AmpScan: Open-source 3D scan shape analysis for prosthetics and orthotics

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BACKGROUND (77 words, max 80)
Surface scanners are used to digitise prosthetic or orthotic device-interfacing anatomy. These scans are then imported into rectification software to design the user-specific device. Previous studies have demonstrated the additional information that can be extracted from analysis of single and multiple scans, including benchmarking low-cost scanners by detailed analysis of plaster casting shape consistency[1], and quantifying limb shape variability across populations[2]. However, this requires tools which are not commonly available to researchers or clinicians.

AIM (32 words, max 40)
The aim of this study is to develop a software package which provides open-source tools to clinicians and researchers, to capture more information from surface scans of devices and their users' anatomy.

METHOD (110 words, max 110)
AmpScan is an open-source software package written in Python. It can be used through either a Graphical User Interface (GUI) or directly through Python functions. A common workflow for a pair of shapes involves importing e.g. residual limb and socket design scans, aligning them using manual and automated methods, and calculating the pairwise shape deviation through registration. Further data including volume[3] and variation in cross-sectional area along the length[4] can also be extracted. Speed performance was quantified relative to a previously reported MATLAB distribution of the code[4], for scans representing typical settings used in the clinic (~3mm vertex distance, 6,500-9,500 vertices) and very high detail (~100,000 vertices, ~1.85mm vertex distance).

RESULTS (106 words, max 140)
Detailed documentation of the software can be found online (ampscan.readthedocs.io/), along with community contribution guidelines and examples. Performance improvements were most marked for very fine, detailed meshes. For a ~100,000 vertex mesh, computing speed was increased by 3.86x for automated alignment (1.1s), 11.3x for registration (11.1s), and 19.6x for smoothing of the mesh (1.7s). This enables large sets of scans to be analysed quickly. The visualisation tools enable the surface deviation between scans of the residual limb and a patella bearing socket to be plotted (Fig1), using a standard convention derived from Sanders et al's seminal studies[5,6], and accessible to users with most colour blindness types (deuteranopia, protanopia and tritanopia).

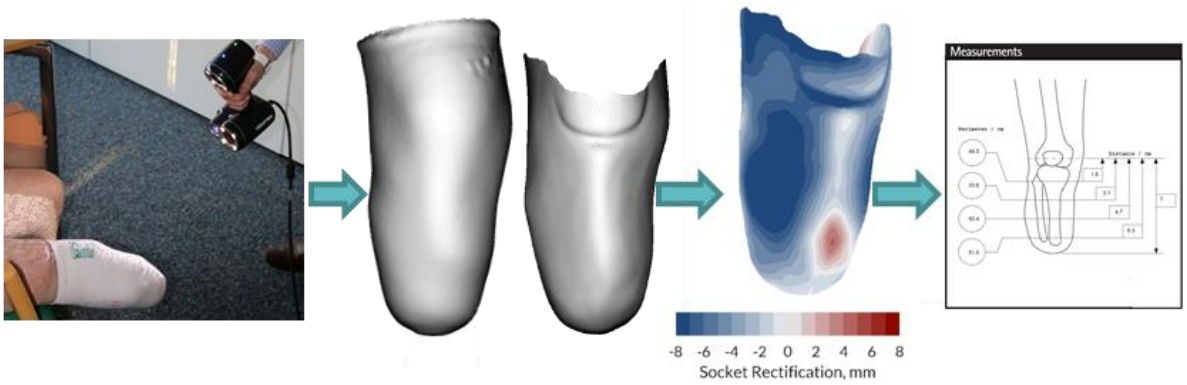

Fig 1: Example AmpScan workflow, from surface scan to quantification of pairwise shape deviation and automated report generation

DISCUSSION AND CONCLUSION (78 words, max 80)
The AmpScan tool will enable researchers and clinicians interested in analysing data from surface scans to access these methods without needing to build them from first principles, or to invest in expensive software. The project's open-source distribution enables the community to contribute to the tool's development, and should allow analysis and results presentation to be benchmarked against a mutually agreed standard. Planned work involves user-experience development, making the GUI available as a web application, and automatic report generation.

REFERENCES (32 words, max 80)

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