Autonomous Systems and Simulators

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Towards Future Air Transport

Requirements and Challenges

• Greening air transport
• Increasing time efficiency
• Customer satisfaction and safety
• Improving cost efficiency
• Protection of aircraft and passengers
• Air transport of the future

Source: EU Transport Research
Technologies

• Carbon Composites
• Noise and vibration reduction
• Unmanned systems
• Wireless communication
• Satellites signals (Galileo, GPS, GLONASS…)

• Complex Systems such as simulators
Ground Test Systems

**STRUCTURAL TEST**

**Applications**
- Static/Fatigue, Dynamic
- Turbine test rigs
- System Integration Labs
- Wind Tunnel Test & Control

**TEST CELLS**

**Applications**
- Engine/motor dynamometers
- Component dynamometers
- Chassis dynamometers
Autonomous Systems

Autonomy is a capability (or a set of capabilities) that enables a particular action of a system to be automatic or, within programmed boundaries, “self-governing.”
Sense

Think

Act

#robotsrock
Applications

- Reconnaissance
- Search and Rescue
- Counter-insurgency
- Border infiltration monitoring
- Unmanned vehicles
- Disaster management
- Aerial photography
- Surveillance
- Battlefield Extraction
- Landmine detection etc..
Top 3 Challenges

1. Designing intelligent and reusable software
2. Translating algorithms to embedded hardware
3. Connecting to the real-world
Challenge #1:
Designing intelligent & reusable software
Advanced Robotics Requires a Lot of Software

Machine Vision

Sensors and Measurements

Control Logic

NATIONAL INSTRUMENTS

LabVIEW™

ni.com
LabVIEW Robotics

**Graphical system** design software framework

**IP** for navigation, steering, kinematics, and more

**Deployment** to Real-Time and FPGA hardware

Tools for integrating text-based algorithms

**Connectivity** to various sensors and actuators

**Physical Simulation** of real-world applications
Challenge #2: Translating algorithms to embedded hardware
Embedded Systems need

**PLC/PAC**
Plants and machine builders want better control capabilities in their automated systems.

**Need optimized automation**

**Custom Design**
Trend toward using FPGAs and higher-level tools for a more integrated tool chain.

**Makes design easier**

**SBC/Embedded**
Need for open, PC-based architectures to quickly develop solutions

**Deliver quality measurements**
Traditional Embedded Value Chain Versus Graphical System Design

“Focus on **Innovation**, not **Implementation**”

Your Core Competencies | Your Domain Expertise
LabVIEW RIO Architecture.

Processor
Real-Time or PC-Based

FPGA

- Analog I/O
- Digital I/O
- Specialized I/O
- Custom I/O
- Bus Protocols

Benefits

- High-Level Software
- Flexible Hardware
- Integrated Hardware and Software Platform

Communication
Motion
Wireless
HMIs
Third-Party I/O
Vision
Alliance Partners
IP for Control, Analysis, etc.

LabVIEW

ni.com
Challenge #3: Connecting to the real-world
Integrate Vision, Motion, and Display Technology to Build a Complete Solution

Benefits
- High-Level Software
- Flexible Hardware
- Integrated Hardware and Software Platform

NI CompactRIO

IP Camera
GigE Camera
Analog Frame Grabber
Analog Camera
Motor Drivers and Drive Interfaces

HMI Display

NI LabVIEW Touch Panel Module
LabVIEW
NI SoftMotion Module
Vision Development Module

Sensors and Actuators

ni.com
We were able to rapidly prototype our system for FedEx with LabVIEW and CompactRIO and create a final deployed solution with NI Single-Board RIO—all in under a year.

– Jeremy Snow, Ventura Aerospace
The NI CompactRIO controller provides the processing speeds, low-power consumption, ruggedness, and compactness necessary to successfully collect and communicate atmospheric data, unpressurized, at altitudes of 64,000 ft aboard unmanned aeronautical platforms like the NASA Global Hawk.

– Laurel A. Watts, Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
Simulators and Trainers in Defense and Aero
Block Diagram of a Simulator

Operator station with Controls and heads-up display

Feedback, Motion Audio and I/O

Video and Graphics

I/O Handling System Control system simulation

Instructor Station

Graphics Server
I/Os

• Diverse
  • Slow DC to RF
  • Varied types of Sensors
  • Capable of Sensor simulation
• Compact
• Synchronized
• Easy to configure
• Sensor Simulation capable
• Modular
• Handle Closed loop controls
• …
Control Loops

- Multi rate control loops
- Best response times
- Minimal latency in data acquisition and transmission
- Parallel loops
- Synchronization
- Interlocks

Communication Buses

- MIL 1553
- CAN
- ARINC
- CIGI ...
Real-Time models to be simulated

- The MathWorks, Inc. Simulink® software
- LabVIEW
- LabVIEW Control Design and Simulation Module
- Esterel SCADE Suite
- Tesis DYNAWare models
- NI MATRIXx SystemBuild
- C/C++/FORTRAN/Ada
- MapleSim models from Maplesoft
- SimulationX from ITI
- GT-POWER engine models from Gamma Technologies Inc.
- AVL BOOST
- AVL CRUISE
- Dynacar from Tecnalia
- CarSim from Mechanical Simulation*
- AMESim from LMS*
- Dymola models from Dynasim**
NI VeriStand™
Real-Time Testing and Simulation Software

- RT Stimulus Generation
- Data Logging
- Test Automation
- Single-Point I/O
- Alarming
- Calculated Channels
- Deterministic Model Execution
- User Account Management
- Multi-Chassis Synchronization
- Multi-Chassis Data Sharing
- Closed-Loop Control
- Scaling and Calibration

Multi-Chassis Systems
PXI
CompactRIO*
Single-Board RIO*

* 128MB DRAM or great required
NI VeriStand

WORKSPACE

Hardware Calibration
RT Stimulus Profile Editor
Data Log File Viewer
System Health Monitor

Macro Record/Playback
Alarm Configuration
Channel Faulting
Model Parameter Manager

NI VERISTAND ENGINE

Server Communication

Single-Point I/O
Channel Forcing
Model Execution
Parameter Updates

Calc Ch Processing
RT Stimulus Generation
Alarm/Procedure Exec
Custom Devices

I/O Drivers
Environmental Simulation

- NASA Chamber B-Johnson Space Center

"For the first time, NASA can achieve the ±3°F end-to-end accuracy requirements for thermocouples with commercial off-the-shelf technology."

-James Dean, Jacobs Technology
“We selected **NI VeriStand** for our Legacy 500 Iron Bird because of the breadth of functionality the environment provides out of the box, which **significantly reduces our development efforts.**”

- M.A. Pires, Testing Device Development Coordinator, Embraer
Questions?