



## Hands-Free Transcranial Color Doppler Probe

**These probes enable full use of TCD technology for neurological diagnostics.**

*Lyndon B. Johnson Space Center, Houston, Texas*

Current transcranial color Doppler (TCD) transducer probes are bulky and difficult to move in tiny increments to search and optimize TCD signals. This invention provides miniature motions of a TCD transducer probe to optimize TCD signals.

The mechanical probe uses a spherical bearing in guiding and locating the tilting crystal face. The lateral motion of the crystal face as it tilts across the full range of motion was achieved by minimizing the distance between the pivot location and the crystal face. The smallest commonly available metal spherical bearing was used with an outer diameter of 12 mm, a 3-mm tall retaining ring, and 5-mm overall height. Small geared motors were used that would provide sufficient power in a very compact package. After confirming the validity of the basic positioning concept, optimization design loops were completed to yield the final design.

A parallel motor configuration was used to minimize the amount of space wasted inside the probe case while minimizing the overall case dimensions. The distance from the front edge of the crys-

tal to the edge of the case was also minimized to allow positioning of the probe very close to the ear on the temporal lobe. The mechanical probe is able to achieve a  $\pm 20^\circ$  tip and tilt with smooth repeatable action in a very compact package. The enclosed probe is about 7 cm long, 4 cm wide, and 1.8 cm tall.

The device is compact, hands-free, and can be adjusted via an innovative touchscreen. Positioning of the probe to the head is performed via conventional transducer gels and pillows. This device is amendable to having advanced software, which could intelligently focus and optimize the TCD signal.

The first effort will be development of monitoring systems for space use and field deployment. The need for long-lived, inexpensive clinical diagnostic instruments for military applications is substantial. Potential future uses of this system by NASA and other commercial end-users include monitoring cerebral blood flow of ambulatory patients, prognostic of potential for embolic stroke, ultrasonic blood clot treatment, monitoring open-heart and carotid end-

arterectomy surgery, and resolution of the controversy regarding transient ischemic attacks and emboli's role. Monitoring applications include those for embolism formation during diving ascents, changes in CBFV (cerebral blood flow velocity) in relation to cognitive function as associated with sick building syndrome or exposure to environmental and workplace toxins, changes of CBFV for testing and evaluating Gulf War Syndrome, and patients or subjects while moving or performing tasks.

*This work was done by Robert Chin of GeneXpress Informatics, and Srihdar Madala and Graham Sattler of Indus Instruments for Johnson Space Center. Further information is contained in a TSP (see page 1).*

*In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:*

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*Refer to MSC-24702-1, volume and number of this NASA Tech Briefs issue, and the page number.*

## Improving Balance Function Using Low Levels of Electrical Stimulation of the Balance Organs

**A device based on this technology may be used as a miniature patch worn by people with disabilities to improve posture and locomotion, and to enhance adaptability or skill acquisition.**

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Crewmembers returning from long-duration space flight face significant challenges due to the microgravity-induced inappropriate adaptations in balance/sensorimotor function. The Neuroscience Laboratory at JSC is developing a method based on stochastic resonance to enhance the brain's ability to detect signals from the balance organs of the inner ear and use them for rapid improvement in balance skill, especially when combined with balance training exercises. This method involves a stimulus delivery system that is

wearable/portable providing imperceptible electrical stimulation to the balance organs of the human body.

Stochastic resonance (SR) is a phenomenon whereby the response of a nonlinear system to a weak periodic input signal is optimized by the presence of a particular non-zero level of noise. This phenomenon of SR is based on the concept of maximizing the flow of information through a system by a non-zero level of noise. Application of imperceptible SR noise coupled with sensory input in hu-

mans has been shown to improve motor, cardiovascular, visual, hearing, and balance functions. SR increases contrast sensitivity and luminance detection; lowers the absolute threshold for tone detection in normal hearing individuals; improves homeostatic function in the human blood pressure regulatory system; improves noise-enhanced muscle spindle function; and improves detection of weak tactile stimuli using mechanical or electrical stimulation. SR noise has been shown to improve postural control when applied