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QUANTITATIVE MAPPING OF WATERWAYS CHARACTERISTICS AT BRIDGE SITES

(IHRB RESEARCH PROJECT TR-569)

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About
IIHR-HYDROSCIENCE & ENGINEERING

IIHR's historic C. Maxwell Stanley Hydraulics Laboratory was dedicated as a National Historic Civil Engineering Landmark in 2005, placing it among the major structures of national importance to the engineering profession. The mission of the IIHR is to conduct research in water resources and environmental engineering.

Bridge and culvert inspection and monitoring made easier with
DIGIMAP
an innovative software providing morphologic and hydrodynamic characteristics of the waterways using images collected at the site.

BACKGROUND

Iowa state, county, and city engineering offices expend considerable effort monitoring the state's approximately 25,000 bridges, most of which span small waterways. In fact, the need for monitoring is actually greater for bridges over small waterways because scour processes are exacerbated by the close proximity of abutments, piers, channel banks, approach embankments, and other local obstructions. The bridges are customarily inspected biennially by the county's road department bridge inspectors. It is obvious that it is extremely time consuming and difficult to obtain consistent, reliable, and timely information on bridge-waterway conditions for so many bridges. Moreover, the current approaches to gather survey information is not uniform, complete, and quantitative.

Old Mill Creek, Iowa
from March 2007 to August 2008

OBJECTIVES

The methodology and associated software (DIGIMAP) enable a non-intrusive means to inspect fast, efficient, and accurate the waterways in the vicinity of the bridges and culverts using only one technique. The technique combines algorithms for image registration and image velocimetry applied to images acquired with conventional devices at the inspection site.

PROCEDURES

In-situ Mapping

The following steps are made in the field:

1. Select a recording position with good visibility of the waterways upstream and downstream the bridge.
2. Record views of the bridge surroundings and flow in the stream for several minutes.
3. Conduct a geodetic survey of several reference points for ortho-rectifying the images (only during the first visit).

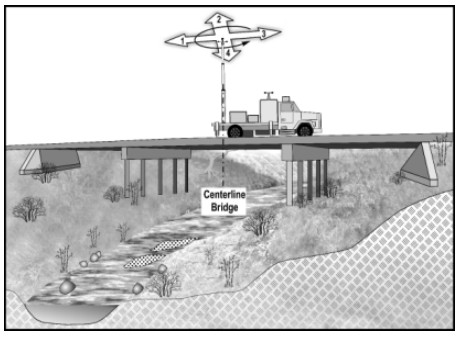


Image Registration and Processing

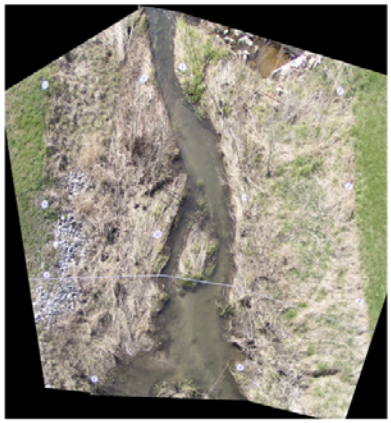
The following steps are made in the lab:

1. Images are decomposed in adjacent planes for successive ortho-rectification (image registration).
2. Image Velocimetry is applied to the recordings of the flow free-surface
3. The results from image registration and processing are assembled for the dry and flow areas to obtain a panoramic view of the bridge or culverts waterway, equivalent to an aerial photograph.

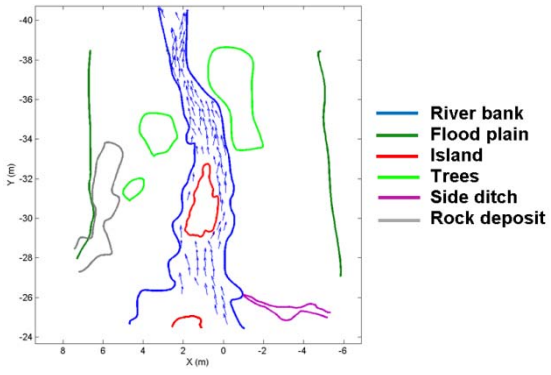
OUTCOMES

The technique produces quantitative maps of the waterway characteristics (i.e., information about flow distribution, velocity magnitude, channel shape, bank characteristics, and accumulation of sediment, debris and vegetation) in digital format.

THE DIGITAL MAP



Repetition of the digital mapping commensurate with the processes evolving in the watershed, allows for early detection of the hydrodynamic and morphologic changes upstream and downstream of the bridge with an emphasis on quantifying changes in channel direction, shape, as well as capturing the evolution of the vegetation and in stream sedimentation/erosion processes.



KEY DIGIMAP ADVANTAGES

The comparison of the current bridge inspection and monitoring methods with the DIGIMAP-based methodology enables to conclude that the new procedure assembles quantitative information on the waterway hydrodynamic and morphologic features with considerable reduced effort, time, and cost. It also improves the safety of the bridge and culvert inspectors operating during normal and extreme hydrologic events. The data and information are recorded in a digital format, enabling immediate and convenient tracking of the waterway changes over short or long time intervals.