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Key Research

Synthetic Speech and Visual Data Communications for Flight Deck Use-- FAA and DOT Volpe Lab

Principal Investigator for research designed to determine the parameters necessary for implementing a synthetic speech system on the flight deck. The aim was to optimize communications between ATC and pilots. Researchers focused on how a synthetic speech system could reduce pilot need to focus attention heads down while in flight while reducing workload and enhancing situational awareness. The research team compared digital message communications (DataComm) text-only messages, synthetic voice ATC communications, and traditional ATC-Pilot voice communications. The research used FAA qualified Flight Simulation Training Devices (FSTD) that incorporated a touch screen display interface using a message set based upon the SC-214 DataComm message set. The touch screen display served as an experimental apparatus for examining digital communication issues during simulated flight. This research led to the development of a touch screen controlled digital data communication device--The *Visual Digital Display.*

Simulated Automatic Flight Training Environment with Virtual Air Traffic (SAFTE-VAT) for the Simulated Flight Environment– ERAU, College of Aviation

A finding of the *Ab Initio Flight Training Device Effectiveness Study* was a need to increase cognitive fidelity of the simulated flight training environment and reduce instructor pilot workload. Dr. Macchiarella led a developmental research project to integrate the application of voice recognition-based air traffic control functionality and semiautonomous virtual air traffic in the university's fleet of flight simulations. The team included Frasca International Inc. engineers and university faculty staff and students. This system is in use at the University for Private Pilot and Instrument flight training.

Simulation Gets Real

Simulation has revolutionized aviation by reducing the risks, costs, and hours spent learning to be a pilot, air traffic controller, and maintenance technician.

As an early adopter and innovator of simulation, Embry-Riddle makes use of 36 flight simulators and training devices, three air traffic control simulation labs, and a High Altitude Normobaric Lab that teaches pilots the symptoms of air sickness induced by loss of oxygen in the cockpit.

But Embry-Riddle researchers are also developing new uses for simulation, ranging from flight training to role-playing by teams in separate locations. They are even creating touch-free, interactive applications for teaching, playing games, and operating equipment.

Researchers Justin Westbrooks and Tom Haritos test SAFTE-VATS, a pilot-ATC simulation tool.

Simulator teaches pilot-ATC teamwork

In partnership with Frasca, Embry-Riddle is developing SAFTE-VAT, an air traffic control simulation tool that will relieve flight instructors from having to play air traffic controller in addition to teaching flight procedures.

Using speech recognition technology, SAFTE-VAT parses the pilot's spoken words and responds with appropriate air traffic controller messages and instructions.

For example, "Daytona Tower, Riddle 345 is 25 left, ready for departure" contains at least five key words - Daytona, Tower, Riddle, 25, and left - that can trigger a response. The new program's virtual air traffic controller may reply with "Riddle 345, Daytona Tower. You are cleared for departure 25 left, maintain runway heading."

The program's software also recognizes non-spoken triggers such as altitude, time, and waypoints.

> "There's a need for brevity. In a congested airspace, it sounds like an auction sometimes. **We want to optimize communication between ATCs and pilots.**"
> [Dan Macchiarella, Embry-Riddle chairman of aeronautical science]

Frasca built SAFTE-VAT, and Embry-Riddle researchers are developing the content for it. Principal investigator is Dan Macchiarella, chairman of aeronautical science at the Daytona Beach campus. The university will be the first user of the program before Frasca puts it on the market.

In a spinoff project, also led by Macchiarella, Embry-Riddle researchers are defining synthetic speech for cockpits in the FAA's planned NextGen environment, where aircraft will have a digital link with air traffic controllers.

"We're examining how much of the message traffic with ATCs should be displayed to the pilot visually or conveyed by synthetic speech," Macchiarella explains. "There's a need for brevity. In a congested airspace, it sounds like an auction sometimes. We want to optimize communication between ATCs and pilots."

Researchers in the FAA-funded project are also exploring ways of presenting air traffic information on cockpit displays and how pilots could respond using a touch screen, buttons, or a keypad.

Ab Initio Flight Training Device Effectiveness Study – ERAU, College of Aviation
Principal Investigator for an 18-month study that applied an experimental flight-training curriculum comprised of 60% flight training device (FTD) flight and 40% airplane flight to certify Private Pilots under Federal Aviation Regulation (FAR) Part 142. The results from the research provided data to ascertain the effective transfer for each flight-training task. Ab initio student pilots practiced each task to standard in an FTD prior to training in an actual airplane. The researchers measured a significant degree of effective transfer for the majority of flight tasks examined. This notable research is the largest scale transfer study completed outside of a military setting as reported by the FAA. The results of the study are directing integration of simulation into ab initio private pilot training, to include the joint development of virtual air traffic (VAT) with Frasca International Inc.

Remote Area Lighting System (RALS) – ERAU, Colleges of Engineering and Aviation

The need for effective low cost runway lighting in remote areas was identified the FAA. Dr. Chris Grant, Civil Engineering Department, served as the Principal Investigation (PI). Dr. Macchiarella served as Co-PI and chief test pilot. Dr. Macchiarella supervised flight-testing, that included the landing of aircraft guided by the new system. The lighting system uses a retroreflective surface to reflect a light wave front back along a vector that is parallel to, but opposite in direction of the beam. This kind of marker requires no power and illuminates brightly when struck by an airplane's landing light. Additionally, low-powered LED lights mark the corners of the landing strip, flashing in synchronization based on GPS time and providing cues to the pilot for airfield identification and landing.

Health and Usage Monitoring System (HUMS) Contract – ERAU, Colleges of Engineering and Aviation

HUMS was a three-year research contract to design and perform a mock certification of a helicopter HUMS device specifically created for usage credits. Usage credits would allow helicopter operators to obtain the maximum life from life-limited parts and to identify any potential safety of flight problems. Dr. Pat Anderson was the PI. Co-PIs were Dr. Andrew Kornecki and Dr. Dan Macchiarella. Additionally, Dr. Macchiarella served as chief test pilot.

Mobile Augmented Reality System (MARS) for Aviation Training—ERAU, College of Aviation

Augmented reality (AR) is a computer vision technology that seamlessly fuses real and virtual images into one spatially integrated scene. Similar to virtual reality (VR) worlds that have become ubiquitous throughout military and commercial aviation training; AR has the potential to meet future requirements for training pilots and aircraft maintenance technicians (AMT) by creating a new instructional delivery system (IDS) that serves as a medium for training psychomotor and cognitive tasks. Implementing AR as a medium for learning in the real world could essentially change human-computer interaction with mixed reality environments that serve as a means of training AMTs. Under Dr. Macchiarella's supervision a Mobile Augmented Reality System (MARS) was created at ERAU. The MARS was worn by the user to see mixed reality worlds. It used a wearable computer and lightweight compact monocular head mounted display (HMD) allowing users to view of virtual information and images with the real world.

Airport Advanced Disaster Management System-ERAU and ETC Simulation

Preparing responders and leaders of disaster responders is a key focus of training following 9-11 events. This developmental effort addressed airport disaster simulations for training. The assessment determined the proper strategy for evaluating and improving the training effectiveness of a disaster simulation. The key aspect studied was the implementation of the Advanced Disaster Management Simulator (ADMS) from Environmental Tectonics Corporation (ETC) in a virtual environment scenario-based training exercise while participants played their disaster response rolls. Dr. Macchiarella was the Co-PI. This research effort identified a methodology to effectively train disaster response in a virtual environment.

Evaluation of Jacksonville Advanced Disaster Management System- ERAU and ETC Simulation

Previous research at ERAU identified a need to develop metrics for disaster response training assessment. This research quantified these metrics. The contract expanded ERAU expertise in simulation disaster response training. The research efforts moved beyond airports to seaports and developed metrics necessary to measure training and compliance with Department of Transportation and Homeland Security initiatives. The very nature of operations at transportation hubs elevates opportunities for either natural or manmade disaster leading to possibilities for loss of life, capital, and infrastructure. By developing "real-world" disaster scenarios, for use in virtual environments, where disaster responders free play responses, responsible agencies can obtain training objectives while capitalizing on the effectiveness and efficiency associated with training in simulated scenarios. Full-scale live disaster response training exercises are complex and costly –these characteristics lead to infrequent use. A virtual environment training system could be widely used by airports and seaports to increase the effectiveness and efficiency of smaller table-top and functional training exercises leading to higher levels or training for disaster response and efficiently meeting training needs. Dr. Macchiarella was the team lead of this multi-university and multi-professor project. This research work led to the preparation and submission of a proposal to the National Transportation Board RFP ACRP 04-04-- *Exercising Command-Level Decision Making for Critical Incidents at Airports.*

Deployable Virtual Training Environment (DVTE)- U.S. Army Research Institute (ARI)
Dr. Macchiarella served as a subject matter expert (SME) for the development of a virtual environment suite of computer-based simulations that allow soldiers/Marines/airmen to train for various roles and air and ground weapons delivery platforms. These roles include Fire Support Team (FST) members, as well as rotary wing and fixed wing aircraft and ground vehicle simulations (e.g., tank).

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