



Mechatronik Trinational
Mécatronique Trinationale



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Continued development of the Flying Tree Top Sampler (FTTS)

Report accompanying Bachelor's
Thesis

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Initial Situation

The rise in accessibility to UAVs brings new approaches to problems in many scientific fields. In environmental science a new approach to gathering samples of branches and foliage from the canopy of forest trees for lab analysis was also derived using a UAV. One essential step in understanding how our habitats will react to changing climatic conditions is to learn how forest trees interact with their surroundings. In particular, the forest canopies hold valuable information on biodiversity, biospheric-atmospheric gas exchange, and ecosystem services. (cf. Brockerhoff et al. 2017)

The proof of concept, dubbed Flying Tree Top Sampler, lead to this follow-up project to build on the benefits and improve on the drawbacks of the previous design.

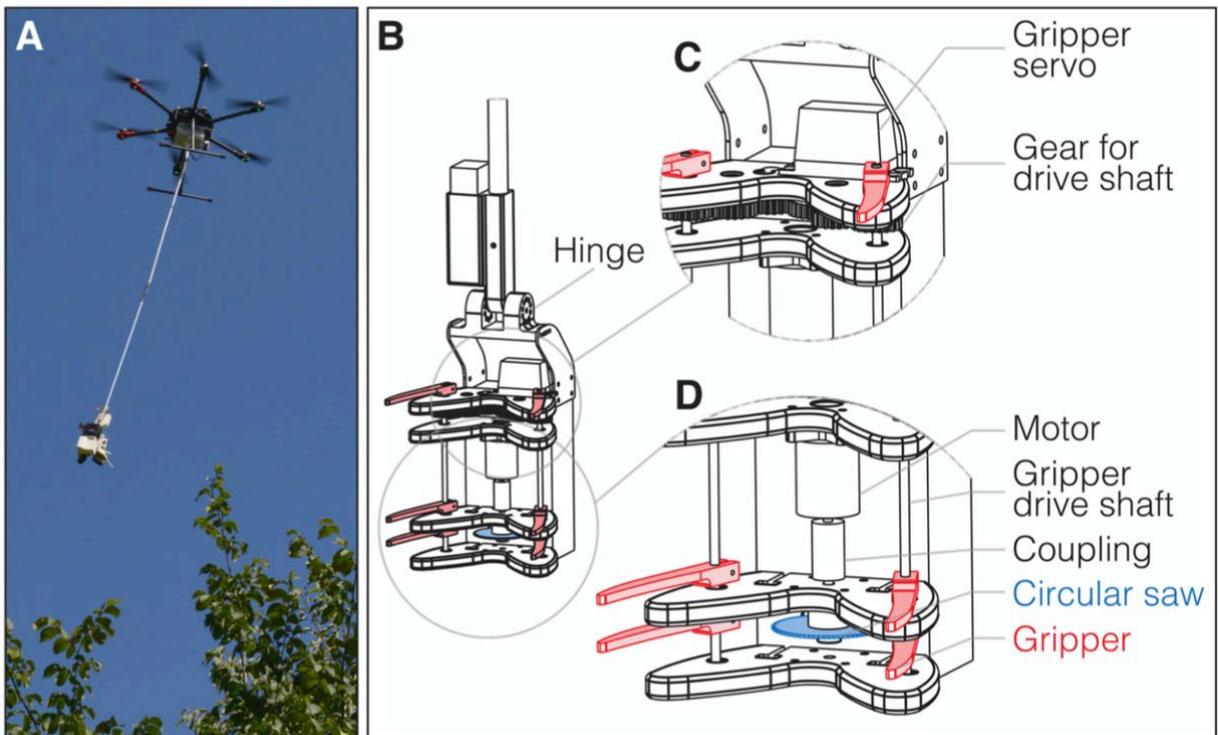


Figure 1: Kaeslin et al. 2018, Novel Twig Sampling Method by Unmanned Aerial Vehicle (UAV)

ETH-Zürich, Department of Environmental Systems Science (D-USYS)

The Department of Environmental Systems Science conducts research and looks into the condition and functions of environmental systems with areas of expertise divided into five foci: Climate Change, Food Security, Sustainable Resource Use, Biological Diversity and Adaptation and Ecosystem Processes and Services. Situated within the Department of Environmental Systems Science is a group named Grassland Sciences, where the Thesis took place.

Approach

As the desired device is a complex system incorporating many different components, a Systems Engineering approach was used to gain an overview of the given situation and requirements. Sketches were made detailing various holistic approaches to the challenge. As the design process contains continual change during the span of the project, these initial sketches laid the foundation of ideas upon which the finished device was based.

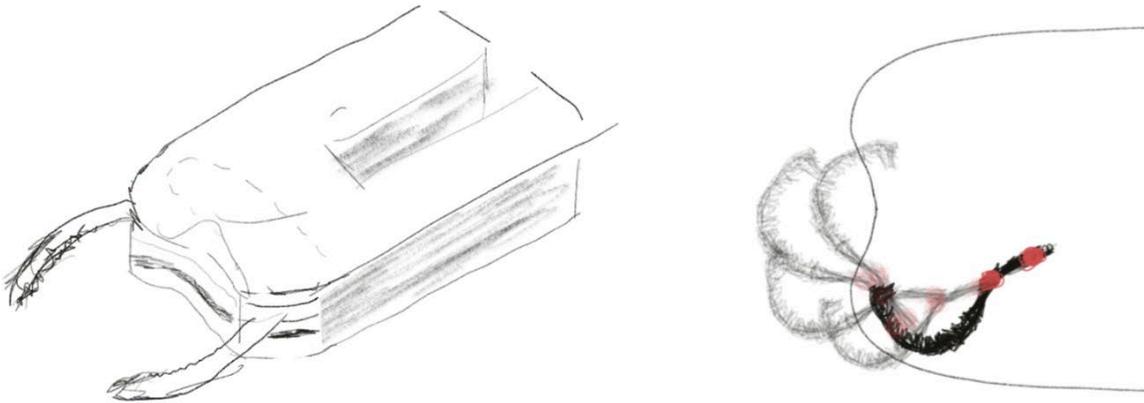


Figure 2: Sketches of possible solutions

Using CAD modelling and Rapid Prototyping techniques, it was possible to iterate through various ideas to find the most fitting and functional solution. A rotating chainsaw would act as the cutting mechanism whilst a mechanical gripper would grip the branches or foliage to be cut.

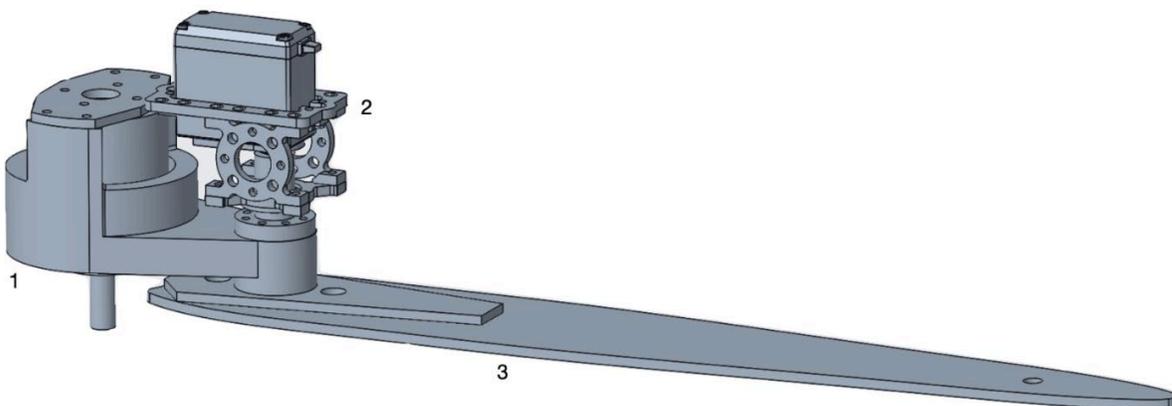


Figure 3: Cutting Mechanism CAD model

Results

Using a 3D imaging camera combined with a Raspberry Pi as an on-board computer and an Arduino Nano, it was possible to design an orientation aid for flight in and around the tree canopy. A separate flight controller would then take the image generated by the on-board computer and transmit it down to the ground-based receiver, which simultaneously acted as a controller for the FTTS.

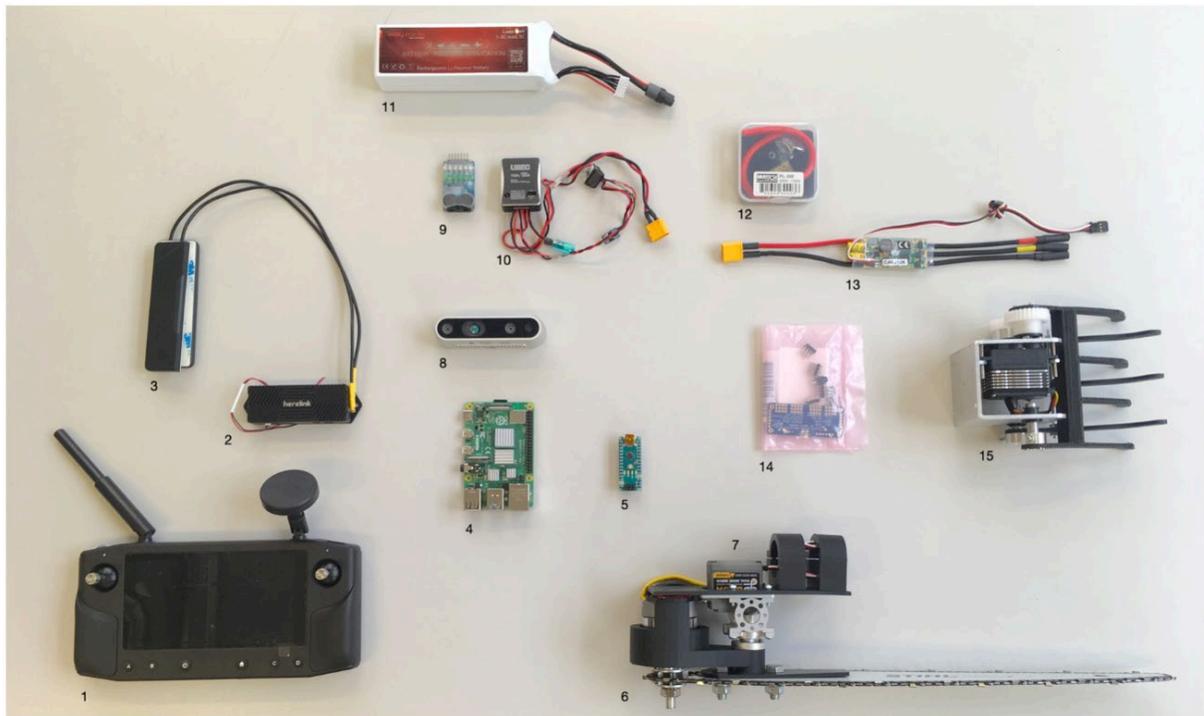


Figure 4: FTTS components laid out

Value Gained

Despite not having flown a functional sampling flight by the end of the Bachelor's Thesis, this generation FTTS proved itself as viable base to improve on. The introduction of electrical orientational aids for the pilot and operator were of great value, along with the implementation of a chainsaw as the cutting mechanism.

Noteworthy

Having an exposure to global issues within the Department of Environmental Systems Science at the ETH-Zurich inspired me to rethink how I can contribute to solving them, with energy science being one of the most ominous requirements to humanity and our society.



Figure 5: Author with assembled FTTS

Finding the position

The position for the Thesis was posted within the Facebook group of Mechatronik Trinational. After applying and a mutually interesting interview, I received confirmation of the position.

Connection to Mechatronik Trinational

As a UAV with a sample retrieval mechanism is a fine combination of electrical and mechanical engineering with computer science, it serves as a prime example of mechatronics and I was able to implement knowledge gained during the interdisciplinary study program.

Recommendations

The wide range of opportunities provided within the course Mechatronik Trinational is almost unique in the area and I highly recommend approaching it with an open and a curious mind to make the most out of the degree course.

My future path

Currently, I am looking to focus on continuing my studies in the energy sector, as it seems to be where I can implement my gained experience to make a positive impact on society and to help tackle the current global issues we are facing as a species.

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