WARREN CRADDOCK

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Profile

Cross-discipline engineer with twenty years of experience in signal processing, image processing, computer vision, machine learning, deep neural networks, optics, computational photography, physical simulation, control systems, applied mathematics, embedded systems and software engineering.

Experience

Senior Software Engineer, Perception, Waymo, March 2016 to March 2023

Waymo (previously the Google Self-Driving Car Project) is among the most ambitious artificial intelligence projects in the world. Waymo combines datacenter-scale machine learning with state-of-the-art robotics, with a mission to make it safe and easy for people to move around.

- Implemented many low-level building blocks (label and zone projectors and renderers, data extraction tools, developer workflow tools) used in dozens of deep neural net projects throughout the company.
- Designed Waymo's earliest evaluation systems for computer vision detectors, classifiers, and localization methods.
- Designed deep neural nets used in multi-object tracking, including appearance embeddings and similarity measures.
- Built the data pipeline for Transformer-based early fusion of camera and radar, a cornerstone of perception.
- Integrated many new sensors, e.g. perimeter view cameras and short-range lidars, into the perception system.
- Designed the Pacifica platform's computer vision system: more than a dozen cameras of three different designs, processing several billion pixels per second. Responsible for image quality and overall imaging performance.
- Contributed to all areas of the computer vision system design: optical simulation, image quality, imaging science, ISP design and tuning, FPGA pre-processing, sensor drivers, low-level system software, and test fixtures.
- Developed algorithms to detect active school-bus stop signs and other small, dynamic features in lidar point clouds.
- Developed fault-tolerant techniques to identify obstructions, condensation, and other failures in camera images.

Senior Software Engineer, Research, Machine Intelligence, Google, September 2014 to March 2016

The Google Clips intelligent camera was an "automatic photographer," which recognized the people you care about and captured their best moments. Google Clips used state-of-the-art mobile (on-device) computer vision, combining fast-moving research with a custom embedded neural network platform.

- Founding member of the project. Selected all key hardware: image sensor, lens, and system-on-a-chip.
- Designed the world's most energy-efficient convolutional neural network engine, compatible with TensorFlow, on the Movidius Myriad 2 vision processor. This engine was used for face recognition, facial landmarking, lighting quality estimation, etc.
- Developed static analysis techniques to improve the speed, memory utilization, and reliability of deep neural networks, particularly in memory-constrained, highly-parallel computing systems.

Senior Software Engineer, Project Glass, Google[x], June 2013 to September 2014

Project Glass was the first Google[x] project to reach mass production. The Android-based wearable computer provided the most advanced user experience – with natural language, gestures, and movements – of any wearable platform to date. Glass was one of Time magazine's 50 Best Inventions of 2012.

- Member of the multimedia team, responsible for all camera functions from apps to the image sensor driver and ISP.
- Responsible for key product features including HDR still photography and energy-efficient video calls.
- Implemented many computational photography algorithms, e.g. exposure fusion, in Halide.
- Led the image-quality tuning effort for photos and videos.

Member of Technical Staff, Computational Photography Group, Lytro, August 2011 to June 2013

The Lytro – the world's first consumer lightfield camera – was Popular Science magazine's Innovation of the Year in 2011, one of Time magazine's 50 Best Inventions of 2011, and won Best of Innovations Award for Digital Imaging at the 2011 Consumer Electronics Show.

- Advanced the lightfield sensor, the key component of the Lytro camera's unique functionality, by tilting and jittering its hexagonal microlenses in 3D to mitigate flaws due to chief-ray angle and uniform sampling.

- Developed a radiometrically-accurate optical simulation platform millions of times faster than Zemax.
- Leveraged the optical simulator to design the Lytro ILLUM's 4D-to-2D photographic reconstruction filter. This used adaptive Wiener deconvolution, with kernels for each focal plane computed by deep ray-trace simulations.
- Applied the optical simulator to many other design challenges, including an intentionally-aberrated main lens, and the development of optical aberration correction and perspective-shift algorithms.

Staff Design Engineer, Intersil Corporation (July 2004 to August 2011)

Designed state-of-the-art optoelectronic and communications systems. Member of the Intersil Systems Initiative, a three-person autonomous, nimble development team.

- Implemented the DSP pipeline and control system of a long-range, active, time-of-flight depth sensor (ISL29200).
- Designed an automatic, adaptive equalizer (ISL59600) for the transmission of video over a mile of inexpensive cable.
- The ISL59600 received the 2010 Best Electronic Design award from Electronic Design magazine, the 2010 Product of the Year award from the EN-Genius Network, and was a finalist for EDN's 2010 Innovation Awards.

Granted Patents

- Determining orders of execution of a neural network, US10699186B2
- Camera assessment techniques for autonomous vehicles, US11227409B1
- Low-light camera occlusion detection, US10891757B2
- Image sensor architecture, US11037968B2
- Optimization of optical systems for improved light field capture and manipulation, US9300932B2
- Plenoptic camera resolution, US9392153B2
- Improvement of plenoptic camera resolution, DE112014005866B4
- Compression of light field images, US9414087B2
- Light-field aberration correction, US9628684B2
- Optical proximity detectors, US9250714B2
- Automatic calibration technique for time of flight (TOF) transceivers, US8274037B2
- Automatic frequency compensation of video signals transmitted across cables, US8341689B2
- Systems and methods for cable equalization, US8451382B1, EP2182647B1, US8390740B2
- Cable equalization locking, US8558955B2
- Direct current (DC) correction circuit for a time of flight (TOF) photodiode front end, US8530819B2

Education

Stanford Center for Professional Development, Stanford University, Stanford, CA.

Bachelor of Science, Computer Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Skills

- Expert skills in many programming languages: **C++, Python, JavaScript, and Java**.
- Experienced with most applied mathematics tools: **NumPy, SciPy, OpenCV, Colaboratory, MATLAB.**
- Experienced with most machine learning frameworks: **TensorFlow, Keras, PyTorch**.

Interests

Photography, astrophotography, and astronomy. The image above is the Horsehead Nebula, captured with a 71 mm refractor. More portfolio images are available at www.warrencraddock.com. Cycling and scuba diving are additional interests. Five-time participant in AIDS/LifeCycle, a 545-mile bike ride from SF to LA that raises millions of dollars for charity.

References

Furnished upon request.