BoB

Monitoring building projects by enriching Building Information Models with real-time on-site progress and activity data.

SETTING THE SCENE

Building Information Modeling (BIM) has propelled the construction industry toward greater digitization, marking a much-needed and long-anticipated advancement. BIM encompasses a process of information management, collaboration, and digital delivery, using object-oriented models shared among all stakeholders in a building project.

However, BIM is still predominantly utilized during the design and planning phases of construction. On-site, during the actual building process, digital models are often underutilized. This disconnect can lead to a decoupling between the models and the real-world situation, resulting in errors and the need for rework. Furthermore, information often becomes fragmented across multiple data sources and subcontractors, each relying on their own tools for estimates and progress tracking. This creates a scattered and incomplete view of the construction process. Additionally, key decisions and progress management are frequently based on intuition rather than objective data or systematic reporting. This lack of integration can disrupt construction schedules, affect material flows, and lead to significant cost overruns.

These challenges could be addressed by making BIM more usable and valuable throughout the entire building lifecycle. This is precisely what the BoB project aims to achieve.

FRAMING THE RESEARCH OBJECTIVE

The research objective of the BoB project was to develop the technology to automate (part of) the tracking of the building progress, making the tracking effort more efficient. This includes, amongst others, working on the automated recognition of activities such as pouring concrete or excavations, or developing technology to map the state of the construction site on the BIM, making it more dynamic.

THREE MAIN OUTCOMES

The main outcomes of the BoB project allow to reduce repetitive manual intervention and data input, which is the current practice:

- Researchers at the imec – IDLab and Data Science Lab extended a declarative language (RDF Mapping Language) to generate knowledge graphs for the context of progress tracking. Such knowledge graphs are used for data integration by mapping various data sources to a common ontology. Here they are generated as a Linked Data Event Stream (LDES).
- Imec – IPI improved algorithms for multi-camera autocalibration (less than 10 cm reprojection error) and multi-view 3D reconstruction (more complete, less outliers) in challenging conditions. This includes taking into account widely differing camera viewpoints, limited overlap between images, and repetitive structures in the scene that might cause ambiguity.
- Researchers at the imec – IDLab developed a compression methodology for the activity recognition model. They used two-stage compression consisting of structured channel pruning and quantization, which proved to have a good performance.
- D-Studio and Balloon Inc. integrated on-site camera captures, offline 3D models (BIM) and construction planning information into an interactive web-dashboard. This was further enriched with the object classifiers and camera calibrations prepared by the research partners.

Key learnings from the project are:

- Working with versioned knowledge graphs using a single event stream model allows to acquire interesting insights.
- The currently available industry-grade object detectors in the market might not be suitable enough for deployment unless they are finetuned with additional labeled data.

- To be able to track construction progress, it is essential to localize relevant objects (e.g. workers, assets, etc.) in the camera images and relate them to the BIM models. This requires multi-modal matching and alignment between images and 3D representations. However, performing this matching automatically remains a challenge. Making it robust enough will require further research. Semi-automated techniques like those developed within the BoB project can be used as an alternative, but are slightly more time-consuming.

NEXT STEPS

The project's partners D-studio and Balloon Inc. intend to collaborate to expand the existing AICON platform (www.aicon.construction) with extended features based on the results of the BoB project. Willemen Groep and Bouwbedrijf Dethier will be available for on-site testing, refinement and user feedback.

The algorithms developed within the BoB project will be further validated, optimized and extended to allow for dynamic camera set-ups through a VLAIO COOCK+ project with a large user group.

Bob partners:

The BoB project was co-funded by imec, with project support from Agentschap Innoveren & Ondernemen (VLAIO)

FACTS

NAME	**BoB (BIM on Building site)**
OBJECTIVE	To analyze on-site building activity and progress, and link it to BIM
TECHNOLOGIES USED	BIM, 3D reconstruction and matching, camera calibration, activity recognition, model compression, semantic modelling, knowledge graphs
TYPE	imec.icon project
DURATION	01/01/2022 – 31/03/2024
PROJECT LEAD	Stefan Boeykens, D-Studio and Django Liénart, Balloon Inc.
RESEARCH LEAD	José Oramas, imec – IDLab – UAntwerpen
BUDGET	2,107,530.92 euro
PROJECT PARTNERS	Balloon Inc., D-Studio, Willemen Groep, Bouwbedrijf Dethier
RESEARCH PARTNERS	N.A.
RESEARCH GROUPS	imec – IDLab – UAntwerpen, imec – IDLab Data Science Lab – UGent, imec – IPI – UGent

WHAT IS AN

IMEC.ICON PROJECT?

The imec.icon research program equals demand-driven, cooperative research. The driving force behind imec.icon projects are multidisciplinary teams of imec researchers, industry partners and/or social-profit organizations. Together, they lay the foundation of digital solutions which find their way into the product portfolios of the participating partners.

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