15-463 Computational Photography, Fall 2021

Final Project Proposal

Due Date: Oct 25, 2021 23:59 ET

Event-based video frame interpolation

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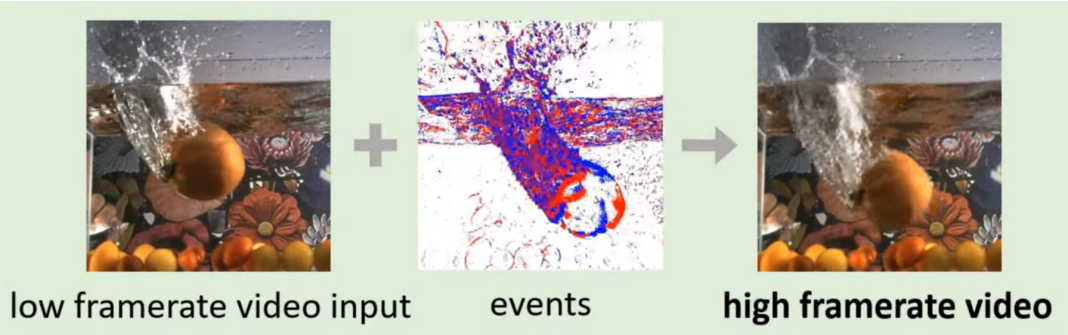

Figure 1: Example TimeLens thumbnail demonstrating the synthesis of high-framerate video from low-framerate input alongside high-speed events.

Summary

The TimeLens project introduces a framework that performs high quality video interpolation by combining the outputs of an RGB video camera for colour data, and a low-latency event camera for motion data. The result should be a smoother and more reliable interpolation between captured frames with a robustness to motion blur, visual artifacts, and non-linear motion artifacts.

In this project, I'll expect to learn how to merge the data from an rgb capture with the motion data from an event camera, and use this to combine warping and synthesis-based interpolation to create smooth good looking high-framerate video.

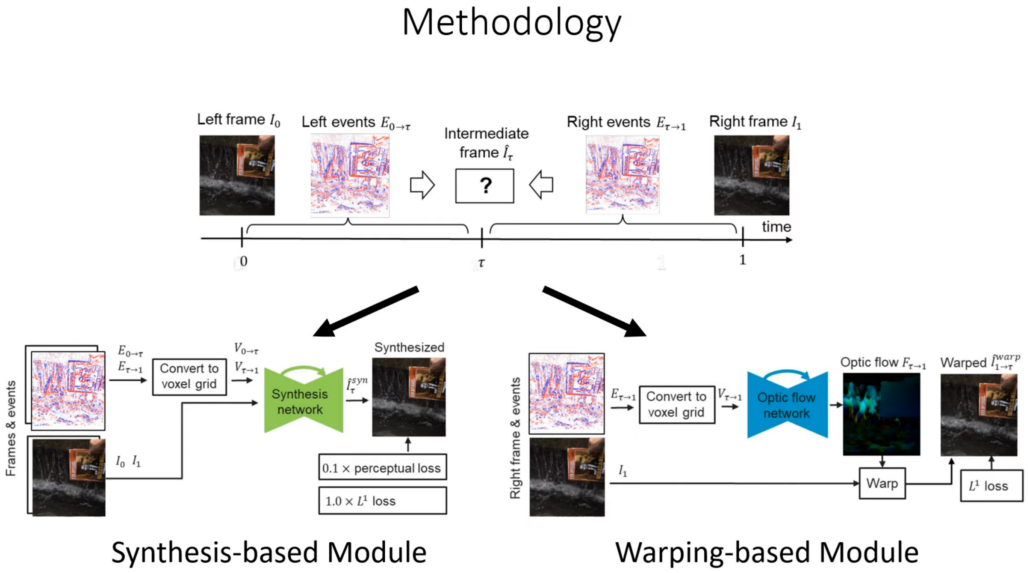

Figure 2: Example methodology demonstrating the combination of the synthesis based module alongside the warping based module to create interpolated frames between two frames using high resolution event data.

Background

Even the best existing frame-based video interpolation methods (DAIN, BMBC, etc.) often suffer from interpolation artifacts and an inability to address complex (non-linear) arbitrary motion. Motion blur is a significant cause of these problems, making fast complex motions hard to predict without additional assumptions. With the novel technological advances of event-based cameras, several significant improvements can be made for video interpolation that can now make use of motion data from captured temporal gradients instead of inferences between frames. Combined with an rgb moderate-framerate video camera for scene reproduction, the result is a more robust implementation to traditional video interpolation.

This is an interesting problem because it would provide access to high quality slow-motion video without requiring an expensive industrial-grade high-framerate video camera. Theoretically, once the cost of consumer event-based cameras decreases enough, the combination of an RGB with an event camera could be used for widespread mobile phone photography with much higher video framerates than are currently possible.

This problem is difficult because it requires intelligently blending the information from an RGB still frame with the low-latency motion data of the event camera. This has to be done carefully in order to create a seamless transition between frames with complex motion data at arbitrary interpolation queries.

Resources

- Event based camera: [`shop.inivation.com/products/dvxplorer-lite-academic-rate`]
- Moderate framerate video camera: My own Android Pixel 4XL, 4k@30 or 1080p@60
- The TimeLens paper (CVPR 2021) [`rpg.ifi.uzh.ch/docs/CVPR21_Gehrig.pdf`]
- High-speed event and RGB dataset & code: [`rpg.ifi.uzh.ch/TimeLens.html`]

Goals and Deliverables

1. Implement a functional version of the paper's framework using their high-speed dataset.
2. Build a camera setup where the event-based and video cameras are coaxial for valid footage collection (may require a beamsplitter from the course).
3. Ensure the framework extends to our hardware which likely have different specifications (resolution, framerate, aspect ratio, etc.).
4. Finish the final report for this project.
5. Complete the presentation for the project.
6. (Hope) Implement GPU (Cuda) acceleration for fast (maybe realtime?) computation.

Schedule

Oct 24 - Oct 30	Aquire imaging hardware and get familiar with the camera
Oct 31 - Nov 06	Begin implementing the framework from the paper
Nov 07 - Nov 13	Continue implementing the framework from the paper
Nov 14 - Nov 20	Continue implementing the framework from the paper
Nov 21 - Nov 27	Capture footage
Nov 28 - Dec 04	Finalize project with footage, final report, and presentation
Dec 05 - Nov 11	Final presentation

Thankfully, since the authors released their high speed event & rgb dataset, I can likely begin implementation without the actual hardware. I'll just need the hardware for final evaluation and capturing my own footage.

Team Justification

I will be working solo for this project.

1 References

- All of the references go to the Robotics and Perception Group @ University of Zurich, Switzerland.

- Images are credited to the team's YouTube video:
`https://www.youtube.com/watch?v=dVLyia-ezvo`