Tactile Situational Awareness System (TSAS)

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PROBLEM STATEMENT

Helicopter landings are more challenging in "brownout" conditions, in which sand and dust is stirred up by the rotary wing aircraft, obscuring visibility and the pilot's ability to maintain a visible horizon. TSAS enables a helicopter pilot to maintain a stable hover position when in a degraded visual environment (DVE) and will ensure that the pilot does not experience excursions outside the prescribed flight envelope during up-and-away maneuvering.

As humans grow and develop, sensory systems mature to control and coordinate movements subconsciously using all of the human senses. Pilots are trained to ignore nearly all of these well developed and extremely accurate senses except that of visual (and aural) stimuli. During times of high mission tasking, at night, or other conditions of low visibility, visual and aural information is available but it may be ignored, or another sense overwhelms the pilot with the wrong information. This results in loss of situational awareness and often ends with catastrophic results. The Tactile Sensory Display System (TSDS) offered by Chesapeake Technology (CTI) will restore the sense of feel and contribute to pilot awareness of aircraft position, attitude, and rates of movement about each aircraft axis.

"In a survey of 970 US Army rotary-wing mishaps from 1987-1995 (Durnford et al., 1995; Braithwaite, Groh, and Alvarez, 1997), 30% of the mishaps were considered to have had spatial disorientation as a major or contributory factor. On average, spatial disorientation cost the US Army 14 lives and $58 million each year."[1]

There are more current statistics about this brownout issue in regards to aircraft mishaps, but this information may not be available for public presentation. If additional, more current information is required, please contact the author of this report.

[1] USAARL Report No. 2004-10 dtd March 2004. Approved for public release, distribution unlimited.

The specific platform that this is directed toward is the AH-1W (Cobra helicopter) / UH-1N (Huey).

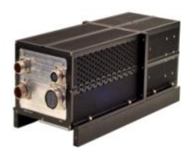
WHO CAN BENEFIT?

Any rotorcraft aircraft will benefit from this spatial disorientation (SD) / situational awareness (SA) tool. The aircraft that are specifically targeted for inclusion over the next few months as a result of this SBIR funding are the SH-60 Seahawk, V-22 Osprey, and CH-53K Super Stallion. Integration will be accomplished via SBIR funding to allow installation and further testing in the Manned Flight Simulator (MFS) located at NATC Patuxent River, Maryland. Additionally, this technology can be used by the fixed wing community as a SA tool to help alleviate vertigo or alignment/ directional issues in the cockpit.

BASELINE TECHNOLOGY

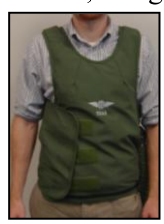
There are no tactile sensing products available for displaying SA solutions.

There are several advanced technologies that have been undertaken to help alleviate SD / improve SA in a DVE through improved visual and aural displays. These developmental systems include Sandblaster, 3D-LZ, HELO (Helicopter Low Level Operations) Product 2 and HALS (Helicopter Autonomous Landing System). All of these developmental systems are in work and are a mix of laser, laser-radar, millimeter wave radar or some type of autonomous landing system technology. While all have benefits, it will be several years before they reach a TRL (Technology Readiness Level) that will allow them to be deployed.



All of these products that are in development rely on the “choke-point” of using visual or aural cues that cause pilots to recognize and process complex information prior to taking action.

CTI’s Phase II SBIR purpose is to develop and produce a modern processor that can interface with fleet aircraft on-board sensor information, develop an integrated pilot tactile display system, test this system in a commercially available rotorcraft, integrate this tactile system into the Manned Flight Simulator’s at NATC Patuxent River and ensure that quantitative and qualitative information from the testing is retained and used during future production configurations of this system.



There is a company, Engineering Acoustics, Inc. that has its own independent Phase II SBIR linked to TSAS development. Their required tasking is to continue development of tactor technology, their company’s core technology, and to provide these components to CTI for integration per NAVAIR direction.

As the integration agent for this system, CTI will integrate this tactor component hardware into our vest as available. Currently, EAI is migrating from their C-2 tactor to a

C-3 tactor (less mass, more capability) that will be added into a networked IP-based system. This networked system will be used by CTI in their vest for future testing.

Strengths of this current approach are that tactile sensory information has been ignored by the flight physiology community in lieu of the development funding dedicated to visual and aural cue technology. The sense of feel is a largely untapped resource available for pilot dissemination of information. TSAS is the first airborne system to fully use tactile information in the pilot's domain.

Weakness is that this technology is still in the infancy stage of acceptance by the system acquisition programs of record.

TECHNOLOGY DESCRIPTION

TSAS enables "tactors" (buzzer type devices) incorporated into a thin vest worn on the upper torso to send tactile signals to a helicopter pilot. The signals are generated by the aircraft inertial navigation system (INS)/attitude reference system and will indicate through vibration to the pilot when he/she is maneuvering in unbalanced/asymmetric flight. This is particularly effective in potentially dangerous situations occurring during inclement weather or brownout/whiteout conditions generated from rotor down wash that obscures the pilot's visual horizon.

Features:

- TSAS will use platform sensor information to determine what signals to send to the tactors to give the pilot supplemental information that he/she may be entering into a dangerous portion of the flight envelope.
- If the platform is not able to provide navigation sensor input (or it is faulty), the TSAS system will use an enclosed EGI (Embedded GPS/INS) as its primary navigation sensor.
- A real time operating system will be used with framework architecture on a 20 millisecond (ms) basis. This method was chosen to ensure that zero false signals would be generated and there would be adequate processor computational reserve for any future growth of the system requirements.
- All system variables are re-programmable. This capability is to allow easy addition of any rotorcraft (or fixed wing) aircraft into the inventory of this system. Currently, aircraft that are planned for integration are the AH-1, CH-53, V-22, CH-46 and of course, our commercial test aircraft, the Robinson R-44.
- To cover the majority of the types of data busses currently deployed, a full capability 1553 A/B card and an ARINC 469 card (both in PC-104 configuration) are added to the processor enclosure.
- The CCP (Cockpit Control Panel) is NVIS capable. This means that it will be fully compatible with the NVG assemblies in use today for combat aircrew.
- TSAS is <u>not</u> a replacement for current/future visual/aural systems to cue a pilot to the approach of hazardous conditions; rather it is a supplemental system to aid the pilot in avoiding/safely returning from dangerous flight regimes.

Advantages:

- It can be deployed quickly. TRL: 6 currently

- It is expected that after MFS integration and testing (mid-2010): TRL 7
- TSAS uses navigation information provided by the aircraft sensors.

Benefits:

- Takes advantage of a pilot's mostly ignored sense of feel and relieves part of the pilot's visual sensory overload.
- Is a supplemental means of keeping the pilot focused on safe flight profiles.

The system produced by CTI will be defined as either part of a Tactile Display Processor (TDP) performance specification or as part of a Tactile Display System (TDS) performance specification. This nuance is highlighted by the logistic and environmental factor that the TDP (made up of the processor enclosure (EGI, PC-104 CPU cards, power supplies, and EAI provided tactor control cards)) and Cockpit Control Panel ((CCP) – a Night Vision Goggle (NVG) compatible cockpit display) and the TDS (vest (with integrated tactors)) will operate and require logistic support in two different aircraft environments – the TDP will be designed to operate as avionics circuitry to be left in the aircraft on a permanent basis and the TDS (vest) will be worn by the pilots to and from the aircraft on a mission-by-mission basis.

Interfacing equipment is to be able to read the navigation information on the aircraft Navigation Bus. If this information is not available or is degraded, TSAS has an embedded EGI mounted inside the TSAS processor enclosure that can be used.

CURRENT STATE OF DEVELOPMENT

At present time, TSAS is at a TRL level 6. We have been through flight testing using a commercial Robinson R-44 test helicopter.

We are about to install TSAS systems into the Manned Flight Simulator (MFS) at NAS Patuxent River, Maryland to enable testing to continue with real world scenarios and operational pilots.

Additional testing needs to be done to collect data and perform analysis of the data to continue to enable increased performance of the TSAS man-machine interface.

REFERENCES

TPOC; NAVAIR PMA 276 CSS; NSI 21491 Great Mills Road, Suite 100; Lexington Park, MD 20653; 301.995.4214; 301.737.1911
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ABOUT THE COMPANY

Chesapeake Technology International Corporation (CTI) is a veteran-owned, small business with headquarters in California, Maryland and a distributed development network with offices in California, Colorado, Virginia, and North Carolina. Actively operating since April 2000, CTI specializes in providing system engineering, software, products, and support for Electronic Warfare (EW) and Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems, simulators, and platforms. Our capabilities span management support, system design, software development, training and ongoing system support for ground, shipboard, and airborne, systems with a special emphasis on system integration and testing of wireless applications, remote control, embedded software development, mission planning, simulation, operational functionality and field support. We have a unique team of operationally experienced analysts and highly qualified systems/software engineers who are thoroughly knowledgeable in key technologies and modern software development. We provide rapid, responsive, proven, cost-effective engineering solutions and operational support for customers who depend on multiple sensors, integrated systems, and data fusion technology to be successful. CTI personnel have over 75 years of operational tactical Electronic Attack (EA) and Psychological Operations (PSYOPS) experience and technical expertise in software development, systems engineering, modeling and simulation, quality assurance and configuration management.