Arash Abadpour

Canadian data scientist proficient in machine vision/deep learning with 10+ years of experience in disruptive North American companies

In the late nineties, I was finishing my undergraduate studies in electrical engineering. I received word that the biomechanics laboratory had acquired a frame-grabber and was looking for someone to help them code up the device into a gait analysis system. In the system that we eventually built, two camcorders captured a person on the catwalk, and our software produced a csv file that contained two sets of x-y trajectories for each retroreflective spherical marker that we had attached to a dozen of the subject's joints. Later on, we added pedobarography (image-based foot pressure analysis) to the system, and the team performed a study on patients with diabetes. 3d modelling of hard and soft tissue using X-ray, CT, MRI, ultrasound and other types of medical images that we received as Dicom files was next on the roster in the lab.

Image processing was applied mathematics on images, and I started a master's program on color image processing at the mathematics science department in 2003. This was an introduction to higher mathematical concepts such as linear spaces and principal component analysis (PCA). This latter one introduced me to watermarking, color transfer (to colored and grayscale images), and semantic segmentation of aerial images. More importantly, I realized that to arrive at high-value image processing algorithms, one needs to be comfortable with the underlying mathematical models.

By 2005, I had moved to Canada and had started my Ph.D. on optimization. I found it fascinating that a complex system can be modelled and analyzed mathematically to produce valuable insights. For my Ph.D. thesis, I carried out this type of analysis on a capacity maximization problem in a cellular system and presented a solution strategy. During that period, I also worked as a research assistant on video-on-demand network design and maintenance using a multi-layer fuzzy clustering model – more info in the journal publication.

I joined Epson Canada in 2009, where for six and a half years, I worked on commercial and industrial applications, including visual inspection, symbology detection, 3d object detection and pose estimation, camera calibration, 3d scan/display systems (using stereo, time-of-flight, and structured light projection), head-mounted displays (for augmented and virtual reality), and robotics (assembly and bin-picking). Multiple patents came from that work. I also expanded my work on fuzzy clustering and published several journal papers during this period.

In 2015 I joined Intellijoint Surgical (IJS). This was my first startup experience and a deep dive into cost optimization within the framework of an image processing system. IJS's infrared monocular camera is an exquisite technology that allows for high-accuracy pose estimation in the operating room. I had the opportunity to work on the tracking system and its applications, including an in-vivo infrared laser scanner -— more info in the patents section.

I first participated in the development of a learning-enabled machine vision application in 2016 at Fio. An Android-based device ran our ML models to recognize rapid diagnostic tests (rdt) and read their results in the field. An rdt is a cassette, 5-10 centimeters (2-4 inches) long, on which one or multiple active membranes allow for rapid testing for diseases such as Malaria, HIV, Dengue, Zika, etc. Thousands of rdts in the market each require that a certain amount of saliva, blood, or urine is added to a particular membrane. Additional chemical solutions are also needed to be added to other membranes on the rdt. While rdts are manufactured in large numbers to facilitate massive cost-efficient deployments of disease diagnostics, the task of information-collection from such implementations mandates machines in the workflow.

When I joined Fio, the company had already field-tested its V-100 version and was working on its V-200 system. These handheld devices allowed for controlled imaging of rdts in the field. Our algorithm visually recognized the rdt and thus provided healthcare workers with info on the use of their particular rdt. Our system then assisted and monitored the healthcare worker as they processed the rdt and the patient. After the incubation time for the rdt was complete, we asked the healthcare worker to put the rdt back in the device drawer. At this time, we captured a final image that was processed by a convolutional neural network (ConvNet) to determine if the patient was positive/negative or whether the test had been soiled due to excessive blood deposition, for example. I led the development of this system in matlab, and we then machine-translated it to python.

As the precision and recall figures from the algo moved into more valuable zones, we also envisioned reducing the human-machine friction. We developed designs for an overhead system, composed of cameras and projectors - an active desk for the healthcare worker, in effect. This device tracked the healthcare worker's hands as they moved rdts and other objects around and provided assistance through interactive objects projected on the desk -— more info in the patents section.

In 2019, Betterview enabled me to experiment with a nuclear network that consumes aerial images and other types of data relevant to the insurance industry to produce property insights. By this time, I had already spent two years on Coursera, and other MOOC resources and I was comfortable with python and its machinery for scientific programming (numpy, scipy, seaborn, pandas, etc.) and machine/deep learning (tensorflow, scikit-learn). At the same time, hands-on experience allowed me to develop sizable gpu-saving strategies through transfer learning and weight sharing at the train time and tensor sharing during inference. At a more personal level, during the same period, I worked on my cloud programming (aws/gcs) skills. Also, I acquired first-hand experience with efficient ground-truth and human annotation acquisition, enrichment, and management (mturk/dls/boutique).

Recently, both the literature and also the experiments that I have been involved in, have produced encouraging results, in terms of the precision, recall, and iou numbers that the state-of-the-art networks of convolutional neural networks are capable of producing. On a more conceptual level, I am fascinated by the fact that the ground-truth modules in these systems simultaneously ingest seemingly different types of information, including images, polygons, rois, scores, and text, and participate in the process of weaving all of that data into predictions that have market value and are produced at scale and significant margins.

In late 2018, I started a self-funded exploratory/educational project that aimed at developing a mobile robot that could recognize its operator and maneuver in its environment safely. As the robot was subsequently named, blue is a sphero rvr connected to an ad-hoc mesh network of 40 raspberry pis and other linux machines. Blue perceives its environment through rgb images and dsm+imu (through an intel realsense stereo camera). The code for blue is in bash and python (including django). Blue uses aws s3/rds for file/data storage and aws sqs for communication.

Blue is a continuous machine learning system that manages the full circle of data acquisition, human annotation collection, classifier training, and inference through cooperation with the other nodes on the network.
– live view of the interactions in the network: kamangir.net/shamim
– source code: github.com/kamangir/mypy and github.com/kamangir/Dec8

Education

2005–2009 **Ph.D.**, *The University of Manitoba, Canada*.
Electrical and Computer Engineering Department

2003–2005 **Master of Science**, *Sharif University of Technology, Iran*.
Mathematics Science Department, Computer Science Group (Scientific Computation)

1996–2003 **Bachelor of Science**, *Sharif University of Technology, Iran*.
Electrical Engineering Department, Control Group

Patents

"*System, method and/or computer readable medium for non-invasive workflow augmentation*", WO Application Number WO2018094534A1, Priority Date 26 November 2016.

"*System, method and/or computer-readable medium for identifying and/or localizing one or more rapid diagnostic tests*", WO Application Number WO2018094533A1, Priority Date 26 November 2016.

"*Visual pattern recognition system, method and/or computer-readable medium*", WO Application Number WO2018094532A1, Priority Date 26 November 2016.

"*Systems and methods for tracker characterization and verification*", US Application Number US20170345177A1, Priority Date 27 May 2016.

"*Systems, methods and devices to scan 3d surfaces for intra-operative localization*", International Publication Number WO2017185170A1, Priority Date 28 April 2016.

"*Method for object pose estimation, apparatus for object pose estimation, method for object estimation pose refinement and computer readable medium*", Japanese Patent JP2013050947A, Publication Date 19 October 2016.

"*HMD Calibration with Direct Geometric Modeling*", US Patent US20160012643A1, Publication Date 14 January 2016.

"*HMD Calibration with Direct Geometric Modeling*", EU Patent No. 15175799.4 - 1902, Filing Date 8 July 2015.

"*System generating three-dimensional model, method and program*", Japanese Patent JP2015176600A, Publication Date 5 October 2015.

"*Holocam Systems and Methods*", US Patent US20150261184, Publication Date 17 September 2015.

"*Method and Apparatus for Improved Training of Object Detecting System*", US Patent US20140079314, Publication Date 20 March 2014.

"*Method for simulating impact printer output, evaluating print quality, and creating teaching print samples*", US Patent 8654398, Publication Date 18 February 2014.

"*Method and apparatus for object pose estimation*", US Patent 8467596, Publication Date 18 June 2013.

Experience

2019–current **Lead Data Scientist**, *Betterview Marketplace, San Diego, USA*.
Design, development, and deployment of a deep learning framework that consumes aerial images and other types of data relevant to the insurance industry and produces property insights.

2016–2019 **Senior Scientific Developer**, *Fio Corporation, Toronto, Canada*.
Design, development, and deployment of a learning-enabled machine vision system that visually identifies and analyzes rapid diagnostics tests (rdt) for infectious diseases such as HIV, Malaria, Dengue, Zika, and others. At inference time, the ML models are run on an android device with limited network and power access. Therefore, battery usage optimization and tolerance to long periods of disconnectivity were essential considerations. Traceability management for data and models was a vital component of this work due to national and international regulatory requirements.

2015–2016 **Research Scientist**, *Intellijoint Surgical, Waterloo, Canada*.
Extensions of the capabilities of a monocular infrared tracking system that was a component within the surgical navigation product that utilized machine vision to carry out and confirm geometrical measurements in-vivo. Also, worked on the inertial data that was produced by the system for validation and augmentation. Parameter estimation using least mean square and Levenberg-Marquardt cost function minimization.

2009–2015 **Researcher**, *Imaging Group, Epson Canada Limited, Toronto, Canada*.
Research and development on future products and concepts in the fields of visual inspection, symbology detection, 3d object detection and pose estimation, camera calibration (monocular, stereo, and depth/range), augmented and virtual reality, 3d scan/display systems (stereo, time-of-flight, structured light projection, and other depth sensors), depth processing (including bilateral upsampling, filtering, and registration and fusion of multiple depth and flat cameras using different variations of iterative closest point - icp), head-mounted displays, and robotics. Stochastic optimization in the presence of outliers using RANSAC and robustified cost minimization.

2001–2004 **Process Control Engineer**, *Karband Eng. Co., Tehran, Iran*.
Design, implementation and erection of PLC-based control systems for medium-sized machinery in pipe and profile production plants.

1998–2001, 2004–2009 **Research Assistant**, *University of Manitoba, Telecommunications Research Laboratories (TRLabs) Winnipeg and Biomechanics Laboratory, Sharif University of Technology*.
Network optimization, earthquake damage detection using satellite/aerial imagery, human gait analysis, 3d surface reconstruction, color image watermarking and data-hiding, visual encryption, image compression, color transfer, grayscale image colorization, computational photography, fuzzy clustering, skin detection, and pornography classification. Fuzzy modelling of multi-layer systems, especially within the field of pattern recognition, using Bayesian models.

Technical Skills

Python, *Python 2, Python 3, PyQt, PyMySQL, OpenCV, NumPy, SciPy, Matplotlib, scikit-learn, TensorFlow, Pandas, Seaborn, Jupyter, Boto3*.

Database, *MySQL, Amazon RDS, phpMyAdmin, PostgreSQL*.

Linux, *bash programming, Ubuntu, Raspbian*.

Cloud, *GCS, Amazon S3, Amazon Simple Queue Service*.

Web, *Django, php*.

Software Development, *agile development, JIRA, GitHub, Bitbucket*.

Hardware, *Raspberry Pi, general electronics, general digital electronics, general circuits*.

Patents, *keyword creation, patent search, patent review, invention disclosures and algorithm description*.

Other, *LaTeX, POV-Ray, IVT, PCL, CImg, OpenGL, Armadillo, Gandalf, Ceres Solver, and other open-source tools*.

Windows, *batch programming*.

MATLAB, *C/MEX, object-oriented programming, matlab command compiler, matlab engine, OpenCV, image processing toolbox, optimization toolbox, matlab gui, PCL, octave*.

C/C++, *C++11, QT, OpenCV*.

– sample code: github.com/kamangir/mypy and github.com/kamangir/Dec8

Certifications

2019 **Deep Learning Specialization**, *Five-Course Specialization*.
By Andrew Ng (deeplearning.ai)

2017 **Neural Networks for Machine Learning**.
By the University of Toronto on Coursera

2017 **Machine Learning**.
By Stanford University on Coursera

2017 **Machine Learning**, *Four-Course Specialization*.
By the University of Washington on Coursera

2013 **Patents**, *Understanding Patents - An Introductory Course*.
McGill University School of Continuing Studies

Select Publications

Journal Paper, *On Applications of Pyramid Doubly Joint Bilateral Filtering in Dense Disparity Propagation*, Arash Abadpour, 3D Research, Volume 5, Issue 2, 25 April 2014, Pages 1–20.

Ph.D. Thesis, *QoS-Constrained Information Theoretic Capacity Maximization in CDMA Systems*, Electrical and Computer Engineering Department, University of Manitoba, Winnipeg, Manitoba, Canada, Supervised by Prof. Attahiru Sule Alfa (Ph.D.), 2005–2009.

M.Sc. Thesis, *Color Image Processing using Principal Component Analysis*, Mathematics Science Department, Sharif University of Technology, Tehran, Iran, Supervised by Shohreh Kasaei (Ph.D.) and A. Daneshgar (Ph.D.), 2004–2005.

– complete list + full text: abadpour.com

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