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AUTOMATION OF HARDNESS MEASUREMENT AND 3D MODELING IN GENERATING A FOREARM HARDNESS MAP

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Measuring tissue hardness is a key aspect in various fields, including medical diagnostics and prosthetic socket design. Accurate tissue hardness mapping can greatly improve the understanding of biomechanical properties and improve the customization of prosthetic devices. This article presents an automated approach to measuring tissue hardness and generating 3D hardness maps of the forearm. Based on a device that allows automation of the process of collecting data from the patient's forearm as well as software preparation for implementation in a CAD environment based on the grasshopper programming language.

The process of designing prosthetic sockets tailored for hardness begins with collecting data from the patient. To achieve variable hardness within the forearm model, transitions between areas naturally filled with more fat or muscle must be designed. For this purpose, a hardness map of the forearm is created, which in Rhinocad will combine a 3D scan converted into a suitably prepared matrix or a parameterized drawing of 3D splines along with the hardness values of individual points. A sensor was developed to read multiple values that can be appropriately interpreted as hardness readings. Due to the use of a high-quality linear motor with readout and appropriate device construction, the program records the calculated value at a specific point in the Cartesian coordinate system. These prepared data can then be processed into a model, and using a properly programmed model and a part responsible for file processing into G-code language, generate a file with a ready-to-produce prosthetic socket model.

The entire article is based on a process that initially and originally relied significantly on meticulous human work, including measurements, scan processing, modeling of the socket, and its manufacturing. However, by leveraging certain technological conveniences and minimizing quality loss, the unit production time is reduced. This, in turn, positively impacts the price, quality, and usability of the final components.