Functional Decomposition and Summary surrounding Plant-Plant communication

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Abstract

Several successful consensus algorithms have been developed using biologically inspired designs, however; such designs have been inspired based upon Kingdom Animalia, including birds, bees, ants, etc.. For this work, however; we research intercommunication found within plant life. The first step for biologically inspired design is to perform a literary review and functional decomposition. The functional decomposition diagram is a tool to identify specific inspirations. This works presents a functional decomposition diagram focusing on the question: "How do plants communicate". The functional decomposition was based on a formal literature review focused on six search terms. This poster presents the initial functional decomposition, literature search strategy, and examples of plant communications which can be used for further research.

Key Terms: "Plant-to-Plant communication", "Mycorrhizae colonies", "Local Signaling in plants", "Root signaling in plants", "Electrical signaling in plants", "Plant Hormones"

Engineering Application

Many algorithms have been inspired by the natural world. Swarm algorithms can be modeled after Ant or Bee behavior, infrastructure systems could be reinforced using models from ant or fungal colonies, and communication systems can be modeled after Mycelium networks. Evolutionary tendencies lead to biological adaptation in order to survive. This research seeks to understand an unexamined source of biological inspiration to use for future engineering design.

Future Work

- Current work includes general break down of plant-to-plant communication
- Future work features in-depth analysis of structural systems within plant life

The Functional Decomposition

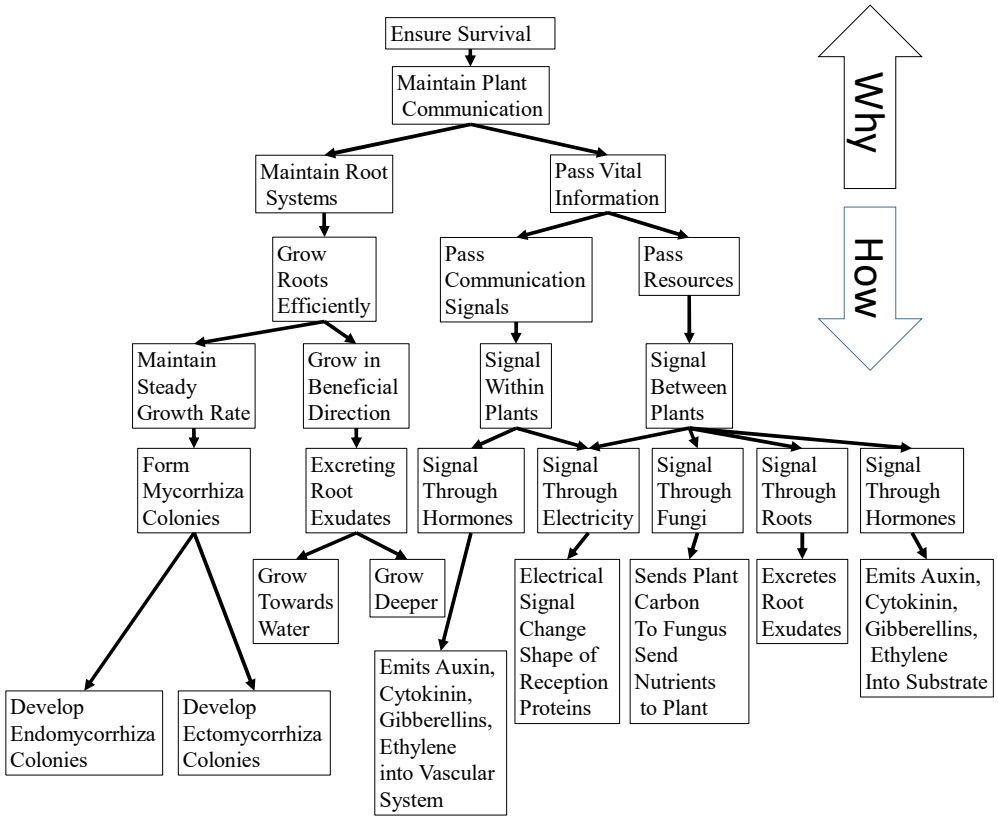

Figure 1: Functional Decomposition on Plant-to-Plant Communication

Functional Decomposition is a Biologically Inspired Design approach that seeks to facilitate analogical transfer. As we travel down the diagram, we seek to answer the question "How?" For example, "How do plants maintain plant communication?" is by "Passing Vital Information." Likewise moving up the diagram answers the question "Why"? Functional decomposition is used to identify functions that can be transferred from their natural occurrence to an engineering problem.

Plant Hormones

These are the primary plant hormones. They can be released into the proximal substrate through roots or through the vascular system.

- Auxin
  - Stimulates stem elongation, root growth, and branching
- Cytokinin
  - Stimulates cell growth, cell division, and germination
- Gibberellins
  - Promotes seed/bus germination, shoot elongation, leaf growth, flowering, and fruit maturation
- Ethylene
  - Promotes fruit ripening and leaf fall

Root Exudates

- Holds substrates together on the micro scale
- Consists of simple/complex sugars, amino acids, polypeptides/proteins, with organic, aliphatic, and fatty acids
- Promotes the growth of self as well as kin plants
- Allelopathic Exudates
- Excretions limit the biological functions of ecological opposition

Mycorrhizae Fungus Colonies

- Endomycorrhiza: Inject themselves into roots to develop secondary internal digestive systems (Arbuscules).
- Ectomycorrhiza: Coats roots in layers of fungal tissue which function to breakdown macronutrients resulting in roots being able to absorb more nutrients than they could have before

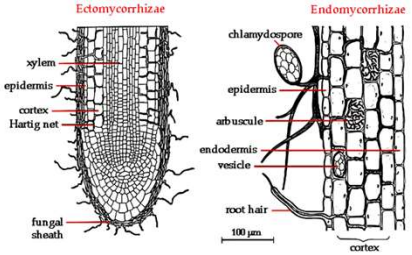

Figure 3: Anatomy of Ecto and Endo Mycorrhiza (www.studysmarter.us)

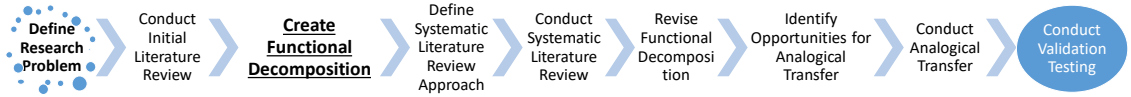

Figure 2: Research Plan and Current Progress

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