DYNASTEE
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Foreword

DYNASTEE informs on dynamic methods for testing, simulation and analysis. So does this newsletter with research progress and results on data gathering and new testing and analysis methods for energy performance of buildings.

In conjunction with the 6th Expert meeting of IEA EBC Annex 71 in Bilbao, DYNASTEE organises a Symposium on 'The Building as the Cornerstone of our Future Energy Infrastructure' (10-11 April 2019). Results of that event will be available soon in an extra issue of this Newsletter, together with the full programmes of the Summer Schools 2019. Two training sessions at different levels will be organised in Denmark (one week in August) and in Granada Spain (two weeks in September). Number 13 will be available within a few weeks from now. Scale up your knowledge and skills in dynamic analysis of energy performance data!

Setup for wall surface temperature/U-value measurement using different types of infrared cameras

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Using UAV-based RGB and thermography images to generate simulation input about envelope geometry and U-values

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Before energetic refurbishments are actually performed, performance simulations can deliver valuable insights about the status quo and about possible refurbishment options. However, collecting sufficient input data is often costly, time-consuming, and/or assumption-based. As a possible solution, various remote sensing tools are currently investigated and tested by German Aerospace Center (DLR) for their applicability on energetic building analysis [1]. Unmanned aerial vehicles (UAVs) can be used as a flexible sensor carrier that is able to quickly reach various positions around a building. In the presented project, UAVs have so far been used for mounting RGB, thermal infrared (IR), and hyperspectral cameras. RGB images are used for the digital geometrical reconstruction of the building envelope via photogrammetry as well as for feature recognition, whilst infrared thermography serves for determining U-values of the walls. Hyperspectral analyses reveal the material classes of the outer wall layer [4]. In DLR's approach, digital 3D reconstruction starts with creating a point cloud out of automatically or manually recorded single lens reflex camera images with commercially available software. Afterwards, semantically annotated surface polygons are reconstructed using an internally developed method and windows are recognized in façade textures generated from the initial images [2]. The use of thermography for U-value measurement from the outside is currently limited by several disturbing factors and significant uncertainties [5]. The current project objective is to reach a reasonable uncertainty value in minimal flight time. Measurements on test walls and on an overheated test building were performed in Winter 2018/2019 to investigate different influencing factors: a tent was placed around the test walls to obtain a more controlled environment; repeated images of the same scene were taken over the days to study the dynamics of the thermal radiation; different methods for calculating convection coefficients were compared; at the test building, various types of uncooled microbolometers like those carried by UAVs and many handheld IR cameras as well as a high-precision cooled camera were used to record images with the goal of analyzing varying measurement values; a black body with known temperature was placed in the scene for calibration purposes; different viewing angles and distances between camera and wall were covered. Evaluation will provide insights on the uncertainties connected with the various influencing factors and possibly improve the accuracy of quantitative external infrared thermography for U-value determination.

A wrap-up of the current state of the project was recently presented at the IEA-EBC Annex 71 expert meeting [3]. Further information on the project progress will be presented at Building Simulation 2019 conference, provided final acceptance of the respective contributions, and in future Annex 71 meetings. This includes not only optical sensor systems, but also microwave radar and ultrasound technology which are tested for application on wall structure and air tightness analysis, respectively.

References: [1]Estevam Schmiedt, J., Cerra, D., Dahlke, D. et al. (2017), 'Remote sensing techniques for building models and energy performance studies of buildings'; [2] Frommholz, D., Linkiewicz, M., Meissner, H. et al. (2017), 'Reconstructing Buildings with Discontinuities and Roof Overhangs from Oblique Aerial Imagery';[3] Gorzalka, P., Estevam Schmiedt, J., Dahlke, D. et al. (2018), 'Building Tomograph – From Remote Sensing Data of Existing Buildings to Building Energy Simulation Input'; [4] Jilge, M., Heiden, U., Habermeyer, M. et al. (2017), 'Detecting Unknown Artificial Urban Surface Materials Based on Spectral Dissimilarity Analysis', Sensors; [5]D., Estevam Schmiedt, J., Röger, M. et al. (2018), 'Approach for external measurements of the heat transfer coefficient (U-value) of building envelope components using UAV based infrared thermography'