Rapid Prototyping of XR Experiences

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This course introduces participants to rapid prototyping for augmented, virtual, and mixed reality. Participants will learn about physical prototyping with paper and Play-Doh and digital prototyping via visual authoring tools. After an overview of the XR prototyping process and tools, participants will complete two hands-on sessions. A combination of paper-based XR design templates and easy-to-use digital authoring tools will be used to create working interactive prototypes that can be run on XR devices. The course is targeted at non-technical audiences including HCI practitioners, user experience researchers, and interaction design professionals and students interested in XR design.

CCS Concepts: • **Human-centered computing** → **Interface design prototyping**; **Mixed / augmented reality**.

Additional Key Words and Phrases: physical prototyping; digital authoring tools; immersive authoring.

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1 INTRODUCTION

XR technologies such as augmented reality (AR) and virtual reality (VR) have been developed and studied in research for over 60 years [2, 3], but it is only recently that they are becoming more readily available. Fully self-contained, head-mounted displays like the Oculus Quest for VR and hundreds of millions of AR capable smartphones using platforms like ARKit and ARCore allow people nowadays to have a mobile XR experience with relatively little effort and cost.

However, until recently, creating AR and VR applications required strong programming skills [1]. This is often an obstacle to people wanting to create novel and intuitive XR user experiences. For example, in our previous work reviewing the landscape of tools for creating XR experiences, we identified two key challenges: *(1)* creating content remains difficult, and *(2)* specifying interactive behavior requires significant programming and often needs to involve multiple tools [6].

In this course, participants will learn how to use a wide array of non-programming tools for rapid prototyping of XR experiences. These will range from physical prototyping tools including paper templates for sketching out XR experiences in 360 degrees around the user, to web-based drag-and-drop applications with rapid previews on XR devices, to immersive authoring tools which can be used for creating 3D interface mockups from within AR or VR, and others. Prototyping methods for a variety of different XR display devices will also be covered, including hand-held devices, head-mounted displays, and projection-based systems.

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2 BENEFITS

The course has two major learning outcomes. First, participants will be introduced to a comprehensive set of methods for both physical and digital prototyping. Second, participants will learn about different types of tools, their requirements in terms of technical skills, and their supported level of fidelity. The methods and tools will be taught hands-on, allowing course participants to design, test, and critique prototypes throughout the course. We anticipate a hybrid format where co-located course participants can work in teams and remote participants can join via Zoom and complete the hands-on portions individually but still coordinate with their teams in break-out rooms. The course will provide a forum for participants to come together to see each of the prototypes, ask questions, and provide feedback. Participants will learn to formulate critiques and reflect on their own experience using the "I like, I wish, What if" method.

The main reason for CHI attendees to take this course will be to get to know and practice some easy-to-learn and apply prototyping techniques for XR experiences. Some of the techniques were developed by the instructors through research and teaching in HCI and interaction design courses. Those who teach similar courses and design workshops, and are interested in adding practical, hands-on XR portions to their instruction, will especially benefit from the course. The instructors will not only teach the materials, but also share them and provide participants with access to tools so that they could give a similar course in the future.

3 INTENDED AUDIENCE

The intended audience are those people who are interested in XR and in creating XR experiences, but don't necessarily have a strong programming or engineering background. This includes not only XR researchers and designers, but also HCI practitioners, and user experience and interaction design professionals in industry, as well as students who have an interest in rapid prototyping for mixed reality. The course is suitable for people with no particular programming or design experience. The techniques taught are tried-and-tested with teams of 4–5 and audiences of up to 40 participants. There is no assumed background, although attendees should bring their own laptops to the course, and there will be links provided ahead of time to tools that can be downloaded to be used during the course.

4 PREREQUISITES

The course is designed for non-technical audiences. Participants with basic knowledge in HCI, user experience, and interaction design will find the contents of this course accessible. There is no need for programming. However, for more advanced participants, the instructors will also be able to share tips and resources, including information on how the techniques could be incorporated with advanced XR development workflows with tools like Unity or Unreal.

5 COURSE CONTENT

This course will be structured into three blocks:

Block 1 (75 minutes)

- Introduction to designing XR experiences (10 minutes)
- Rapid prototyping motivation/process (10 minutes)
- Low/medium/high fidelity XR rapid prototyping tools (35 minutes)
  - Blocks, Marquette, Aero, Lens Studio, A-Frame, Unity, Vuforia, MRTK, etc.
- XR experience interface guidelines & design principles (15 minutes)

Block 2 (75 minutes)

- Intro to physical prototyping with paper templates/Play-Doh (15 minutes)
- Group work: hands-on physical prototyping session for a given topic (45 minutes)
- Group presentation: feedback & critique using "I Like/I Wish/What If" (15 minutes)

Block 3 (75 minutes)

- Creating interactive prototypes in tools introduced in Block 1 (45 minutes)
- Discussion, lessons learned, Q&A (20 minutes)
- Resources available (10 minutes)

In the first block, participants will be introduced to XR prototyping and the key differences to prototyping for web and mobile. We will also share guidelines and techniques for interfaces to be adapted for head-mounted displays, including various zones that are comfortable and safe target areas around an HMD user. The materials will cover key design principles central to XR and the main differences between designing for AR and VR, raising awareness of the increased degrees of freedom of movement and interaction in XR, the notions of autonomy/agency and presence/immersion, and how to deal with eye strain and motion sickness through design.

In the second block, participants will engage in brainstorming sessions while building physical prototypes of their ideas using paper and various templates for designing in 360 around the user [4] as well as Play-Doh for "3D modelling" [5]. The instructors will guide participants through hands-on exercises both by giving a pre-scoped design problem and carefully allocating portions of time for each step in the low-fi prototyping process and workflow with a particular focus on the environment and 3D characters that drive the story of an XR experience.

In the third block, participants will be transferring their physical prototypes to digital while we help them scope the exploration of digital tools. The instructors will narrow down the selection to 2–3 tools that are fairly recent and compatible with most computers but will require access to a webcam (common with laptops). They will walk the participants through the tools and guide them in the process of rapidly prototyping selected portions of their physical prototypes in a digital tool to increase fidelity. The session will conclude with a discussion including lessons learned and open questions. The instructors will again walk participants through the available course materials and how they can be accessed even after the completion of the course.

6 PRACTICAL WORK

In the hands-on session, participants will engage in physical prototyping with paper and Play-Doh in two steps. First, participants will be introduced to a set of paper prototyping templates emerging in the practitioners' community (e.g., 360-degree templates based on the principles of 360 photos and videos to conceptualize and sketch XR scenes "around" the user [4]). This will focus their design thinking on the XR environment in which the envisioned scenes will take place. Second, participants will transition from paper to physical prototyping, making use of the physical environment (e.g., using the table as a stage) to create "dioramas," with physical 3D models of the envisioned XR scenes created using cardboard, transparency and Play-Doh (based on techniques from one of the instructor's ProtoAR project [5]. This will focus their attention on the scenes' main 3D characters.

After sharing their progress and experience with the physical prototypes, participants will engage in digital prototyping with selected authoring tools [6]. To scope the activity and make sure it can be effective despite the time constraints, participants will be asked to focus on prototyping 1–2 key interactions from their physical prototypes and will be provided with tool recommendations and starter projects that they can learn from and then adapt to their projects.

7 INSTRUCTOR BACKGROUND

The instructors are experienced in teaching the techniques to a broad student body with a wide variety of non-technical backgrounds, including design, architecture, medicine, education, and psychology, in addition to HCI and computer science. They regularly teach the techniques at both undergraduate and graduate levels and had previous courses at CHI 2019 and 2020.

Mark Billinghurst is Professor of Human Computer Interaction at the University of South Australia in Adelaide, Australia, and Professor in the BioEngineering Institute at the University of Auckland in New Zealand. He earned a PhD in 2002 from the University of Washington and researches innovative computer interfaces that explore how virtual and real worlds can be merged, publishing over 500 research papers in topics such as wearable computing, Augmented Reality and mobile interfaces. Prior to joining the University of South Australia he was Director of the HIT Lab NZ at the University of Canterbury, in Christchurch, New Zealand. He has also previously worked at British Telecom, Nokia, Google, and the MIT Media Laboratory. He received the 2013 IEEE VR Technical Achievement Award for contributions to research and commercialization in AR and in 2019 the IEEE VGTC Virtual/Augmented Reality Career Award for lifetime contributions to Human-Computer Interactions for Augmented and Virtual Reality. He has been teaching classes on AR and VR since 2003, including many courses at ACM SIGCHI and SIGGRAPH.

Michael Nebeling is an Assistant Professor at the University of Michigan School of Information, where he directs the Information Interaction Lab (**https://mi2lab.com**). He earned his PhD in 2012 from ETH Zurich and his current research contributes new techniques, tools, and technologies to make XR interface development easier and faster. He received a Disney Research Faculty Award and a Mozilla Research Award for his work on empowering XR designers and end-users in 2018. He started his role as the XR Faculty Innovator-in-Residence with Academic Innovation's U-M wide XR Initiative in 2019. He regularly serves on the program committees of the ACM CHI and UIST conferences. He is papers co-chair of UIST 2021. He has been teaching XR focused courses for the past 5 years. He taught a similar XR prototyping course at CHI 2019. He is the creator of the XR MOOC series on Coursera (**http://xrmooc.com**) that shares many goals of this CHI course.

8 RESOURCES

All of the presentation material for this course, and additional videos, papers, online tools, and links to software will be made available at the course website: **http://xr-prototyping.org**. We also invite participants to Michael Nebeling's XR MOOC specialization: **http://xrmooc.com**.

REFERENCES

[1] Narges Ashtari, Andrea Bunt, Joanna McGrenere, Michael Nebeling, and Parmit K Chilana. 2020. Creating Augmented and Virtual Reality Applications: Current Practices, Challenges, and Opportunities. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–13.

[2] Michael Haller, Mark Billinghurst, and Bruce H. Thomas. 2007. *Emerging technologies of augmented reality - interfaces and design*. Idea Group Publishing.

[3] Dongpyo Hong, Tobias Höllerer, Michael Haller, Haruo Takemura, Adrian David Cheok, Gerard Jounghyun Kim, Mark Billinghurst, Woontack Woo, Eva Hornecker, Robert J. K. Jacob, Caroline Hummels, Brygg Ullmer, Albrecht Schmidt, Elise van den Hoven, and Ali Mazalek. 2008. Advances in Tangible Interaction and Ubiquitous Virtual Reality. *IEEE Pervasive Comput.* 7, 2 (2008), 90–96.

[4] Michael Nebeling and Katy Madier. 2019. 360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–13.

[5] Michael Nebeling, Janet Nebeling, Ao Yu, and Rob Rumble. 2018. ProtoAR: Rapid Physical-Digital Prototyping of Mobile Augmented Reality Applications. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, CHI 2018, Montreal, QC, Canada, April 21-26, 2018*. 353.

[6] Michael Nebeling and Maximilian Speicher. 2018. The trouble with augmented reality/virtual reality authoring tools. In *2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct)*. IEEE, 333–337.