Laser Scanning for Bridge Inspection and Management

Pingbo Tang
PhD Student
Carnegie Mellon University
Pittsburgh, PA, USA
tangpingbo@cmu.edu

Burcu Akinci
Associate Professor
Carnegie Mellon University
Pittsburgh, PA, USA
bakinci@cmu.edu

James H. Garrett
Professor
Carnegie Mellon University
Pittsburgh, PA, USA
garrett@cmu.edu

Summary

The current process for acquiring bridge geometric data for the National Bridge Inventory (NBI) is based on manual surveying, manual data processing and interpretation. Hence, it is time-consuming and error-prone. This paper presents a laser-scanning-based approach to acquire geometric data for bridge inspection, describes a case study and discusses the advantages of this approach over current practice from the perspectives of both bridge inspection and management. Both current approach and laser-scanning based approach are composed of three major steps of data collection, data processing and data interpretation. Yet, a comparison of these approaches highlights major differences in the accuracy and comprehensiveness of the data collected. Based on the comparison, we suggest a need for a formalized way to decompose higher level bridge inspection goals to enable successful application of laser scanning technology for bridge inspection.

Keywords: bridge inspection, laser scanning, bridge management, inspection goal decomposition, sensor planning, geometric feature extraction, geometric reasoning

1. Introduction

In the United States, the National Bridge Inventory (NBI) program requires bridge inspectors to inspect more than 600,000 bridges at least once every two years. According to our research, of the 116 NBI data items, 16 are related to bridge geometric features (Table 1) and 11 are deduced from bridge geometric features[1]. Hence, geometric data collection is important for bridge management. In spite of these facts, current bridge geometric data collection methods are time-consuming and error-prone because they rely on manual data collection methods[2]. Traditional geometric data collection instruments, such as tape, gauge, and total station often involve the physical positioning of an inspector near hard-to-accessible bridge components [3], which causes safety problems for the bridge inspectors and makes the data collection process tedious and time consuming [4, 2]. These instruments are also only capable of acquiring measurements at discrete and sparse positions. Hence, they can not effectively capture the shape of the structure to detect the deflection pattern [5]. Moreover, most collected data are recorded in a paper-based manner or in form of flat text file without any semantic support so that the geometric information interpretation and retrieval process involves a large amount of manual data transfer work.

Table 1 *Geometric Data Items in NBI and their Accuracy Requirements*

Item Number	Name	Precision Requirement
34	Skew	Degree
116	Minimum Navigation Vertical Clearance, Vertical Lift Bridge	10^{-1}m
49	Structure Length	10^{-1}m
48	Length of Maximum Span	10^{-1}m
50	Curb or Sidewalk Widths	10^{-1}m
51	Bridge Roadway Width, Curb to Curb	10^{-1}m
52	Deck Width, Out to Out	10^{-1}m
32	Approach Roadway Width	10^{-1}m
47	Inventory Total Horizontal Clearance	10^{-1}m
55	Minimum Lateral Under Clearance on Right	10^{-1}m
56	Minimum Lateral Under Clearance on Left	10^{-1}m
39	Navigation Vertical Clearance	10^{-1}m
40	Navigation Horizontal Clearance	10^{-1}m
10	Inventory Route Minimum Vertical Clearance	10^{-2}m
54	Minimum Vertical Under Clearance	10^{-2}m
53	Minimum Vertical Clearance over Bridge Roadway	10^{-2}m

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