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Providing real-estate services through the integration of 3D laser scanning and building information modelling

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ABSTRACT

There is an opportunity for real-estate services sector to deliver more accurate, faster and quality building surveys and information models. This paper reports on a study, designed to establish automated procedures for the development of a digital model to assist in faster and better services and delivery of real-estate services by integrating 3D laser scanning and BIM technology. It proposes an intuitive and interactive building model that is easy to query and navigate, and thus support property developers, buyers and sellers in the property sales sector. An outline of the new approach is provided to illustrate the benefits of the proposed method to the real-estate services sector. The key arguments in the paper are consolidated by the results of a qualitative study amongst real-estate professionals, which sought to determine the added value of BIM-3D laser scanning in comparison to conventional building surveying and Computer Aided Design (CAD) methods.

1. Introduction

Three-dimensional (3D) laser scanning and building information modelling (BIM) technologies have offered new possibilities for capturing, mapping and the analysis of building information. Much of the work and application of the technologies in the built environment to date has however tended to focus on Architecture, Engineering and Construction (AEC) [14,7,6] whilst the real-estate services sector has somewhat lagged behind. This is so in spite of the high dependency of the real-estate services sector on the availability and accuracy of information on properties. The prospects of being able to scan buildings to create accurate 3D representations should therefore be highly attractive to the discharge of real-estate services. In addition, given the infrequency with which property purchasing decisions are made and the difficulty of getting information from an opaque and decentralised marketplace, among other complexities, there is a significant risk that buyers' decision-making may not conform to rational choice [32]. Thus, although the property sales sector demands a holistic view of buildings, mainly informed by location, there is potential for a building-centric application of BIM technology. This paper reports on a study that seeks to examine automated procedures for the integration between scanning technology and BIM to assist in faster and better delivery of real-estate services. The proposed system provides both the prospective property buyers and sellers with an intuitive and interactive building digital model that is easier to query and navigate, and thus support them in their transaction decisions.

2. Research methodology

This study seeks to establish the case and rationale for the adoption of BIM and laser scanning technologies in the real-estate services sector. This is achieved through a critical review of the existing state of the art and practices on the subject and concept of BIM and laser scanning, and a qualitative study amongst real-estate professionals. Two main factors informed the adoption of this approach. First, the authors recognise the increasing prominence of critical review of literature as a proxy for primary research, especially when the review is conducted with the same amount of rigour [9]. Secondly, it became evident from the initial inquiries that this technology has not yet practically found its expression in the real-estate services sector and as such the prospects of a detailed survey of the industry may not yield much. However, in addition to the review of the state of the art, albeit few,

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the study also sought to validate the findings by conducting a qualitative study with a selection of practitioners and professionals in the real-estate sectors, who had previously had an opportunity of making use of BIM and laser scanning technologies in their operations in the various lifecycle stages of buildings.

3. The rationale for 3D laser scanning and BIM in the real-estate services sector

Building surveys are complicated by numerous limitations associated with traditional approaches. The Royal Institution of Chartered Surveyors (RICS) provides its members with guidance notes on conducting building surveys of different types [27,28]. These guidance notes are founded on the traditional approaches and it is therefore common for the many limitations of these survey techniques to be acknowledged. For example, Table 1 is a summary of the general procedure and guidance notes on carrying out building surveys of residential property.

To assist Building Surveyors in carrying out the above tasks, the RICS [27] recommends the use of a range of equipment, such as those listed in Table 2.

In recognising the multiple limitations of the conventional methods of surveying properties, the RICS [27] suggests that the degree of inspection will depend on the purpose of the survey, the practical limitations, and the purpose of the report. The professional body further cautions that the client should be made aware of the practical limitations of the survey exercise.

With regard to data capture during the building surveys, Douglas and Noy [8] argue that there is a variety of ways for surveyors to record their survey findings, such as a checklist, dictating machine, and digital still/video camera. It is suggested that the format of the checklist should be flexible enough to accommodate most building types whilst at the same time allowing for unconventional details on the property to be recorded. The major drawback with checklists is that they have the potential to distort originality in the report format, leading to failure to cover all contingencies. These expositions of limitations associated with conventional methods of undertaking building inspections and surveys demonstrate the need to look for better ways of doing things in the real-estate sector. It is important to recognise that the real-estate services industry has traditionally been an information business with high transaction costs and considerable inefficiency associated with the unique characteristics of real-estate [35]. These characteristics can affect prices and hence buyers' decisions.

The use of 3D scan data within the development of virtual 'tours' of areas has certainly been the subject of many studies in recent years, particularly within the presentation of historical buildings and sites, including the use of augmented reality (e.g. [1,2]), although the real-time navigation of massive and highly accurate point cloud data sets is quite different to open VR navigation systems, such as Google Earth [15]. Consequently, to be able to provide information and save on search costs, a system is needed that enables numerous properties to be conveniently imaged and uploaded with real time updating [18]. The Internet alone may not be able to achieve this task but possibly needs the support of more robust visualisation technologies that mimics reality, and with the capability to represent intangible data such as organisational requirements, maintenance scheduling and resource use, including finances. Barlish and Sullivan [4] identified a range of the most commonly reported benefits of BIM adoption, which tended to focus on scheduling, productivity and fabrication and construction processes, although visualisation of designs (3D) also features as a positive virtue within design. There are many areas in the property buying process that BIM and laser scanning technology can be useful [33], including energy performance of existing buildings, condition surveys, measurements, material characteristics, decorations, compliance with building regulations, inventory of fixtures and fittings, dampness, and many other value factors that a potential buyer would want to take into account. The potential of BIM and laser scanning technology in accounting for and visualising these value factors can never be over-emphasised and would benefit both the buyers and sellers (and their agents) through more improved information and time savings.

Although solutions are available for inputting and processing the collected data, it is perhaps the inspection and information storage and retrieval phases that would potentially benefit most from the use of BIM, not just for energy efficiency certification, but also in terms of visualising and accounting for much of the information requirements, and monitoring in the property buying process. In addition, the potential for health monitoring of structures using laser scanning [23] offers a substantial benefit to the real-estate services. An important issue in health monitoring of structures using techniques such as genetic programming (GP) allows the automatic detection and checking of cracks, such as the examining of their width, length, and orientation [22]. This recognition of the potential of BIM and laser scanning integration in the provision of real-estate services is so critical that it deserves a more detailed technical case for the adoption of the technology.

4. The potential of building information modelling

Building information modelling (BIM) is a technology that involves the application and maintenance of an integral digital representation of building information for different phases of the

Table 1
Building surveys of residential property (inspections).

Main aspect of the building	RICS recommendation/guidance	Limitations
Roof	• The roof areas should be inspected visually as closely as is practicable using available equipment and safe vantage points • Inaccessible voids should be noted and an opinion given by inference	• Certain areas of the roof may be impracticable and unsafe for close inspection • Making an opinion by inference may lead to inaccurate capture of the building's details
Walls	• Exposed elements of all walls should be visibly inspected where not obscured	• Vantage points for close inspection may not always be available especially in complex building structures. • Development of cracks in walls and ceilings are not easily and accurately monitored.
Ceilings	• Inspect the ceilings from the floor level	• Detailed features of the ceiling are not easily inspected and analysed from floor level.
Windows, doors and joinery	• Check joinery where accessible from ground level externally a nd open windows, where practicable, to examine vulnerable areas at closer quarters	• Certain areas of the property may be impracticable and unsafe for close inspection

Source: Adapted from RICS [27].