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Digital image processing based approach for tunnel excavation faces

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Abstract

The New Austrian Tunneling Method (NATM) is the most popular construction method in rock tunnel projects. Geological logging and rock mass classification are two major tasks prior to NATM tunnel excavation. Excavation face conditions are presently determined and logged by manual visual investigation for most, if not all tunnel projects. 2D geotechnical maps may then be drawn to show the locations and directions of weak planes. It is a costly and time-consuming process. To overcome the limitations of conventional approaches, image processing and information management techniques were adopted for tunnel face image storage, management, processing, interpolation, reconstruction, and visualization. An information system was used to manage and manipulate tunnel face related information, including geological description, rock mass rating and excavation face images. Image processing techniques in both spatial and frequency domains were applied to analyze and identify significant geological features (such as faults, joints and shear zones) from excavation faces. Shape-based image interpolation was then adopted to interpolate inter-slices between two neighboring captured images. Finally, a 3D image reconstruction and visualization environment was established to effectively assist geologists and tunnel project engineers in analyzing and evaluating geological characteristics of tunnel excavation faces.

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1. Introduction

Information plays a key role in the management of a project life cycle. It is an essential and valuable resource for project planning, design, control, and

operation tasks. Because of the important role information plays, many studies have been done on architecture/engineering/construction (A/E/C) information modeling. These studies primarily focused on the product, process, and project information, as well as their integration [8,33]. Their main goal was to establish an effective data management mechanism to store and manipulate enormous amounts of data generated during a construction project life cycle. During an informa-

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tion life cycle, in addition to traditional numerical and string data attributes, valuable information contains multi-media attributes, such as images, video and audio. Conventional information systems generally provide the capabilities of assembling, storing, manipulating and displaying these data attributes. Nevertheless, valuable and meaningful information may also be embedded in the multi-media attributes. Conventional information systems put little emphasis on extracting valuable information from these attributes. This paper describes the

application of image processing techniques to tackle a problem in a New Austrian Tunneling Method (NATM) tunnel project: extraction of meaningful information from digital tunnel excavation face images.

The NATM is the most popular method used in rock tunnel construction [2]. A typical NATM design and construction flow is illustrated in Fig. 1. In essence, NATM is an approach or philosophy integrating the principles of rock behavior under load and monitoring the performance of under-

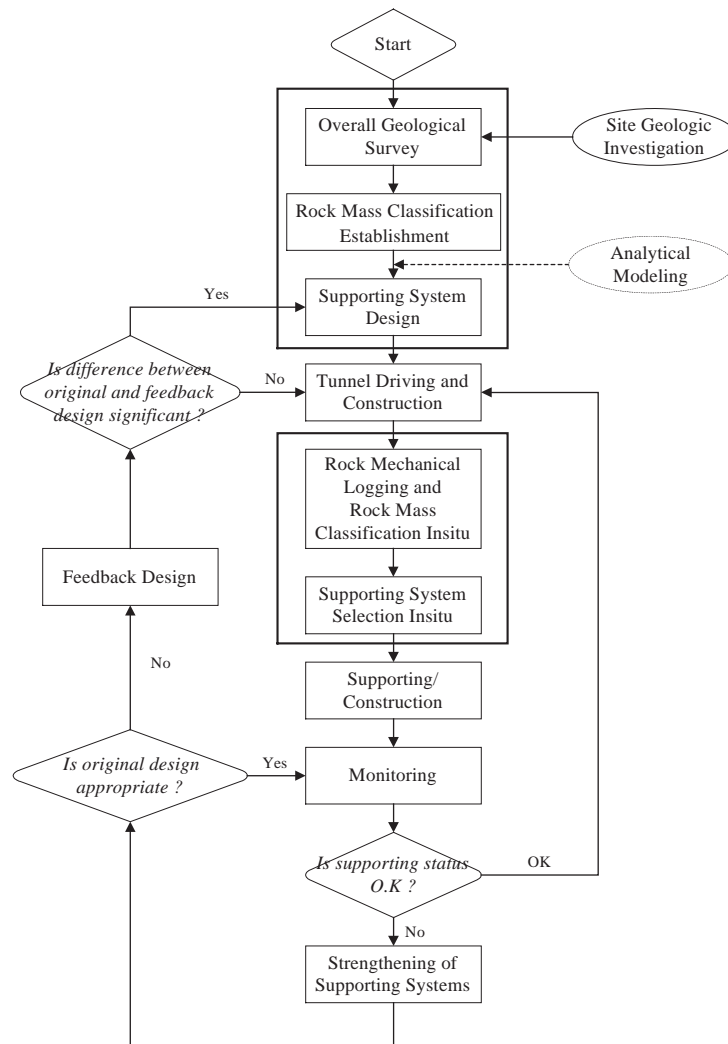


Fig. 1. Classical flow of NATM construction.

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