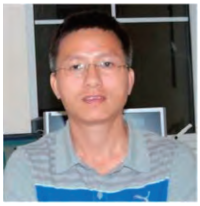
A SEMI-AUTOMATIC MEMBER DETECTION FOR METAL BRIDGES

Linh Truong-Hong[(1)] and Debra F. Laefer[(2)]

Linh TRUONG-HONG



Research Scientist
Urban Modelling Group
School of Civil, Structural and Environmental Engineering, University College Dublin, Dublin, Ireland

linh.truonghong@ucd.ie

Linh Truong-Hong, born 1978 in Vietnam and received his civil engineering degrees (B.Eng. and M.Eng.) from Ho Chi Minh city University of Technology and Ph.D. from University College Dublin. His research interests include geometric reconstruction from LiDAR data, structural health monitoring, and structural modelling.

Debra F. LAEFER

Associate Professor
Urban Modelling Group
School of Civil, Structural and Environmental Engineering, University College Dublin, Dublin, Ireland

debra.laefer@ucd.ie

Debra F. Laefer is a tenured faculty member at the University College Dublin in Ireland. She holds degrees from Columbia University, NYU-Poly, and the University of Illinois at Urbana-Champaign. Her research focuses on the protection of historic structures from natural and manmade activities.

Abstract:

Terrestrial laser scanners (TLSs) are prominent non-contact instruments for acquiring highly detailed geometries of bridge components in only minutes. A TLS can be a strategic instrument for data collection for bridge inspection and documentation, because it can reduce significantly required field time and auxiliary equipment. To deploy a TLS in this field, a semi-automatic method for post-processing a point cloud for documentation of a historic metal bridge is proposed. In this work, generating 3D model of existing structural members and identifying connection characteristics are mainly of interest. The Guinness Bridge built in 1880s in Dublin, Ireland is presented as a case study for the proposed semi-automatic workflow.

Keywords: Terrestrial Laser Scanning, Point Cloud, Connection, Historic Mental Bridge, Damage, Documentation

1. Introduction

To provide sufficient information for a decision on rehabilitation or replacement or preservation, the problems of functional deficiencies, damage and structural deficiencies must be addressed. This paper proposes a method for post-processing TLS data to identify 3D structural member model and connection parameters (e.g. number and type of rivets).

2. Background

The background section is restricted to laser based method for section and connection identification.

3. Methodology

This research study is to propose a method for post-processing TLS data for the documentation metal, truss bridges but can be extended for other steel structures. The algorithm involves: (1) 3D metal structural member and (2) connection identification. The structure used for validation was the Guinness Bridge, also known as the Farmleigh Bridge, a Victorian metal bridge over the river Liffey built in 1880.

4. Implementation

4.1 Generate 3D metal structure

As manual generation of a 3D model is time consuming, the proposed algorithm is aimed to automatically identify the cross-section for 3D structure model reconstruction from TLS data. The workflow is shown in the Fig. 1.

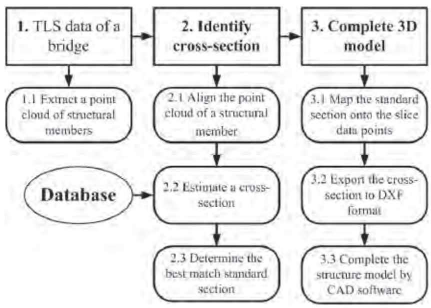


Fig. 1. Workflow of cross-section identification

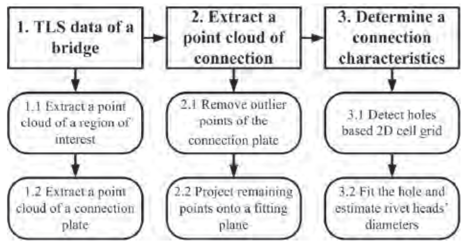


Fig. 2. Workflow to determine connection

4.2 Connection

The proposed work shown in Fig. 2 determines the number and type of rivets. The idea was that the number of rivets equals the number of holes due to the occlusion of a rivet's head and that the rivet type can be determine based on the diameter of a rivet head. A combination of an angle criterion and 2D cell grid was proposed to determine boundary points around each hole. The least squares method was employed to fit the hole based on its boundary points.

5. Discussion

The proposed method automatically identified the cross-section of metal structural members of a historic bridge and subsequently generated 3D models from the structural members. The 3D model is appropriate for finite element analysis to assess bridge capacity or for general documentation. The proposed method can be used to identify the cross-section from different standards, presuming the member dimensions are entered into the database.

Although the proposed method was successful in generating 3D structural member model, there are still many challenges affecting the quality of the final model, which are occlusions and noise. Furthermore, noise in the connection data and configuration of the rivet head can restrict hole determination in the connection plate.

6. Conclusions

This paper proposes a set of techniques appropriate for automatic sizing detection of structural members and affiliated rivets. The proposed algorithms were successful in reconstructing standard cross-section of the Guinness Bridge built in 1880s in Dublin, Ireland. Furthermore, the algorithm can be extended to generate modern standard, metal cross-sections from various standards. However, efforts must be made to minimize noise in the data to prevent improper section identification.