Mind-reading helmets on the horizon for fighter pilots

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Big brother may not be watching you in the future. He may just be reading your thoughts.

A team at the University of California's San Diego campus has been working on a project to miniaturize EEG brain scanners, allowing them to monitor a pilot's mental state and confirm he's concentrating on flying, rather than daydreaming.

They're starting by fitting those scanners into a fighter pilot's helmet, thanks to a miniaturization breakthrough from Taiwanese chipmakers.

The helmet based monitoring system would also signal if a pilot is reaching processing overload; pilots today must contend with increasingly complex weapons systems while processing huge volumes of information.

EEG, or electroencephalographic technology, monitors electrical activity in the brain. First introduced in the 1920s, doctors use EEG for a range of things, from studying epilepsy to sleep patterns. Technically it's just technology -- scans of the electrical fields used by nerves in the brain for communication.

By monitoring those electrical signals, the base can join a pilot in the cockpit (virtually speaking). If the pilot misses a warning light, falls asleep, becomes unconscious or panics, the sensors will pick up on this and relay it to the base.

Theoretically, someone on the ground could then step in and put the plane on autopilot.

Historically, such an application of EEG scanners was impractical, as they required cumbersome wires and a heavy cap, and the user needed to stay perfectly still to prevent facial movements that could interfere with signals.

But a team of scientists led by Scott Makeig, director of UCSD's Swartz Center for Computational Neuroscience, and professor Tzyy-Ping Jung, working Taiwan's National Chiao-Tung University have cracked the size problem. Chipmakers in Taiwan miniaturized those EEG scanners and fit them into a pilot's helmet -- and achieved a brain-computer interface.

The four-channel headband connects wirelessly via Bluetooth to a cellphone or tablet where the data is disentangled and processed for meaningful information. And 64-channel systems will be available in a few months, they say.

Better precision has been achieved through improved algorithms developed by Malveig. Known as independent component analysis, it takes signals from several electrodes and uses them to infer the origin of a particular impulse within the brain.

"The brain evolved to organize behavior, to optimize results of behavior and to detect results of behavior," Malveig said.

His algorithms can even filter out brain signals from non-brain signals such as movement -- the muscle work required to fly a plane, talk, walk or run -- a key advance. Even an eyebrow twitch could mess up readings in the past, they say.

Researchers refer to this advance as being able to now hear a single voice in a crowded room -- and it's all thanks to a new chip smaller than your fingernail, meaning the system can weigh less than a few ounces.

Gamers may find themselves already familiar with similar technology. Wireless EEG technology hit the market in 2009 with Mattel's Mindflex, in which users duel with balls they control with their mind. Then came NeuroSky's Uncle Milton's Force Trainer, a Star Wars-themed game that teaches how to "use the Force" to move an object.

Makeig has also been using the miniaturized EEG tech to study movement. Using mobile brain/body imaging (MoBI), the team has been able to study how thoughts lead or motivate movement.

Using motion-capture technology and high-density EEG caps, he has been examining how thought relates to movement in people with autism. And the potential is even more impressive: These advances in miniaturizing may lead to a single chip that could be implanted in the brain to prepare someone suffering from epilepsy for surgery, he speculates -- replacing months of study and

countless hours strapped to electrodes.

The researchers say that in the long term, the technology could lead to advances in numerous fields, including studies of autism, epilepsy, paralysis and fatigue.

The immediate potential is in military and civilian applications, however. Fatigue can erode performance, after all: Pilots are often required to fly grueling and unforgiving schedules. And warfighters endure equally punishing hours.

We live in a “contra-circadian society,” Makeig says, one that flies in the face of a biological need for sleep. Monitoring fatigue and concentration could be helpful, but come with a trade-off -- having a commander literally in your helmet.

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