

# Rahul Arora

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## CONTACT INFORMATION

Meta Platforms  
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## RESEARCH INTERESTS

Interactive Computer Graphics  
Virtual and Augmented Realities (VR/AR)

Human-Computer Interaction (HCI)  
Applied Perception

## WORK EXPERIENCE

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/](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](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  $K_{3,3}$ -free and  $K_5$ -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**

**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>

**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). River Publishers. In press.*

**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). River Publishers. In press.*

**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). River Publishers. In press.*

### 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). River Publishers. In press.*

### 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/3lCTjtw>

## 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

<b>Adobe Research, Seattle, USA</b> <i>with Timothy Langlois, Danny Kaufman, and Rubaiat Habib</i> Worked on techniques for creating stylized animations of 2D fluids.	Summer 2019
<b>Adobe Research, Seattle, USA</b> <i>with Wil Li, Rubaiat Habib, and Danny Kaufman</i> Studied gestural methods for authoring animations in VR.	Summer 2018
<b>Autodesk Research, Toronto, Canada</b> <i>with Rubaiat Habib and Tovi Grossman</i> Developed an augmented reality tool for 3D concept sketching.	Winter 2017
<b>Autodesk Research, Toronto, Canada</b> <i>with Tovi Grossman, Rubaiat Habib, and Fraser Anderson</i> Conducted lab experiments to understand 3D sketching ability.	Summer 2016
<b>Inria, Sophia-Antipolis, France</b> <i>with Adrien Bousseau</i> Developed a user-guided method for ideation sketch interpolation.	Summer 2014
<b>Adobe Research, Bangalore, India</b> <i>with Ramesh Srinivasaraghavan</i> Built a gamified crowdsourcing platform for object recognition tasks.	Summer 2013

<b>SKILLS</b>	<b>Programming:</b> C#, Unity Engine, MATLAB, Python, C++.	
	<b>Techniques:</b> 3D graphics, numerical optimization, geometry processing, physical simulation, quantitative studies, qualitative studies, statistical analysis, eye tracking.	
	<b>Tools:</b> Adobe Photoshop, Blender, Adobe Premiere, L <sup>A</sup> T <sub>E</sub> X, Microsoft Office.	
<b>TALKS</b>	<b>Université de Montréal HCI Course, Remote Talk</b> On Immersive 3D Sketching and Modelling	April 2022
	<b>Toronto Geometry Colloquium, Remote Talk</b> <a href="#">On Human-Centered Graphics for Immersive Creative Expression</a>	October 2021
	<b>SIGGRAPH 2021, Remote Talk</b> <a href="#">Paper presentation: Mid-Air Drawing of Curves on 3D Surfaces in Virtual Reality</a>	August 2021
	<b>Autodesk Research, Remote Talk</b> On Human-Centered Graphics for Immersive Creative Expression	April 2021
	<b>Facebook Reality Labs, Remote Talk</b> On Human-Centered Graphics for Immersive Creative Expression	April 2021
	<b>UBC AR/VR Course, Remote Guest Lecture</b> On Gesture-Based Animation in VR	March 2021
	<b>GraphDeco Group, Inria Sophia-Antipolis, Remote Talk</b> On Human-Centered Graphics for Immersive Art & Design	March 2021
	<b>MIT Computer Graphics Group, Remote Talk</b> On Volumetric Michell Trusses	December 2020
	<b>CHI 2020 Doctoral Symposium, Remote Talk</b> On Creative Expression with Immersive 3D Interactions	May 2020
	<b>Motograph Workshop, Waterloo, Canada</b> On Stylized Fluid Animation	December 2019
	<b>UIST 2019, New Orleans, USA</b> <a href="#">Paper presentation: MagicalHands</a>	October 2019
	<b>SCF 2019, Pittsburgh, USA</b> <a href="#">Paper presentation: Volumetric Michell Trusses for Parametric Design &amp; Fabrication</a>	June 2019
	<b>CHI 2018, Montreal, Canada</b> <a href="#">Paper presentation: SymbiosisSketch</a>	May 2018
	<b>Toronto SIGCHI Chapter, Toronto, Canada</b> On Hybrid 2D–3D Sketching in SymbiosisSketch	March 2018
	<b>Tomograph Workshop, Toronto, Canada</b> On Truss Topology Optimization for Design & Manufacturing	December 2017
	<b>IIT Kanpur, India</b> On 2D Sketching and Immersive 3D Sketching	May 2017

**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; SIGGRAPH Asia 2020–2022; 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; Transactions on Visualization and Computer Graphics (TVCG) 2019–2020; Computer-Aided Design (CAD) 2019; Computer & Graphics 2019; Computer Graphics & Applications 2017.

**Reviewer** for HCI conferences  
Conference on Human Factors in Computing Systems (CHI) 2017–2023; User Interfaces Software and Technology (UIST) 2018–2020, 2022; 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

<b>Computer Graphics</b> , University of Toronto Teaching Assistant for Prof. Karan Singh and Prof. David Levin	Winter 2018
<b>Computer Graphics</b> , University of Toronto Teaching Assistant for Prof. Karan Singh and Prof. Alec Jacobson	Fall 2017
<b>Intro to Theory of Computation</b> , University of Toronto Teaching Assistant for Prof. Azadeh Farzan	Fall 2015
<b>Introduction to Computer Graphics</b> , IIT Kanpur Teaching Assistant for Prof. Vinay P. Namboodiri	Fall 2014