# DEVELOPMENT AND REALIZATION OF PROJECTILES DIRECTING ALGORITHM FOR 3-D ATMOSPHERIC INTERCEPTION

By

**Mahmoud Ahmed Mahmoud Tolba Ali Soliman**

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
**MASTER OF SCIENCE**
in
**Aerospace Engineering**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

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**Title of Thesis:**

DEVELOPMENT AND REALIZATION OF PROJECTILES DIRECTING ALGORITHM FOR 3-D ATMOSPHERIC INTERCEPTION

**Key Words:**
Interception; Prediction Angle; Kalman Filter; Exterior Ballistics; Projectile Trajectory

**Summary:**

This thesis aims to develop an efficient solution for the problem of intercepting a target flying in atmosphere by unguided projectiles. At first, the fire control algorithm introduced by John H. Blakelock in 1979 for planar interception was adapted for use by an earth-mounted launcher instead of a flying launcher. The projectile time of flight equation of this algorithm, given for a certain projectile type, was generalized for application to a generic projectile. The main output of this thesis is the development of an algorithm for the 3-D interception case utilizing Kalman filter tracking to estimate the target future position, while compensating for deviations in the projectile trajectory due to gravity, aerodynamic forces and the gyroscopic effect by applying corrections determined during previous offline simulations of the projectile trajectories. Estimates of the aerodynamic coefficients employed in such simulations were obtained from PRODAS®. Real-time HIL simulation of the interception algorithms was implemented on a microcontroller platform receiving target information from a host computer, which simulates target motion and tracker output. To provide a success measure for the interception, offline simulation of various interception scenarios was performed on the host computer while determining the miss-distances for a sequence of projectiles fired at a certain rate. Both real-time and offline simulations on the host computer were performed using MATLAB®. Results showed the capability of the developed algorithm to handle 3-D interception cases much more effectively as compared to the planar interception algorithm.

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