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, when I received word that the biomechanics laboratory had acquired a frame-grabber and were looking for someone to help them code up the device into a gait analysis system, i.e. 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 on the person'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.

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, and more importantly to the realization that to arrive at a high-value image processing algorithm 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 produced 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 Andriod-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 centimetres (2-4 inches) long, on

H +1 647 567 3487 • B arash@abadpour.com • kamangir.net/zoom

which one or multiple active membranes allow for rapid testing for diseases such as Malaria, HIV, Dengue, Zeka, etc. Thousands of RDTs in the market each require that a certain ammount of saliva, blood, or urine is added to a certain membrane. Additional chemical solutions are also required to be added to other membranes on the RDT. While RDTs are manufactured in large numbers in order to facilitate massive cost-efficient deployments of disease diagnostics, the task of information collection from such deployments mandates the addition of machines to the network.

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, for 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 and 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 that were 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 to produce property insights. By this time I had already spent two years on Coursera, and other online MOOC resources, and I was entirely comfortable with python and its machinery for scientific programming (numpy, scipy, seaborn, pandas, etc.), and more specifically machine/deep learning (tensorflow, scikit-learn). Additionally, hands-on experience allowed me to develop massive gpu-saving strategies and to obtain cloud programming (aws/gcs) and efficient human annotation management (mturk/dls/boutique) skills.

That work has continued to be a source of fascinating results in terms of precision, recall, and iou numbers that the state-of-the-art networks of convolutional neural networks are capable of producing.

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. As the robot was subsequently named, Blue is a Sphero RVR connected to an ad-hoc mesh network of Raspberry Pis and other linux machines. Blue perceives its environment through rgb images as well as dsm+imu (through an intel realsense stereo camera). The code for Blue is written 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, model 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.**, *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.

Professional History

2019–2020 **Lead Data Scientist**, *Betterview Marketplace, San Diego, USA*.
Design, development, and deployment of a Deep Learning framework for processing aerial imagery in order to fulfill the requirements of an insurtech application.

2016–2019 **Senior Scientific Developer**, *Fio Corporation, Toronto, Canada*.
Design, development, and deployment of a Machine Learning framework for the purpose of visual identification and analysis of Rapid Diagnostics Tests (RDT) for infectious diseases such as HIV, Malaria, Dengue, and others on an android device with limited network and power access.

2015–2016 **Research Scientist**, *Intellijoint Surgical, Waterloo, Canada*.
Extension of the capabilities of a surgical navigation product which utilizes machine vision in order to carry out and confirm geometrical measurements in vivo.

2009–2015 **Researcher**, *Imaging Group, Epson Canada Limited, Toronto, Canada*.
Research and development of Epson's future products and concepts in the fields of Visual Inspection, Symbology Detection, 3D Object Detection and Pose Estimation, Camera Calibration, Augmented and Virtual Reality, 3D Scan/Display Systems, Head-Mounted Displays, and Robotics.

2001–2004 **Process Control Engineer**, *Karband Eng. Co., Tehran, Iran*.
Responsible for 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, Image Encryption, Image Compression, Color Transfer, Grayscale Image Colorization, and Pornography Detection.

Industry Experience

Machine Learning,
◦ *Classifier design, training, evaluation, and productization.*
◦ *Neural Network training and deployment, including Deep Learning and Convolutional Neural Networks.*
◦ *Ground-truth data collection and tagging as the back-end for training and evaluation of ML utilizing AWS/GCS.*
◦ *Offline ML training orchestration on a cluster of loosely–connected machines.*
◦ *Traceability management for data and models in order to satisfy regulatory requirements.*
◦ *On-the-device deployment of ML algorithms, given processing power, execution time, and battery consumption requirements.*
◦ *User interface design for ML algorithms, for the purposes of data tagging, problem specification, and assessment of the results.*
◦ *Deployment management, including model transfer to the production pipeline.*

Image Processing,
◦ *General image processing, including grayscale, color, infrared, and depth image processing.*
◦ *Semantic Segmentation of aerial images using Convolutional Networks for insurance and real estate purposes.*
◦ *Image processing for robotics applications, including pose estimation, camera calibration, and stereo processing.*
◦ *Bilateral and trilateral filtering for the purposes of noise removal and interpolation.*

Machine Vision,
◦ *3D object detection using mono and stereo camera systems.*
◦ *3D object pose estimation using low and high level features and training data collected on real or CAD data.*
◦ *Bin picking using a robotic arm.*
◦ *Visual inspection of output of printing processes as well as fidelity of manufactured parts.*

Photogrammetry,
◦ *Fiducial-based pose estimation, including utilizing available technologies such as ARToolKit and ARTag, as well as designing in-house solutions.*
◦ *NIR-domain tracking for the purpose of sub-millimeter and sub-degree 6 DoF pose estimation.*

Medical Image Processing,
◦ *DICOM import and processing.*
◦ *Geometric modeling of organs using MRI slices.*
◦ *Sterile-field image processing for the purpose of surgical navigation.*

H *+1 647 567 3487* • B *arash@abadpour.com* • *kamangir.net/zoom*

Optimization,
◦ *Inverse problem-based parameter estimation using least mean square and Levenberg-Marquardt minimization.*
◦ *Stochastic optimization in the presence of outliers using RANSAC and robustified cost minimization.*
◦ *Fuzzy modeling of multi-layer systems, especially within the field of pattern recognition, using Bayesian models.*

Range-Data Processing,
◦ *Data acquisition and calibration of depth sensors, including stereo, structured light and Time of Flight (ToF) sensors.*
◦ *RGBD filtering using bilateral and trilateral filtering pipelines.*
◦ *Depth fusion between multiple depth sources as well as between a depth source and a raster image sensor.*
◦ *Multi-sensor depth registration utilizing both 3D and 2D features and different variations of the Iterative Closest Point (ICP) algorithm.*
◦ *Depth up-sampling and noise-reduction.*

Human-Machine Interface,
◦ *Data acquisition and calibration of augmented and virtual reality systems.*
◦ *3D scan/display systems utilizing multiple depth sensors.*

Pattern Recognition,
◦ *Cost function derivation using Bayesian Inference for the purpose of clustering and modeling.*
◦ *Unsupervised clustering using FCM, PCM, FPCM, and other variants.*
◦ *Extensive research on the stability of fuzzy clustering models.*
◦ *Principal Component Analysis (PCA) for color classification, including skin detection and color image segmentation.*

Symbology,
◦ *Symbology detection and interpretation, using available technologies as well as designing in-house solutions.*

Computational Photography,
◦ *Color transfer between color images and color video sequences.*
◦ *Colorization of available grayscale image and video sequences using other color content.*

Image Data Management,
◦ *Visual watermarking and data hiding using redundancy in the spectral domain.*

Inertial Data Processing,
◦ *Accelerometer data processing for the purpose of validation and augmentation of optical systems.*

Technical Skills

Python, *Python 2, Python 3, PyQt, PyMySQL, OpenCV, NumPy, SciPy, Matplotlib, scikit-learn, TensorFlow, Keras, Caffe.*

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

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

Windows, *Batch Programming*.

Linux, *Bash Programming, Ubuntu, Raspbian*.

Cloud Storage, *GCS*.

Cloud Execution, *Kubeflow*.

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*.

MATLAB, *C/MEX, Object-Oriented Programming, Matlab Compiler, Matlab Engine, OpenCV, Image Processing Toolbox, Optimization Toolbox, Matlab GUI, Octave*.

Web Programming, *php, RSS*.

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

– 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 University of Toronto on Coursera

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

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

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

Selected 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

– revision 3.38 - July 29, 2020