2025 Research Aid Award
Dr. John Nelson, University of North Carolina

Biography:

Dr. John Nelson grew up in Newtown, CT and attended college as a student athlete at Villanova University. Graduating with a bachelor's degree in mechanical engineering, John worked as a software engineer for 10 years. Although he loved solving technical problems, he decided to change careers and enter dental school – a better meld for him in complex problem solving with direct patient care. At the University of Connecticut School of Dental Medicine, John was able to apply his software background to identifying incidental pathology in Cone Beam Computed Tomography using neural networks. Blending his love for mechanics and forces, John was then fortunate to be accepted into the University of North Carolina Orthodontics residency. Orthodontics further blends his passion for dentistry, technology, and the tinkering engineer that originally began his educational journey.

Description of the project:

Traditional panoramic and cephalometric X-rays used in treatment planning of orthodontic patients suffer from the inherent limitation of 2D images representing 3D structures. Cone Beam Computed Tomography (CBCT) allows accurate 3D volumetric representation of dentition in skeletal anatomy when compared to 2D imaging. Effective radiation dosages however, although substantially less than Medical CT, are still significantly greater than traditional 2D imaging. Furthermore, as we adjust CBCT acquisition parameters to improve CBCT spatial resolution, patients are subsequently exposed to additional ionizing radiation. Following basic "As Low As Reasonable Achievable" or ALARA radiation exposure principles, strategies to further reduce the amount of ionizing radiation are important to be explored.

Neural networks in machine learning are capable of modeling signals or patterns not often readily apparent to humans. In a commercial example, the Nvidia Corporation used Deep Learning Super Sampling (DLSS), a neural network specifically trained to upscale a rendered videogame frame to improve render times while preserving image fidelity. This project explores an analogous application to determine if neural networks can improve the spatial resolution of a low-dosage CBCT scan. The training data will be prepared with phantoms (skulls encased in soft-tissue medium) to prove feasibility. The upscaled scans generated by this neural network will be numerically compared to a standard resolution scan to quantify error artifacts produced with this technology. Furthermore, beyond reducing ionizing radiation, the same model can be further used to upscale standard CBCT scans to improve spatial resolution needed for orthodontic appliance manufacturing and usage.

Statement of how Orthodontic Education will benefit from your award:

Traditional panoramic and cephalometric 2D films are commonly used in training orthodontic residents. As the prevalence of CBCT increases and technological improvements continue, the usage of CBCT on each patient will increase. By reducing the ionizing radiation burden for a large field of view CBCT while also increase the spatial resolution, this grant award further facilitates this transition to a new standard of care.

Why the Foundation is important to your project

Without receiving funding from the AAOF, we may not be unable to conduct this line of research due to cost prohibitive limitations. Coordinating the use of phantoms (skulls encased in soft tissue mediums) between institutions for training data and leveraging online cloud-compute servers for training the model would not be possible without AAOF funding support.

How foundation funding is expected to or has benefitted your career

I first learned to program in the 4th grade and further developed this technical skillset over the course of two decades. Many people in dentistry and especially orthodontics bring unique backgrounds coupled with a large curiosity, yet research financial support can often be limiting. Funding support first as a dental student and now as an orthodontic resident has helped me foster a life-long commitment of combining my multiple passions. I subsequently hope, as a future educator, to encourage future residents to share their own unique experiences and curiosities to drive future orthodontic advances.