The Development and Evaluation of 3D Printed, Hygromorphic, Biodegradable and Self-Locomotive Soft Robots (Hygrobots), as a Powerful Tool for Environmental Monitoring and Protection

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Currently, environmental monitoring is time-consuming, requires training, produces pollution and, due to human interference, distorted results. This is why autonomous, biodegradable, and self-locomotive sensor platforms are of great interest. Inspired by biological examples, hygromorphic bilayers made of WOOD-PLA and PLA were created using a commercially available 3d printer and a Python-based GUI with an integrated slicer. These bilayers can be supplemented with platforms, which are part of a scalable and modular system, to create Hygrobots. The design of single-bilayer Hygrobots was optimized by an evolutionary algorithm. The platforms of multi-legged Hygrobots were designed in a way that loads or sensors can be attached. Since the democratisation of the emergent field is key, the GUI was designed to be user-friendly, and the design process (GCode generation) was largely automated. Furthermore, inexpensive and sustainable materials and manufacturing processes were used and a symbolic design language was developed to enable a quicker exchange of Hygrobot designs. A porous wood filament (Laywood Meta5) was mainly used, which consists of up to 40% wood fibres situated in a PLA matrix. The fibres are a waste product from planing mills. To understand the behaviour of the filament in wet state (post-stimulation), its chemical composition was analysed and the influence of individual chemical components clarified. The result are functional Hygrobots, which master various tasks and natural terrains through programmed movements and draw their energy from humidity fluctuations. Ultimately, scientists and governments could be provided with a powerful tool to monitor the effects of climate change or to protect vulnerable ecosystems from illegal pollution, for instance.