National Aeronautics and Space Administration

Sub-Audible Speech Recognition Based on Electromyographic Signals

NASA has developed a new technology with the potential to automate human-to-human and human-to-machine communication. Such communications are traditionally dominated by visual and verbal information and alphanumeric input. Commercial speech recognition efforts typically emphasize the audible aspects. This new invention relates to analysis of electromyographic signals produced in a human body. It provides and applies a system for receipt and analysis of sub-audible signals to estimate and generate a characterization of speech that is sotto voce or is not fully formed for purposes of normal speech recognition. The system relies on surface measurement of muscle signals (i.e., electromyographic "EMG" signals) to discriminate and recognize sub-audible speech signals produced with relatively little acoustic input.

This invention is available for licensing from NASA's space program to benefit U.S. industry.

Patent

This technology is protected by US Patent Nos. 8,200,486 and 7,574,357 (Reference No. ARC- 15040-1; ARC-15519-1)

Benefits

- Minimization of word variations
- Shared language and shared sound production
- Reliable
- Reasonably accurate
- Resistant to presence of noise
- Soundless communication in difficult environments
- Mimics an idealized, thought-based approach
- Non-invasive sensing
- Privacy

Technology Details

Sub-audible speech is a new form of human communication that uses tiny neural impulses (EMG signals) in the human vocal tract rather than audible sounds. These EMG signals arise from commands sent by the brain's speech center to tongue and larynx muscles that enable production of audible sounds. Sub-audible speech arises from EMG signals intercepted before an audible sound is produced and, in many instances, allows inference of the corresponding word or sound. Where sub-audible speech is received and appropriately processed, production of recognizable sounds is no longer important. Further, the presence of noise and of intelligibility barriers, such as accents associated with the audible speech, no longer hinder communication. Neural signals are consistent, arising from use of a similar communication mechanism between (sub-audible) speaker and listener. This approach relies on the fact that audible speech muscle control signals must be highly repeatable, in order to be understood by others. These audible and sub-audible signals are intercepted and analyzed before sound is generated by air pressure using these signals. The recognized signals are then fed into a neural network pattern classifier, and near silent or sub-audible speech that occurs when a person "talks to himself or to herself' is processed. In this alternative, the tongue and throat muscles still respond, at a lowered intensity level, as if a word or phrase (referred to collectively herein as a "word") is to be made audible, with little or no external movement cues present. This approach uses a training phase and a subsequent word recognition phase.

Speech Recognition

Commercial Applications

- Human-to-machine commands
- Physically and speech disabled persons
- Medical and Emergency service workers
- Interactive database searches
- Silent cellular phones
- Space flights, astronauts
- Military operations
- Underwater operations
- Homeland security
- Robotic command/control
- SWAT Teams, Navy Seals
- Fire Fighters
- Confidential, offline or sotto voice comments during telecons

Contact the Ames Technology Partnerships Office at 1-855-627-2249 or ARC-TechTransfer@mail.nasa.gov