Compressed sensing (CS) is a novel approach to collecting and analyzing data of all types. By exploiting prior knowledge of the compressibility of many naturally-occurring signals, specially designed sensors can dramatically undersample the data of interest and still achieve high performance. However, the generated data are pseudorandomly mixed and must be processed before use. In this work, a model of a single-pixel compressive video camera is used to explore the problems of performing inference based on these undersampled measurements. Three broad types of inference from CS measurements are considered: recovery of video frames, target tracking, and object classification/detection. Potential applications include automated surveillance, autonomous navigation, and medical imaging and diagnosis.

Recovery of CS video frames is far more complex than still images, which are known to be (approximately) sparse in a linear basis such as the discrete cosine transform. By combining sparsity of individual frames with an optical flow-based model of inter-frame dependence, the perceptual quality and peak signal to noise ratio (PSNR)
of reconstructed frames is improved. The efficacy of this approach is demonstrated for the cases of \textit{a priori} known image motion and unknown but constant image-wide motion.

Although video sequences can be reconstructed from CS measurements, the process is computationally costly. In autonomous systems, this reconstruction step is unnecessary if higher-level conclusions can be drawn directly from the CS data. A tracking algorithm is described and evaluated which can hold target vehicles at very high levels of compression where reconstruction of video frames fails. The algorithm performs tracking by detection using a particle filter with likelihood given by a maximum average correlation height (MACH) target template model.

Motivated by possible improvements over the MACH filter-based likelihood estimation of the tracking algorithm, the application of deep learning models to detection and classification of compressively sensed images is explored. In tests, a Deep Boltzmann Machine trained on CS measurements outperforms a naive reconstruct-first approach. Taken together, progress in these three areas of CS inference has the potential to lower system cost and improve performance, opening up new applications of CS video cameras.