Analyzing Camera Motion in Immersive Dome Movies using Optic Flow

Emma Broman* Karljohan Lundin Palmerius Anders Ynnerman Alexander Bock

WHAT

This work presents early results from an ongoing project on using optic flow to **quantify** and **analyze** the visual effect of motion in movies for immersive domes and planetariums.

By studying motion in state-of-the-art productions, we aim to derive metrics to support filmmakers in both designing and evaluating dome-specific content.

WHY?

- Provide useful insights for dome movie producers
- Derive metrics and guidelines for camera motion design, that help reduce the risk of visually induced motion sickness (VIMS)
- Expand the limited documented knowledge base on camera motion design in fulldome filmmaking and support future producers

Details in poster summary PDF!

Example from movie Chemistry of Life, produced by Visualization Center C

Full clip

Scan or click QR codes for clips from the movie!

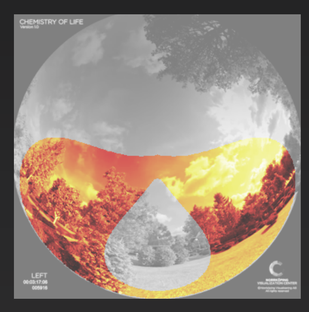
HOW?

Inspired by VIMS mitigation strategies from the VR community, we quantify motion effects using optic flow in the **peripheral field of view**. For each fisheye video frame, we compute:

- **Average optic flow magnitude** in the peripheral visual field
- **Image features,** such as contrast, lightness, and local variance

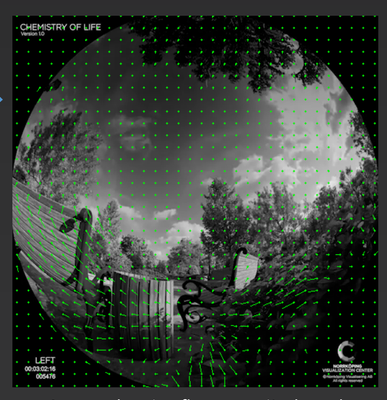
To support higher-level and segment-specific analysis, we also **divide each movie into segments** with similar visual features, and measurements are averaged per segment.

Periphery

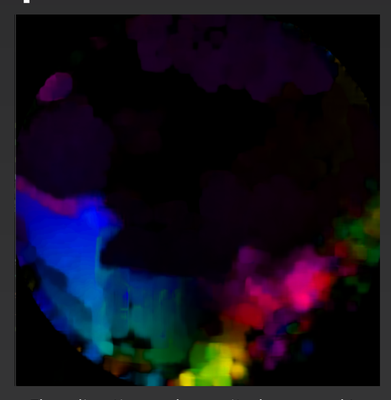


The area in the fisheye frame used to represent the peripheral field. Assumes a fixed focus point.

Dense 2D optic flow



Arrows showing flow magnitude and direction in sampled locations

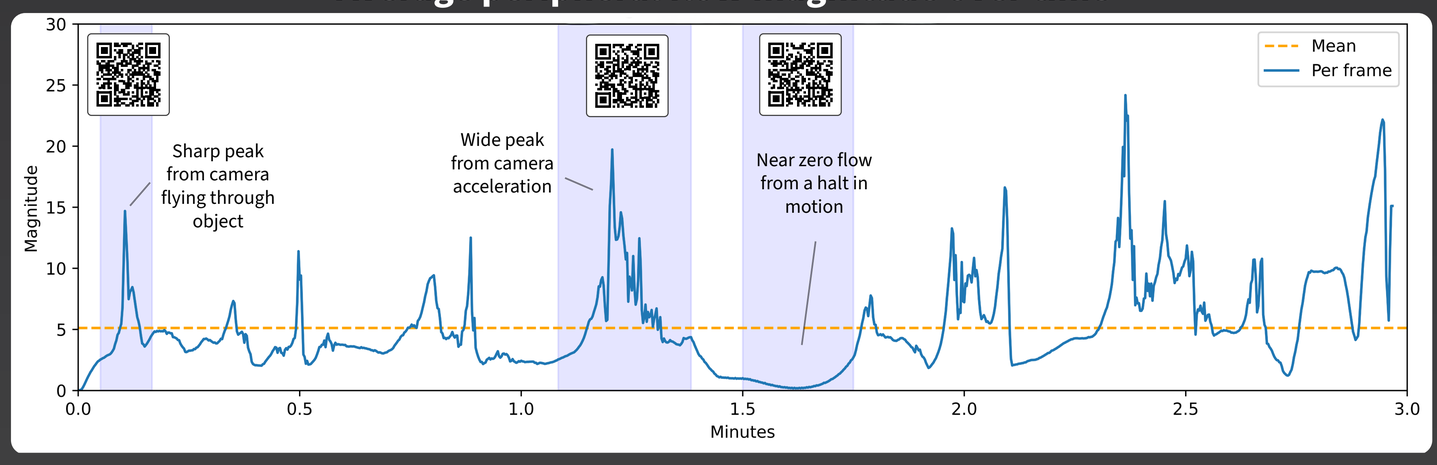


Flow direction and magnitude mapped to color hue and brightness

2D → 3D
Flow vectors are converted to 3D spherical coordinates to better represent audience experienced flow.

Average peripheral flow and image metrics are plotted over time

Average peripheral flow magnitude over time



Average peripheral flow plot showing motion throughout the scene. Peaks highlight dynamic moments caused by camera movement or nearby object motion. Moments of low flow signal stillness, which is also of interest as motion is essential for engagement and preserving depth perception.

Expert Feedback

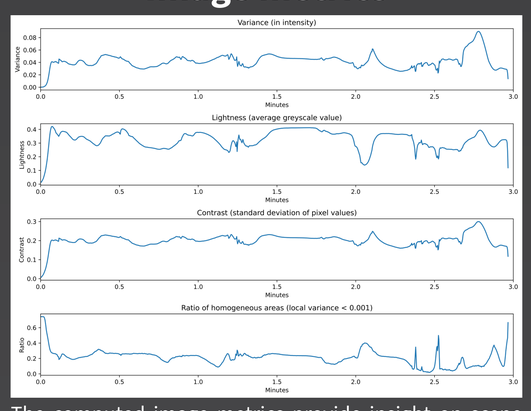
Preliminary results show promising optic flow patterns, with peaks aligning to moments that may require producer attention and reflecting overall pacing.

Informal interviews with producers revealed a potential in using the analysis to streamline production workflows and improve resource usage, for example by detecting motion-related issues before entering the dome.

Next Steps

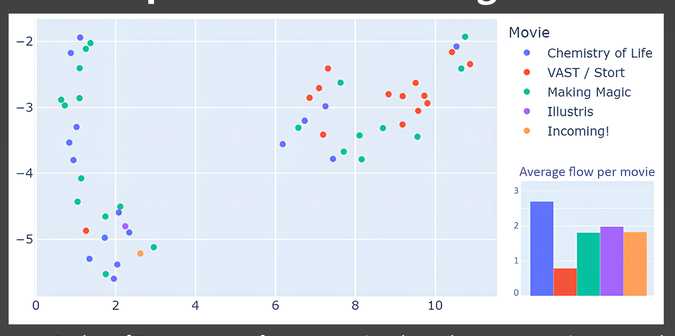
- Verify how flow correlates with audience experience (e.g., link peak frequency/magnitude to VIMS)
- Extend analysis to more movies and translate findings into guidelines
- Estimate likely viewer focus point
- Integrate analysis into a visualization tool for dome movie producers

Image metrics



The computed image metrics provide insight on scene characteristics and help determine whether low flow values reflect actual stillness or are due to a lack of visual features for motion detection.

Comparison of movie segments



UMAP plot of 53 segments from 5 movies, based on average image and peripheral flow metrics. The left cluster shows more dynamic (high-flow) shots, while the right shows slower-paced (low-flow) ones. We see that VAST has more slow-paced segments overall, consistent with its lower average flow (inset). Subclusters appear to reflect image features; the far-right group includes dark, low-flow segments like intros or credits.

LINKÖPING UNIVERSITY

Contact

emma.broman@liu.se

VIS2025