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Consultant for hire | Super-resolution microscopy | giga-pixel imaging optics & control | GPU-accelerated camera pipeline

High-throughput laser-scanning imaging system design with 10+ years of experience in image processing, resolution calibration, super-resolution algorithm design and acceleration. Turn bioinformatics scientist's algorithm ideas into physical instrument and production code. Make project-critical decisions on the laser architecture (wafer-level or package level diode array), CMOS image sensor vendor, control board, multi-GPU workstation, and customized Linux drivers. Establish model-in-the-loop, R&D workflow driven by first principles to accelerate the concept-to-market time in startup environments.

SKILLS

Collaboration	Lead Discovery Group at Amgen Inc, 96-camera HW/SW design taskforce, Genomic onboard primary analysis workgroup, Adobe Image Content Authenticity Initiative, Qualcomm secure camera taskforce
Optical modelling	Fourier optics (Fraunhofer & Fresnel), Classical optics (Fermat), Quazi-quantum optics (Jablonski fluorescence & Poisson), Multi-criteria design optimization (MOGA)
Imaging algorithm modelling	Augmented Lagrangian method, Gaussian & Poission photon statistics, Total-variation prior, Gradient descent, Python/Pybind11, MATLAB, Armadillo matrix library
High-throughput computing	Halide/C++17, GPU/CUDA, Eigen3/SSE/AVX/NEON, MPI/Supercomputer cluster
Opto-mechanical system design	Thorlabs, Newport, Back-side illumination (Sony Exmor RS), Plastic-molded objective lens, MIPI/CSI camera interface, Zemax, FreeCAD, Solidwork, AutoCAD, Slic3r/3D printing
Technical writing	Adobe Content Authenticity Initiative, Nature scientific reports, Journal of Optical Society of America, Photonics West Conference
Technical illustration	Inkscape, SVG, Matplotlib/Python, Solidworks
Microcontroller interface	AVR/Atmel, Qualcomm Snapdragon SoC, Nvidia Jetson SoM, low-latency computing (C++14/no malloc), UART, I ² C
Mixed signal electronic design	gEDA/KiCAD, PLL laser pulse trigger, Sallen-Key OpAmp filter, Root-locus analysis, Verilog

PATENTS

63/703,524	Systems and methods for autofocusing an imaging apparatus
US20220078522	Protocol and system for tee-based authenticating and editing of mobile-device captured visual and audio media
US20220294640 A1	System and method for capturing authenticatable digital media files on connected media-capture devices
US20190137753 A1	Parallel image acquisition and restoration method for array level Fourier ptychographic imager
US20190174078 A1	Recovery of pixel resolution in scanning imaging

EXPERIENCES

February 2023 Present	Consultant (new product development, giga-pixel bio-imaging system), SELF EMPLOYED, San Diego <ul style="list-style-type: none">➤ Consultant for hire, serving bio-instrument and bio-molecule startups needing industry-level giga-pixel instrument control, sensing, algorithm and GPU acceleration design critique and implementation services.➤ Offer design critique of mechanical & electronic CAD drawings, instrument control code, and image processing algorithms.➤ Deliver mechanical & electronic CAD drawings, GPU-accelerated algorithms, and instrument control code to build clients' minimal viable products (MVPs). Negotiate with OEM vendors to minimize delays.➤ Capture product requirement specification, conduct end-to-end design traceability analysis; flush out and eliminate legacy design solutions that are no longer part of the MVP.➤ Past assignments: Pleno Inc, San Diego, CA; completed in Oct 2024. AR/VR goggles developer, Cupertino; completed in Aug 2023; Major imaging flow cytometer manufacturer, San Jose; completed in June 2023. Stealth mode imaging biotech, Santa Monica; completed in April 2023. Stealth mode imaging biotech, Boston; completed in February 2021. <div style="display: flex; justify-content: space-between; font-size: 0.8em;">Consultingtechnology liaisonrequirement capture & traceability analysisoptical CAD/CAMRISC-V/ARM system on board</div> <div style="display: flex; justify-content: space-between; font-size: 0.8em;">Halide languageimage distortion modellingGPU accelerationtechnical writinginstrument control firmware</div>
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July 2021
February 2023

Senior Engineer II (Embedded software & FPGA), ELEMENT BIOSCIENCES, San Diego

- ▶ Acting scientific liaison between the Bioinformatics team and the FPGA architect to facilitate the DNA sequencer primary analysis algorithm design transfer. Authored 30+ internal tech reports, and 500+ lines of ARM/FPGA accelerated code per week, cross-referencing the concepts between bioinformatics and signal processing disciplines.
- ▶ Delivered the NGS flowcell docking and berthing mechanism solution, requirement specifications, and firmware; coordinated multi-disciplinary design teams (laser autofocusing HW, flowcell fiducial marker, image signal processing) to validate and deploy the feature to the product.

Techology liaison design transfer FPGA-acceleration Xilinx Zynq SoC Userspace driver imaging problem formulation
Instrument control onboard genomic basecalling

December 2019
July 2021

Camera system engineer (Android HLOS & ARM Trustzone), TRUEPIC, San Diego

- ▶ Developed a tamper-proof smartphone to capture, transmit, and encode raw pixels from the camera that is virtually un-hackable by all means (computer virus, RF jamming signals, power cycle, etc).
- ▶ Delivered 6 working smartphones to mainstream reporters (BBC, New York Times) to cover the 2020 US election; all captured photos impossible to be modified without breaking the digital signature.
- ▶ Hosted weekly design review meetings with the Qualcomm secure camera taskforce, to ensure the fingerprint camera driver and processing HW/FW stack fits our usecase (high-resolution images from the rear camera).
- ▶ Co-authored the technical specifications whitepaper to the Adobe-led content authenticity initiative (CAI). Provided expert's critique of the JPEG open specification, dictating how Adobe's photo editing software should recognize Truepic's hardware cryptographic signature in the photos; how the News media can preserve, publish, and prove the photo editing paper trail from Truepic's raw pixels on their news website.
- ▶ Acted as the scientific liaison between Qualcomm camera security team and Truepic's marketing team, to build the intuition on various camera "modes". To create a camera "Pro mode" blacklist of all pixel tampering algorithms in the GPU/DSP, e.g. skin-beautifying filters.

Technical writing Taskforce team building Android/HLOS Time-of-flight camera fingerprint sensor Qualcomm CamX/CHI
ARM Trustzone Camera security Technical writing liaison

January 2017
September 2019

Resident entrepreneur, CALTECH BIOPHOTONICS LABORATORY, Pasadena

- ▶ Co-inventor of the 96-CMOS parallel imaging system (material cost \$100k). Delivered the product to Amgen, the biopharmaceutical company, to facilitate high-throughput cell screening and drug testing of hiPSC cell cultures on a 96-well plate format. (> 10 plates per day, 96 conditions per plates, > 8,000 cells per condition).
- ▶ Secured two year worth of seed funding (living allowance, lab hardware, travel expenses) to achieve semi-autonomy from the host laboratory.
- ▶ Adverted the supply chain & RMA crisis due to 2017-era US tariffs; identified local OEMs for giga-pixel imaging and motion solutions.
- ▶ Re-configured Caltech-patented super-resolution imaging problem formulation for real world scenarios; Plastic-molded lenses with low precision, Bayer filter, rolling shutter, coded exposure, Poisson photon statistics. Filed a patent on the new Maths, new algorithms, and new imaging hardware.
- ▶ Joined the host laboratory's business delegation to identify potential collaborators (Verily, CA; Univ. Miami, FL; Clearbridge, Singapore); co-authored multi-PI research initiative proposals.
- ▶ Made project-critical decisions with remote design services (plastic-molded lenses, FPGA camera frame grabber, laser system, motion control, > 30 engineers) every week to streamline the production of 96-in-1 camera system-on-board solution (more on the next page).
- ▶ Reported monthly to multiple stakeholders of the project: Caltech for research outputs, scholarship foundations for the financial burn-through rate, and Amgen for requirement tracking purposes.
- ▶ Supervised the BOM and manufacturing schedules (CMOS array, FPGA firmware, custom imaging optics, custom fluorescence filter, nano-positioning platforms and custom high-power laser) of various OEMs.

Research & development budgeting technical writing High-precision optics assembly Terapixel data storage
Cypress USB3.1 Omnivision MIPI-CMOS sensor Linux camera userspace driver 3.5 Watt laser for IMAX cinema
CMOS MIPI-FPGA integration GPU acceleration C++17 Technical leadership Taskforce team building

September 2012
August 2016

Graduate researcher (Imaging flow cytometry), ALPHAHKU LAB, The University of Hong Kong, Hong Kong

- ▶ Conceptualized, characterized, and prototyped the all-optical spatial light modulator (SLM) (costs \$20k, weigh 20kg, > 1 GHz pattern response rate) capable of ultra-high frame rate rendering (> 10⁶ FPS) for multi-foci excitation. Conducted the cost-benefit analysis of its application on structured illumination microscopy on a flow cell. Mothballed various projects for the PI; re-directed research funding for other more promising ideas.

Scientific writing High performance computing mode-locked pulse laser fabrication precision optics design & assembly
FPGA high-level synthesis Matlab Symulink Collaboration Research Conference presentation

- 2016 PhD in Electrical & Electronic Engineering, The University of Hong Kong
- 2014 Exchange student of Siegman International School of Lasers, Stanford University
- 2012 BEng in Medical Engineering, The University of Hong Kong

 COLLABORATIONS**PROXIMAL: THE 5TH GENERATION LANGUAGE FOR IMAGE SUPERRESOLUTION AND BASECALLING VIA CONVEX OPTIMIZATION** 2019 – PRESENT

The autonomous landing of the rocket (SpaceX) is enabled by the CVXGen compiler invented at Stanford. The compiler generates baremetal C code for the flight computer running at >100Hz, that enables Physists and Mathematicians directly program the onboard flight computer with Math equations, thus preserving the original design intent in the rocket. Motivated by this, I worked with Felix Heide and Steven Diamond at Princeton to implement **a code generator that compiles the Maths (a convex optimization equation) into raw Nvidia/NVPTX GPU code**. The technology is **applied to various startups**: lens-free microscopy for bioburden testing of surgical tools, and brain slice 3D deconvolution with denoising.

Reserch & development Halide language Optimizing compiler design Structural typing GPU acceleration algorithm auto-tuning

ONBOARD SEQUENCING PRIMARY ANALYSIS (OBPA) DESIGN TRANSFER 2022 – 2023

Acted as the scientific liaison between the Bioinformatics team and the FPGA architect. Challenged NGS biotech's conventions of waterfall-style primary analysis algorithm design transfer from scientists to the engineers as low-level C-style code. Advocated for a new system engineering framework so that the bioinformatics scientist's original intent, i.e. fluorescent-tagged single-strand macro-molecule image signal generation & distortion theory, can be preserved with zero-overhead in the FPGA compute engine. Presented the proposals to my manager and the Bioinformatics team. Prototyped and demonstrated the idea in the Halide language. Ensured that the FPGA architect's domain-specific feedback is relayed to bioinformatics scientists without confusion.

Technical communications High-throughput computing System engineering Imaging algorithm FPGA

QUALCOMM SECURE CAMERA TASKFORCE 2019 – 2020

At Truepic, we desire to combat fake news due to manipulated images on the social media and news websites. The technology works by black-listing all untrusted camera ISP drivers and software running on smartphones, e.g. skin beautifying filters. In response, Qualcomm assembled a cross-disciplinary team to address to our needs, consisting of Camera hardware, Camera firmware, Hexagon DSP, and the Trusted execution environment (TEE). I hosted regular bi-weekly online meetings across USA and South Asia to drive our requirements, reviewed the Taskforce's reports, analyzed their technical proposals, and implemented software to strip out all *untrusted* camera ISP codes. The proof-of-concept secure camera is successfully demonstrated **during the Qualcomm Snapdragon Tech Summit 2020**.

Team building Technical specification writing Halide CamX hardware interface Android AOSP Baremetal clang toolchain

96-CAMERA SYSTEM-ON-BOARD DESIGN TASKFORCE 2017 – 2019

At Caltech, we outsourced the R&D effort of the parallel 96-microscope system-on-board (SoB) design to a oversea design firm. Working across international time-zones, I drove their business transition **from an automotive self-driving camera to bio-medical microscopy domain**. In response, the firm assembled a cross-functional taskforce to facilitate the design transfer. I engage with them weekly via online meetings to source image sensor, to draft functional specifications of FPGA databus interface, and to oversee the power & thermal management solution in the manufacturing process. I also delivered to them the digital test harness to establish the quality control procedure before SoB left the factory. The product, 96-CMOS SoB, was delivered to our Caltech laboratory, and in turn **fully integrated to the final product (96-microscope system) for our partners at the Lead Discovery Group, Amgen Inc**.

Outsourcing Vendor selection Technical specification writing Test-driven development Halide FPGA

IMAGING FLOW CYTOMETER (10⁶ FPS) PIXEL SUPER-RESOLUTION RESEARCH 2012 – 2016

The real-time circulating tumor cell (CTC) screening initiative is created under the joint venture of 6 research groups: Oncology, micro-fluidic flow cell, fiber-based laser super-continuum, digitizer & FPGA design, model-based algorithm design, and high-throughput photonic circuit (my group). The initiative aims to screen patient blood cells at > 100,000 frames per second without prior CTC enrichment, or fluorescence staining assays. However, the only digitizer available at the time (80 GSa/s, 16 GHz BW) requires a US's export control license due to its military-grade RF technology. I proved from the first principle that the digitizer can be cost effective at 5 GSa/s, without impacting microscope optical resolution thanks to pixel super-resolution technology. **I defined the fempto-second laser specification, digitizer specification, and integrated the components** into the initiative's working prototype (> 100 optical components, custom FPGA firmware, home-made laser modules), and **developed the custom super-resolution algorithm** to reconstruct high-resolution image of human cell line (MCF7), and oil-in-water emulsion in a high-speed flow (2 m s⁻¹). The work results in one filed patent, and 3+ scientific publications.

Research Unconventional imaging technology literature review technical writing high-throughput computing microscope prototyping

SELECTED PUBLICATIONS (586 CITATIONS)

- **A. C. Chan**, Jinho Kim, An Pan, Han Xu, Dana Nojima, Christopher Hale, Songli Wang and Changhuei Yang, “Parallel Fourier Ptychographic Microscopy for high throughput screening with 96 cameras (96 Eyes)” *Scientific Reports*, vol. **9**, no. 11114, 2019. Open access available at <https://doi.org/10.1038/s41598-019-47146-z>
- **A. C. Chan**, H. O. Ng, S. C. V. Bogaraju, H. K. H. So, E. Y. Lam, and K. K. Tsia, “All-passive pixel super-resolution of time-stretch imaging.” *Scientific Reports*, vol. **7**, no. 44608, 2017. Open access available at <https://doi.org/10.1038/srep44608>.
- J. Wu, Y. Xu, X. Wei, **A. C. Chan**, A. H. Tang, A. K. Lau, B. M. Chung, H. C. Shum, E. Y. Lam, and K. K. Tsia, “Ultrafast laser-scanning time-stretch imaging at visible wavelengths,” *Light: Science & Applications*, vol. **6**, no. e16196, 2016.
- **A. C. Chan**, Z. Ren, E. Y. Lam, and K. K. Tsia, “Subsampled scanning holographic imaging (SuSHI) for fast, non-adaptive recording of three-dimensional objects,” *Optica*, vol. **3**, no. 8, p. 911–7, 2016. Open access available at <https://doi.org/10.1364/OPTICA.3.000911>.
- **A. C. Chan**, A. K. S. Lau, E. Y. Lam, and K. K. Tsia, “Arbitrary two-dimensional spectrally encoded pattern generation: a new strategy for high-speed patterned illumination imaging,” *Optica*, vol. **2**, no. 12, p. 1037–44, 2015. Open access available at <https://doi.org/10.1364/OPTICA.2.001037>.
- **A. C. Chan**, T. T. W. Wong, K. K. Y. Wong, E. Y. Lam, and K. K. Tsia, “Speed-dependent resolution analysis of ultrafast laser-scanning fluorescence microscopy,” *Journal of Optical Society of America B*, vol. **31**, no. 4, p. 755, Mar. 2014.
- A. K. S. Lau, T. T. W. Wong, K. K. Y. Ho, M. T. H. Tang, **A. C. Chan**, X. Wei, E. Y. Lam, H. C. Shum, K. K. Y. Wong, and K. K. Tsia, “Interferometric time-stretch microscopy for ultrafast quantitative cellular and tissue imaging at $1\mu\text{m}$,” *Journal of Biomedical Optics*, vol. **19**, no. 7, p. 076001, Jul. 2014.
- T. T. W. Wong, A. K. S. Lau, K. K. Y. Ho, M. T. H. Tang, J. D. F. Robles, X. Wei, **A. C. Chan**, A. H. L. Tang, E. Y. Lam, K. K. Y. Wong, G. C. F. Chan, H. C. Shum, and K. K. Tsia, “Asymmetric-detection time-stretch optical microscopy (ATOM) for ultrafast high-contrast cellular imaging in flow,” *Scientific Reports*, vol. **4**, p. 3656, Jan. 2014.