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An Automated Deterioration Detection and Control System for Islamic Buildings and Monuments

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ABSTRACT

The heritage of Egypt commands exceptional international importance and enjoys highly captivating worldwide attraction as it incorporates the many aspects of human civilizations, and records its development over the ages.

Maintaining Islamic architectural heritage represents a great challenge due to the variety of buildings & structures that it's date back to the twelfth century. While many asset management systems have been introduced in the literature, few have focused on deterioration detection and predication for these monuments before. Existing systems however, may not adequately cover all the particular cases and address the uniqueness of these structures.

This research introduces an automated system to detect and predict the deterioration of the Islamic buildings, the system introduces the following novel developments: 1) Monitoring data are collected from a variety of sources; 2) An automated system was developed for analysis of the gathered data and gives results; and 3) The data was feed to the automated system which provides support for detection and predicting deterioration, scheduling maintenance and calculating life cycle of the monuments.

A case study was used to validate the system and test it using data obtained from El-Merdani mosque in Cairo, The system proved to be practical & capable of detect the deterioration state of the monument and predicting the time of maintenance of the monument, The system as such will aid consultants & Government officials in appropriately planning and scheduling maintenance for the monuments in Egypt to ensure the preservation of our culture and part of the world heritage.

Chapter (1)

Introduction

1.1. Background

The heritage of Egypt commands exceptional international importance and enjoys highly captivating worldwide attraction as it incorporates the many aspects of human civilizations, and records its development over the ages. Together with locally and internationally valuable and viable natural resources of renowned beauty. The cultural heritage of Egypt in particular has the singular distinction of its spectacular and almost miraculous colorful continuity over the span of some 7000 years. Architecture Heritage of a nation is a mirror of its history and civilization. Living with and studying the remains of such heritage not only provides information on the physical and non-physical conditions in which our predecessors lived, but also provides warmth and value to our lives. Preserving a nation's heritage reinforces its identity, and guides its future (Elegal Bahgat, 2004).

Egypt enjoys a great diversity of architectural heritage from the Ancient Egyptian to modern times. While Pharonic, Greco-Roman, Coptic, and Islamic monuments attract the attention of a wide range of international as well national scholars and conservation bodies, we find the "less fortunate"(Ettouny,2000) heritage that is not listed- faces a lesser degree of attention from the general public, namely the Colonial, and Pre-Modern. Recently, interest in the architecture heritage of the 19^{th}, and 20^{th} century is gaining a wide audience. Figure (1-1) and Figure (1-2) show some monuments in Egypt. Many efforts on the level of research and implementation are being utilized in conservation and public education of such urban and architecture wealth (Dalila ElKerdany**,** 2003**).**

Many of these monuments suffer from various forms of deterioration which may lead to their collapse unless they receive the deserved attention and needed maintenance.

Figure (1-1) Karnak Template Avenu of the Sphinxes and le Pylon (Bernd Fitzner, Kurt Heinrichs, Dennis La Bouchardiere ,2003)

Figure (1-2) Islamic centre of Cairo (Bernd Fitzner, Kurt Heinrichs, Dennis La Bouchardiere ,2003)

The Islamic architectural heritage in Egypt is rich with a variety of buildings and structures that date back to the twelfth century. In 1979, Islamic Cairo was inscribed by UNESCO into the World Heritage List as 'one of the world's oldest Islamic cities, which became the new centre of the Islamic world, reaching its Golden Age in the 14th century'. Tertiary porous limestones from quarries near Cairo represent the characteristic stone type used for the construction of the Islamic monuments. In monument preservation practice these limestones are still used for stone replacement or rebuilding works on the Cairo monuments. Porous limestones were commonly used for the construction of historical monuments in the whole Mediterranean area.

Many Islamic monuments in Cairo are seriously threatened by damage and, therefore, are in need of intervention. Stone weathering represents an important cause of damage. Air pollution as a consequence of the rapid expansion of Cairo and rising water table in combination with increasing water pollution due to insufficient or leaking sewage systems are considered to be important weathering factors. Precise knowledge of the properties and the weathering behavior of the limestones are required as basis for sustainable monument preservation.

Figure (1-3) El-Merdani Mosque in Cairo

1.2. The Statement of the problem:

Islamic monuments are important assets which need to be preserved. It is essential to predict and detect causes of building deterioration to preserve our cultural assets. Therefore the detection system will provide an early warning against deterioration, and with proper and timely maintenance automated system, the cost of expensive restoration interventions may be reduced significantly. In addition it also helps in making a priority maintenance schedule between the different monuments according to the predicting deterioration time for each one.

1.3. Objectives and Scope:

1. Identify the various factors affecting the deterioration of Islamic monuments and the components of the limestone which some Islamic monuments are formed in order to prevent the collapse and loss of our architectural heritage
2. Developing an automated control system to detect and predict the deterioration of the monuments.
3. Develop a prototype, based on the proposed developments, and demonstrate its use on a real life application.

1.4. Methodology:

In order to achieve the aforementioned objectives the approach to be employed in this research consists of the following:

1. Conduct an extensive literature review of asset management research, including techniques and software.
2. Evaluate relative importance of various Islamic monuments components through a questionnaire survey among monument maintenance professionals. The relative importances of the components are used as weights to roll up the condition at upper levels in the asset hierarchy.
3. Monitoring data are collected from a variety of sources ranging from human inspection to complicated sensor system to measure the state of the monument.
4. A Deterioration Detection and Predicating system will be developed for analysis of the collected data and providing results.

5. The data will be fed to the automated system which provides support for predicting deterioration, scheduling maintenance, and calculating life cycle of the buildings.

6. Validate the developed system and demonstrate its capabilities on a real-life project to establish its reliability for managing monument restoration.

1.5. Thesis Organization:

Chapter (2) includes Literature survey on preventing the damage of historical stone monuments, Literature survey on the evaluation of the Status of historical Monuments and Literature survey on automated system for control and predicting structures

Chapter (3) presents El-Merdani Mosque in Cairo as a selected Criteria of Building for investigation within the frame of my Study for reasons of its historical importance, characteristic stone materials and considerable stone damages

Chapter (4) presents the role of the control system in preservation the historical monuments, the work flow of the designed program and the program applied on the El-Merdani Mosque in Cairo

Finally, the conclusions of the research work along with future recommendations for future research are given in chapter (5)