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Non-Ionising Imaging

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Technology description

Technology Overview
The technology uses light at a given near infrared wavelength [NIR] to create a transmission image of dental caries (decay). Healthy hard tissues (enamel, dentine and cementum) tend to 'guide' light of this wavelength, leading to a bright image, whereas decay and other inhomogeneities cause optical scattering. This produces high definition images of dental caries. This is very well illustrated in the lower image below, where the caries is obviously visible. The device is designed to utilize commercial-off-the-shelf technology for production at commercial scale. The light source produces infra-red light which is collimated by a lens and is directed on to an array of digital mirrors (similar to those used in digital light projectors) at 45 degrees to the plane of the light. Software controls the mirrors in such a way that only a certain number of specifically selected mirrors are aligned in the 'on' position, i.e. they will reflect beamlets of the incident collimated light in the direction of the camera, at one particular time point.

Figure 1. Comparative images: X-ray versus NIR: (TOP) In-Vivo X-ray of molar, (BOTTOM) Ex-Vivo NIR image of molar acquired using technology with the caries very apparent.

Imaging would be utilized more frequently in dental and oral applications if it did not use ionizing radiation (X-rays) and was better at identifying and monitoring tooth decay and other oral conditions. NIR imaging does not use ionizing radiation and unlike existing optical methods can image through teeth and the jaw giving a view equivalent to an X-ray image. The crucial limitation of other optical imaging systems developed for dental applications such as Optical Coherence Tomography or Quantitative Light Fluorescence imaging is that light penetration of the tooth is limited, so the systems are only able to image using optical back-scattering and so cannot produce an image in transmission which provides the same detail and definition as X-rays.
Studies indicate that NIR can identify demineralization (the early stage of decay) while it can still be potentially reversed and importantly before it can be reliably identified through clinical examination or X-ray imaging. This enables a shift in dental care towards prevention and away from restoration (filings) which the profession is seeking to implement. Routine visualization of decay progressing over time or responding to therapy also becomes possible, because of the absence of radiation exposure to patients, and staff.

For dentists and oral surgeons, NIR offers the opportunity to improve decision making and practice efficiency across multiple procedures, not just for caries.

For the healthcare provider or insurer, NIR offers the potential to reduce the cost of routine screening for dental decay and potential for ‘payment by results’ in preventative programs.

Detection of the initial stages of dental caries, as well as secondary caries lesions, particularly on approximal tooth surfaces, presents significant clinical challenges to dentists and conventionally intraoral radiographs are used. In orthodontic analysis, assessment of developing occlusions in children, particularly in the mixed dentition phase and in relation to orthodontic diagnosis, conventionally involves the use of panoramic radiography with its increased radiation dose compared to intraoral radiography. The device will allow visualization of un-erupted teeth and thus aid in the reduction of the numbers of panoramic radiographs.

Endodontic treatment of an individual tooth currently requires the use of several intraoral radiographs for diagnostic, treatment and monitoring purposes. The device will image the roots of teeth. In the placement of dental implants, the work-up for the use of dental implants requires a considerable number of radiographs and the drilling of bone and placement of the implant is carried out ‘blind’, involving inherent risks of unwanted tissue damage. The device will have exploratory and confirmatory uses in implant placement.

Other potentially important dental applications include monitoring (and possibly quantifying) dental erosion/tooth wear and detection of tooth cracks in relation to ‘cracked-tooth syndrome’.

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