Augmented Reality Microscope in Endodontic Access Navigation

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

We propose a workflow that integrates AR with patient-specific CBCT data, offering real-time, dynamic navigation during primary access preparation. The system will utilize segmented CBCT data to generate 3D, color-coded anatomical models, viewable through an operation microscope. The microscope is equipped with an optical see-through display and a camera system for live video capturing. By utilizing marker-based optical tracking and 6 degrees of freedom pose estimation on the rubber dam clamp, the AR visualization is provided real-time to help guiding the procedure.

Background and Motivation

Endodontic procedures, particularly primary access preparation, are intricate and demand precision to ensure patient safety and treatment efficacy. Traditionally, these procedures rely heavily on the practitioner's skill and experience, often involving a steep learning curve. The integration of technology, specifically augmented reality (AR), promises to enhance accuracy, learning, and overall patient outcomes [1 – 3].

The motivation for this project stems from the challenges associated with the complexity of endodontic access preparations. Variability in root and canal anatomy, visibility issues, and the risk of structural damage to the tooth are persistent concerns. Previous work has explored the utilization of Cone Beam Computed Tomography (CBCT) for detailed anatomical insights, but the integration of this data into real-time, navigational assistance during procedures using microscope remains an untapped potential.

Student's Tasks Description

- Optimize the marker tracking for increased stability and robustness.

- Render accessible AR guidance visuals.

- Lab visits may be required for students to test and interact with the setup.

Technical Prerequisites

- Basic Computer Vision knowledge

- Programming skills to develop in Unity3D/C# (preferable), Python or C++, with OpenCV library

- Turn your creativity into a working prototype

References

[1] Song, T., Yang, C., Dianat, O. and Azimi, E., 2018. Endodontic guided treatment using augmented reality on a head‐mounted display system. Healthcare Technology Letters, 5(5), pp.201-207.

Please send the completed proposal to tianyu.song@tum.de, shervin.dehghani@tum.de and felix.tristram@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.

[2] Dolega-Dolegowski, D., Proniewska, K., Dolega-Dolegowska, M., Pregowska, A., Hajto-Bryk, J., Trojak, M., Chmiel, J., Walecki, P. and Fudalej, P.S., 2022. Application of holography and augmented reality based technology to visualize the internal structure of the dental root–a proof of concept. Head & face medicine, 18(1), pp.1-6.

[3] Akulauskas, M., Butkus, K., Rutkūnas, V., Blažauskas, T. and Jegelevičius, D., 2023. Implementation of augmented reality in dental surgery using HoloLens 2: an in vitro study and accuracy assessment. Applied Sciences, 13(14), p.8315.