International Association for Automation and Robotics in Construction

2017 Newsletter

IAARC Newsletter

FROM THE PRESIDENT'S DESK

Dear IAARC Members, Friends, and Colleagues,

The annual newsletter of the International Association for Automation and Robotics in Construction (IAARC) covers some of the most recent events and achievements of our IAARC community. It also provides you with the latest information to the 35th International Symposium on Automation and Robotics in Construction (ISARC) which will be held in Berlin, Germany from June 20-25, 2018.

This past summer we witnessed another successful ISARC in Taipei, Taiwan. The symposium had over 150 papers, presentations and posters from researchers around the globe. In addition, research workshops were conducted by Prof. Soonwook Kwon, Prof. Shuo-Yan Chou, Prof. Heng Li and Prof. Benny Raphael on special topics. Due to the increased interest of the construction industry in information technology and automated solutions the number of attendees at ISARCs continues to grow. The event also featured keynote speakers Prof. Miroslaw Skibenski, Prof. Dongping Fang and Prof. Min-Yuan Cheng. A technical tour was conducted to see the Danjiang Bridge, designed by the famous architect Zaha Hadid.

Preparations are underway for ISARC 2018 in Berlin, Germany. The event will be chaired by the organizing committee of Jochen Teizer, Markus König and Timo Hartmann. A new inclusion for ISARC in Berlin is the AEC/FM Hackathon. This three-day event will bring together students, young professionals, researchers and industry professionals to work on a myriad of problems relevant to the symposium. The awards night will feature solutions proposed by the teams and prizes will be given to teams that distinguish themselves. Apart from paper and poster presentations, the organizing team is arranging for technical tours to construction sites in Berlin.

On behalf of the entire IAARC community, I wish to thank the organizing team for ISARC 2017. I take this opportunity to personally thank the conference chair Min-Yuan Cheng and co-chairs Hung-Ming Chen, Jui-Sheng Chou, Yo-Ming Hsieh and I-Tung Yang. The event would not have succeeded without their tireless efforts.

Finally, I look forward to seeing you all at ISARC 2018 in Berlin. I encourage you to bring your students to attend the AEC/FM hackathon and the ISARC symposium.

Prof. Carl T. Haas
IAARC President

Professor Min-Yuan Cheng was the recipient of the Prestigious Tucker-Hasegawa Award at the 2017 ISARC in Taipei, Taiwan

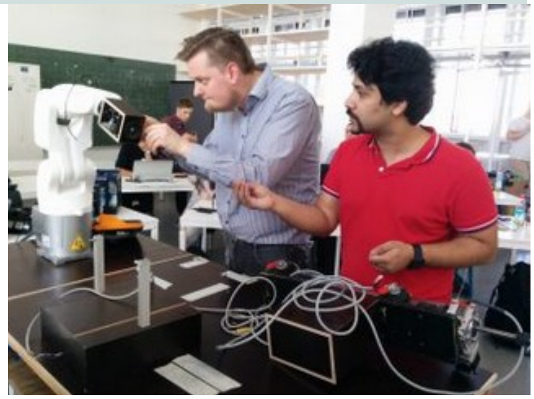
INSIDE THIS ISSUE

REGITER NOW at ISARC2018.ORG

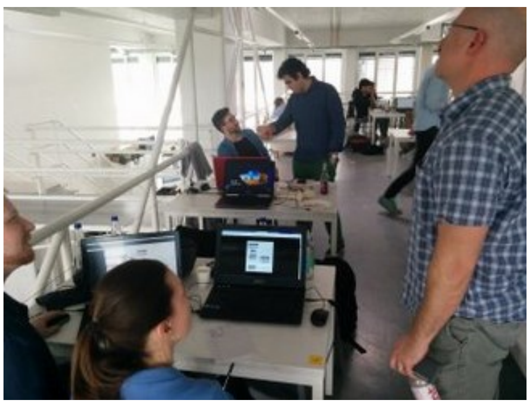
ISARC, 2018

The 35th International Symposium on Automation and Robotics in Construction and the International AEC/FM Hackathon will be held in Berlin, Germany from July 20 to 25, 2018.

AEC/FM HACKATHON



A hackathon (also known as a hack day or weekend, hackfest or codefest) is a design sprint-like event in which computer programmers and others involved in hard- and software development, including engineers, architects, graphic designers, interface designers, project managers, and others, often including subject-matter-experts, collaborate intensively on prototype or research projects. The goal of a hackathon is to create usable hard- or software. Hackathons tend to have a specific focus, which can include sensors, robots, or programming language used, the operating system, an application, an API, or the subject and the demographic group of the researchers and developers. In other cases, there is no restriction on the type of product



Six themes will be featured at the Hackathon in Berlin this July. Students have to choose one of the themes to participate in the event.

1. Autodesk Dynamo: World-leading experts of Autodesk will introduce the latest developments of its standalone programming environment that lets engineers and designers create visual logic to explore parametric conceptual designs and automate tasks.

2. Autodesk Forge: Autodesk will also introduce challenges on the latest developments of Forge, a powerful, cloud-based software platform of web service APIs that allow you to integrate Autodesk products such as Fusion Team, BIM 360 Docs, etc.

3. Big Data Mining: This challenge will focus on learning from New York City open data including data of the years 2009-12017 from UBER and taxi car movements to improve NYC's urban land-

4. Construction Robotics: The Chair for Individualized Production (IP) in architecture of RWTH Aachen University in cooperation with Robots in Architecture showcases a parametric robot programming interface through Autodesk Dynamo

5. Mixed Realities (AR/VR): The Chair of Computing in Engineering at Ruhr-University Bochum will introduce in a workshop AR/VR-related technologies and make them physically available for hacking.

6. Remote Sensing & Internet of Things: Topcon will offer in its workshop concepts and physical access to a variety of sensors and its data, i.e. related to GNSS, drones/UAVs, machine guidance/control. Potential hackathon topics may focus on intelligent use of hardware, software, or computational data processing techniques, e.g. linking sensor data with building or infrastructure information models.

TAIPEI, 2017

The 34th ISARC was hosted by the National Taiwan University of Science and Technology. The main theme for the conference was ‘*Bridge to the iERA—Innovative Energy, Robotics & Automation*’. Several papers were presented in these areas, along with keynote talks by Prof. Miroslaw Skibenski, Prof. Dongping Fang and Prof. Min-Yuan Cheng. Hands-on technical workshop were presented by Prof. Soonwook Kwon, Prof. Shuo-Yan Chou, Prof. Heng Li and Prof. Benny Raphael.

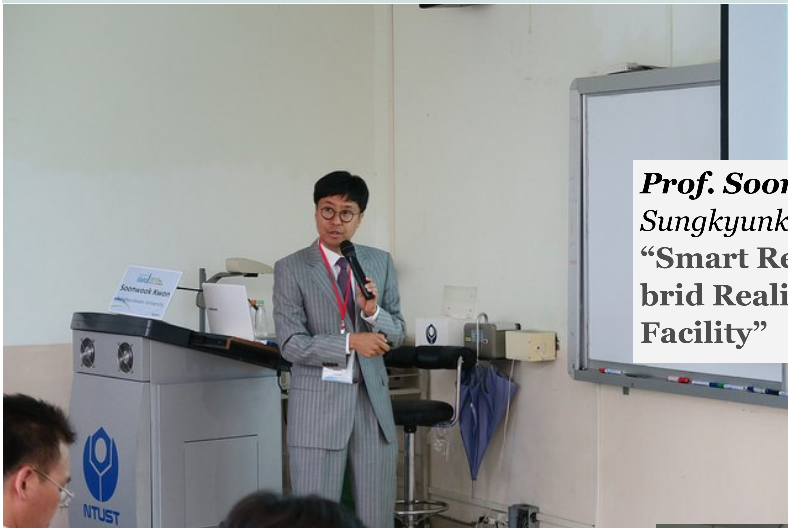
ISARC 2017

June 28 – July 1

TAIPEI, TAIWAN

TAIWAN TECH

Technical Workshops at ISARC 2017 in Taipei, Taiwan



Prof. Soonwook Kwon
Sungkyunkwan University, Korea
"Smart Reverse Engineering and Hybrid Reality Technology for Industrial Facility"

Prof. Shuo-Yan Chou
National Taiwan University of Science & Technology, Taiwan

"Industry 4.0 for Construction"

Prof. Heng Li
Hong Kong Polytechnic University, China
" Location Based Site Safety Management"

Prof. Benny Raphael

IIT Madras, India

"Machine Learning Applications in Civil Engineering"

Keynote Talks at ISARC 2017

Prof. Miroslaw Skibniewski **Prof. Dongping Fang** **Prof. Min-Yuan Cheng**

Social Events and Site Visits at ISARC 2017

BEST PAPER
ISARC 2017, TAIPEI, TAIWAN

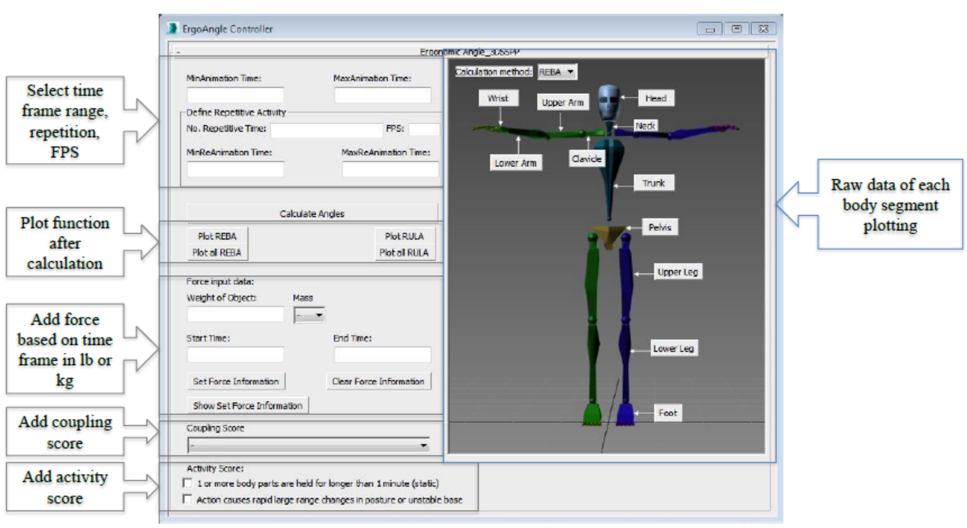
Automated Ergonomic Risk Assessment based on 3D Visualization

X. Li, S. Han, M. Gül and M. Al-Hussein

Abstract –

Conventional ergonomic risk assessment of physical work is conducted through observation and direct/indirect physiological measurements. However, these methods are time-consuming and require human subjects to actually perform the motion in order to obtain detailed body movement data. 3D visualization, alternatively, allows users to simulate an operational task on the computer screen, a process that is less time- consuming and which eliminates the need for costly on- site devices, as well as the detrimental effect of human error during experimentation. It can also proactively visualize a proposed design prior to implementation in the real world. This paper presents an automated ergonomic risk assessment framework based on 3D modelling with the support of a user-friendly interface for data-post processing. 3ds Max is utilized together with its built-in MAXScript.

The presented system enables the automation of body motion risk identification by detecting awkward body postures, evaluating the handled force/ load and frequency that cause ergonomic risk during body movements of workers. As the outcome, it provides detailed risk scores for body segments, such that users are able to review the continuous motion and corresponding risk by precise time frame. The capability of this 3D visualization- based ergonomic risk assessment can be extended to support the re-design of the workplace and optimization of human body movement accordingly. The ultimate goal of this study is to proactively mitigate ergonomic risk and further reduce potential injuries and workers' compensation insurance costs in the



BEST PAPER—First Runner Up
ISARC 2017, TAIPEI, TAIWAN

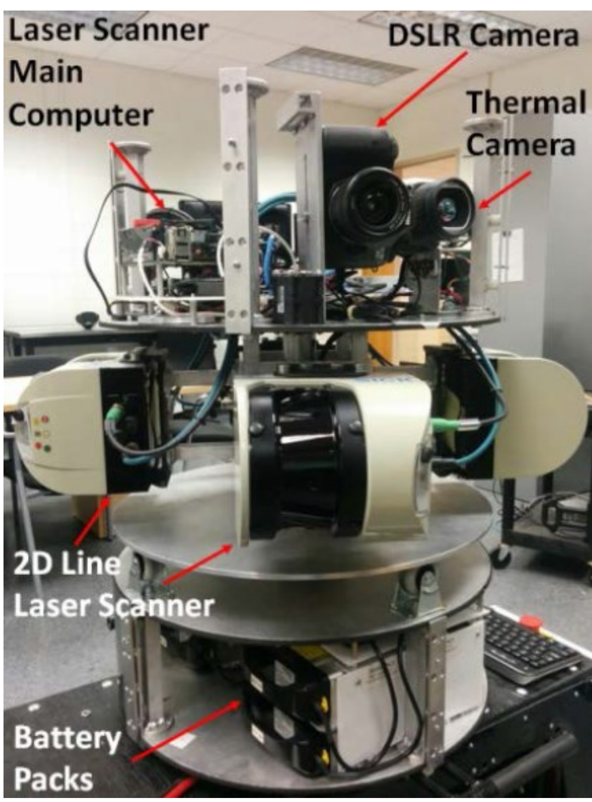
Building element recognition with thermal-mapped point clouds

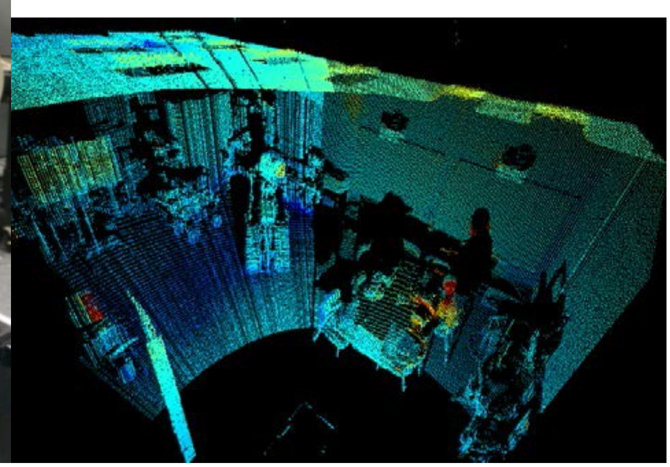
Pileun Kim, Jingdao Chen, and Yong Kwon Cho

Abstract –

Automated recognition of building elements convey vital information for inspection, monitoring and maintenance operations in indoor environments. However, existing object recognition methods from point clouds suffer from problems due to sensor noise, occlusion and clutter, which are prevalent in indoor environments. This paper proposes an object recognition method based on thermal-mapped point clouds for building elements consisting of electrical systems and heating, ventilation, and air-conditioning (HVAC) components.

The proposed processing pipeline involves data collection from a mobile robot using both laser scanners and a thermal camera where temperature mapping can be performed from thermal images to point cloud. Next, the ceiling region containing the building elements of interest is identified and extracted from the point cloud. Segmentation of peak and valley thermal intensity regions is carried out based on absolute and relative temperature threshold values. The identified point cloud clusters can be each associated with a building element and localized based on the cluster center. The proposed building element recognition method was validated with two sets of laser scan data collected in an indoor laboratory. Experimental results for detection of lighting elements and cooling elements showed that the method achieved an average of 100% precision, 90% recall, and 0.25m root mean squared error (RMSE).





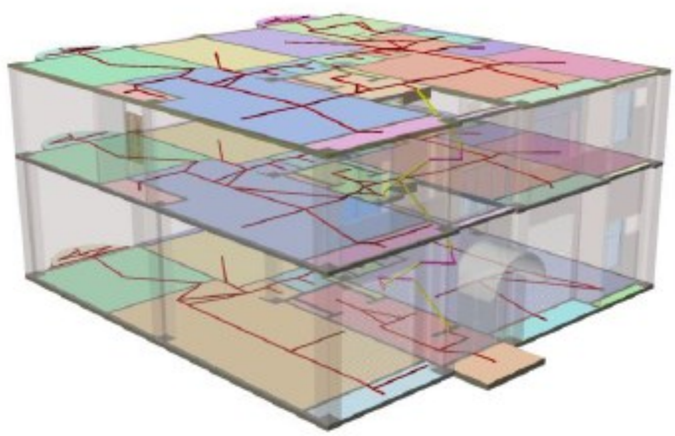
BEST PAPER—Second Runner Up
ISARC 2017, TAIPEI, TAIWAN

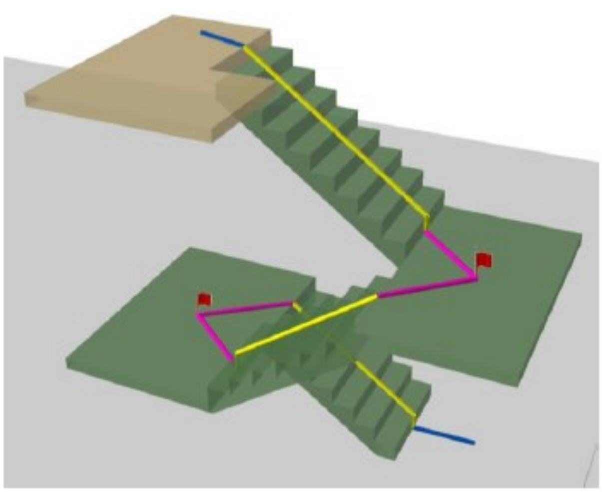
Automating the Generation of Indoor Space Topology for 3D Route Planning Using BIM and 3D-GIS Techniques

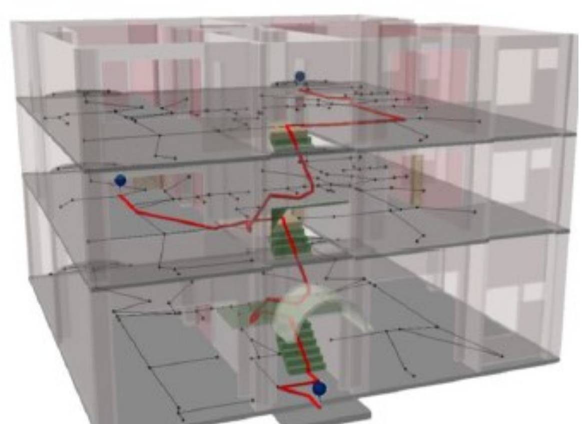
W.Y. Lin, P.H. Lin and H.P. Tserng

Abstract –

3D Indoor space topology, mainly referred as floor layouts and navigation routes, is the foundation of indoor Location-based Services (LBS), such as navigation in large shopping malls or interchange in large transport stations. Manually generating this topology is highly time-consuming, less cost effective, and prone to errors. This research adopts 3-D GIS technology and proposes a novel workflow to automatically generate the indoor space topology based on 3D building models in a format of Industry Foundation Classes (IFC). Floor layouts and paths including stairs will be identified and generated in the environment of ESRI ArcScene. Several categories of navigation routes are defined and constructed by a collective algorithm called i-GIT. This paper demonstrates the entire workflow and concepts to produce floor layouts and navigation routes using a 3-story commercial building model. More details related to i-GIT as well as







Target-Free Automatic Registration of Point Clouds

Pileun Kim, Yong Kwon Cho and Jingdao Chen

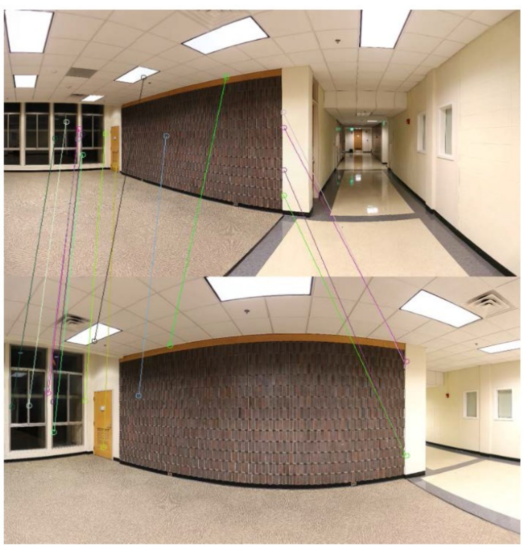
BEST PAPER AWARD

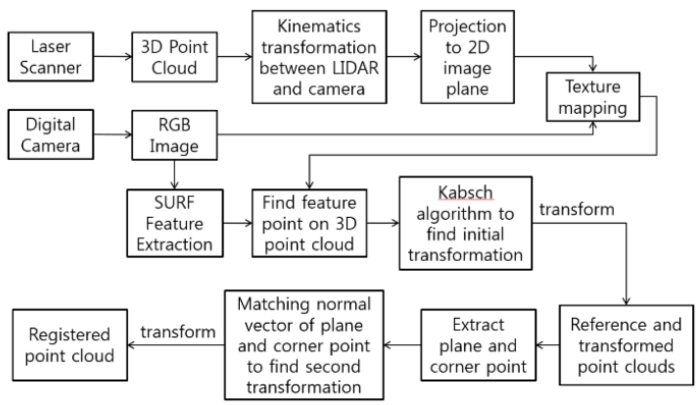
ISARC 2016

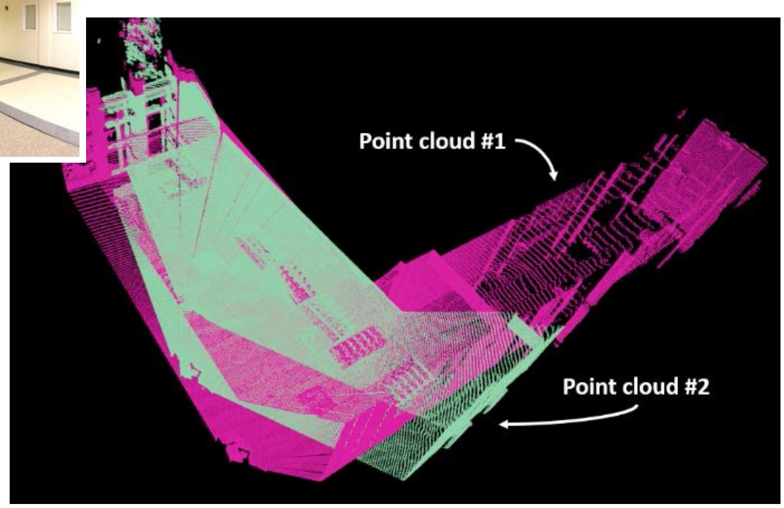
AUBURN, AL, USA

Abstract –

The aim of this paper is to introduce a novel method that automatically registers colored 3D point cloud sets without using targets or any other manual alignment processes. For fully automated point cloud registration without targets or landmarks, our approach utilizes feature detection algorithms used in computer vision. A digital camera and a laser scanner is utilized and the sensor data is merged based on a kinematic solution. The proposed approach is to detect and extract common features not directly from a 3D point cloud but from digital images corresponding to the point clouds. The initial alignment is achieved by matching common SURF features from corresponding digital images. Further alignment is obtained using plane segmentation and matching from the 3D point clouds. The test outcomes show promising results in terms of registration accuracy and processing time.







BEST PAPER AWARD

ISARC 2016

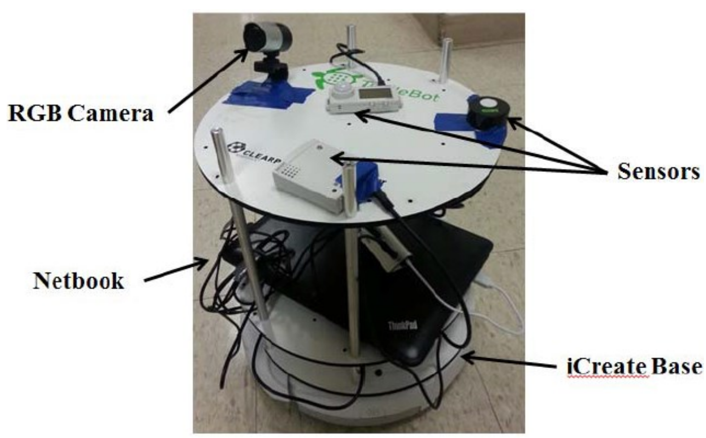
AUBURN, AL, USA

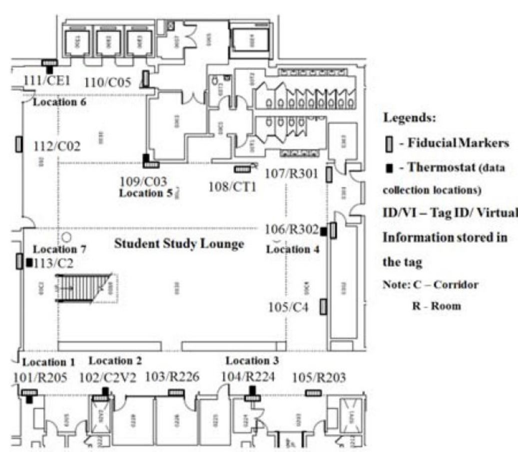
Ambient Data Collection in Indoor Building Environments Using Mobile Robots

Bharadwaj R. K. Mantha, Carol C. Menassa, and Vineet R. Kamat

Abstract –

Building designers have increasingly looked at simulation to improve the performance of building systems with the primary objective of simultaneously maximizing comfort, and minimizing energy use. The quality of the simulations depends on the quality of the data being input into the models. The input data for simulation comprises the current real state of a building which encompasses several components that include the state of occupants, comfort parameters, and the building systems. Typically, such data is aggregated using preinstalled Building Automation Systems (BAS) with the help of stationary wired or wireless sensor networks. Such a process is cost-prohibitive, time consuming, and often impractical in existing buildings without BAS. This paper proposes mobile platform based robotic data collection for gathering energy and comfort related data in real-time which can be utilized for further simulation analysis and decision-making. The fiducial marker based navigation and drift correction algorithms developed to facilitate the robotic platform navigation in a building are discussed in detail. This method successfully achieves the navigation task by providing directional navigation information along with drift correction at critical discrete locations instead of the traditional continuous updating process, which is computationally intensive. An experimental study validating the statistical equivalence of the two data sets gathered by the traditional preinstalled fixed sensor networks and the multi-sensor fused robot was performed. The results demonstrate the feasibility of the proposed methodology in efficiently collecting large datasets in buildings using only a single set of sensors in contrast to the scads of similar sensors data collection methods.





Large Scale 3D Printing of Complex Geometric Shapes in Construction

Jochen Teizer, Alexander Blickle, Tobias King, Olaf Leitzbach and Daniel Guenther

BEST PAPER AWARD

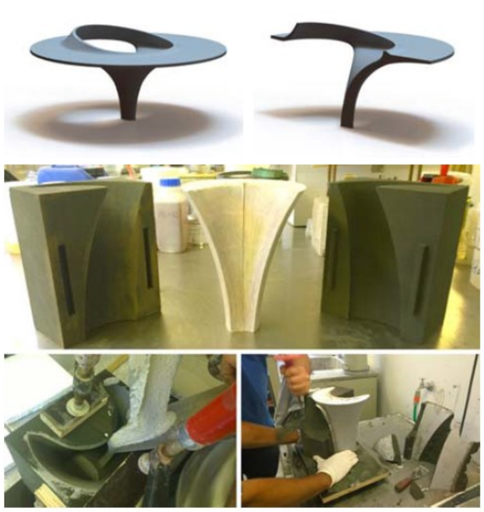
ISARC 2016

AUBURN, AL, USA

Abstract –

3D printing, also known as additive manufacturing, has become an established technology in many industry sectors for the fabrication of three-dimensional (3D) objects. The layered production of scaled prototypes and smaller series typically use automated computer controlled systems that rely on a-priori designed digital 3D models. General principles for 3D modeling, printing, and finishing exist utilizing the cutting, melting, or softening of paper, polymer, or metal materials.

While advantages and limitations of the 3D printing processes require careful review for its final application, the construction industry itself has adopted industrial applications successfully in many examples where, for example, consecutive layers of concrete are combined into a desired structure or form. One of construction's key challenges though is its need for large scale 3D printing of complex geometric shapes on projects where construction time, cost, and quality are the predominant and determining success criteria. While complexity and scale of the planned structure become available at finer detail during the architectural design process, final fabrication of large-scale geometric shapes often fails because of constructability issues.



This article introduces conventional construction methods for building large scale and complex geometric structures using on purpose built, automated and robotic 3D printing machines. It therefore contributes the missing link between demanding architectural design that otherwise could only be built at large cost. Commonly known advantages and limitations of existing 3D printing processes, including modeling, printing, and finishing principles are reviewed. Significance of resolution, speed, and quality of materials in 3D printing are explained. Results to an implementation of complex formwork in a major capital construction project are shown. Preliminary benefits and limitations from the perspective of a construction company explain what it takes to advance 3D printing to a field-ready construction method.