Breakthrough Could Revolutionize Sampling Technology Forever

Yonina Eldar of the Faculty of Electrical Engineering.

Researchers from the Technion-Israel institute of Technology have made a breakthrough that could revolutionize the way broadband signals are sampled, recorded and processed. The breakthrough could someday be used to make significant improvements in radar capabilities and performance, increase the capacity of audio recording devices, and reduce patient exposure to radiation during such procedures as MRIs, x-rays and CT-scans.

"Sampling" technology is central to the operation of these devices and in general to the field of digital communications. Increasing the bandwidth of the signals that can be sampled while maintaining a low sampling rate would increase the capabilities of these devices.

"In digital devices, physical signals (images, sounds, etc.) are stored using a series of bits," explains Prof. Yonina Eldar of the Faculty of Electrical Engineering. "The goal of the sampling stage is to cleverly convert a physical signal into bits of data (a series of zeros and ones) in such a way that the true underlying signal can later be recovered. This recovery is performed in the reconstruction process, in which the bits are translated back into a physical signal that can be heard or seen."

Using only commercially available components, the team led by Prof. Eldar has built a patented prototype that far exceeds basic established limits for sampling by hundreds of percentages. It also precludes the need for processors with high computational capabilities.

Until the Technion breakthrough, it was believed that exact reconstruction of a signal with unknown spectral support using digital processing was possible only if it was sampled at a rate twice the maximum frequency of the signal (as established in 1949 by the Nyquist-Shannon sampling theorem).

Under Prof. Eldar's supervision, graduate student Moshe Mishali set out to design a single sampling system for signals with multiple, broadband channels. Doing so successfully would make it possible to sample and reconstruct those signals perfectly at significantly lower rates than existing samplers. According to Prof. Eldar, the breakthrough was achieved by utilizing the fact that there is no broadcasting in parts of the spectrum.

"The idea is to wisely use the 'holes' in the spectrum in order to significantly lower the sampling rate without damaging the signal," explains Prof. Eldar. "The difficulty lies in the fact that since we do not know where in the spectrum these holes are placed, traditional mathematical models can no longer be used to characterize and manipulate such signals. What we were able to prove is that the mere fact that we know the signal does not occupy the entire spectrum, enables reducing the sampling rate, something that was not possible until now."

The Technion-Israel Institute of Technology is Israel's leading science and technology university. Home to the country's winners of the Nobel Prize in science, it commands a worldwide reputation for its pioneering work in nanotechnology, computer science, biotechnology, water-resource management, materials engineering, aerospace and medicine. The majority of the founders and managers of Israel's high-tech companies are alumni. Based in New York City, the American Technion Society (ATS) is the leading American organization supporting higher education in Israel, with offices around the country.