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Modal decomposition of phase camera images using convolutional neural networks

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The alignment control systems of gravitational wave interferometers extensively rely on heterodyne imaging techniques to sense various length & misalignment degrees of freedom. This is achieved via demodulating the beat of various radio-frequency sidebands measured on single and quadrant element photo-diodes. Such a technique offers very high bandwidth sensing but is limited to resolutions of only a few pixels. Future gravitational wave detectors that utilize both higher circulating powers and higher levels of squeezing will require alignment systems which can sense and correct for higher order defects. There are currently various high resolution heterodyne imaging techniques, known collectively as phase cameras, which can provide higher resolution images of the sideband fields and allow the sensing of higher order defects. The utilization of phase cameras requires the development of techniques for processing and analyzing the images they produce.

In this presentation we report on recent work in training a convolutional neural network to perform modal decomposition using simulated phase camera images. This is to our knowledge the first machine learning decomposition scheme to utilize complex phase information to perform modal decomposition. The results of this work shows promise for future machine learning integrated alignment control schemes.

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