Master Theses Proposal

Garden of the Future:
Developing Low-Tech Electric Motors and Drives for ArtScience Applications Powered by Direct Renewable Energy

Background

Ohme, an ArtScience production, research and education organisation based in Brussels, operates at the intersection of art and science, fostering collaborations and pushing the boundaries of interdisciplinary research. Their 2024 call for artist residencies on Sustainable Robotics is a collaboration with Brussels Institute for Advanced Studies – BrIAS and with FARI – Institute of Artificial Intelligence for the Common Good, both co-founded and co-led by the ULB and VUB.

Kris Verdonck, founder of A Two Dogs Company (ATDC), has been selected for this residency to explore the integration of robotic systems into natural environments, reflecting on the synergy between technology and ecology and questioning the way in which man-made machines use energy. His 'Garden of the Future' project, in collaboration with the Royal Belgian Institute of Natural Sciences (KBIN-IRSNB), imagines a landscape where autonomous robots activated by electric motors fulfil ecological roles by directly following the cycles of fluctuating renewable energy sources such as solar and wind power, challenging the norms of energy consumption and robotic functionality. Engineer Vincent Malstaf is also collaborating on the technical development of the project at ATDC.

Prof. Johan Gyselinck from BEAMS Electrical Energy at Université Libre de Bruxelles, with expertise in electrical machines and drives and renewable energy systems, will provide academic supervision.

This partnership ensures that the project is grounded in cutting-edge scientific research while also being propelled by artistic innovation.

Research Question

The core research question focuses on the feasibility, design, and control of low-tech naturally powered electric motors that can adapt to and operate solely on the irregular availability of natural resources like sunlight and wind. This approach fundamentally questions the prevalent models of continuous and stable energy supply, proposing a shift towards systems that resonate more closely with ecological cycles.
How can we design electrical machines and robotic systems that integrate seamlessly into natural cycles and contribute positively to ecological functions without relying on traditional power infrastructure and energy storage?
How can we ensure that an electric motor continues to operate and to fulfil its functions (at least partially) even when it is not supplied with its rated/nominal power,

and by extension over the widest possible range of supply powers and operating points? All in a durable manner, maintaining a long service life?

Description of the Master Thesis Project

The master thesis will involve extensive collaboration with ATDC and Ohme, focusing on the practical and theoretical aspects of designing and controlling electrical machines and robots that operate within the constraints of direct, renewable energy sources.
More generally, the project will comprise a main strand described above, which is at the heart of master thesis, and secondary strands on which the partners are currently working, and which are described here solely so that the master's students have an overall view of the project.
The distribution of topics and tasks will also depend on the number of interested students and the discussions and cross-interests between the student(s), their supervisor Prof. Johan Gyselinck, Kris Verdonck and Vincent Malstaf from ATDC, Ohme and KBIN-IRSNB.

- **Technical Design and Development of Electrical Machines (main)**

Students will study, design and prototype low-tech electrical machines suitable for robots in the 'Garden of the Future'. These designs will prioritize sustainability, relying on solar and wind energy without backup power systems. The aim is to create models that can operate under the fluctuating conditions of these energy sources, embodying the principles of an irregular, organic-like energy supply.

- **Electromechanical Design and Implementation**

This component focuses on the mechanical and electronic aspects of creating animal-like robots that are capable of operating outdoors under various environmental constraints. One goal is to integrate the low-tech electrical motors developed by the master student(s) to design robots that not only function autonomously using direct renewable energy but are also robust enough to withstand outdoor conditions. The design process will involve the consideration of materials, structural integrity, and electronic systems that can endure and adapt to weather variations and other natural elements. This stage will also explore the practical integration of the motors into mobile, autonomous robotic frameworks, ensuring that the mechanical designs are both efficient and environmentally adaptive.

- **Biomechanics, Ecological Integration and Impact Assessment**

This component focuses on assessing how these robots can mimic or replace the ecological functions of species that have been lost to environmental degradation. This component emphasizes the integration of biomechanics to develop robots that can mimic or replace the ecological functions of species lost to environmental degradation. Understanding biomechanical principles will be crucial in designing robots that move and interact in ways that are harmonious with their natural environments. This approach ensures that the robots' activities align with and support the restoration or maintenance of biodiversity, addressing both biological principles and ecological needs effectively.

- **Artistic and Scientific Synergy**

Reflecting on the interplay between artistic vision and scientific application, this part will document and analyse how this project pushes the boundaries of what is traditionally expected from both fields. This analysis will explore how electrical machines using direct renewable energy and sustainable robotics can not only serve practical ecological purposes but also provoke thought and discussion about the role of technology in nature.

In conclusion, this project - and the master thesis that is proposed here and forms part of it - will not only contribute to the academic field but will also pave the way for concrete applications in sustainable robotics, offering a new perspective on how technology and ecology can coexist and benefit each other in a future where interdisciplinary approaches are crucial to tackling complex societal challenges.