Chapter 9
Automated Building Process Monitoring

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ABSTRACT

Monitoring of building process activities is the basis for effective control and management of a building project. In its traditional way it is, however, time consuming, inaccurate and expensive. To improve the monitoring process researchers are investigating methods to automate monitoring and support project managers with accurate and timely information about activity progress. The chapter describes some of these methods and then concentrates on a solution, which takes into account all three aspects of project management: coordination, control and communication. Activity progress is monitored directly by using a combination of data collection methods, which are based on the building information model (BIM), especially on the 4D model of the building. The resulting system is described, evaluated and discussed.

1 INTRODUCTION

Building projects are exposed to many unforeseen events and site conditions, which are causing changes in planned activities. If activity changes are not adequately monitored, the project will much likely run out of schedule and budget. Research in the area of IT-supported automated monitoring methods has intensified in the last few years and brought some interesting results.

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The main goal of this chapter is to present, i) the problem and possible solutions, ii) the current research in this area and iii) one of the current systems that authors are developing and testing.

Management Information Systems (Shahid and Froese 1998, Li et al. 2006) and new approaches, such as dynamic planning and control (Lee 2006), help to improve project control, but any chosen system or methodology depends on reliable and relevant information. In practice, data assembling and activity-progress monitoring is still mainly based on traditional methods, which are slow, inaccurate and expensive (Davidson and Skibniewski 1995, Chang and Chen 2002). If on-site activities progress according to plan, the time-interval between, an on-site event and the moment data is fed to a control system is irrelevant. However, if a critical-path activity is being delayed, the whole activity plan has to be promptly rescheduled in order to minimize the negative impacts to the project. According to experience, activity monitoring is efficient if it is performed on the daily level (Navon and Sacks 2007).

Construction companies are gradually recognizing the problem of timely information and are putting lots of efforts into capturing and analysing activity data (McCullouch 1997). Regrettably, in real situations too many construction projects sooner or later erode the benefits of carefully-prepared activity plans and degenerate into improvisation. The only solution for ensuring a consistent flow of relevant information seems to be the automation of data collection (Kiziltas, 2008). Many attempts have already been made using various approaches in order to control construction project performance. They have been based on indirect indicators such as labour productivity (Stauffer and Grimson 2000, Navon and Goldschmidt 2002), use of equipment (Sacks et al. 2002), material's flow (Cheng and Chen 2002, Ergen et al. 2007) or directly-measured activity progress, and some recent methods are based on site image recognition which will be detailed in the following sections.

2 AUTOMATED MONITORING SYSTEMS

Most of the present research in automated monitoring of construction project activities is based on direct identification of already built construction elements. In this section some of the current research projects and results will be presented in a more detail. Additionally, research based on indirect approach of tracking material resources is considered due to global trends in RFID development and application.

Automated Object Identification Based on Site Images

The technological advancements in digital imaging, the widespread popularity of digital cameras, and the increasing demand by owners and contractors for detailed and complete site photograph logs have triggered an ever-increasing growth of construction image data collections, with thousands of images being stored for each project. However, the sheer volume of images and the difficulties in accurately and manually indexing them, have generated a strong need for methods that can index and retrieve images with minimal or no user intervention. The development and research efforts in indexing and retrieval of construction site images have reached a level where automated site-image recognition is becoming feasible.

Material-based construction site image retrieval (CBIR) method (Brilakis et al. 2005) is based on image retrieval techniques, which matches known material samples with material clusters within the image content. The evaluation has shown that this method can successfully suit material-based image queries by pre-identifying the materials in each image and comparing material signatures instead of image signatures. This method enables the engineer to retrieve images in real time according to more efficient higher-level, domain-specific concepts such as materials instead of the lower-level concepts of colour, texture and structure. Moreover, the proposed method addresses all of the issues and limitations of other methodologies. It takes advantage of the domain-specific characteristics of construction and is overcoming the problem-specific deficiencies of the image retrieval methods for generic content based construction site.

The large amount of pictures collected daily at construction sites and the time needed manually classify them motivated the researchers to inves-

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