BioRizom. Host Biotransducer based in mycotic rhizome

BioRizom. Biotransductor huésped basado en redes micóticas

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Abstract

The growth of urban settlements is a phenomenon on the rise. It is expected that more than 70% of the people will live in urban settlements by 2050. To be able to tackle and embrace this growth, we need alternative tools that help us to face these challenges. On this framework, this proposal aims to raise the paradigm of how the information can be gathered and used to equilibrate urban systems in terms of planning concerning the distribution of resources. To achieve this goal, the exchange of data through an organic system of biochemical interaction network is proposed.

Keywords: Smart City; Urban planning; Social Development; Bio-sensor; Internet of Things.

Introduction

This project is an alternative proposal of what is already developed and understood in the intersection of Technology and Urban settlements. A resilient alternative for the vision that Eremia, Toma and Sanduleac (2017) propose in “The Smart City Concept in the 21st Century”. What we find interesting in this frame, is the integration of Information and Communication technology and Internet of Things technology to use and develop Urban Informatics. Nevertheless, we find a weak point in the structure where those technologies are developed. In the nature of those agents that are not physically constrained to the Urban context where the settlement exists. That is, the developers and interpreters of the Data that these technology gather, generate and use, are, with a few exceptions, outsiders of the geographic urban circumstances where they have influence.

This creates a point of dependency in the interactions of the Urban Growth that can mutate into bigger problems like; excessive costs, out of the context solutions and misunderstanding of the real needs of the network. Besides the political frictions it might spark. Another interesting factor is the way the energy and the materials are used to develop these tools. Our alternative proposes an integrative solution with a comprehensive approach to the agents and stakeholders that will benefit of this implementation.

BioRizom is a sustainable strategy taking advantage of the Inter-plant communication and physiology (Gorzelak, Asay, Pickles, Simard, 2015) and the bio-chemistry processes related to it.

A first intention, is to design a system which works like a massive load cell to sense the changes in the surface of the ground. Due to the diversity of the plant-fungus network (Toju, Guimarães, Olesen, Thompson, 2014), we define our active interactive agent as a plant. Its characteristics of growth will give us the feedback of the state in the network.

This data interchange can be used to build intelligent solutions contributing to the transformation of the way humans interact with Urban space. Such interactive system (sense and acting) can be integrated with existing technology networks of data like: IoT, Information and communication technology, urban planning and urban growth.

Beside the technological needs, our second intention is to reinforce the empowerment of the Local Agent. Those that are inherent and pertinent, geographically speaking, to the Urban settlement. Avoiding or diminishing the use of agents that do not physically belong to the local urban network.

And the third intention is; to use Growth as a tool to harness, embrace and interact with the Space. To knit a Human-Built landscape scaffold in technology rails, embedded as it is, in closed tie with the environment. This is a project of Social Development carried out with applied technology in the verge of biotechnology and Internet of Things.

Methodology

The problem is related with the connectivity in a digital network and the possibility of interconnect an analog biological network to sense changes and transmit the Data to other information networks.

We defined knowledge fields as a departure point from where to start the development of the solution and the interconnections between the research in those fields. Through an interdisciplinary research, and due to the knowledge areas, experience and fields of interest inherent to the team, we defined these fields as: Material Science, Biology, Urbanism, Architecture and Industrial Design.

To develop the design project, three core questions where stripped from the scenario:

1. How to cope and harness Urban Growth?
2. What can be really an alternative tool or set of tools to those that are already in use in the “Smart City” concept?
3. How innovation through design can integrate the components of life to solve problems about building and planning?

The BioRizom system works like a load cell which has sensors for detecting the bio-signals. This information received from the environment will be transmitted to an interface that transforms it into digital data. Once digital, this data will work to reinforce the IoT, Communication and digital information data and a reinterpretation for useful information could be depicted. The whole system is divided in 3 main parts: BioWire Grid Architecture by natural Growth, BioSensing and Big Data threshold.

Design Description

BioWire

This part of the system, the Grid Architecture by natural Growth, works taking advantage of the Fungal mycelium development in the soil. This can be understood as a complex *wiring* that naturally grows in the soil. It is the consortia of colonies of fungi and microbes of different species what constitutes the *Building-Block* of our project.

To have a convenient reading of the interactions happening within the network, we designed a chamber for hosting an agent that reads, in a natural way, the information exchange in the network (Figure 1, Part 1). We decided the use of a *Myco-heterotroph*, this because their characteristic of living on fungi (Merckx, V. S. F. T., 2013). These behavior of the plants, give us an accurate agent through which we can measure changes in the network.

Our chamber has some holes in its walls to channel the interactions within the natural soil consortia of plants and microbes (Figure 1, Part 1). These agents have a natural way of interaction between them: that is the feeding and nutrients attaining myco-heterotroph processes. This idea is not new (Pörtner, R., & Märkl, H., 1998), our project propose a design that the Host Chamber incorporates specific windows for these interactions to happen. The design of the windows itself was realized taking in account the connection of the factors that can give us different measure points for or system through different sensors (Figure 1, Part 3).

By monitoring the interactions at the root-soil-microbe interface, we will gather data. The idea is to apply the discoveries in a crossover approach with another power grid and relate them to the inputs from different networks. After a

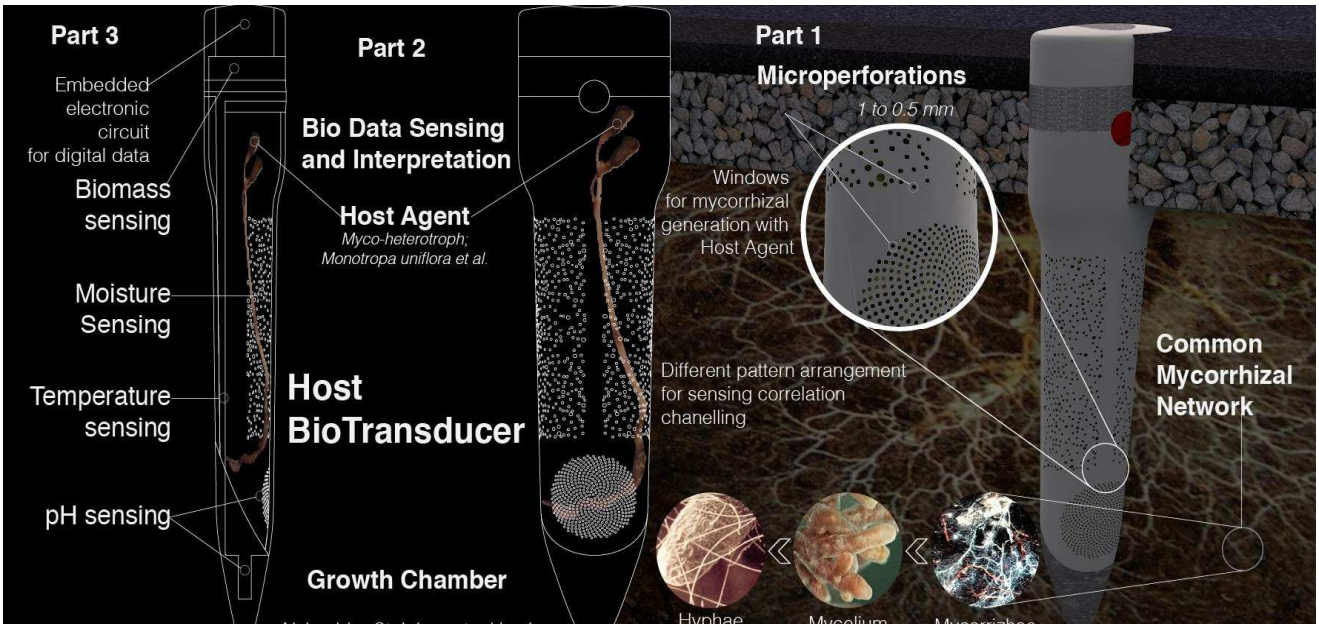

Figure 1: Schematic Description of the Chamber and the Host

data treatment we will have useful inferences to be applied in the threshold of human scale.

Bio-Sensing

Setting the Building-Block under the mechanisms of the nature, gives us a natural reader of the interaction between two living organisms. This give us three readings; an external energy free communication exchange, an implicit set of agents with natural growth behavior and an environment sensor combo. It is a co-culture that already happens in nature and by sniffing body changes in the Host agent (Figure 1 part 3) we have our spy.

This system, the interconnections, are linked to the interdependencies of the species. The roots create a tissue that can sense changes in a bigger scale, as exposed by Said, S. B., and Or, D. (2017) in “Synthetic microbial ecology: Engineering habitats for modular consortia”.

Any change in the environment is sensed. Therefore it can work to infer different characteristics of the Urban phenomena without dependence of any external agent of the local network. The sensing of the changes in the host agent, give us a trusted point of references of the changes within the consortia of local agents.

When the system sense a change, when an external agent like a volume of mass, heat change, Ph-modification happens within the area, the Building-Block will have a change in its interactions. The mycelium will have a chemical change, might be something like a dehydration, might be a change in the biomass of the Myco-heterotroph and this produce elemental changes that could be read due to an excess or relative scarcity in the normal metabolism of the Host. That change, modifies the chemistry and the electrical conductivity in the soil. This set of reactions comes to be read as a bio-load cell (Figure 1, Part 2)

Data Threshold

The chemical changes in the host plant, will have an impact in its physical and chemical composition. As a consequence of this, the changes will be read by analogue sensors (Biomass, Moisture, Temperature and Ph) connected to an embedded circuit inside the Chamber (Figure 1, Part 3).

The differences in conditions and changes in the ratios, will work like as triggers to spark a signaling reaction to be read.

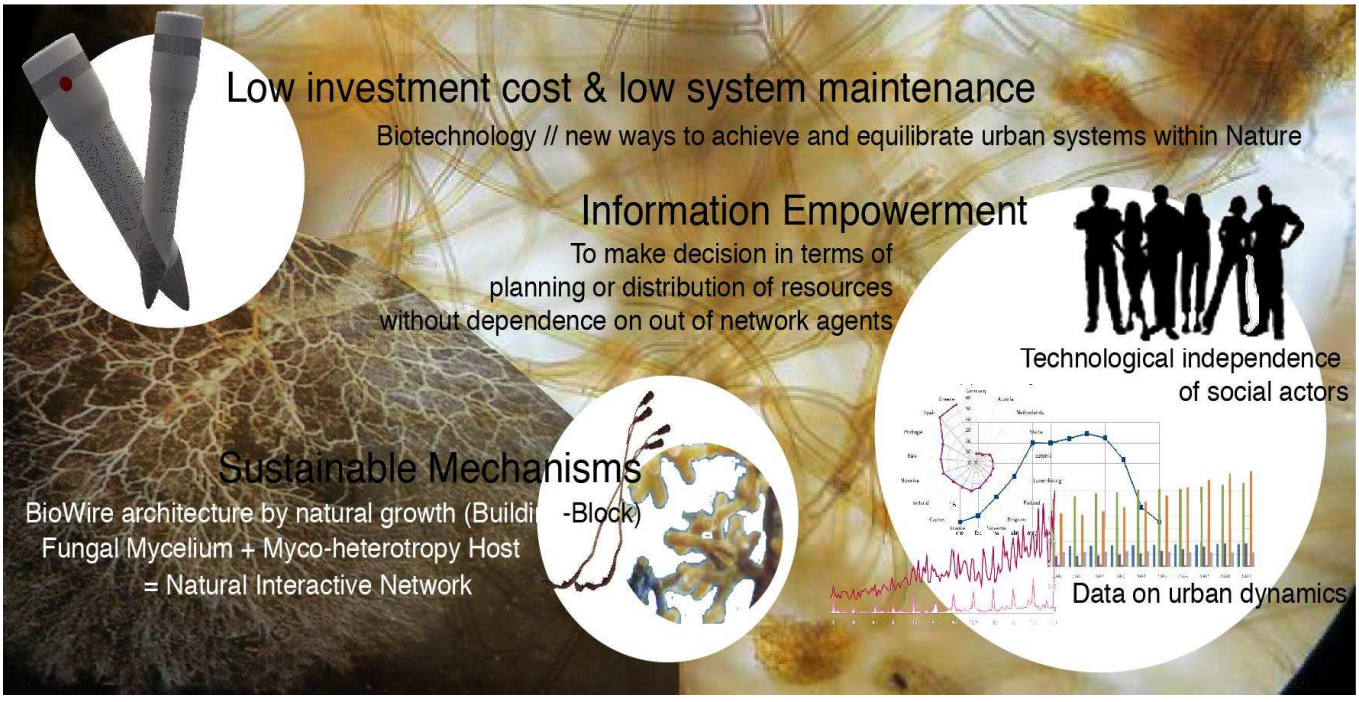

Figure 2: Environment Benefits

What is known

Currently, the research about the Myco-rhizome chemical exchange and the Soil micro ecosystems, is done focusing on the physiology of the Soil and the chemical connectivity between the agents such as plants and fungi. It is done with more emphasis in: Bioremediation of soils, Pharmaceuticals, Biofuels and Bioreactors.

The inference that we can extract from the information exchange of different networks with different energy exchanges will have a different outcome of the phenomena. Some application of this information could reflect a different status of the urban settlement, Earthquake sensing and ground health for eco-social awareness demands .

Our approach to use the fungal network behavior as a communication channel is not new, but our aim in use that network exchange with or without human interaction is it. This give us an alternative data input for practical uses and applications. Specially in the field of urban planning, architecture, soil health and social ecosystem development

Future application

In the process of growth and development of cities and urban areas, it is important to incorporate new ways of information exchange and knowledge generation. To embrace the interactions between the old agents and the newcomers that participate in the ecosystem where urban settlements exist. Exploring the application of bio-sensing the environment through a bio-analogical / digital device give us an option of the vision in how a different Internet of Things can be developed. We can have diverse kind of solutions to improve the quality of life, human development and embracing the environment and take care of it at the same time.

Conclusions

The inquiry about natural networks within the soil lead us to the possibility of biosensors development. This project pushes in the state of art about how this relationship is explored for practical and industrial applications.

On the other hand, the feasibility of this proposal can be escalated progressively, which allows to identify the versatility of the use according to the data that will be obtained. The current statue of the project has changed Due to natural phenomena and changes in the panorama within the last days made us delve and focus more in sensing Earthquakes. To redefine some of the milestones within the previous scope. Nevertheless the design of an extended and practical proof of concept is nascent to involve bigger actors to engage in the lead of the project. We look forward to hear news from your side.

Regards

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