ABSTRACT

Author: Mott, John, H. Ph.D.
Institution: Purdue University
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Title: Measurement of Airport Operations Using a Low-Cost Transponder Data Receiver and Collection Unit.
Major Professor: Darcy Bullock

Accurate counts of aircraft operations at unmonitored or partially-monitored general aviation airports are important due to their role in the allocation of federal and state funds for airport development and improvement. The Federal Aviation Administration annually invests approximately $1B in small commercial and general aviation airports, with additional funding appropriated at the state level. Of the 3,331 airports in the United States that constitute the National Plan of Integrated Airport Systems (NPIAS), however, only slightly more than 500 have either full- or part-time air traffic control facilities and related personnel who are available to register operations counts.

Methods used to count aircraft operations at airports with limited personnel generally sample operations over time, and include counts from acoustic, pneumatic, or video devices, and observations from contract staff. These sample sizes are inherently small due to the difficulty of deploying counting devices for extended periods, leading to inaccuracies in the extrapolation of long-term totals. In some cases, the counts may simply be estimated unscientifically by airport managers.

While air traffic system modernization efforts to date have focused primarily on the use of transponder technology for airspace management, transponder data can also be used to accurately count airport operations. This data may be collected by a software-defined radio and appropriate signal processing hardware and software. A small portion of the received signals (Extended Mode S) contain position data from which distances may be directly computed. The majority of the signals (Basic Mode S and Mode C), however, do not contain aircraft positions. A method for estimating distance information from the latter two types of signals is presented here, enabling the associated aircraft to be included in the counting process. This method is based on a digital adaptive low-pass filter that utilizes known position information to optimize filter parameters, and results in an average distance error of 0.77 nm per aircraft in measurements.
within a 5.0 nm radius of the receiver. The daily operations counts are then summed to produce a total count over multiple days. Error due to limited counts may be reduced by estimating the total using a Bayesian hierarchical model and Monte Carlo simulation.

Over 16 million data records from three receiver installations at two different general aviation airports with collection periods varying from eight to 180 days were used to evaluate the algorithms. The automated operations counts were compared with official air traffic control tower counts obtained from the FAA’s Air Traffic Activity Data System (ATADS) database. This comparison indicated that the new technology is accurate to within 10% of the totals reported by the tower operators; it therefore appears to be an effective and inexpensive means of establishing accurate operations counts at not only the study airports, but potentially at more than 2,800 of the 3,331 NPIAS airports that do not have associated control towers.