OHIO DEPARTMENT OF TRANSPORTATION
OFFICE OF CADD & MAPPING SERVICES
RESEARCH IMPLEMENTATION SUMMARY

Project Title:	Rapid Orthophoto Development System		
Research Agency:	OSU	**Researcher(s):**	Charles Toth
Sponsor(s):	OCMS	**Technical Liaison(s):**	Rachel Lewis
State Job #:	134414	**PID:**	84945
Project Start Date:	December 1, 2008	**Project End Date:**	April 1, 2013
Project Cost:	$1,474,391.20	**Funding Type:**	SPR2 (80/20)

1) Background

ODOT's Office of CADD & Mapping Services (OCMS) produces approximately 50 project specific orthophotos annually which are used for many types of planning and design purposes. Many projects are planning and analysis related where traffic and safety issues govern the time sensitive nature of the requested orthophoto products needed to resolve an issue. Current project specific orthophoto generation processes are tedious and time consuming to achieve the image quality and geometric accuracy necessary to meet our current transportation needs. There is a need for a rapid orthophoto system that is capable of producing high quality, high accuracy orthophotos.

2) Research Objectives

The objective of this research is to recommend and update, including hardware and software components, the OCMS mapping system to provide a significant improvement in orthophoto production. The proposed digital mapping system should allow for: (1) the elimination of time-consuming and labor-intensive tasks that are associated with analog system components, (2) fast data transfer between the major processing units, and (3) high level automation of various processes, all needed to achieve an efficient orthopho production.

3) Research Deliverables

- A recommendation for large-format digital aerial camera acquisition, based on the OCMS requirements, and subsequent procurement.
- Algorithmic developments to introduce an improved orthophoto generation sequence that is less sensitive to occlusions.
- Algorithmic developments to improve the ortho creation process for bridges.
- Prototype MATLAB code used for algorithmic research and testing.
- A software suite of tools with the basic user-friendly interface that can be integrated into the existing workflow of OCMS. The programs will be developed in MATLAB and Microsoft Visual C++ environment for windows workstations (note that the MATLAB code is wrapped into C++). The actual implementation could be a suite of stand-alone utilities or tools that could be integrated into one of the software systems widely used in the OCMS.
- All source code and documents related to the project.
- Final report including the following:
    - Performance analysis of the rapid orthophoto production system, including digital camera performance validation, quality characterization of direct digital imagery, georeferencing solution, and orthophoto performance validation. The latter includes visual evaluation, error budget, accuracy, processing time performance, and QC/QA measures.
- Inventoried Equipment:
    - DMC Camera System
    - Applanix POS V5 Hardware

4) **Researcher's Recommendations**

- The analysis of the results confirmed that the DMC meets the manufacturer's specification. To maintain consistent performance in regular operations, calibration flight and the use of ground controls as check point is highly recommended. In addition to further support QA/QC, the use of automated aerial triangulation is also suggested.
- An innovative method was developed to support the orthoimage generation at bridges. The concept is built around a development of a precise bridge model, which is formed from the DMC imagery and LiDAR data.
- To address occlusions, a true orthophoto generation process was implemented.
- The OSU-developed code in Matlab will be updated by the official end of the project. For a short time, OSU expects to support ODOT personnel to assure a smooth introduction of the tools to production.

5) **Liaison's Recommendations**

The DMC camera system and accompanying manufacture software has been fully implemented. Since January 2011, all aerial photography has been done with this unit. The accuracy of the DMC system is substantially higher than previously used equipment. Productivity has increased accommodating an average of 70 ODOT-based projects per year as opposed to 50. The software developed by the research team should not be implemented. Based on testing, utilization of the researcher's software increased overall production time without providing a substantial improvement on accuracy. Additional research on this topic is not warranted.

6) **Implementation Evaluation / Return on Investment**

Additional funds beyond the original research project were not required to implement the DMC camera system. Since the issuance of this research and incorporation of the equipment, an increase in production of approximately 28% has been experienced. The overall accuracy of data has been increased by approximately 75% resulting in data that is more precise and reliable. Based on advances in technology, the estimated useful life of the DMC system is 15 years. Therefore, the total investment of this research, including the equipment purchase, equates to an annual investment of $98,293 over the projected useful life. Considering the outputs of this system have implications on projects costing in excess of $1.4 billion annually, the investment in both the system and the research will be recuperated at a ratio of 7:1 for each year of systems' useful life. Additional evaluation for the purposes of calculating a return on investment is not necessary.

In addition, this research has served to ensure that the OCMS is able to provide their customers with reliable, accurate and timely service. Those customers include ODOT districts and program offices such as Environmental Services, Geotechnical Engineering, Construction Administration, and Communications as well as external agencies such as Ohio Department of Natural Resources, the Office of the Attorney General, Army Corps of Engineers, and the Ohio Department of Corrections. The total number of jobs processed for external agencies ranges from one to 15 per year. These jobs are in addition to those conducted for ODOT.

Signatures below constitute approval of the liaison recommendations and subsequent sections of the implementation summary. Modifications to the plan can be made at any time. All modifications must be in writing. For assistance with making modifications to an implementation summary, contact the Research Section.

Approved By: (attached additional sheets as necessary)

Technical Liaison(s):

Signature: Rachel Lewis Office: CADD/Mapping Date: 11/19/13

Signature: Office: Date:

Office Administrator(s):

Signature: Rachel J Lewis Office: CADD/Mapping Date: 11/19/13

Signature: Office: Date: