Assessment of Aircraft Radar Cross-Section for Detection Analysis

Björn Persson

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ABSTRACT

Hiding from and surprising an opponent are tactics that have been used in warfare throughout history. They were features that aircraft originally possessed when they were first used in military operations. However, development of military technology is an endless struggle between advances in technology and counter technology. During World War II this struggle led to the development of a new technology called radar, which was designed to detect sea vessels and aircraft at a distance and deny them the element of surprise. This laid the foundation for modern air defenses and simultaneously created a need for aircraft to penetrate such defenses. Central to the tactics and technological development that followed from the deployment of radar on the modern battlefield is the radar cross-section (RCS) of aircraft, which dictates the range at which aircraft can be detected by radar. In this thesis some aspects of the RCS of aircraft in radar detection are investigated. A combination of experimental measurement of aircraft and digital model development of the RCS of aircraft has been used.

From flight experiments, the uncertainty in aspect angle to a threat sensor, due to aircraft dynamics, is quantified for various aircraft. In addition, the RCS fluctuation behavior of a military jet trainer is investigated by dynamic in-flight measurement. The monostatic and bistatic RCS of an F-117 are modeled and findings show that spline interpolation provides superior accuracy when interpolating the RCS data. Smooth and conservative RCS models are suggested and a new RCS sampling scheme is presented. A model based on experimental data is suggested for determining the range of aspect angles that an aircraft is likely to orient towards a threat sensor, and experimental RCS data is compared to the classical Swerling radar target models.

Possible consequences for military operations and the design of military systems are discussed and considerations for modeling the interaction between air defenses and aircraft penetrating those defenses are given.

This thesis should be of interest to military actors and the defense industry, since the analyses of the ability to detect aircraft using radar are important for military operations and their planning.