Measuring the potential of augmented reality in civil engineering

Sebastjan Meža, Žiga Turk, Matevž Dolenc*

Chair of Construction Informatics, University of Ljubljana, Faculty of Civil and Geodetic Engineering, Jamova 2, 1000 Ljubljana, Slovenia

ABSTRACT

Recently building information models have substantially improved the explicit semantic content of design information. Information models are used to integrate the initial phases of project development. On the construction site, however, the designs are still mostly represented as line-based paper drawings or projections on portable displays. A generic technology that can integrate information and situate it in time, place and context is augmented reality. The specific research issues addressed are (1) does augmented reality have a potential use in civil engineering, (2) how big – in comparison to other technologies – is this potential and (3) what are the main barriers to its adoption. The generic research issue was to develop a methodology for evaluation of potentials of technology. A prototype was built. It was tested on a real construction site to evaluate the potential of its use using the action-research method. A set of structured interviews with potential users was then conducted to compare the prototype to conventional presentation methods. Using this methodology it has been found out that augmented reality is expected to be as big a step as the transition from 2D line drawings to photorealistic 3D projections. The main barrier to the adoption is immature core virtual reality technology, conservative nature of construction businesses and size of building information models.

Keywords:
Augmented reality
Mobile computing
Computer integrated design
Computer integrated engineering
Civil engineering
Project documentation
Building information modelling
BIM

1. Introduction

Tools for designing in construction have evolved through history. Pens, pencils and paper have been replaced with CAD (computer aided design) and BIM (building information modelling) software. Engineers, builders, planners and contractors also use various domain specific software to support their work. A priority for construction informatics research and practice has been to effectively integrate the specific software to support their work. A priority for construction informatics research and practice has been to effectively integrate the construction processes using information technology [12]. Adequate standards, e.g. Industry Foundation Classes (IFC), have the potential of solving the problem of interoperability of software and representation of information in designing [15].

While the design phase is largely digitised and increasingly integrated around BIM, for a complete digitalisation of construction industry, structured information models would need to be available on construction site where the information is used to shape material world. However, on the construction site the IT infrastructure is not readily available. Things began to change with the introduction of mobile computing [10]. The field is still evolving.

1.1. Motivation

The outputs of construction information processes (designs, plans and schedules) provide the control information for the material processes in construction [42]. The media to bring the information from the digital models to construction site where it is used to shape physical reality are still 2D documents such as floor plans, cross sections, sketches, etc. The construction site is integrated into the construction process using media and formats that pre-date computers. Situating information and establishing the relation between the real world of the construction site and design information remains the task of humans. In this task they are not assisted much by technology. Relevant information from the model has to be extracted, based on the user’s role in the project, location and time. The graphical representation of this information in 2D must be situated and contextualised with the physical 3D reality for which people rely on their spatial awareness. It is the technologically largely unassisted human mind that is bridging the gap between the real world of the construction site and the virtual world of the information model and is integrating the two. This is what engineers on site have been doing since the introduction of drawn design information centuries ago. The problem at hand is how to assist this process with technology.

The hypothesis of our research of augmented reality (AR) was that by using a synthetic environment that enables the integration of 4D building information models into the live picture of real world it is possible to improve the understanding and ease the use of project information. It should be possible to measure this improvement.

We claim that such synthetic environment is augmented reality. It is not just feasible, but it is also more effective than the more traditional, well-established presentations on blueprints or on-screen projections.
The specific questions the paper asks are (a) does AR have potential in structural engineering, (b) how big an improvement this technology is and (c) what are the barriers to its adoption. To answer these questions we had to develop a methodology, which is generic in nature and applicable to other technology related research in the interdisciplinary area of structural engineering and computer science.

2.1. Augmented reality

In this section augmented reality is discussed from theoretical, technological and practical points of view. It explains our understanding of the building information modelling and its relation to construction project documentation. As construction can be understood as the materialisation – physical realisation of the project documentation [26,31,41], a philosophical discussion on relations among human mind, virtual and real environment is provided.

2.2. Building information modelling/model

By definition the building information modelling is a process of digital designing, which results in some form of a building information model (BIM). Ideally it should include all the data needed for the construction instead of the data being scattered throughout numerous drawings, folders, tables, reports, documents, etc. [9].

The basic premise of building information modelling is to enable frictionless collaboration of different actors (professions) at various stages of a building life cycle, integrated around a shared model. The actors may enter, retrieve, update or adopt the information in BIM and with that justify their roles as the participants in the construction process [6,24]. The 4D BIM is a model that includes the temporal properties. The 5th and 6th dimensions of BIM sometimes denote cost and facility management [32].

2.3. Project documentation

Formally speaking, the project documentation that is required by Slovenian legislation is defined by the Construction Act [40]. It should consist of the conceptual design, preliminary design, basic design, detailed design, and as-built design.

In this paper the term “project documentation” is used broader than formally defined by Slovenia legislation. The term project documentation is used to denote a set of all documents needed for the construction. It includes all information contained in building information models.

2.4. Intersection between conscious real and virtual

The role of augmented reality can theoretically be explained in the context of the meaningful triangle in Fig. 1 [31]. The concept is an idea in the mind that refers to that specific referent (real world object). The symbol is a visual or audible signal symbolising the idea about that referent.

The presented example shows that it is possible to establish a direct relation between referent-reference and reference-symbol (Fig. 1). The first is called referencing and the second modelling. The relation between the symbol and the object is more complicated as both exist outside the mind of the human. However, one could say
دریافت فوری
متن کامل مقاله
امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات