CORA Cork Open Research Archive
Cartlann Taighde Oscailte Chorcaí

Title	Automated tissue boundary detection
Authors	Grygoryev, Konstantin;Sugrue, Patrick;Fisher, Carl;Li, Celina;Komolibus, Katarzyna;Andersson-Engels, Stefan;Burke, Ray
Publication date	2022-04-01
Original Citation	Grygoryev, K., Sugrue, P., Fisher, C., Li, C., Komolibus, K., Andersson-Engels, S. and Burke, R. (2022) 'Automated tissue boundary detection', in Biophotonics Congress: Biomedical Optics 2022 (Translational, Microscopy, OCT, OTS, BRAIN). Fort Lauderdale, Florida: Optica Publishing Group, TTu2B.2. doi: 10.1364/TRANSLATIONAL.2022.TTu2B.2.
Type of publication	Conference item
Link to publisher's version	https://doi.org/10.1364/TRANSLATIONAL.2022.TTu2B.2 - 10.1364/TRANSLATIONAL.2022.TTu2B.2
Rights	© 2022 The Author(s). Published by Optica Publishing Group
Download date	2026-11-16 09:04:10
Item downloaded from	https://hdl.handle.net/10468/13739

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Biophotonics Congress: Biomedical Optics (Translational, Microscopy, OCT, OTS, BRAIN) © Optica Publishing Group 2022

Automated tissue boundary detection

Konstantin Grygoryev, Patrick Sugrue, Carl Fisher, Celina Li, Katarzyna Komolibus, Stefan Andersson-Engels and Ray Burke

Tyndall National Institute, Lee Maltings Complex, Dyke parade, Cork, Ireland, T12R5CP

konstantin.grygoryev@tyndall.ie

Abstract: To address the challenge of tissue differentiation during cranial perforation surgery, presented research aims to integrate optical illumination and detection capability into rotating assemblies of surgical tools. © 2022 The Author(s)

1. Introduction

Cyto-reductive surgery of brain tumours requires removal of a portion of the cranium. This step in the procedure is termed craniotomy and carries an increased risk of brain tissue damage due to accidental plunging of the cranial perforator (CP) [1–4]. Our previous investigations where optical sensing was integrated with rotating drills and burrs showed that the boundary between the bone and underlying tissue can be detected directly, in real time using diffuse reflectance spectroscopy [5, 6]. The drawback of the previous instruments was the noisy, inefficient coupling of light between the rotating drill attachments and stationary source-detector components as well as lengthy optical fibres and electrical wires.

The aim of current research is to develop a wireless and ”fibreless” instrument capable of two-wavelengths tissue illumination as well as light collection, data processing and automatically stopping the drill prior to crossing the tissue boundary. By placing the illumination sources, detectors as well as micro-controllers on a PCB mated to the rotating CP, it will be possible to create a compact tool with direct measurement capability and solve the inefficiencies associated with light coupling into rotating optical elements.

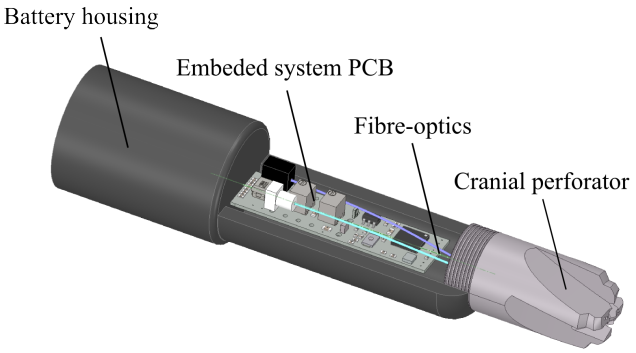


Fig. 1. Envisioned wireless CP attachment. The PCB and optical element are designed to fit inside a narrow cylindrical enclosure and rotate together with cranial perforator.

2. Hardware development

2.1. Cranial perforator

Figure 2(a) shows a custom burr (14mm DIA) with geometry suitable for cranial perforation was machined from stainless steel. Two 1mm openings for were also created in a single relief surface of the cutting tool to allow integration of short optical fibres.

2.2. Embedded source-detector

Figure 2(b) shows a custom 10x30mm PCB designed and manufactured for the application. The PCB layout allowed integration of two light emitting diodes with 530 and 850nm wavelengths, a single photodiode and a micro-controller as well as supporting SMD components.

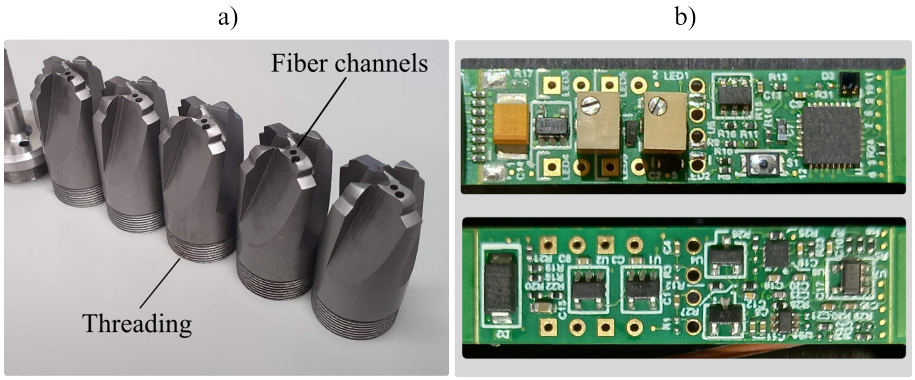


Fig. 2. a) Custom machined threaded cranial perforators. b) LED control and data acquisition PCB (top and bottom).

2.3. Ongoing instrument characterization

The PCB is currently undergoing characterization of individual electronic sub-systems including LED drivers, signal digitization and synchronization. The micro-controller software is also under development and will allow the collected DRS data to be processed in real time on the PCB. We are aiming to be able to present a range of prelimenary results early 2022.

References

1. T. W. Vogel, B. J. Dlouhy, and M. A. Howard, "Don't take the plunge: avoiding adverse events with cranial perforators," J. Neurosurg. **115**, 570–575 (2011).
2. J. Caird and K. Choudhari, "Plunging during burr hole craniostomy: a persistent problem amongst neurosurgeons in britain and ireland," Br. J. Neurosurg. **17**, 509–512 (2003).
3. M. Beniwal and D. Shukla, "Management of perforator plunge in the transverse sinus," Pediatr. neurosurgery **51**, 273–275 (2016).
4. M. Ito, T. Sonokawa, H. Mishina, and K. Sato, "Penetrating injury of the brain by the burr of a high-speed air drill during craniotomy: case report," J. clinical neuroscience **8**, 261–263 (2001).
5. M. Duperron, K. Grygoryev, G. Nunan, C. Eason, J. Gunther, R. Burke, K. Manley, and P. O'brien, "Diffuse reflectance spectroscopy-enhanced drill for bone boundary detection," Biomed. Opt. Express **10**, 961–977 (2019).
6. K. Grygoryev, K. Komolibus, J. Gunther, G. Nunan, K. Manley, S. Andersson-Engels, and R. Burke, "Cranial perforation using an optically-enhanced surgical drill," IEEE Transactions on Biomed. Eng. **67**, 3474–3482 (2020).