MODELING AND SIMULATION OF AERODYNAMIC AND BALLISTIC SYSTEMS

Controller and Model Design and V&V

Generate Software from Model

Target Software to Platform

SwRI uses model-based design techniques as part of its system design process. Institute staff members create system models and controllers using the design tools and extensively test and evaluate their performance against the system requirements. In subsequent efforts, the design tools produce software which eliminates the need for manual conversion and reduces development time.

We welcome your inquiries. For additional information, please contact:

Christopher E. Camargo
Director
Avionics and Support Systems Department
(210) 522-2095 • Fax (210) 522-2572
christopher.camargo@swri.org

Defense & Intelligence Solutions
Southwest Research Institute 6220
Culebra Road (78238-5166) P.O.
Drawer 28510 (78228-0510) San
Antonio, Texas

Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies 1,200 acres in San Antonio, Texas, and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for more than 3,000 employees who perform contract work for industry and government clients.

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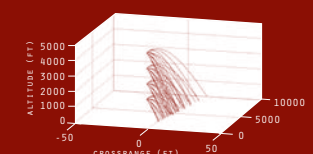
In modern warfare, the tactical and accurate delivery of weapons is paramount. Guided weapons and guidance accessories for modern aircraft have improved the accuracy of weapon systems; however, many legacy aircraft continue to deliver free-fall ordnance with degraded accuracy.

Accuracy errors can be offset by pilot adjustments and improvements to the weapon model within the onboard ballistic computer, but confirmation of the model improvement is currently limited to flight test and ballistic algorithm analysis. Flight test is an expensive technique and proprietary data restrictions limit the effectiveness of software analysis.

Southwest Research Institute® (SwRI®) has been providing engineering solutions in support of ballistics for more than 25 years. The Institute has capabilities and experience in all stages of ballistics including interior, exterior, intermediate and terminal ballistics. SwRI applies its diverse engineering expertise and facilities to answer challenges to the accurate delivery of non-guided, free-fall ordnance and provide alternative solutions to flight test and algorithm analysis.

SwRI engineers apply model-based design techniques to develop ballistic models, design weapon scoring algorithms, and test real-time software. SwRI staff evaluate fire control avionics with a mission replay tool which includes a hardware-in-the-loop (HIL) simulation. Previous efforts have included redesign of avionics hardware. Staff members perform design and development under ISO 9001:2000-compliant processes.

AIRCRAFT FLIGHT AND BALLISTIC MODELING

Capabilities
- Autopilot and 6-DOF aircraft model for HIL simulation
- 3-DOF, modified point mass, and 6-DOF weapon models
- Atmospheric conditions (wind) and translation between reference frames
- Image generation using GraIL (DTED and UMC) and open source software
- Mission replay tool incorporated into HIL simulator
- Sensitivity analysis and data reduction toolset as subset of mission replay
- Weapon delivery evaluation toolset as subset of mission replay

Experience
- Investigation of generic ballistic scoring
- HIL simulator
- Propulsion upgrade program evaluation of Ground Collision Avoidance System (GCAS)

REAL-TIME SOFTWARE

Capabilities
- Green Hills Integrity
- RTOS Linux
- Wind River Vx Works
- Ada

Experience
- Improved Electronic Processor Unit for A-10 turbine engine monitor
- A-10 HIL simulator

AVIONICS SIMULATION HARDWARE

Capabilities
- VME hardware interface to digital and analog avionics ports
- Flight control with stick and throttle
- PC workstation with avionics bus interfaces
- Virtual instrumentation readouts
- PXI/PCI capable configuration
- Oversized video display
- Video display mixed with stroked symbology
- Proprietary and open source image generation

Experience
- Redesign of LASTE (A-10 fire control computer) circuit cards
- Redesign of engine monitoring avionics

SOFTWARE LANGUAGES

- Ada
- C/C++
- MATLAB
- Simulink
- Java

MULTIDISCIPLINARY STAFF

- Ballisticians
- Modeling and control engineers
- Training and simulation engineers
- Aerospace engineers
- Software engineers
- Statisticians
- Electronic hardware design engineers
- Mechanical design engineers
- Avionics technicians
- Systems engineers

FACILITIES

- 10-acre outdoor facility with 12 designated test sites on the SwRI grounds in San Antonio
- Test facility for small arms testing (up to .50-caliber)
- Indoor range for small compressed gas guns (bore diameters 0.1 – 3.0 inches)
- Test site for large-scale experiments approximately 60 miles southwest of San Antonio
- Personnel and laboratories at additional sites available to provide ballistics support
- HIL laboratories

True Impact Point
Target (True)
Bomb (Truth)
Bomb (Ballistic Computer)

A/C (Truth)
A/C (Ballistic Computer)
Weapon (Truth)
Weapon (Ballistic Computer)

D015917

ANALOG SIGNALS
CPU
AIRCRAFT SIMULATION HARDWARE
DIGITAL SIGNALS
VIDEO MIXER
ANALOG SIGNALS
FIRE CONTROL AVIONICS
DISPLAY DEVICE

D015918

D015916