Pranjul Gupta

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Education

Justus-Liebig University (JLU) Giessen, Germany
Ph.D. under Dr.rer.nat. Katharina Dobs, Visual Cognition & Computational Neuroscience, Lab Head
Department of Experimental Psychology - FB06 2020 - 2024

- Faces & Objects: Exploring the boundaries of artificial and human perception
  - 1st Project: CNNs reveal the computational implausibility of the expertise hypothesis.
  - 2nd Project: Human-like face pareidolia emerges in deep neural networks optimized for face and object recognition.
  - 3rd Project: Investigating face pareidolia using DeepGaze: Bridging human and artificial perception.
  - Reference: Dr.rer.nat. Katharina Dobs, Lab Head (katharina.dobs@gmail.com).

Fraunhofer Institute of Production Technology (IPT) Aachen, Germany
Master Thesis under Prof. Dr.-Ing. Thomas Bergs MBA, GPA: 1.0/4.0
Process Technology, Department Head 2020

- Thesis: "Wear detection of cutting tools with digital image processing."
  - Show advantages of modern computer vision over traditional image processing methods.
  - Make algorithm robust to changes that match production environment (light, orientation, colors).
  - Test different approaches for scaling the algorithm in the future for different tool types.
  - Develop an algorithm for an edge computing device with auto-focus capable RGB camera.
  - Deploy setup online in a CNC machine to give real-time tool wear values.
  - Reference: Mr. M.Sc. Carsten Holst, Scientific Staff (+49 241 8904-123, carsten.holst@ipt.fraunhofer.de).

Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen, Germany
M.Sc. in Simulation Science, GPA: 1.7/4.0
School for Simulation and Data Science (SSD) 2017 –2020

- Mathematical modeling with focus on data-driven applications.
- Completed subjects:
  - 1st Semester: Numerical Methods for Partial Differential Equations, From Molecular to Continuum Physics I, Applied Quantum Mechanics, Data Analysis and Visualization, Parallel Programming I
  - 2nd Semester: Fast Iterative Solvers, Parallel Computing in Simulation Sciences, From Molecular to Continuum Physics II, Simulation Sciences Seminar
  - 3rd Semester: Simulation Sciences Laboratory, Model-Based Estimation Methods, Statistical Classification, Introduction to Data Science, Machine Learning
  - 4th and 5th Semester: Computer Vision, Virtual Reality

National Institute of Technology (NIT) Kurukshetra, India
Bachelor Thesis under Prof. Dixit Garg
Mechanical Engineering, Department Head 2015 –2016

- Thesis: "Automated visual inspection systems for industrial applications."
  - Literature research and compile different image processing algorithms used in a production setting.
  - Implement canny edge detector in C++ for quality check of printed circuit boards (PCBs).
  - Build a working prototype using an embedded computing device (Arduino) and digital camera.
  - Use quality assurance methods and practices like statistical sampling to calculate defect rate.
  - Reference: Prof. Dixit Garg (+91 1744-233457, dixitgarg1@nitkkr.ac.in).

National Institute of Technology (NIT) Kurukshetra, India
B.Tech. in Mechanical Engineering, GPA: 1.4/4.0
Department of Mechanical Engineering 2012–2016

- Four-year undergraduate program with a focus on design, simulation, production, and operations.

Modern Vidya Niketan (MVN) India
High school graduation, GPA: 1.0/4.0 2012

Industrial Experience

Fraunhofer Institute of Production Technology (IPT) Aachen, Germany
Hilfswissenschaftler (Part Time-Software Developer)/High Performance Cutting April 2018 - September 2020

- Fraunhofer IPT develops systems solutions for manufacturing. My tasks:
  - Work done under the umbrella of Industrial Internet of Things (Industry 4.0).
  - Aggregate and analyze data from experiments and simulations carried out on CNC milling machines.
  - Data used: Times Series (Acoustic Emission Sensors), RGB Images (Microscopic Camera), Log files.
  - Develop predictive tool wear models using artificial intelligence methods such as deep learning.
  - Compile, analyze, and visualize results to check the accuracy and feasibility of built models.
  - Implement models in production using best coding practices.
  - Reference: Mr. M.Sc. Carsten Holst, Scientific Staff (+49 241 8904-123, carsten.holst@ipt.fraunhofer.de).

Tata Motors Limited (TML) Rudrapur, India
Technical Planner (Assistant Manager)
Technical Services - Commercial Vehicles August 2016 - August 2017

- Tata Motors Limited is the largest automobile manufacturer in India. My tasks:
  - Product Design Analysis (CATIA), Parts Assembly Study (Teamcenter), Layout Designing (AutoCAD).
  - Use of Enterprise Resource Management (ERP) Tools: Siemens PLM and SAP for product planning.
  - Successfully manage the production (0 to 100 daily) of a new vehicle.
  - Planning manufacturing processes, automation, technical specifications of tools, machines, raw materials, manpower, budget, and plant layout for manufacturing new products.
  - Coordination with other departments (Mechanical, Electrical, Software, Logistics, HR) and implementation of final plan for mass production.
  - Reduction of cycle time and takt time to ensure faster production and lower manufacturing cost.
  - Modifications and rectifications in existing vehicle designs and machine technology upgrades.
  - Use data from the Manufacturing Execution System (MES) to balance production line load.
  - Time series modeling of pressure sensor data from pressure lines of the manufacturing plant.
  - Process control using statistical methods like check sheets, Pareto charts, scatter diagrams, etc.
  - Design analysis and sign-off for new products or changes in existing ones.
  - LinkedIn Reference: Mr. Sudhanshu Mishra, Senior Manager (linkedin.com/in/sudhanshu-mishra-916843180).

Publications

Gupta, P., & Dobs, K. (2024). Investigating face pareidolia using deepgaze: Bridging human and artificial perception [In Preparation].

Gupta, P., & Dobs, K. (2023). Human-like face pareidolia emerges in deep neural networks optimized for face and object recognition [Under Review]. *PLoS computational biology*.

Kanwisher, N., Gupta, P., & Dobs, K. (2023). Cnns reveal the computational implausibility of the expertise hypothesis. *Iscience*, *26*(2).

Holst, C., Yavuz, T. B., Gupta, P., Ganser, P., & Bergs, T. (2022). Deep learning and rule-based image processing pipeline for automated metal cutting tool wear detection and measurement. *IFAC-PapersOnLine*, *55*(2), 534–539.

Bergs, T., Holst, C., Gupta, P., & Augspurger, T. (2020). Digital image processing with deep learning for automated cutting tool wear detection. *Procedia Manufacturing*, *48*, 947–958.

Talks, Posters, Conferences & Workshops

- **CMBB Day 2023 poster:** Gupta, P., & Dobs, K., "Investigating face pareidolia using DeepGaze: Bridging human and artificial perception", *available on my Twitter page, 2023*
- **SFB Retreat 2022 talk:** Gupta, P., & Dobs, K., "Human-like face pareidolia emerges in deep neural networks optimized for face and object recognition", *Schloss Rauischholzhausen, 2022*
- **ECVP 2022 poster:** Gupta, P., Kanwisher, N., & Dobs, K., "Cnns reveal the computational implausibility of the expertise hypothesis", *In Perception. SAGE PUBLICATIONS LTD 1 OLIVERS YARD, 55 CITY ROAD, LONDON EC1Y 1SP, ENGLAND, 2022*
- **LIN 2022 Workshop poster:** Gupta, P., Kanwisher, N., & Dobs, K., "Cnns reveal the computational implausibility of the expertise hypothesis", *Schloss Rauischholzhausen, 2022*
- **ECVP 2021 talk:** Gupta, P., & Dobs, K., "A computational explanation for the unreasonable human ability to detect faces in things", *In Perception. SAGE PUBLICATIONS LTD 1 OLIVERS YARD, 55 CITY ROAD, LONDON EC1Y 1SP, ENGLAND, 2021*

Thesis supervision & Reviewer Experience

- Bachelor Thesis: Christine Huschens, "DeepGaze & Face Pareidolia" 2023
- Perception journal article reviewer: Verma, Ashika; Keane, Kyle; Unell, Alyssa; Musser, Anna; Sinha, Pawan, "Using Psychophysics to Characterize Transformation Tolerance during Transfer Learning in Machine-based Face Recognition Systems" 2022
- Master Thesis: Samuel Sander, "Inversion Effects in Humans and Deep Neural Networks" 2022

Latest Projects

VCCN lab 2023

Investigating face pareidolia using DeepGaze: Bridging human and artificial perception

- DeepGaze models are a promising tool for investigating complex perceptual phenomena like face pareidolia:
  - Use a state-of-the-art human face detection algorithm (Li et al, 2019) to predict "face-like" behavior in the context of face pareidolia.
  - Test if human face-specific features are enough with a highly accurate open-source human face-detection system.
  - Compare face detection model with gaze-based saliency model for testing face-generic features.
  - Directly compare the gaze-based heatmaps generated by DeepGaze IIE with human gaze heatmaps (n = 38).

    - The latest model of DeepGaze III allows the study of strong individual differences in eye saccades while free viewing the same stimuli.

VCCN lab 2022

Human-like face pareidolia emerges in deep neural networks optimized for face and object recognition

- Pareidolia is a by-product of the visual system's optimization for face and object recognition:
    - Compare obtained neural MEG responses with representations in CNNs using the 96 images from Wardle et al. (2020).
    - Use VGG16 architecture with varying task optimizations to test for face pareidolia in CNNs.
    - Generate layer-wise RDMs using stimulus set by extracting activations from specific layers of CNN.
    - Use MDS to visualize the obtained layer-wise RDMs.
    - Measure similarity between different RDMs using RSA.
    - Visualization of critical features used by the CNN to classify face pareidolia stimuli.

VCCN lab 2021

CNNs reveal the computational implausibility of the expertise hypothesis

- Expertise hypothesis does not make sense computationally:
    - Use task-optimized CNNs to test the computational plausibility of "expertise hypothesis".
    - Train VGG16 architecture on either face identity recognition or object categorization.
    - Fine-tune the networks and perform lesioning experiments.
    - Decode categories using activation patterns extracted from the layers of CNNs.
    - Perform statistical tests to meet significance criteria.

Fraunhofer IPT 2020

Automated tool cutting on Mikron HPM 800U HD using the Keyence VHX-6000 series microscope

- Driving efficiency and quality using image-based AI:
    - Design pipeline for image data classification of different tool images using TensorFlow 2.
    - Devise end-to-end machine learning system for bounding box detection of various tools.
    - Algorithm development for real-time calculation of wear values from worn tool images.
    - Develop deep learning model on Raspberry Pi with auto-focus capable RGB camera.
    - Deploy models in a manufacturing setting using Nvidia Xavier AGX and Jetson Nano.

Fraunhofer IPT 2019

Automated tool cutting on Mikron HPM 800U HD using the Kistler Piezotron/8852A acoustic sensor

- Driving efficiency and quality using audio-based AI:
    - Compose deep learning system for acoustic emission data classification using TensorFlow 2.
    - Create a noise separation algorithm for separating signal from noise in audio data using TensorFlow 1.4.
    - Analyze, explore, and visualize audio data using Jupyter Notebooks.

Fraunhofer IPT 2019

Automated tool cutting on Mikron HPM 800U HD using 5G edge computing

- Driving efficiency and quality using generative AI:
    - Use Pix2Pix GAN for tool image to segment image mapping generation.
    - Engineer a pipeline for semantic segmentation of tool wear images using TensorFlow 1.4.

Fraunhofer IPT 2018

Collected data from sensors on the CNC machine using a non-relational database

- Process optimization for preventive maintenance:
    - Analyze, explore, and feature engineer structured data using Jupyter Notebooks.
    - Predict label values from N-dimensional big data available in a structured format.

Coursework 2018

Course exercise learning about databases

- Tasks:
  - Predict label values from N-dimensional big data available in an unstructured format.
  - Learn to use HDFS and other prominent databases.

Other Coursework 2018

Miscellaneous

- Topics covered:
  - PDE Solvers: Write finite difference, element, and volume solvers for PDEs from scratch.
  - Parallel Programming: Use Single Instruction Multiple Data (SIMD) operations with the help of OpenMP and MPI.
  - Model-Based Estimation: Use Kalman Filters for estimating unknown variables in linear and non-linear systems.
  - Iterative Solvers: Code fast iterative solvers for partial differential equations from scratch.
  - Data Science: Introduction to process mining for the analysis of processes based on event logs.

Scholarships and Awards

- Winner, Vision 2020, Robowars. 2015
- Winner, Think India, IEEE format report submission on solar power generation. 2015
- Winner, Start-up Business plan, conceptualization and presentation to setup paper recycling plant. 2014
- Complete High School Scholarship. 2010–2012

Vocational Education

- **Summer trainee** at Product Development Center, Whirlpool Ltd. Summer 2015
  Carried out thermal and fluid flow design analysis for refrigeration systems.
- **Summer trainee** at Research and Development Center, Indian Railways. Summer 2014
  Performed fluid flow analysis for turbochargers present in diesel engine locomotives.

Skills

- **Programming Languages:** Python, Matlab, C/C++, Bash Scripting, Java, design-level familiarity with some others.
- **Data technologies:** SQL, MySQL/PostgreSQL/LiteSQL/MongoDB, Docker, Hadoop, MapReduce.
- **AI Frameworks:** Pytorch, Tensorflow, Keras, Pandas, Numpy, Scipy, OpenCV.
- **Management:** Microsoft Excel, PowerPoint, Word, Outlook, Lotus Notes.
- **Version Control:** Github, GIT Source Version Control, GitLab.
- **Manufacturing Operation Tools:** Siemens PLM, Teamcenter, SAP
- **Visualisation:** Matplotlib, Seaborn, D3, Tableau.
- **Simulation:** Abaqus FEA student edition, Ansys
- **Parallel Programming:** OpenMP, MPI, CUDA.
- **Design:** CATIA V5, AutoCAD
- **OS:** Mac, Windows, Linux Ubuntu.

Languages

- **English:** Business Fluent
- **German:** Average
- **Hindi:** Native

Extracurricular Activities

- Social media 2021–2024
  Networking with authors on platforms like Twitter, LinkedIn, ResearchGate, YouTube, etc
- Garden Group 2018–2020
  Growing organic fruits and vegetables with a bunch of neighbors.
- Rooh (NGO) 2013–2016
  Organized blood donation camps, and social awareness drives.
- National Cadet Corp (NCC) 2012–2013
  Basic military training and leadership development.