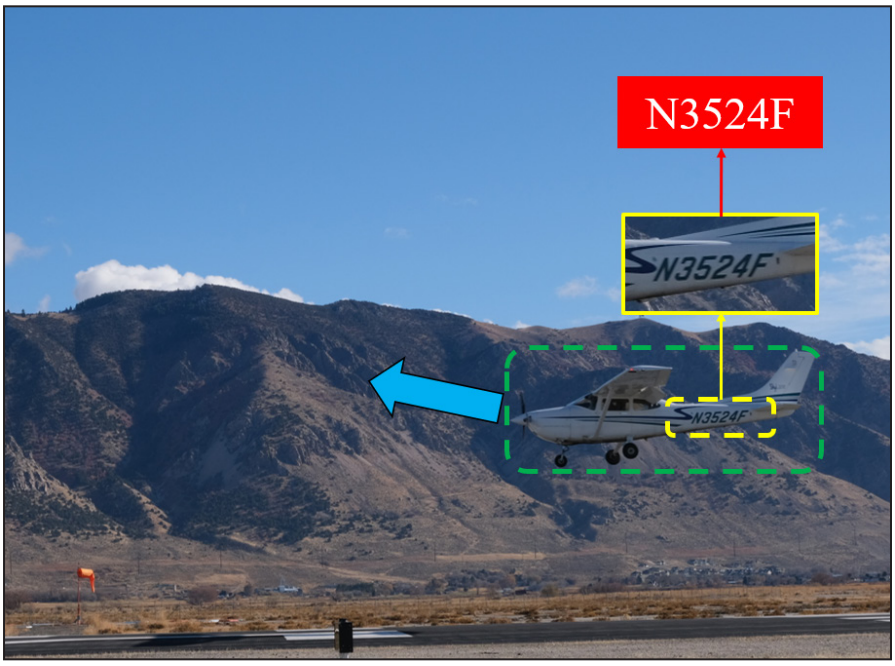
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 22-476 (project 639) | August 2022

Automated Image-based Aircraft Tracking and Record-keeping for Utah Airports



the ISSUE

There are many airports without control towers in the United States. These airports provide vital services such as aerial firefighting, aeromedical flights, law enforcement support, and corporate flights. To plan for future development and to assure safety and security of these airports, aviation planners need the number of aircraft operations as well as the fleet mix information. Without towers or staff to document the aircraft operations at these airports, many attempts have been made to automatically record the operations using radio, acoustics, and ADS-B technologies. While these methods come with some advantages, they cannot accurately monitor aircraft operations due to technological and commercial shortcomings.

the RESEARCH

This project attempts to develop intelligent cameras for performing operation count and recognition by using machine learning techniques. The focus of this research project was twofold: 1) conducting the necessary data collections at general aviation airports to find the best camera layout to efficiently monitor the aircraft operations in their airfield; 2) developing machine learning-based algorithms to automate the process of aircraft operation count and recognition.

To develop a machine vision system for aircraft operation monitoring, researchers explored different camera layouts and various machine learning algorithms. Two camera layouts are proposed for full coverage of the aircraft operations at airports. The proposed camera layouts are determined with consideration of the possible airport configurations. The necessary algorithms to empower the camera footage with machine vision include aircraft detection, aircraft tracking, aircraft tail number detection, and aircraft tail number recognition. The researchers used machine learning and deep learning methods to build intelligent detection models to automatically perform the abovementioned tasks.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

Colorado State University
North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

Lead Investigator(s)

Abbas Rashidi
abbas.rashidi@utah.edu

Co-Investigator(s)

Nikola Marković
nikola.markovic@utah.edu

Research Assistant(s)

Md. Farhadmanesh, GRA, PhD

Project Title

Automated Image-based Aircraft Tracking and Record-keeping for Utah Airports

Sponsors | Partners

Utah Department of Transportation, Division of Aeronautics

USDOT, Research and Innovative Technology Administration

the **RESEARCH** (cont.)

The feasibility of the developed system is tested on video data collected from general aviation airports within the state of Utah. Collected data include different weather conditions (sunny, cloudy, and snowy) and different illumination conditions. The selected test locations allowed researchers to have access to a wide range of civil aviation fleets. Also, different airport configurations (i.e., runway and taxiway arrangement) are considered when the test locations are selected.

the **FINDINGS**

Data collection sessions proved that airport operations could be accurately monitored using a limited number of cameras placed at strategic locations within the airfield. Depending on the required accuracy for the aircraft operation counts and aircraft tail number recognition, the number of the required cameras varies. Furthermore, affordable off-the-shelf digital cameras were used to evaluate the feasibility of the proposed system.

Regarding the software, deep learning-based aircraft detection models have shown higher accuracy compared with less computationally intensive detection models. It is also found that the use of correlation-based object (aircraft) trackers such as channel and spatial reliability tracking (CSRT) enhances the system. Finally, multi-frame-based aircraft tail number detection was essential for the recognition of the aircraft since, in some video frames, the aircraft tail might not be visible.

The proposed method can accurately count both departures and arrivals, while the current in-practice system (acoustical counter) only can count departures. The practitioners double the departure counts obtained by the acoustical counter to find the total number of operations. Nonetheless, this research has shown that the correlation between departures and arrivals varies from airport to airport and during different seasons.

the **IMPACT**

The research shows that a vision-based system can provide accurate airport operational data. The proposed system is a good alternative to existing systems and provides aviation planners with a complementary tool for increasing the accuracy of the existing deployed counters in their study of airports. Enhanced data will provide more accurate information for airport planning, funding allocations, and safety and security assessments.

For more information on this project, download the main report at https://www.ugpti.org/resources/reports/details.php?id=1096

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.