Detachable Dental Handpiece Imaging System

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Abstract

Restorative dentistry procedures are common for dentists to perform throughout the U.S. [1] Currently, in order to operate on the less accessible rear teeth in patients with small mouths, dentists must mainly rely on a mixture of mirrors and intuition. There are few designs available to solve this problem, all of which 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

- Dentists sometimes have trouble viewing the teeth they're operating on- consequently forcing them to rely solely on their intuition during procedures.
- Current designs available are either not easily accessible or if they are, not effective for modern dentistry. [2]
- The designs that are in the market have problems including size, ease of use, and manufacturability.

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

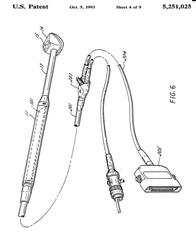


Figure 2: An electronic video dental camera. (US5251025A)

Design Specifications

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

Durability:
- Withstand forces applied during use.

Cost:
- <$10 for raw material use, <$50 for camera. Total cost is less than $400.

Final Camera Mount Design

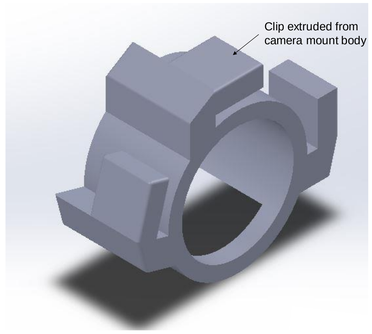


Figure 3: A SolidWorks depiction of the clip camera mount design. 3D-printed from form II Dental SG plastic.

- 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
- Clips hold camera base and camera in place via friction and intrinsic elasticity

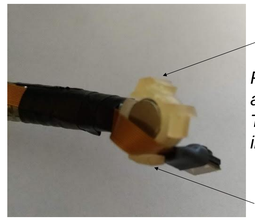


Figure 4: Depiction of camera attachment fit onto the drill. The camera cord is clipped into the attachment.

SolidWorks Simulation Testing

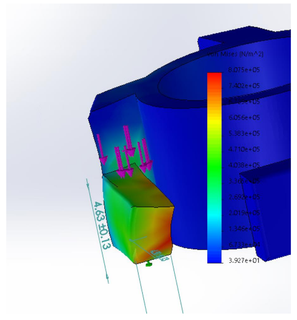


Figure 5: Stress of one placeholder

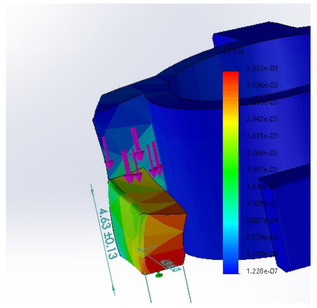


Figure 6: Strain of one placeholder

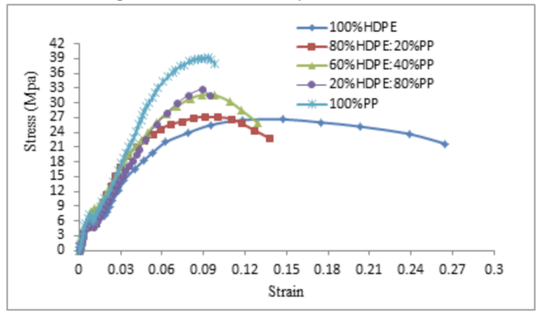


Figure 7: Stress and strain curve of HDPE

- Ultimate average Strength: 20.3 MPa
- Average strain: 0.10
- The red section of both the stress and strain simulation indicate the most affected
- The camera (negligible weight) will not produce enough force to produce this stress or strain

References

[1] R. J. Manski 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/st368/stat368.shtml. [Accessed: 06-Dec-2018].

[2] "US5049070A - Dental drill integral camera and optics," *Google Patents*, 09-Jan-1990. [Online]. Available: https://patents.google.com/patent/US5049070?oq=US5049070A. [Accessed: 04-Dec-2018].

[3] W. A. Rutala, D. J. Weber et al., "Guideline for Disinfection and Sterilization in Healthcare Facilities (2008)," *Centers for Disease Control and Prevention*, 2008. [Online]. Available: https://www.cdc.gov/infectioncontrol/guidelines/disinfection/index.html. [Accessed: 04-Apr-2019].

Ethanol Resilience Testing

- Ethanol, while not as effective as an autoclave, can be used to sterilize non-invasive medical equipment [3].
- Typical concentrations of ethanol-based sterilization solutions use 60 – 90% ethanol by volume [3].
- Testing was conducted with extra pieces of form II dental plastic which were submerged in 70% ethanol for 30 minutes with occasional stirring.
- Degradation was measured via changes in mass.

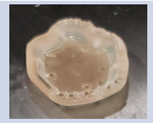
	Piece 1	Piece 2	Average
Initial Mass (g)	 0.57	 0.66	0.615
Final Mass (g)	 0.56	 0.67	0.615
Net Change in Mass (g)	-0.01	+0.01	0.00

Table 1: Material degradation in 70% EtOH

Future Project Development

- Integrate the entire camera device into the handpiece itself, granting improved water resistance and an even more compact design.
- Obtain smaller camera if possible
- Implement a mechanical arm-like mechanism to attach the touch-screen interface that has six degrees of freedom for increased ease of access
- Possibly use Bluetooth transceiver to remove necessity for camera cord
- Explore implementing camera on mirror instead of drill

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