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Modeling Evasion Tactics of a Fighter Against Missiles in Three Dimensions

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Approximating the savior trajectory of a fighter under missile is aimed in this study. Like our previous work, this paper is a part of the ongoing academic project, the Visual End-Game Simulation. A realistic generic fighter model is used as the target of a missile that employs proportional navigation system. For a fighter in the cone of a missile seeker, finding the closest point of this cone and applying the suitable commands to evade out on that point is taken as the objective function. Taking into account both the state and control variable inequality constraints, the three-dimensional evasion trajectory is sought. Example trajectories and control histories are shown. Also, the horizontal-s maneuver, of which the optimality is already proven, is analyzed by applying predefined controls in order to compare to our solution.

Nomenclature

C_D	=	drag coefficient
C_{D0}	=	zero-lift drag coefficient
C_{Di}	=	lift-induced drag coefficient
C_f	=	skin friction coefficient
C_L	=	lift coefficient
g	=	acceleration of gravity
h	=	altitude
m	=	mass
M	=	Mach number
n	=	load factor
n_c	=	acceleration command
N'	=	effective navigation ratio
q	=	dynamic pressure
S	=	reference wing area
T	=	thrust force
u	=	throttle setting
V	=	velocity
x, y, z	=	coordinates
α	=	angle of attack
γ	=	flight path angle
χ	=	heading angle
ε	=	angular limit of the missile seeker
$\dot{\lambda}$	=	line-of-sight rate
μ	=	bank angle
ρ	=	air density
σ	=	Angle Off Tail
$(\ )_{t,a}$	=	target, aircraft
$(\ )_m$	=	missile

I. Introduction

Along with the endless technological developments in aeronautics and, recently, with the growing needs and exhausting resources, we are now living in a new era where local threats have become global. These facts oblige and drive every country to develop new tactics, or to follow latest accepted methods to solve tactical problems, etc. Coping with the missile threat for a fighter is one of these tactical, moreover, strategic problems. For years, finding the optimal evasive maneuver against missiles and projectiles has been one of the most widely observed problems.

Generally, the performance of the maneuver is measured in terms of the miss distance and the flight time. Terminal miss distance is the range between the target and missile at the closest approach. The object of the target is