End-to-End Design of a Snapshot Hyperspectral Microscopy System

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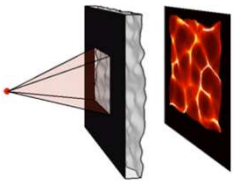
Abstract

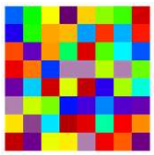
System performance is highly desirable and sample dependent in computational imaging. In this work, we introduce an end-to-end design for a snapshot hyperspectral microscopy system which jointly optimizes the parameters of the hyperspectral filter array and reconstruction algorithm to achieve improved reconstructions in comparison to heuristic designs.

Introduction

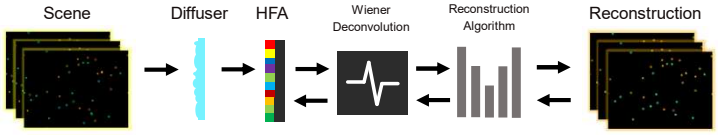
A diffuser spreads the light from one point source on our scene to many points on our sensor, and compressive sensing techniques allow us to recover the original scene despite this mapping



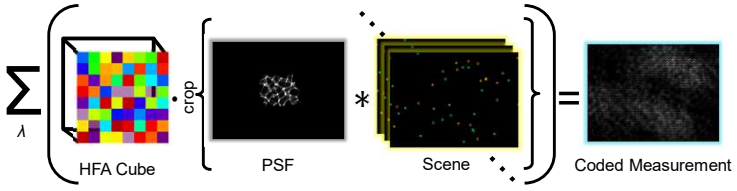
A hyperspectral filter array made up of an 8x8 grid of filters is glued onto the sensor and allows us to capture 64 spectral channels of interest



Methodology

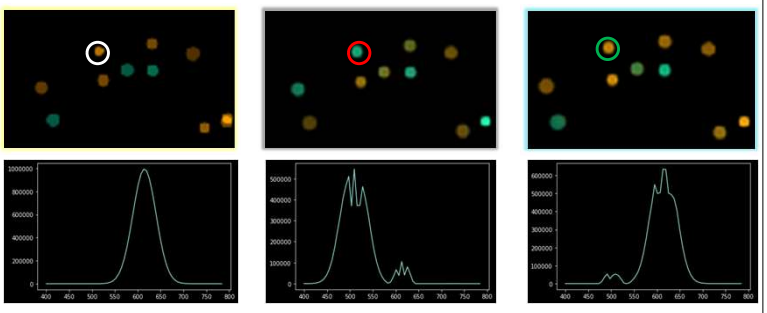


Overview of our end-to-end design that jointly optimizes the parameters of our hyperspectral filter array and U-Net-based reconstruction algorithm

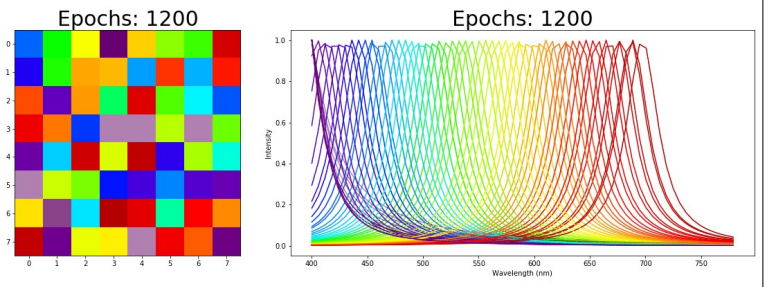


Discrete forward imaging model which takes in our scene and outputs a coded measurement for the reconstruction algorithm

Results



Our jointly optimized hyperspectral filter array and reconstruction algorithm outperforms a fixed design



The jointly optimized hyperspectral filter array after 1200 epochs and the corresponding intensity vs wavelength graph for 64 spectral channels of interest

Conclusion

In conclusion, we have successfully developed a framework for sample specific design in microscopy and introduced an end-to-end design for a snapshot hyperspectral microscopy system that outperforms heuristically designed systems.

References

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