Power grid fluctuations hidden in audio recordings proved a powerful tool for police forensics

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The I2R A*STAR team together with their collaborators from SPF. Credit: A*STAR Institute for Infocomm Research

Audio and video recordings are important sources of evidence in criminal investigations, especially as more electronic devices are in use now than ever before. However, for recordings to be admissible, investigators often need to determine the time they were made, which can be difficult. Now, a team led by Vrizlynn Thing at the A*STAR Institute for Infocomm Research (I2R), in collaboration with the Singapore Police Force, has developed an impressive new system that reliably estimates the time of recordings by identifying small

fluctuations in the frequency of the electrical power grid.

The 'electrical network frequency' (ENF) of power grids is centered around 50 or 60 Hertz, and is picked up in audio recordings as a background hum. The ENF shifts up and down randomly, which provides each recording with a unique fingerprint that can be compared to the long-term records captured continuously and maintained at forensic labs.

"The random fluctuations are consistent across different places within the same power grid," explains team member Lilei Zheng. "As a consequence, recordings captured in different places at the same time will have ENF fingerprints showing the same fluctuations."

By visually inspecting the ENF, human investigators can reliably match recorded fluctuations to a time in the long-term records, but this is a laborious task best done by a computer. In response, the I2R team developed a similarity criterion called bitwise similarity (bSim) that mimics the way humans judge the similarity of two signals.

The team tested bSim by using it to identify the timing of 187 audio recordings made around Singapore using various mobile phones.

They found that bSim greatly outperformed previous similarity metrics, which were thrown into doubt by small deviations even when the general shapes of the signals were clearly similar. "bSim enables us to focus our attention on the overlapped parts instead of being drawn away by the deviated parts," says Zheng.

"The science behind ENF pattern matching has been proven to be reliable, like fingerprints and DNA," says Thing. "It has been used in courts in various jurisdictions and the cases cut across many different crimes. We hope to extend our work from audio recordings to videos,

which not only contain audio but may also enable us to 'see' the ENF through variations in lighting."

"This innovative solution towards audio authenticity verification developed by I2R has already proven itself in actual use, and we are excited about the potential it holds," says a representative of Singapore Police Force.

More information: Lilei Zheng et al. Time-of-recording estimation for audio recordings, *Digital Investigation* (2017). DOI: 10.1016/j.diin.2017.06.001

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