Workflow for Synthesizing Data Sources for Constructing Digital Twin Models of Structures

Summary

Today, the setup of digital models is often a largely manual process, highly reliant on user interaction, being thus time-consuming and prone to human error and system/model misconfiguration. The data gathering automatization for digital twins will enable a reliable source of information to inform the multi-objective holistic design approach of the construction and renovation projects. Leveraging digital information and coupled workflows will help to improve on this aspect. This research aims to develop a conceptual workflow and test the prototype workflow on case structures for reality capture and reconstruction of information by analyzing data from existing databases and synthesizing it with new data. Data flow for delivering renovation and construction projects in the context of a highly fragmented industry is essential. For achieving the research aim, the project addresses the following research questions: • What approaches and methodology for reality capture of existing structures are available, and what are their benefits and limitations? • What kind of a workflow could be developed for reality capture and reconstruction of information for existing structures by utilizing data from measurements, existing databases and synthesizing it with new data? • What are the effects and how does the workflow benefit the different stakeholders?

Research field:	Building and civil engineering and architecture
Supervisors:	Prof. Dr. Targo Kalamees Prof. Dr. Ergo Pikas
Availability:	This position is available.
Offered by:	School of Engineering Department of Civil Engineering and Architecture
Application deadline:	Applications are accepted between June 01, 2022 00:00 and June 30, 2022 23:59 (Europe/Zurich)

Description

BIM has become business as usual, providing the common data platform, the foundation for digitalization in the construction industry. This has led researchers to focus more on data management, such as digital twin systems. The current focus in the digital twin research tends to be on the new structures and the automation of data capture and the reconstruction of information. However, in the context of existing structures, existing data is often underutilized. That is, there are already much data about existing structures in the national registries, such as in the Estonian national digital twin system or e-permitting system. Those data could be utilized jointly with new data to improve reality capture and information reconstruction. This is especially salient in the context of the European Green Deal. For example, around 75% of existing buildings in Europe need to be renovated within the next 30 years. Buildings to be renovated are relatively standardized, meaning that some generalizations could be developed.

This research aims to develop a conceptual workflow and test the prototype workflow on case structures for reality capture and reconstruction of information by analyzing data from existing databases and synthesizing it with new data. The reconstructed models and information could be used for following purposes: (1) integration of data sources and optimization for design, construction and renovation processes; (2) reconstruction and information organization into digital twin models; (3) data capture for process planning and control; and (3) industrialization of the renovation of apartment buildings. Although data in existing registries may not be accurate, it might be accurate enough for developing reference models that can be used for example in the standardization of renovation solutions.

Supervisors:

Main supervisor: Prof. Dr. Ergo Pikas
Co-supervisor: Prof. Dr. Targo Kalamees

The research will be conducted in the following phases:

1. preparation, planning, and objectives;

2. availability and quality analysis of existing data;
3. development of the workflow concept and architecture;
4. designing, developing, and testing the solution prototype; and
5. summative evaluation and conclusions.

The first phase is important for understanding the context, existing approaches, and technologies and establishing criteria for reality capture and information reconstruction for the renovation of existing structures. In the second phase, digital registries are identified, and data availability and quality are assessed. In the third phase, the new workflow and its architecture for existing structures are established. In the fourth phase, the solution is designed, developed, and tested in the context of existing structures. In the final phase, the outcomes are assessed, and future research topics are addressed.

Responsibilities and (foreseen) tasks

- Study the state of the art in the reality capture in the context of construction and related fields.
- Map, identify, assess and utilize available data and develop an improved data capture method for existing structures.
- Develop and test the workflow and technology to reconstruct the information about existing structures needed for renovation purposes of structures.
- Demonstrate and test the feasibility of the proposed reality capture workflow
- Contribute to the organization of research and practitioner workshops where project findings are presented

Applicants should fulfil the following requirements:

- Have a master's degree preferably in civil engineering or a relevant discipline
- Excellent command of English
- Strong and demonstrable writing and analytical skills
- Capacity to work both as an independent researcher and as part of a team
- Capacity and willingness to assist in organizational tasks relevant to the project

The following experience is beneficial:

- Working knowledge of statistics
- Working knowledge of modeling and simulation of structures
- Basic knowledge of programming and data analytics

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks, and propose theoretical lenses to be used.

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About the research units

The core competencies and research areas of the Building Life Cycle Research Group include construction technology, design and construction management, project management, construction economics, building information management/modeling, and construction information technology. The group has and is continually contributing to

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the development of national and international legislation, standards, and guidelines, including, for example, “Public Owner's BIM General Requirements”; building design management standards; legal analysis of digitalizing construction permitting and processes; international Construction Information Classification system; and industrialized renovation processes. In addition, research group members have worked on the topics related to digital twin systems for construction management.

The nZEB Research Group has contributed to the development of the Estonian energy performance calculation framework and methodology; to the preparation of technical definitions and system boundaries of nearly zero energy buildings on the European level; and the development of Estonian nZEB requirements. The group has long-term experience in scientific and applied research in building physics, energy performance, renovation, and indoor climate-related areas.

Additional information

For further information, please contact Professor of digital construction Ergo Pikas at ergo.pikas@taltech.ee and Professor of building physics Targo Kalamees at targo.kalamees@taltech.ee

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