16:332:571 VR Technology Spring 2025 Project 2

Project 2 is a group project. You can select your own group members. Each group can have 2-3 students. Each group can choose from two options described below. The project has 5 milestones that must be completed. Please work with your group members and make sure all five milestones are met on time.

Project Timeline:

Task	Due Date / Dates	Percentage
Project Signup	March 28	5%
Project Proposal Presentation	April 3/4 and April 7/8	10%
Project Proposal Document	April 11	15%
Final Project Presentation	April 28/29 and May 1/2	10%
Final Project Report	May 5	60%

If your group encountered any issues during the project, e.g., dataset cannot be downloaded or persistent errors preventing the source code from running despite multiple attempts to fix them, please contact the course instructor and TA at: vr-spring2025@teams.rutgers.edu.

Project Signup:

Please use the following link to sign up your group for the project:
VR Technology Spring 2025 Project 2 Signup

Project Proposal Presentation:

Each group will give a 10-minute project proposal presentation. Every group member must contribute to the group presentation.

The presentation should include the following content:

- Project topic: what will your group work on?
- Why is the problem significant? Explain why it is worth the research effort.
- Briefly discuss the solutions you will evaluate, describe if you have successfully run the released software so far. If not successful, describe your plan to resolve the issues.
- Evaluation plan: how do you plan to evaluate the solutions? e.g., baseline solutions, software code, datasets, etc.

Project proposal presentation slides are due by 11:59pm the night before the scheduled presentation date.

Project Proposal Report:

The project proposal report should include the following content:

- **Introduction**: explain the project topic, clearly define the problem statement, and discuss its significance
- **Literature review**: describe existing solutions to the problem
- **Solutions:** list the solutions to be evaluated, a discussion of these solutions, and if applicable, a discussion of the datasets that will be used for evaluation
- **Evaluation plan:** explain how you plan to evaluate the solutions, e.g., baseline solutions, software code, datasets, etc.
- **Progress so far:** describe what has been completed so far, e.g., software code has been tested and functional, datasets have been downloaded.

Final Project Presentation:

Each group will give a 10-minute final project presentation. Every group member must contribute to the group presentation.

The presentation should include the following content:

- Project topic
- Solutions evaluated: a brief discussion of the solutions you evaluated. This discussion can be short if already discussed in the project proposal presentation.
- Evaluation results: present your evaluation results, data analysis, e.g., comparisons, and your findings.
- Your critique of the paper, e.g., its strengths, weakness, and areas of improvement
- Conclusion: summarize key takeaways and potential future directions

Final project presentation slides are due by 11:59pm the night before the scheduled presentation date.

Final Project Report:

Please find the final project report requirements under respective options below.

Option 1:

View prediction is an important task in virtual reality. It can be used for reducing the latency between motion and visual updates, which can help provide a smooth immersive experience. In addition, it can be used for optimizing the transmission of 3-DoF (e.g., 360-degree video) and 6-DoF (e.g., volumetric video) by prioritizing and streaming only the relevant portions of the scene that the user is likely to consume.

If you choose this option, you will do literature search on existing view prediction algorithms and evaluate their performance on existing VR user navigation datasets.

List of Available 3-DoF and 6-DoF VR User Navigation Datasets

Note: You do not need to use all the datasets in the list above in your evaluation. See the project report requirements below.

- 6DoF VR User Navigation Dataset: https://www.dis.cwi.nl/6dof-nav-dataset/
- 6DOF VR and 360° Video Datasets: https://struga.org/Jakov/6DOF_VR_Dataset.htm
- VRViewportPose Dataset: https://github.com/VRViewportPose/VRViewportPose
- User perspective dataset for 6-DoF point cloud video: https://github.com/Yong-Chen94/6DoF_Video_FoV_Dataset
- A Dataset for Exploring User Behaviors in Spherical Video Streaming: https://wuchlei-thu.github.io/
- 360-Degree Videos Head Movements Dataset: https://dl.acm.org/do/10.1145/3193701/full/
- 360° Video Viewing Dataset in Head-Mounted Virtual Reality: https://dl.acm.org/do/10.1145/3192927/full/

This list is not exhaustive. There are many additional VR user navigation datasets available. Please feel free to include them in your evaluation.

List of Existing Viewport Prediction Solutions

Note: This list is not exhaustive. Many other viewport prediction solutions are available. Please feel free to include view prediction solutions not listed here:

Title: PARIMA: Viewport Adaptive 360-Degree Video Streaming
Authors: Lovish Chopra, Sarthak Chakraborty, Abhijit Mondal, Sandip Chakraborty
Paper Link:
https://arxiv.org/pdf/2103.00981

Repository Link:
https://github.com/sarthak-chakraborty/PARIMA

Title: VR Viewport Pose Model for Quantifying and Exploiting Frame Correlations
Authors: Ying Chen, Hojung Kwon, Hazer Inaltekin, Maria Gorlatova
Paper Link:
https://arxiv.org/pdf/2201.04060
Repository Link: https://github.com/VRViewportPose/VRViewportPose

Title: LiveObj: Object semantics-based viewport prediction for live mobile virtual reality streaming
Authors: Xianglong Feng, Zeyang Bao, Sheng Wei
Paper Link: https://par.nsf.gov/servlets/purl/10281759
Repository Link: https://github.com/hwsel/LiveObj

Title: Your Attention is Unique: Detecting 360-Degree Video Saliency in Head-Mounted Display for Head Movement Prediction
Authors: Anh Nguyen, Zhisheng Yan, Klara Nahrstedt
Paper Link: https://mason.gmu.edu/~zyan4/papers/panosalnet_mm18.pdf
Repository Link:
https://github.com/phananh1010/PanoSalNet
https://github.com/phananh1010/PanoSalResnet

Title: Kalman Filter-based Head Motion Prediction for Cloud-based Mixed Reality
Authors: Serhan Gül, Sebastian Bosse, Dimitri Podborski, Thomas Schierl, Cornelius Hellge
Paper Link:
https://dl.acm.org/doi/10.1145/3394171.3413699
Repository Link:
https://github.com/fraunhoferhhi/pred6dof

Project Report Requirements:

The project report must include the following sections:

- **Introduction**: explain what is viewport prediction and why it is important for VR, discuss the challenges for view prediction in 3-DoF and 6-DoF
- **Literature Review**: a description of existing view prediction algorithms, for 3-DoF and 6-DoF
- **Datasets**: a description of the dataset/s used in your project
- **Evaluation Results**: compare the performance of different view prediction algorithms based on appropriate evaluation metrics
    - The evaluation results section should not be a complete replication of the results in the original paper. For example, you can include new datasets and new baselines in the evaluation.

Option 2:

In recent years, many published research papers have released reproducible artifacts, enabling others to verify and build upon their work. Publishers like ACM have also been promoting the concept of “Reproducible Research”, encouraging authors to share their developed software and provide a way for interested readers to run and evaluate the results. This practice allows these papers to serve as baselines for future research. Some papers go even further by carefully documenting the artifacts, ensuring that the results presented in the paper can be fully replicated.

If you choose this option, you will

- Select a paper that includes reproducible artifacts
- Review the paper and critique its proposed solution
- Evaluate the solution by running the released source code

List of Example Papers with Software Artifacts Available Online

Below is a list of example papers with software artifacts available online. However, you are free to choose from papers that you are more interested in.

If you choose to select a paper not in this list, please send an email to “vr-spring2025@teams.rutgers.edu” with the following details:

- Title and link of the paper
- Link of the repository
- Explanation of how this paper relates to VR

Title: User Mobility Simulator for Full-Immersive Multiuser Virtual Reality with Redirected Walking
Authors: Filip Lemic, Jakob Struye, and Jeroen Famaey
Paper Link:
https://www.famaey.eu/papers/cnf-lemic2021a.pdf
Repository Link:
https://bitbucket.org/filip_lemic/pm4vr/src/master/

Title: TVMC: Time-Varying Mesh Compression Using Volume-Tracked Reference Meshes
Authors: Guodong Chen, Filip Hácha, Libor Váša, Mallesham Dasari
Paper Link:
https://github.com/frozzzen3/TVMC/blob/main/files/TVMC_accepted.pdf
Repository Link:
https://github.com/SINRG-Lab/TVMC

Title: Power-Efficient Live Virtual Reality Streaming Using Edge
Authors: Zichen Zhu, Xianglong Feng, Zhongze Tang, Nan Jiang, Tian Guo, Lisong Xu, and Sheng Wei

Paper Link:
https://dl.acm.org/doi/abs/10.1145/3534088.3534351
Repository Link:
https://github.com/hwsel/EdgeVR

Title: MetaSapiens: Real-Time Neural Rendering with Efficiency-Aware Pruning and Accelerated Foveated Rendering
Authors: Weikai Lin, Yu Feng, Yuhao Zhu
Paper Link:
https://horizon-lab.org/metasapiens/
Repository Link:
https://github.com/horizon-research/Fov-3DGS

Title: SGSS: Streaming 6-DoF Navigation of Gaussian Splat Scenes
Authors: Mufeng Zhu, Mingju Liu, Cunxi Yu, Cheng-Hsin Hsu, Yao Liu
Paper Link:
https://yaoliu-yl.github.io/publications/mmsys25-sgss.pdf
Repository Link:
https://github.com/symmru/SGSS

Title: Theia: Gaze-driven and Perception-aware Volumetric Content Delivery for Mixed Reality Headsets
Authors: Nan Wu, Kaiyan Liu, Ruizhi Cheng, Bo Han, Puqi Zhou
Paper Link:
https://dl.acm.org/doi/10.1145/3643832.3661858
Repository Links:
https://zenodo.org/records/11095706
https://github.com/wunan96nj/Theia_MobiSys2024

Title: RenderFusion: Balancing Local and Remote Rendering for Interactive 3D Scenes
Authors: Edward Lu, Sagar Bharadwaj, Mallesham Dasari, Connor Smith, Srinivasan Seshan, Anthony Rowe
Paper Link:
https://par.nsf.gov/servlets/purl/10545244
Repository Link:
https://github.com/arenaxr/arena-renderfusion

Title: Rectangular-Mapping-based-Foveated-Rendering
Authors: Jiannan Ye, Anqi Xie, Susmija Jabbireddy, Yunchuan Li, Xubo Yang, Xiaoxu Meng
Paper Link:
https://3dvar.com/Ye2022Rectangular.pdf
Repository Link:
https://github.com/Bob-Yeah/Rectangular-Mapping-based-Foveated-Rendering

Before signing up for reviewing and evaluating a paper, please make sure you have the hardware capabilities required to run the author-provided source code. For example, RenderFusion requires a VR headset, MetaSapiens and Theia require a CUDA-compatible GPU.

Project Report Requirements:

Reviewing:
When reviewing the paper, you should address the following questions

- What is this paper about?
- Why is this an important issue to address?
- What are prior solutions to this problem?
- What are the advantages of the proposed solution?
- What are its drawbacks?

Evaluation:
When running released source code, consider the following

- Does the paper deliver the improvements claimed in the paper?
    - Present the evaluation results in your project report
- Beyond the original datasets used in the paper, test the software on a different dataset.
    - Can the software run successfully on the new dataset?
    - Include the evaluation results in your project report