HORIZON 2020

Fungal architectures

Berichterstattung

Projektinformationen

FUNGAR

ID Finanzhilfevereinbarung: 858132

Projektwebsite

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10.3030/858132

Projekt abgeschlossen

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Koordiniert durch
UNIVERSITY OF THE WEST OF ENGLAND, BRISTOL
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Periodic Reporting for period 2 - FUNGAR (Fungal architectures)

Berichtszeitraum: 2020-12-01 bis 2023-05-31

Zusammenfassung vom Kontext und den Gesamtzielen des Projekts

We propose to develop a structural substrate by using live fungal mycelium, functionalise the substrate with nanoparticles and polymers to make a mycelium-based electronics, implement sensorial fusion and decision making in the fungal electronics and to grow monolithic buildings from

the functionalized fungal composites. Fungal buildings will self-grow to target geometries, self repair, remediate waste products, sense and naturally adapt to the environment.
As one of the primary consumers of environmental resources, the building industry faces unprecedented challenges to reduce the environmental impact of current consumption practices. This applies to the construction of the built environment and resource consumption during its occupation and use. Where incremental improvements to current practices can be realised, the net benefits are often far outstripped by the demands of rapidly increasing population growth and urbanisation. Against the backdrop of this grand societal challenge, it is necessary to explore approaches that envision a paradigm shift in how material is sourced, processed, and assembled to address the magnitude of these challenges in a sustainable way, with added value. The buildings will have low production and running costs, will not require a substantial workforce to build, they are carbon free and waste using and can be returned to nature when no longer used. This building cycle will radically decrease or even nullify the environmental costs of building material production.
Objective 1. Biofabrication: Cultivation of large (metre length scale) living mycelium.
Objective. 2. Functionalizing: Changing electrical and mechanical properties of mycelium network.
Objective 3. Computing: Implementation of information processing on mycelial networks.
Objective 4. Designing: Development of design rules and construction logics.

Arbeit, die ab Beginn des Projekts bis zum Ende des durch den Bericht erfassten Berichtszeitraums geleistet wurde, und die wichtigsten bis dahin erzielten Ergebnisse

Selection of optimal growth substrates for fungi.
FUNGAR project aims to develop a fully integrated structural and computational substrate using living fungal mycelium for the purpose of growing sentient architecture. In this context few fungal strains will be combined with different types of substrates and bioprocessing techniques. We provide a selection and best combination of raw materials derived from agroindustrial activities including miscanthus,rice straw, hemp shives, and substrates, such as spent coffee grounds, soybean hulls and rice husks. The evaluation considers the impact of such combination on fungal growth, contamination risk, nutrition content, biological and mechanical properties of biofabricated composite materials, costs and logistics features. Hemp shives+coffee grounds and hemp shives + soybean hulls as best performing combination.

Automated scaffold production
This task reported on here targets the development of automated methods for producing sparse Kagome woven stay-in-place formwork/reinforcement scaffolds. These scaffolds are a central component of the FUNGAR construction methodology as outlined in the description of work. To achieve spatial enclosures and maximise design potentials, the scaffolds need to exhibit complex 3D morphologies comprising double curvature, branching and fusing. Automating the production of these morphologies will significantly extend the state-of-the-art in technical textile production. Collaborative industrial robots have been used for production. Robotic instructions and path planning have been developed from high resolution weave representations of target geometries using Medial Construction and mesh relaxation methods to ensure geometries are producible from straight strips of material. In

addition, we have developed a custom Mesh Topology Adjustment Scheme (MTAS) for automating mesh topology adjustment in digital design contexts. Bespoke robotic proof-of-concept end-effectors have been successfully developed to accomplish the weaving task.

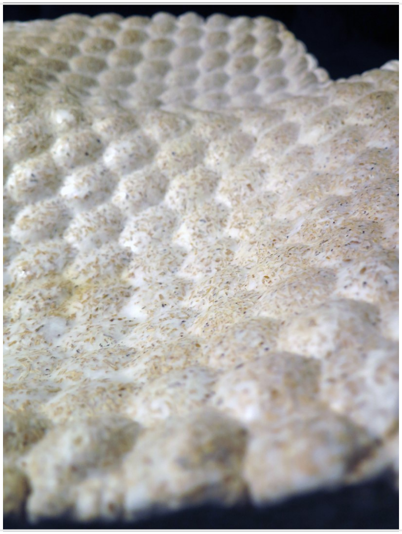
Computing and sending with fungi
The tasks reported on here targets establishing communication protocols with mycelium network. We designed and implemented an experimental setup for recording electrical activity of fungi in a controlled environment. We studied spontaneous discharges, (ir)regularly oscillating potential, particularly distinguishing patterns of spontaneous activity formed by a single spike of electrical potential and different types of bursts according to intra-burst ring frequency. Key findings are as following. Oyster fungi Pleurotus djamor generate action potential like spikes of electrical potential. The trains of spikes manifest propagation of growing mycelium in a substrate, transportation of nutrients and metabolites and communication processes in the mycelium network. We propose original techniques for detecting and classifying the spiking activity of fungi. Using these techniques, we analyse the information-theoretic complexity of the fungal electrical activity. The results pave ways for future research on sensorial fusion and decision making of fungi

Fortschritte, die über den aktuellen Stand der Technik hinausgehen und voraussichtliche potenzielle Auswirkungen (einschließlich der bis dato erzielten sozioökonomischen Auswirkungen und weiter gefassten gesellschaftlichen Auswirkungen des Projekts)

The progress beyond the state of the art is envisaged in biofabrication, sensing and information processing, architecture and urban environment.

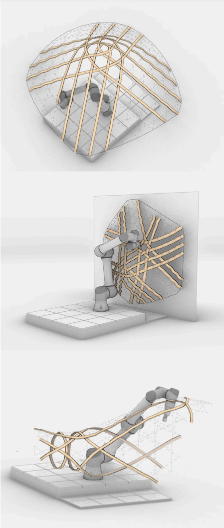
Biofabrication.
Using fungi we can grow `green’ building materials. Fungal materials are not novel per se however, current methodologies grow mycelium to shape at the scale of components (bricks/blocks). The mycelium is then 'killed' through drying and the units assembled using stacking or post-tensioning strategies. Our approach is based on a radically different set of construction principles that offer a range of advantages to the construction process and in-use functionalities. We start with the triaxial weaving of a complete stay-in-place formwork that also acts as a reinforcement. The formwork is filled, inoculated and mycelia grows throughout as a complete network. The anticipated advantages of this new approach are: formworks can be pre-fabricated in large sub-elements with minimal connectivity to assemble on-site; structurally superior hybrid construction (weave/mycelium) also because the mycelium is a complete network; fungal sensing/computing potential of the network; environmentally responsible, sustainable throughout the supply chain and full lifecycle of the structure.
Sensing and information processing.
Fungal material will not be passive elements but capable for multi-input sensorial fusion and information processing. To functionalise the mycelium we will use metal nanoparticles and conductive polymers. Both living and non-living biomass sorbs metals to their surface, this process does not take energy. Sorption to the outer surface of the fungal hyphae is the way to functionalize mycelium for

electrical use and embed nano-scale soft electronics into a new class of building material. The unconventional electronics inside this material will allow for sensing of environment/occupants, distributed decision making.
Architecture and urban environment.
The material can be grown locally, reducing the energy/time for transportation. Mycelium-bound building components can act to reverse carbon emissions through the absorption of carbon.
Mycelium-bound computationally functionalised materials offer significant ecological advantages over established engineered materials and technical systems, and offer an entirely novel class of environmentally and structurally performing, actively 'intelligent material' with an unprecedented degree of integration, robustness and availability.



MycoPanel Convex

FUNGAR Prototype



Robot setup

Letzte Aktualisierung: 7 Juni 2024

Permalink: https://cordis.europa.eu/project/id/858132/reporting/de