I-SP03 Guidance Navigation & Control 2

13:00-15:00 **Chair : Song Chan Ho (Agency for Defense Development)**
Room : C202 **Co-Chair : Takano Hiroyuki (National Defense Academy)**

13:00 – 13:20 **I-SP03-1**

Compensation for the Body-Coupling in the 2-Gimballed Seeker Homing Loop on BTT Missile

Sangkeun Jeong, Eulgon Kim, Chanho Song, and Hangju Cho
(ADD)

It is observed that if the 2-gimballed seeker is stabilized using rate gyros mounted along its primary axis, line of sight change measured in the seeker is induced by the rolling due to the bank-to-turn(BTT) steering as well as the actual change. This body-coupling within BTT homing includes the spurious target maneuver effect and the coupling loop due to the rate gyro misalignment. In this paper we formulates the linear BTT homing loop model with a 2-gimballed seeker including those body-coupling effects. With the model, we analyze the effects of the couplings, and show that the roll rate coupling to the rate gyro for the stabilztion of gimbal could seriously deteriorate the homing loop stability. And we propose a direct linear compensator for the coupling to recover the stability.h

13:20 – 13:40 **I-SP03-2**

Trajectory Optimization of a Hypersonic Airplane

H. Takano, and Y. Baba
(National Defense Academy)

Hypersonic civil airplanes are recently heated up again in USA and Japan, but there are several difficulties when we obtain its optimal trajectories. In this paper, we formulated the trajectory optimization problem as an optimal control problem and solved it by the direct shooting method with the Genetic Algorithm, GA. The result shows it is effective to use this method for the trajectory optimization of the hypersonic flight.

13:40 – 14:00 **I-SP03-3**

Synthesis and Investigation of the Neural Network Guidance Based on Pursuit-Evasion Games

Han-Lim Choi, Min-Jea Tahk, and Hyo-Choong Bang (Korea Advanced Institute of Science and Technology)
Hun-Gu Lee(Space Technology Research Center)

This paper handles synthesis and investigation of a neural network guidance law based on pursuit-evasion games. This work considers two-dimensional pursuit-evasion games solved by using the gradient method. The procedure of developing a guidance law from the game-optimal solutions is deeply examined, and important features of the neural network guidance are investigated. The proposed neural network guidance law takes the range, range rate, line-of-sight rate, and heading error as its input variables. By reconstructing the trajectory, the accuracy of the neural network approximation is verified. Afterwards, robustness of the neural network guidance to the autopilot lag, which results from its feedback structure, is investigated. ..

14:00 – 14:20 **I-SP03-4**

Evaluation of the Performance of Re-entry System for the Typical Uncertainties

L. Daewoo, and C. Kyeumrae(Pusan National Univ.)
P. Soohong(Dongseo Univ.)

The uncertainties of an atmospheric re-entry flight with respect to stability and controllability are aerodynamic error, measurement error of the angle of attack, variation of dynamic pressure, wind, and trim position of the control surfaces, etc.. During hypersonic flight, a future angle of attack is biased from a nominal schedule. In order words, because the angle of attack is estimated from the navigation data, estimation error occurs due to wind, atmospheric density variation, etc.. Error models used in this study, include a standard deviation of +-3 sigma, and are the normal distribution of statistics. This paper shows the appraisement of tracking performance onto the raference trajectory, satisfaction of the initial condition of TAEM about the re-entry system.

14:20 – 14:40 **I-SP03-5**

Stabilization Loop Design Method on Dynamic Platform

Young Shin Kwon, Doh Hyun Kim, Lee Han Kim
(R&D 3Group, LG Innotek),
Hong Yeon Hwang(ADD)

Stabilized tracking platform in a missile consisting of a flat planar antenna, pitch/yaw gimbals, gear trains, and current controlled DC drive motors for pitch and yaw gimbal must have a capability to track a target as an inertial sensor in the presence of missile body motion such as maneuvering and vibration. Because of this reason, tracking a target from dynamic platform requires a servo architecture that includes a outer tracking loop(position loop) and inner rate loop that stabilizes the line of sight(LOS). This paper presents a gimbaled platform model including nonlinear phenomena due to viscous and Coulomb friction based on experimental data and torque equilibrium equation, the design concept for the inner tacholoop having P controller structure ...

14:40-15:00 **I-SP03-6**

A study on Automatic Air Combat Simulation

Fumiak IMADO, Keiichi FURUKAWA(Shinshu Univ.)
Yoichiro OZAWA(Yamazaki Mazak)
Tomokazu MORi(Japan Photoelectronic Industry)

A computer software system which enables to assess the air combat performance only by a computer is currently under development. The system is composed with plural aircraft models, missile models, bullet models etc. The aircraft can implement several empirical air combat maneuvers automatically depending on the situation, therefore air combat simulations and assessment can be attained. Some of these maneuvers and features are explained.