ionizing radiation**, and provides robust **early detection** capabilities.

Methods/Experimental Approaches

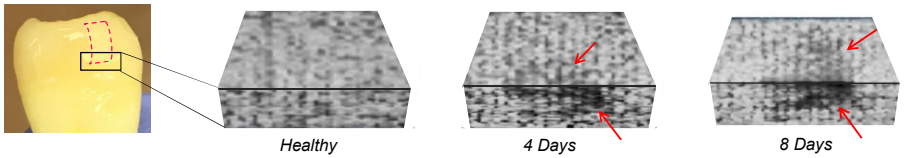
- eTC-PCt employs a **chirped pulse excitation** waveform, an **808-nm diode laser** and a **400 Hz mid-IR camera**.



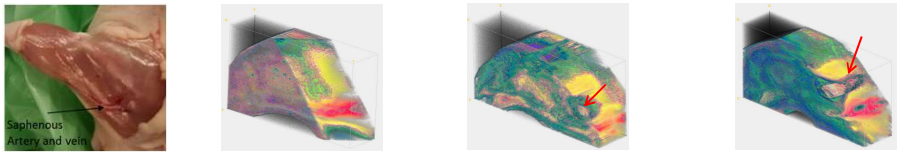
- Chirped pulse excitation and pulse-compression enable **thermally confined absorber localization (high axial resolution) and high depth penetration.**
- eTC-PCT uses cross-correlation and signal truncation based on a time-gating filter to **generate consecutive 2D images** correlating with depth inside sample**.**
- **Compiling 2D slices/tomograms => 3D reconstruction**



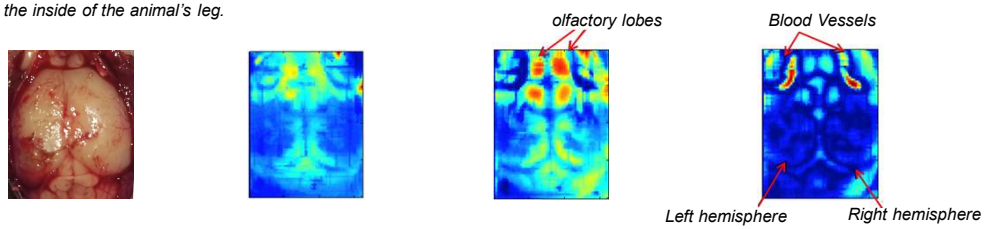
Major Outcomes/Results/Impact



Application of eTC-PCT to early dental caries in-vitro, revealing the progression of caries inside the tooth enamel. (The "trapezoid" shaped part of this image is a 3D cross-section of the subsurface layers)



Application of eTC-PCT to early tumour imaging in small animals to monitor growth. Each image is a cross-section revealing the inside of the animal's leg.



Application of eTC-PCT to structural brain imaging in small animals ex-vivo. Each 2D slice shows a "deeper" subsurface layer of the brain.

The Future: Challenges & Opportunities

- eTC-PCT is currently mostly a qualitative imaging/ monitoring modality. Efforts are underway to **bolster the quantitative aspects** of the system (e.g. depth measurement)
- Use of **Long-IR cameras** for increased non-radiative signal component and lower cost.
- **eTC-PCT shows great promise in complementing the data gathered by conventional imaging modalities**, without limitations such as radiation exposure.

Acknowledgements

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