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2021 August 9th

Master thesis project description

Development of a new method for measuring and mapping thermal efficiency over large urban areas.

Students for a master thesis project wanted!

I am currently looking for one student to work in a technical and innovative project, which will develop a novel method to measure and map the thermal efficiency of buildings over large urban areas. The project will take place in the autumn 2021 and/or spring 2022 in collaboration with Umeå University and Umeå Kommun.

The facts

Buildings are responsible for approximately 40% of EU energy consumption and 36% of greenhouse emissions, therefore being the largest energy consumer in Europe [1]. Identifying the least energy efficient buildings and their worst performing parts could be a key step in developing a more energetically sustainable housing park and mitigating climate change, as well as to contribute in the green economy.

Currently, national and local administrations have two main approaches to quantify the efficiency of buildings: theoretical models that combine already existing data or direct measurements on the site. Theoretical models are easy to up-scale over large areas, but they lack the resolution to identify what individual components of buildings require improvement. On the top of that, theoretical models can be just as good as the already existing data they rely on, which in many cases might be insufficient or outdated. Direct measurements can provide accurate and high-resolution data, but existing techniques are slow and expensive to implement, and therefore unsuited for large-scale application. Therefore, the need for a technique that can measure large urban areas and identify all individual elements that are energetically underperforming remains unanswered. Until now.

The idea

I am currently developing a new method for autonomously measuring and mapping the thermal efficiency of buildings and their parts (windows, roofs, doors, etc) over cities. The method relies on different kind of detectors, such as thermal cameras, LIDAR technology and GNSS positioners, and on powerful algorithms that use deep neural networks and big-data analysis techniques to process the information and extract results.

The master thesis project

This project is a 30 hp master thesis to be carried out during the fall semester 2021 and spring semester 2022, with time flexibility. The main goal is to implement our new method into a real case study, which the student will develop through three different phases:

- **Composition of measurement device**: our group has already developed a first prototype of the measurement device, and we are currently working on the second one. These however are proof-of-concept devices, not user friendly and not yet well suited for field measurements. The first task of the student will be to prepare the device for field operation, possibly building a suitable housing structure, installing an autonomous power supply unit and programming a simple user interface for real-time data acquisition and device control.

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- **Field measurements:** in this part, the student will use the prepared device to measure few selected buildings owned by Umeå Kommun. The Kommun engineers specifically suggested the buildings for two reasons: they have already characterized their efficiency using other methods, and they represent the best and the worst examples of energy efficiency in town.
- **Data analysis:** we will analyse the measured data, create simple models to extract useful physical parameters and compare the results with those provided by the Kommun.

During the development of the project, the student will receive access to tools, materials and workspace that she/he can use upon convenience.

The requirements

The students applying for this project should be enrolled in the university during the whole time span of the project and satisfy the conditions to start a master thesis in accordance to the Teknisk Fysik program guidelines. Distance working on a flexible (to some extent) schedule is allowed for the parts that do not require in person activity, such as working with hardware in the designated workshop or making the field measurements.

The applicants should feel comfortable working independently and be fluent in English. Previous experience working with experimental equipment and programming data acquisition routines are not necessary but considered a positive asset.

How to apply

In order to apply, send me a short description (around 15 lines) of yourself and your interests, together with your CV, to aitordand@physicalthinking.tech **before 15th September**. For questions related to the project, please contact me through the stated email. For any questions and details regarding registration, please contact Krister Wiklund at krister.wiklund@umu.se

About the supervisor

My name is Aitor De Andres and I am 4th year PhD student in Umeå University doing research in ultrafast optics. During my free time, I like to develop my own projects and ideas, with the future vision of becoming a part-time professor and to manage my own private company on the side. Two years ago, I registered myself as a single-person company and started to collaborate in selected projects with different tech-related startups and companies. After learning a great deal from them, I feel now confident enough to start laying the foundations of a startup, which is the reason why I decided to start this project.

References

[1] – Energy performance of buildings directive, EU commission, "https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en", accessed on March 16th, 2021