ADVANCED ORTHOTICS VIA ADDITIVE MANUFACTURING: FROM LOW-COST TO HIGH-END DESIGN

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Introduction

Recent developments in the design and manufacture of orthotic devices have been driven by emerging 3D geometry-capturing methods and the availability of various Additive Manufacturing (AM) methods to generate the device according to CAD design specifications. However most of the currently prescribed orthotic devices are still produced with conventional techniques: vacuum forming, composite materials layup, numerical controlled milling, etc. This work presents a number of fully-functional ankle-foot and foot orthotic devices produced as a result of the A-FOOTPRINT project.

Method

Two types of orthotic devices: Ankle-foot and foot orthotics where designed starting from a sample lower limb 3-dimensional scan file. The resulting designs were manufactured by means of two AM methods: Selective Laser Sintering (SLS) and a low-cost Fused Deposition Modelling (FDM). These processes differ in material type (mainly Nylon 11/12 for SLS and PLA for FDM), material cost, build-time and overall mechanical properties. Mechanical tests were performed to investigate the structural behaviour of selected devices, compared to their conventionally manufactured counterparts.

Results

Both AFO and FFO devices were designed and built following the procedure in figure 1. While structural integrity tests confirmed that SLS-made AFOs exhibit a reasonably good bending behaviour when compared to their thermoplastic counterparts (60-70 N.m /15 dorsiflexion degrees), orthotics built with the FDM system lack the structural integrity to be used as final products unless they are reinforced with fibre composites. This possibility allows low cost systems to generate a wider range of orthotic designs (fig 2).

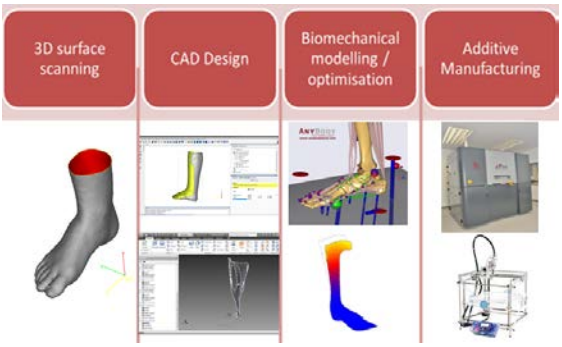

Figure 1. The A-FOOTPRINT model for orthotic manufacturing

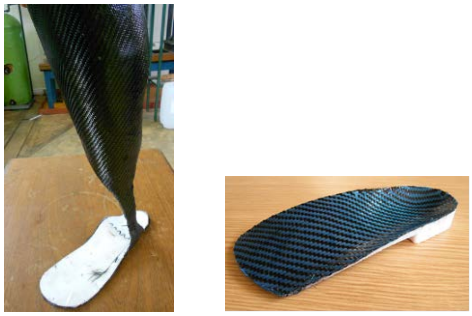

Figure 2. Sample AFO with ABS core and carbon fibre reinforcement (left) and PLA+carbon fibre (right)

Discussion

This research has shown that it is possible to use both SLS and FDM as the basis for fully functional personalised orthotic devices. The overall orthotic design must be optimized for AM in order to take full advantage of the potential of the technology by developing designs which use features such as variable thickness, or reinforcement of specific areas in order to create a functionally gradient device with locally varying stiffness.

Acknowledgements

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