SimSystem is a unique, state of the art simulation system that combines one meter or better satellite imagery with 3D real-time PC-based virtual simulations that enables researchers to study human performance with both individual and teams. This simulation system is an ideal platform for experimental research in a variety of domains, but is ideally suited for Uninhabited Aerial Systems.
SimSystem

- Ideal for a variety of research domains
  - Electronic warfare
  - UAS operations
  - Air combat operations
  - Ground operations
  - Intelligence, Surveillance, & Reconnaissance (ISR) tasks
  - Mission rehearsal
SimSystem
Testbed Overview

- 4 participant consoles
- 4 experimenter consoles
- Teams of 1 to 4 participants (example)
  - Pilot
  - Sensor Operator
  - Data Exploiter
  - Electronic Warfare
- Capability for High Level distributed interactive simulation (DIS/HLA)
- Ability to add multiple UASs
- Software includes training modules and tests
- Master Control software
  - User friendly
  - Remotely launches and controls software
  - Collects and moves data
  - Logs user actions
- Experimenter access to participant screens
- Experimenter can take control of participant applications
- Capability to insert team situation awareness roadblocks into scenario (e.g. audio, video, ad-hoc targets, etc.)
  - Ability to disable select communication channels or insert noise into channels (simulate hardware malfunction)
- Extensive measurement capabilities
  - Knowledge and process (coordination, communication, team situation awareness)
- Video recording and playback functionality
- Reconnaissance Task
- Over 1,000 natural imagery target library
- 700 3-D models typical of U.S. & Middle Eastern characteristics
  - Military and Civilian People
  - Commercial as well as Military Platforms
  - Roadside Signs and Construction Equipment
  - Animals and Farming Equipment
  - Typical Housing for U.S. & Middle East
  - Land, Sea, and Air Transport Vehicles
- Ability to create scripts for all objects
- 3D high resolution towns/villages
- Custom 3D animations
- Databases and entities fully IR compliant
- Voice & Chat options for communication

- Current Applications
  - 3 person RPA team
    - Reconnaissance task
  - Sensor Operator Task
    - IED Task
  - Connect SimSystem to ASU Air Traffic Control Simulation
    - Insert UASs into the National Airspace
SimSystem’s most recent delivery was a 3 person UAS scenario to Dr. Nancy Cooke
ASU & CERI
CERTT Laboratory
An instance of 3 person UAS reconnaissance task represented in a single ganged unit. Consoles are individual towers and can be configured in any way (Co-Located or Distributed).
Pilot Console

- Controls heading, airspeed, altitude of UAS
- Communicates current and projected UAS status to team
- Control panel readily modified
Sensor Operator Console

- Controls sensor on the UAS via UI and/or Joystick
  - Direction of sensor
  - Zoom
  - Sensor modes
    - EO/IR/NV
  - Attach laser to target
  - Track targets
  - Take photos and send to Data Exploiter

- Control panel readily modified
Data Exploiter Console

- Searches for targets
- Plans UAS route
- Relays UAS restrictions to team (altitude, airspeed, etc.)
- Analyzes photos taken by Sensor Operator
- Sends imagery to customer
- Control panel readily modified
Electronic Warfare

Ability to simulate an entire Integrated Air Defense System (IADS)

- **IADS Radar Site Types**
  - Early Warning (EW) Radar
  - Sector Operations Centers (SOCs)
  - Acquisition (ACQ) Radar
  - Target-tracking Radar (TTR)
  - Height-finding (HF) Radar

- **Auto Sites**
  - Autonomous non-IADS Sites
  - Can track and acquire a target themselves

- **Other Sites**
  - Radio Station
  - Abstract objects (Bull’s-eyes)
  - Non-IADS but may radiate or be targeted by aircraft
Electronic Warfare Displays

- **Self-Protection Displays:**
  - RADAR Warning Receiver (AN/ALR-69)
  - Infrared Warning Receiver (AN/AAR-47)
  - Chaff and Flare Dispenser (AN/ALE-40)
  - Towed Decoy (AN/ALE-50)

- **Kinetic Attack Displays:**
  - Armament Control panel
  - AGM-88 Control panel

- **Electronic Attack Displays:**
  - Communications Jammer (USQ-113)
  - Self-Protection Jammer (AN/ALQ-172v3)
  - Manual On-board Jammer (AN/ALQ-161)

- **Electronic Warfare Support Displays:**
  - Panoramic Receiver Set (AN/ALR-20)
  - Direction Finding Display
  - Reconnaissance Log
System Components

- **Console**
  - Ergonomically designed fully enclosed 19” rack cabinet
    - Removable side doors
    - Rear louvered doors
    - Powder coated paint
    - Custom Corian writing surface
    - Rack mounted power strip

- **Main Displays**
  - Touchscreen Monitors (2)
    - 22” widescreen projected capacitive display
    - 16:9 aspect ratio
    - Zero bezel all glass front surface
    - HID compliant
    - 1920 x 1080 resolution

- **Terrain**
  - 12 TB North America 3D Terrain
    - 1 meter-per-pixel (mpp) natural color imagery from the Simulator Database Facility (SDBF) at Kirtland Air Force Base, with high-resolution imagery ranging from 0.24 to 0.50 mpp for several urban areas and US military installations
  - 1.5 TB Asia 3D Terrain:
    - 15 meters-per-pixel (mpp) LandSat imagery of India, Iran, Japan, Pakistan, Turkey, and the UAE, and portions of Uzbekistan, Turkmenistan, and Tajikistan, 2.5 mpp SPOT satellite imagery of Afghanistan, 1 mpp black and white imagery color fused with 15 mpp color LandSat imagery of Iraq (approximately 70-geocell area) ; 0.60 mpp natural color insets of Baghdad, Basra, Kabul province, Kandahar, Kirkuk, Tehran, Tokyo, and Osaka

- **Secondary Displays/Computers**
  - Touchscreen Computers (2):
    - 8.4-inch (SVGA 800 × 600) TFT computer
    - USB 2.0 ports (4)
    - Resistive film (Analog)
    - LAN ports (2)
    - Solid State Drive (SSD)
    - Intel ULV Celeron M 1.0 GHz

- **Computer (1)**
  - Intel Core i7-2600 CPU @ 3.40 GHz
  - 16.0 GB RAM
  - Windows 7 64 bit OS
  - 2TB Western Digital Hard Drive (min.)
  - NVidia GeForce GTX 580 w/ 3.0 GB

- **Accessories**
  - Flexsteel chair mounted on slider
  - Keyboard & mouse
  - Uninterruptable power supply
  - Hour meter
  - On/off switch
  - David Clark headsets

- **Communication**
  - VoIP Intercom System
  - Text Chat
Data Collection Capabilities
Data Collection Capabilities

Training

• Custom training framework designed to train participants on individual task and computer interface

• Components

• Individually oriented
  – Easily modified
  – Includes training assessment
    • Quiz
      – Incorrect answers automatically progress to review slide
    • Criterion for successful completion
Data Collection Capabilities

Performance

• Components
  – Data Logging embedded in MetaVR & BSI
  – Post Processing/Scoring
    • Stand alone application
    • Flexible scoring
  – Generic scoring formula
    • Weights can be changed for varying research objectives
Data Collection Capabilities

Communications

• Components
  – Communication
    • Audio communications
      – All communications recorded and time stamped
        » Communication flow data is recorded (who is talking)
          • Binary @ 10Hz
            • For each node in the system
              » Time communication initiated as well as duration
              • Sender/receiver recorded
    • Text/Chat
      – All text messages are recorded and time stamped
        » Time sent
        » Time received/read
        » Sender/Receiver recorded
Software Environment

- Battlespace Simulations, Inc (BSI)
  - Modern Air Combat Environment (MACE)
- MetaVR
  - Virtual Reality Scene Generator (VRSG)
- Sandia Research Corporation
  - Custom User Interfaces
  - Scenario Development
  - Measures/Metrics

Integrated Software Environment

- SRC Interface & Scenarios
- MetaVR
- BSI Mace
Shared View of UAS in the world
Custom Sensor Operator User Interface
Custom Pilot User Interface
Custom Data Exploiter User Interface
3D High Resolution Population Centers
Examples of Measures & Metrics utilized by previous researchers and implemented by Sandia Research Corporation
Metrics and Measures

Knowledge Taskwork

- Individual and team responses to structured questionnaires related to taskwork

Components
  - Team knowledge of taskwork
    - Stand alone taskwork rating application
    - Individual and team relatedness ratings on task relevant concepts
  - Knowledge Network Organizational Tool
    - Pathfinder
      - Networks reduce and represent ratings data in a graph structure

Metrics and Measures
Knowledge
Teamwork

• Individual and team responses to structured questionnaires related to teamwork

• Components
  – Teamwork measures
    • Stand along teamwork application
    • Participants rate essential elements required for mission success
      – Ex. Identify critical communications necessary

Metrics and Measures
Workload

- Used to assess individual workload
- Components
  - NASA TLX workload questionnaire
  - User’s subjective assessment on mental and physical workload

3. How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

LOW(0)----------------------------------------------------------(50)----------------------------------------------------------HIGH(100)

Metrics and Measures

Process
Coordination

- Isolated measures of individual and team coordination

Components
- Custom created standalone coordination logging software
  - Recording and time stamping of team communication events
    - Can be recorded live or post processed
    - Subjective estimates of coordination

Metrics and Measures

Process

Situation Awareness

• Online subjective measure of situational awareness

• Components
  
  – Situation Awareness Tools
    • Queries to individuals and team on current and future events
  
  • Roadblocks
    – Communications cut
    – Take control of participant station
    – Ad hoc targets

Metrics and Measures

Process

Communication

• Embedded and isolated measures of individual and team process

• Components
  – Communication
    • Audio and Chat communications
      – Communications flow data recorded by SimSystem is processed using Dynamics
        » Dynamical Analysis Toolkit
      • Real time communication flow analysis
  – Developed by Sandia Research Corporation in conjunction with Dr. Nia Amazeen, Dr. Jamie Gorman, & Dr. Nancy Cooke

Metrics and Measures
Performance

• Isolated and composite measures of individual and team performance

• Components
  • RPA status (altitude, airspeed, etc.)
  • Waypoints/Targets visited
  • Photos taken
Metrics and Measures
Eye Tracking

- Components
  - High-speed eye tracking comes with portability through its USB 2.0 port
  - Quick Link API to allow researchers and developers access to valuable metrics such as gaze position, dwell times, blink rates, pupil size, and much more
Debriefing

• Used to collect demographics as well as participant experience during the experiment

• Components

• Debriefing Questions
  – Demographics
    • Stand alone application that collects and records participant demographic information
  – Questionnaire designed to elicit participant experience (i.e.; if they liked the study, feelings about other teammates, etc.)
  – Surveys
    • Personality Survey
      – Individual personality measurement tool
To learn more about how SimSystem can solve your research needs contact:

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