Rahul Arora

CONTACT INFORMATION

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RESEARCH INTERESTS

Interactive Computer Graphics
Virtual and Augmented Realities (VR/AR)
Human-Computer Interaction (HCI)
Applied Perception

WORK EXPRERIENCE

Research Scientist, **Reality Labs, Meta** 2021-present
Interaction researcher in the Input Explorations team working on multimodal interactions in AR.

EDUCATION

PhD, **University of Toronto** 2015-2021
Major: Computer Science
Thesis: Creative Expression in Immersive 3D Environments
Adviser: Prof. Karan Singh
CGPA: 4.0/4.0

MTech, **Indian Institute of Technology, Kanpur** 2014-2015
Major: Computer Science and Engineering
Thesis: Exploring Design Space by Interpolating between Multiple Sketches
Advisers: Prof. Vinay P. Namboodiri and Dr. Adrien Bousseau
CGPA: 9.6/10.0

BTech, **Indian Institute of Technology, Kanpur** 2010-2015
Major: Computer Science and Engineering
CGPA: 8.5/10.0

PEER-REVIEWED PUBLICATIONS

Piecewise-Smooth Surface Fitting onto Unstructured 3D Sketches
Emilie Yu, **Rahul Arora**, J. Andreas Bærentzen, Karan Singh, and Adrien Bousseau
ACM Transactions on Graphics (TOG) 2022, proc. SIGGRAPH
https://em-yu.github.io/research/surfacing_3d_sketches/

Mid-Air Drawing of Curves on 3D Surfaces in Virtual Reality
Rahul Arora and Karan Singh
ACM Transactions on Graphics (TOG) 2021, presented at SIGGRAPH 2021
http://bit.ly/tog21_mimicry

CASSIE: Curve and Surface Sketching in Immersive Environments
Emilie Yu, **Rahul Arora**, Tibor Stanko, J. Andreas Bærentzen, Karan Singh, and Adrien Bousseau
ACM SIGCHI Conference on Human Factors in Computing Systems 2021 (CHI '21)
Best Paper Honorable Mention
https://em-yu.github.io/research/cassie/

MagicalHands: Mid-Air Hand Gestures for Animating in VR
Rahul Arora, Rubaiat Habib Kazi, Danny Kaufman, Wilmot Li, and Karan Singh

ACM Symposium on User Interface Software and Technology 2019 (UIST '19)
https://www.dgp.toronto.edu/projects/magical-hands/

Volumetric Michell Trusses for Parametric Design & Fabrication
Rahul Arora, Alec Jacobson, Timothy R. Langlois, Yijiang Huang, Caitlin Mueller, Wojciech Matusik, Ariel Shamir, Karan Singh, and David I.W. Levin
ACM Symposium on Computational Fabrication 2019 (SCF '19)
https://www.dgp.toronto.edu/projects/michell/

SymbiosisSketch: Combining 2D and 3D Sketching for Designing Detailed 3D Objects in Situ
Rahul Arora, Rubaiat Habib Kazi, Tovi Grossman, George Fitzmaurice, and Karan Singh
ACM SIGCHI Conference on Human Factors in Computing Systems 2018 (CHI '18)
https://doi.org/10.1145/3328939.3328999

Experimental Evaluation of Sketching on Surfaces in VR
Rahul Arora, Rubaiat Habib Kazi, Fraser Anderson, Tovi Grossman, Karan Singh, and George Fitzmaurice
ACM SIGCHI Conference on Human Factors in Computing Systems 2017 (CHI '17)
http://dx.doi.org/10.1145/3025453.3025474

SketchSoup: Exploratory Ideation using Design Sketching
Rahul Arora, Ishan Darolia, Vinay P. Namboodiri, Karan Singh, and Adrien Bousseau
Computer Graphics Forum (CGF) 2017, presented at Eurographics 2017
http://dx.doi.org/10.1111/cgf.13081

Derandomizing Isolation Lemma for $\mathbf{K}_{3,3}$-free and $\mathbf{K}_5$-free Bipartite Graphs
Rahul Arora, Ashu Gupta, Rohit Gurjar, and Raghunath Tewari
Symposium on Theoretical Aspects of Computer Science (STACS) 2016
http://dx.doi.org/10.4230/LIPIcs.STACS.2016.10

OTHER PUBLICATIONS

A Generic Noninvasive Neuromotor Interface for Human-Computer Interaction (Preprint)
CTRL-Labs at Reality Labs (over 250 contributors including **Rahul Arora**)
https://www.biorxiv.org/content/10.1101/2024.02.23.581779v1

Introduction to 3D Sketching (Invited Book Chapter)
Rahul Arora, Mayra Donaji Barrera Machuca, Philipp Wacker, Daniel Keefe, and Johann Habakuk Israel
In Interactive Sketch-Based Interfaces and Modelling for Design (ed. Alexandra Bonnici and Kenneth P. Camilleri). River Publishers. 2023. https://dx.doi.org/10.1201/9781003360650-8

Input Processing and Geometric Representations for 3D Sketches (Invited Book Chapter)
Johann Habakuk Israel, Mayra Donaji Barrera Machuca, **Rahul Arora**, Philipp Wacker, and Daniel Keefe
In Interactive Sketch-Based Interfaces and Modelling for Design (ed. Alexandra Bonnici and Kenneth P. Camilleri). River Publishers. 2023. https://dx.doi.org/10.1201/9781003360650-9

Interaction Devices and Techniques for 3D Sketching (Invited Book Chapter)
Mayra Donaji Barrera Machuca, **Rahul Arora**, Philipp Wacker, Daniel Keefe, and Johann Habakuk Israel

In Interactive Sketch-Based Interfaces and Modelling for Design (ed. Alexandra Bonnici and Kenneth P. Camilleri). River Publishers. 2023. https://dx.doi.org/10.1201/9781003360650-10

3D Sketching Application Scenarios (Invited Book Chapter)
Philipp Wacker, **Rahul Arora**, Mayra Donaji Barrera Machuca, Daniel Keefe, and Johann Habakuk Israel
In Interactive Sketch-Based Interfaces and Modelling for Design (ed. Alexandra Bonnici and Kenneth P. Camilleri). River Publishers. 2023. https://dx.doi.org/10.1201/9781003360650-11

Thinking Outside the Lab: VR Size & Depth Perception in the Wild (Preprint)
Rahul Arora, Jiannan Li, Gongyi Shi, Karan Singh
https://arxiv.org/2105.00584

Creative Expression with Immersive 3D Interactions (Juried)
Rahul Arora
Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20 Doctoral Consortium)
https://dl.acm.org/doi/10.1145/3334480.3375028

Designing Volumetric Truss Structures for Computational Fabrication (Juried)
Rahul Arora, Alec Jacobson, Timothy R. Langlois, Karan Singh, and David I.W. Levin
Graphics Interface 2018 Posters (GI '18)
https://bit.ly/31CTjtw

AWARDS AND RECOGNITION

CHI Best Paper Honorable Mention Award	2021
Robert C. Lansdale/Okino Computer Graphics Fellowship: CA $4,000	2020
Wolfond Scholarship in Wireless Information Technology: CA $10,000	2019
UofT Libraries Grad Exhibit Competition (3 winners): CA $1,000	2019
Adobe Research Fellowship 2019 (11 fellows): US $10,000	2018
Adobe Research Fellowship 2018 Finalist	2017
Mitacs Accelerate Award for industrial partnership: CA $15,000	2016
Merit-cum-Means Scholarship, IIT Kanpur: Full tuition amount	2010–2014
Academic Excellence Award, IIT Kanpur (top 5% students)	2013

INTERNSHIPS

Adobe Research, Seattle, USA Summer 2019
with Timothy Langlois, Danny Kaufman, and Rubaiat Habib
Worked on techniques for creating stylized animations of 2D fluids.

Adobe Research, Seattle, USA Summer 2018
with Wil Li, Rubaiat Habib, and Danny Kaufman
Studied gestural methods for authoring animations in VR.

Autodesk Research, Toronto, Canada Winter 2017
with Rubaiat Habib and Tovi Grossman
Developed an augmented reality tool for 3D concept sketching.

Autodesk Research, Toronto, Canada Summer 2016
with Tovi Grossman, Rubaiat Habib, and Fraser Anderson
Conducted lab experiments to understand 3D sketching ability.

Inria, Sophia-Antipolis, France Summer 2014
with Adrien Bousseau
Developed a user-guided method for ideation sketch interpolation.

Adobe Research, Bangalore, India Summer 2013
with Ramesh Srinivasaraghavan
Built a gamified crowdsourcing platform for object recognition tasks.

SKILLS

Programming: C#, Python, Unity Engine, MATLAB, C++, TypeScript.

Techniques: 3D graphics, numerical optimization, geometry processing, quantitative studies, qualitative studies, statistical analysis, eye tracking, inertial measurement units (IMUs).

Tools: Adobe Photoshop, Blender, Adobe Premiere, LaTeX, Microsoft Office.

TALKS

New York University HCI Course, Remote Talk November 2023
On Immersive 3D Sketching and Modelling

Université de Montréal HCI Course, Remote Talk April 2022
On Immersive 3D Sketching and Modelling

Toronto Geometry Colloquium, Remote Talk October 2021
On Human-Centered Graphics for Immersive Creative Expression

SIGGRAPH 2021, Remote Talk August 2021
Paper presentation: Mid-Air Drawing of Curves on 3D Surfaces in Virtual Reality

Autodesk Research, Remote Talk April 2021
On Human-Centered Graphics for Immersive Creative Expression

Facebook Reality Labs, Remote Talk April 2021
On Human-Centered Graphics for Immersive Creative Expression

UBC AR/VR Course, Remote Guest Lecture March 2021
On Gesture-Based Animation in VR

GraphDeco Group, Inria Sophia-Antipolis, Remote Talk March 2021
On Human-Centered Graphics for Immersive Art & Design

MIT Computer Graphics Group, Remote Talk December 2020
On Volumetric Michell Trusses

CHI 2020 Doctoral Symposium, Remote Talk May 2020
On Creative Expression with Immersive 3D Interactions

Motograph Workshop, Waterloo, Canada December 2019
On Stylized Fluid Animation

UIST 2019, New Orleans, USA October 2019
Paper presentation: MagicalHands

SCF 2019, Pittsburgh, USA June 2019

Paper presentation: Volumetric Michell Trusses for Parametric Design & Fabrication

CHI 2018, Montreal, Canada May 2018
Paper presentation: SymbiosisSketch

Toronto SIGCHI Chapter, Toronto, Canada March 2018
On Hybrid 2D–3D Sketching in SymbiosisSketch

Tomograph Workshop, Toronto, Canada December 2017
On Truss Topology Optimization for Design & Manufacturing

IIT Kanpur, India May 2017
On 2D Sketching and Immersive 3D Sketching

CHI 2017, Denver, USA May 2017
Paper presentation: Experimental Evaluation of Sketching on Surfaces in VR

Eurographics 2017, Lyon, France May 2017
Paper presentation: SketchSoup

SERVICE

Committee Member for CHI 2022 and 2023 Late-Breaking Work.

Committee Member for ICCV 2021 Workshop on Sketching for Human Expressivity.

Committee Member for Pacific Graphics 2021 and 2022.

Committee Member for SIGGRAPH Asia 2020 XR Program.

Area Chair for Graphics Interface (GI) 2020.

Student Volunteer at User Interface Software and Technology (UIST) 2019.

Reviewer for computer graphics conferences
SIGGRAPH 2020, 2022–2024; SIGGRAPH Asia 2020–2023; SIGGRAPH Posters Program 2021; Eurographics (EG) Short Papers 2021; Symposium for Computational Fabrication (SCF) 2020; Pacific Graphics 2021–2022; Graphics Interface (GI) 2018, 2020.

Reviewer for computer graphics journals
Transactions on Graphics (TOG) 2021; Computer Graphics Forum (CGF) 2020, 2023; Transactions on Visualization and Computer Graphics (TVCG) 2019–2020, 2023; Computer-Aided Design (CAD) 2019; Computer & Graphics 2019; Computer Graphics & Applications 2017.

Reviewer for HCI conferences
Conference on Human Factors in Computing Systems (CHI) 2017–2024; User Interfaces Software and Technology (UIST) 2018–2020, 2022–2023; Designing Interactive Systems (DIS) 2018; Creativity & Cognition 2022; Graphics Interface (GI) 2020.

Reviewer for HCI journals
International Journal of Human-Computer Interaction (IJHCI) 2018; International Journal of Human-Computer Studies (IJHCS) 2021.

Reviewer for specialized VR/AR conferences
Virtual Reality (IEEE VR) 2018, 2020–2023; Virtual Reality Software and Technology

(VRST) 2020; International Symposium on Mixed and Augmented Reality (ISMAR) 2020–2022; Spatial User Interaction (SUI) 2017.

Reviewer for other venues
Springer Nature Applied Sciences (SNAS) 2019.

TEACHING EXPERIENCE

Computer Graphics, University of Toronto — Winter 2020
Teaching Assistant for Prof. David Levin

Computer Graphics, University of Toronto — Fall 2019
Teaching Assistant for Prof. Alec Jacobson

Computer Graphics, University of Toronto — Winter 2019
Teaching Assistant for Prof. David Levin

Computer Graphics, University of Toronto — Winter 2018
Teaching Assistant for Prof. Karan Singh and Prof. David Levin

Computer Graphics, University of Toronto — Fall 2017
Teaching Assistant for Prof. Karan Singh and Prof. Alec Jacobson

Intro to Theory of Computation, University of Toronto — Fall 2015
Teaching Assistant for Prof. Azadeh Farzan

Introduction to Computer Graphics, IIT Kanpur — Fall 2014
Teaching Assistant for Prof. Vinay P. Namboodiri