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Algorithm for Reconstruction-Free Image Recognition from Compressive Sensors

Compressed Sensing (CS) technologies are becoming increasingly important in the signal processing field. Sensors in CS do not output the signal of interest, but instead, output a vector of measurement composed of mixtures of the signal's components. This compressively sensed data can be reconstructed, and the results may be used for purposes such as image classification or recognition. Some signals can be reconstructed using fewer measurements than the length of the signal itself, which has helped make CS research popular. CS technologies have the potential to reduce costs and data rate requirements in many sensor applications. However, traditional methods of CS are computationally expensive and limited in regards to sampling rates. This is because the compressively sensed data cannot typically be used without undergoing a reconstruction stage, which may involve complex optimization problems. Additionally, sensed data that is substantially under-sampled (i.e. ~1% of a Nyquist rate) cannot be reconstructed. Thus, there is a need for an image recognition process that can be performed directly on CS data (including those of lower sample rates), without the need for a full reconstruction stage.

Researchers at ASU have developed a reconstruction-free imaging recognition technology which operates directly on compressed data obtained by a CS sensor. This technology uses a deep machine learning algorithm, incorporating a Deep Boltzmann Machine (DBM) trained on both compressed and uncompressed datasets. Image recognition using this approach is just as, if not more accurate than traditional reconstruction-first methods. Avoiding the reconstruction stage not only saves time, but also allows for the use of CS sensors with lower sampling rates. Non-reconstructible CS data once considered to be of limited use due to their lower sample rates are now usable because the reconstruction stage is bypassed.

Potential Applications

- Sensors
- Surveillance
- Autonomous Navigation
- Photography
- Digital Forensics
- Microscopy/Laboratory Equipment

Benefits and Advantages

- Speed – the lack of need for an image reconstruction step makes this method faster than traditional methods
- Cost-Efficiency – conventional sensors can be replaced with less costly and

less computationally expensive CS cameras

- Compatibility with Lower Sample Rates – this method can be applied to samples below the Nyquist rate, where traditional methods cannot function because reconstruction is not possible

For more information about the inventor(s) and their research, please see

Pavan Turaga's directory webpage

Andreas Spanias's directory webpage

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