

Abstract

Restorative dentistry procedures are common for dentists to perform throughout the U.S. [1] Currently, in order to operate on the harder to reach teeth, such as the back molars, dentists must mainly rely on a combination of mirrors and their own intuition. There are few designs available that solve this problem and they all revolve around integrating the camera into the handpiece. [2] Our team has designed a device that is easily attached and detached from the drill. This design is both cost effective and allows dentists to continue to use their own drills rather than acquiring new ones.

Problem Definition

- During restorative dentistry procedures, dentists often have trouble viewing the teeth they're operating on, forcing them to rely solely on their intuition during the procedure.
- The few current designs available are not easily accessible to modern dentistry along with containing an array of other problems that affect the procedure. [2]
- These problems include size, ease of use, and manufacturability.

Figure 2: A diagram of a crown implant procedure and what a crown looks like

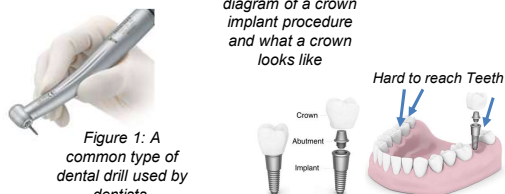


Figure 1: A common type of dental drill used by dentists.

Design Specifications

Function:

- Record the live video for the working position in mouth during the crown or bridge replacement.
- Display the live video of the working position on the display screen to assist the replacement surgery.
- Allow for adjusting the brightness, saturation of the live video.

Durability:

- Withstand the digestion from the salivary enzyme.

Cost:

- <\$10 for raw material use, <\$50 for camera. Total cost is less than \$300.

Final Camera Mount Design

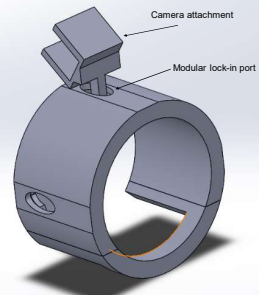


Figure 3: A SolidWorks depiction of the modular camera mount design. 3D-printed from form II plastic.

- Modular design allows camera attachment to be moved to the top, left, or right sides of the drill
- Camera attachment is inserted into oval ports, then turned clockwise to lock in place
- Camera mount slides onto the drill head from the back, neatly locking into place to prevent movement
- Rear of camera mount left open to allow the axle of the drill to rotate freely

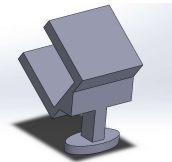


Figure 4: Depiction of camera attachment alone. Fits into camera mount and can be turned to lock into place.

Coding and GUI Development

- GUI was designed in python on a raspberry pi to display the real-time video feed from the perspective of the dental drill.
- For ease of use, controls were added to allow the dentist to control the brightness, saturation, filters, and other functionalities of the camera system.
- A Snapshot functionality would allow for images of the operative dentistry procedures to be taken and saved to the system.
- The GUI is displayed on a touch screen to allow for it to be changed during the operation without adding significant time to the restorative dentistry operation.

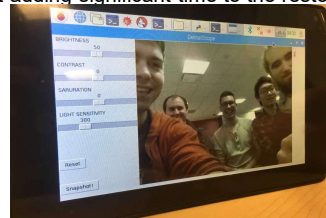


Figure 7: A Graphical User interface is displayed on a 7" touch screen display. The interface has four sliders to control light sensitivity, brightness, saturation, and contrast along with two buttons to reset parameters and take a snapshot.

Considerations:

- Must minimize dental operation time to decrease cost for the patient and dentist
- Must be simple, intuitive and convenient for users of varying technological backgrounds
- Must be functional and robust to operate as expected for the user without error

References

- [1] R. J. Minski and E. Brown, "Dental Procedures, United States, 1999 and 2009," Medical Expenditure Panel Survey Summary Data Tables Search Results, Apr-2012. [Online]. Available: https://meps.ahrq.gov/data_files/publications/4368/4368.shtml. [Accessed: 06-Dec-2016].
- [2] "US5049070A - Dental drill integral camera and optics," Google Patents, 09-Jan-1990. [Online]. Available: <https://patents.google.com/patent/US5049070A>. [Accessed: 04-Dec-2018].
- [3] L. Achok, G. P. Sathya, G. Hema, "Estimation of salivary amylase and total protein in leukemia patients and its correlation with clinical feature and radiographic finding," Indian Journal of Dental Research, vol. 21, no. 4, pp. 486-490, December 2010. [Online]. Available: <http://dx.doi.org/10.4103/0975-5400.14222>. [Accessed Dec. 4, 2016].
- [4] J. Barron, "Enzymes, Part 2 of 3," Digestive Enzymes Formula | Natural Digestive Health, November 2003. [Online]. Available: <http://burtonson.com/enzymes/enzymes-part-2-3/>. [Accessed Dec. 5, 2018].

Amylase Resilience Testing

- Normal Salivary Amylase Concentration: 1440 +/- 160 DU/mL (DU = Dextrinizing Units) [3]
- CapraZyme® is a supplement capsule with a mixture of digestive enzymes including amylase
- Amylase Concentration in CapraZyme® Capsule: 4,500 SKBU/capsule
- SKBU & DU are equivalent FCC units for amylase [4].
- Capsules per mL: 3

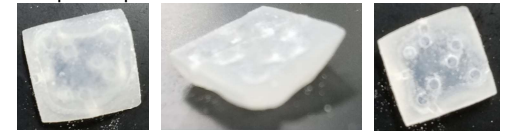


Figure 5: Test Piece Initial Pictures (from left to right: bottom, side, top view)

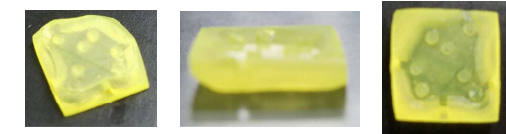


Figure 6: Test Piece Final Pictures (from left to right: bottom, side, top view)

Initial Measurements:

10 mm x 10 mm x 3 mm 0.23 g

Final Measurements:

10 mm x 10 mm x 3mm 0.23 g

Change in surface area: 0 mm²

Future Project Development

- Design an arm to attach the touch-screen interface to that has six degrees of freedom for increased ease of access.
- Integrate the entire camera device into the handpiece itself granting improved water resistance and an even more compact design.
- Have 10 qualified dentists try out the device and relay feedback and ideas via simple survey.
- Find or develop camera hardware and an operating system capable of handling high resolutions smoothly while being extremely small.

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