

## Final Presentation

# Insect-based spatial orientation algorithm

**Students:** Iddo Bar-Haim, Elior Schneider  
**Supervisor:** Yuval Silman

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**In collaboration with:** Rafael 



**Credit:** Photo by Mr Kristiansen (mymicroscopicworld@gmail.com)



# Outline

- Project Goal
- Background
- Literature Survey
- Chosen Solution
- Results
- Future work
- References

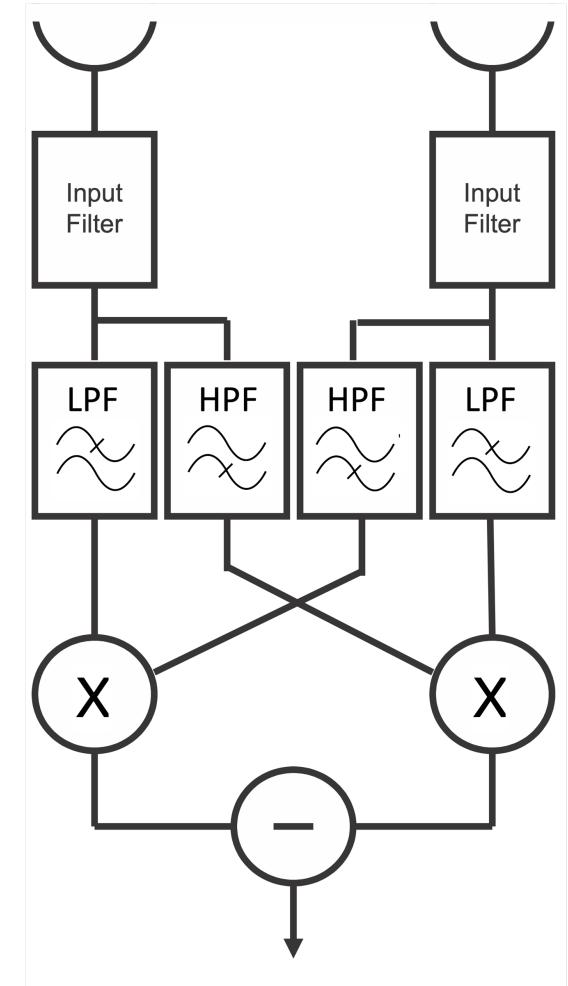
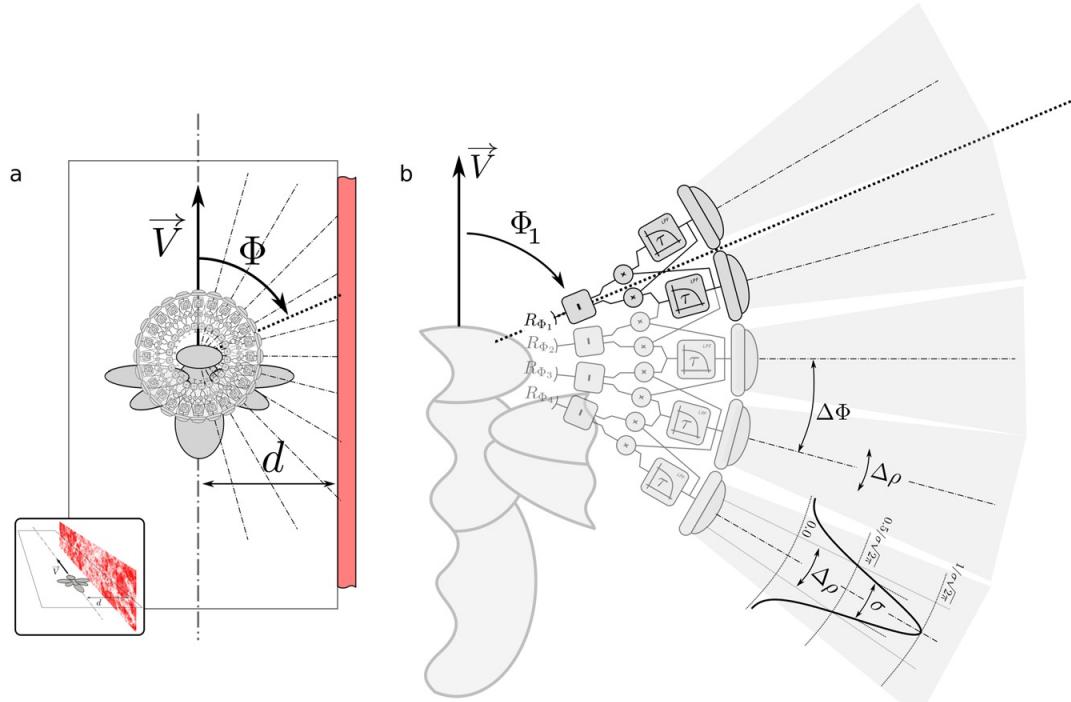
# Project Goal

- Implement a model that **analyses spatial motion** using simple sensors and a reduced calculation cost



# Background

- The Drosophila vision model – EMD
- Successful EMD-based applications



# Background

- Event Camera – New Opportunities



CLASSIC SENSOR



PROPHESEE SENSOR

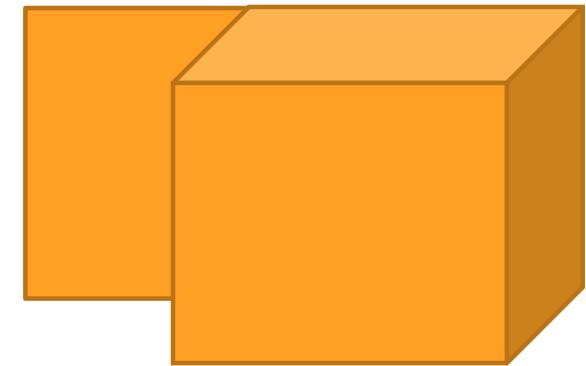
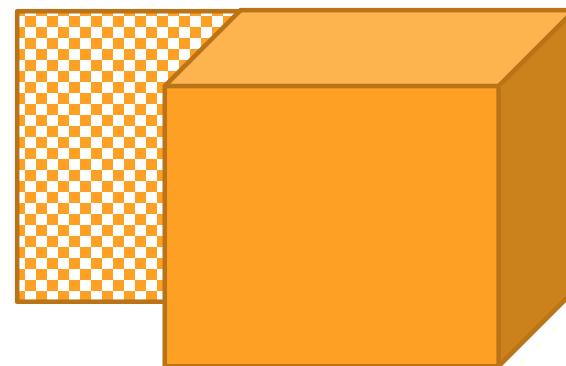
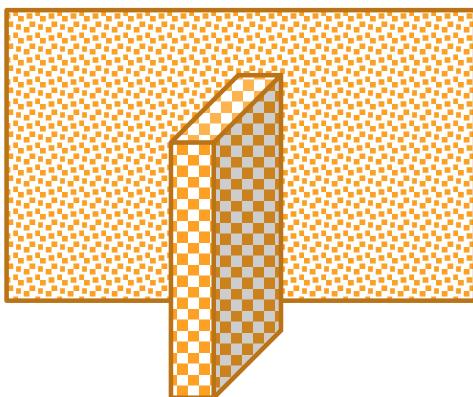
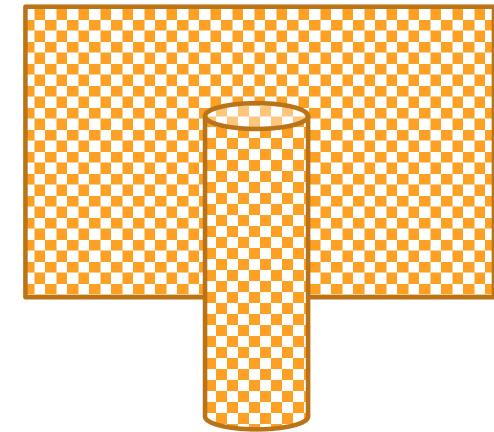
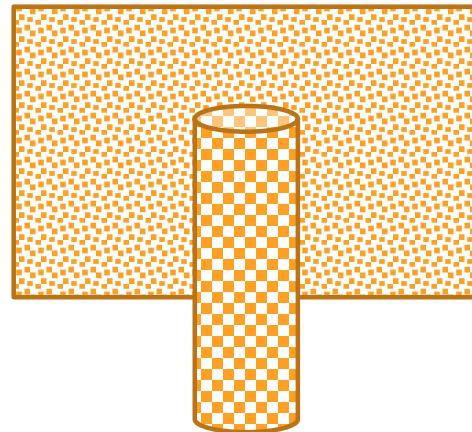
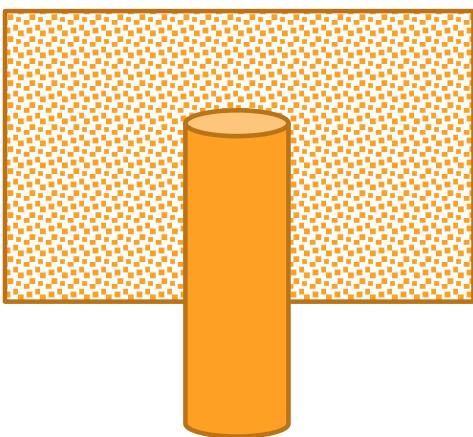
## Literature Survey

- Lecoeur, et al. 2018 analysed the response of an azimuthally distributed array of EMDs
- Gallego, et al. 2020 Event-Based Vision: A Survey

## Chosen Solution

- Simulate photoreceptors input by capturing well-defined video scenes
- Compare performance of altered EMD models
- Asses EMD abilities drawing a comparison to Event Camera output

# Chosen Solution – Create Dataset



# Chosen Solution – Create Dataset

Frame Captured by Our Camera

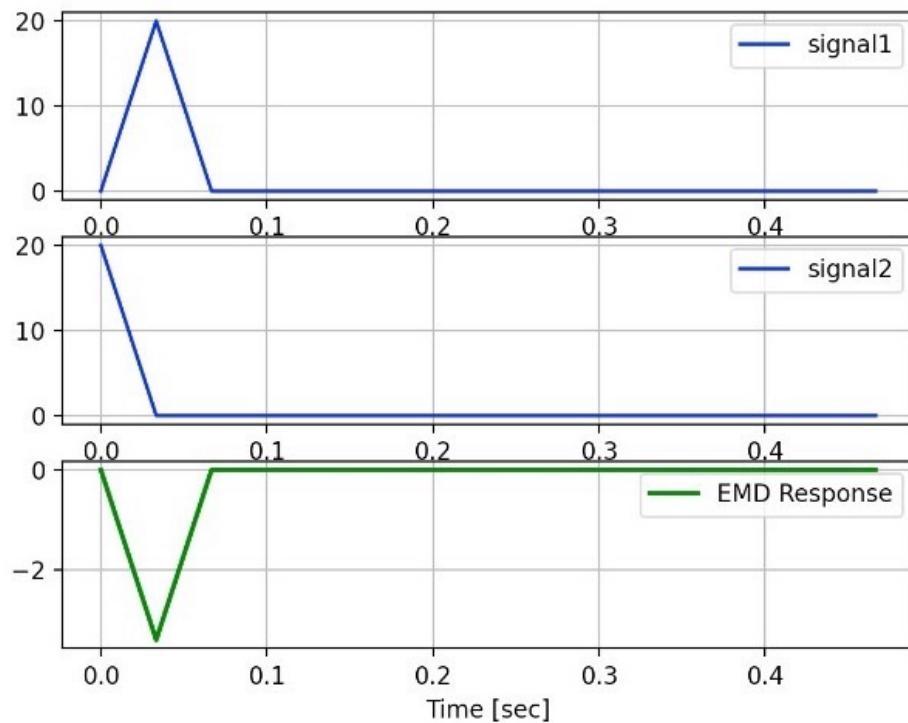


Frame adjustment to resemble an array of Photoreceptors

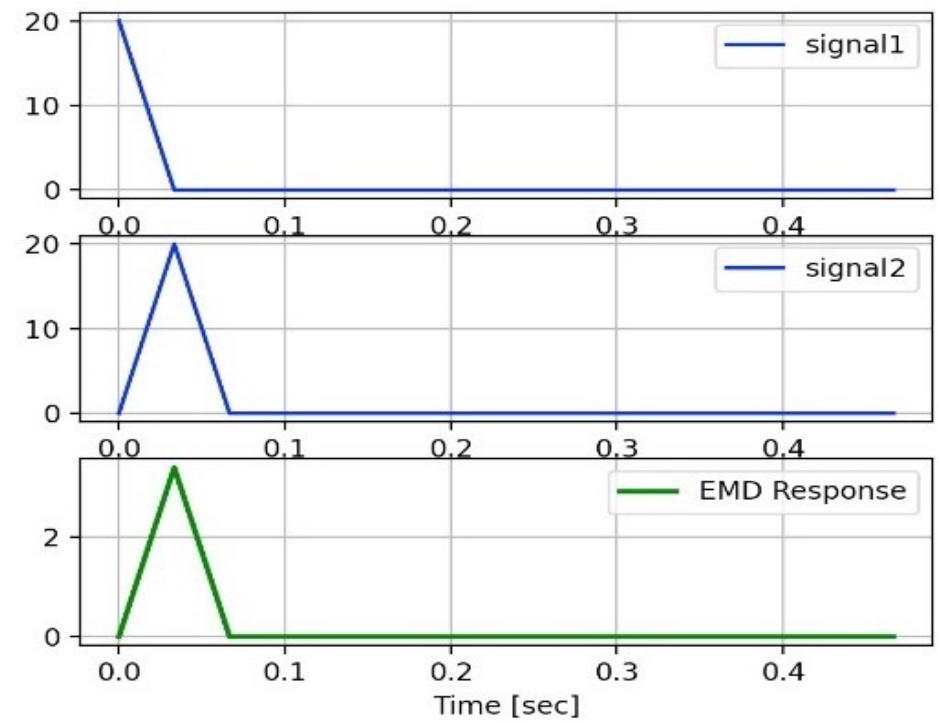


# Results – Synthetic Input

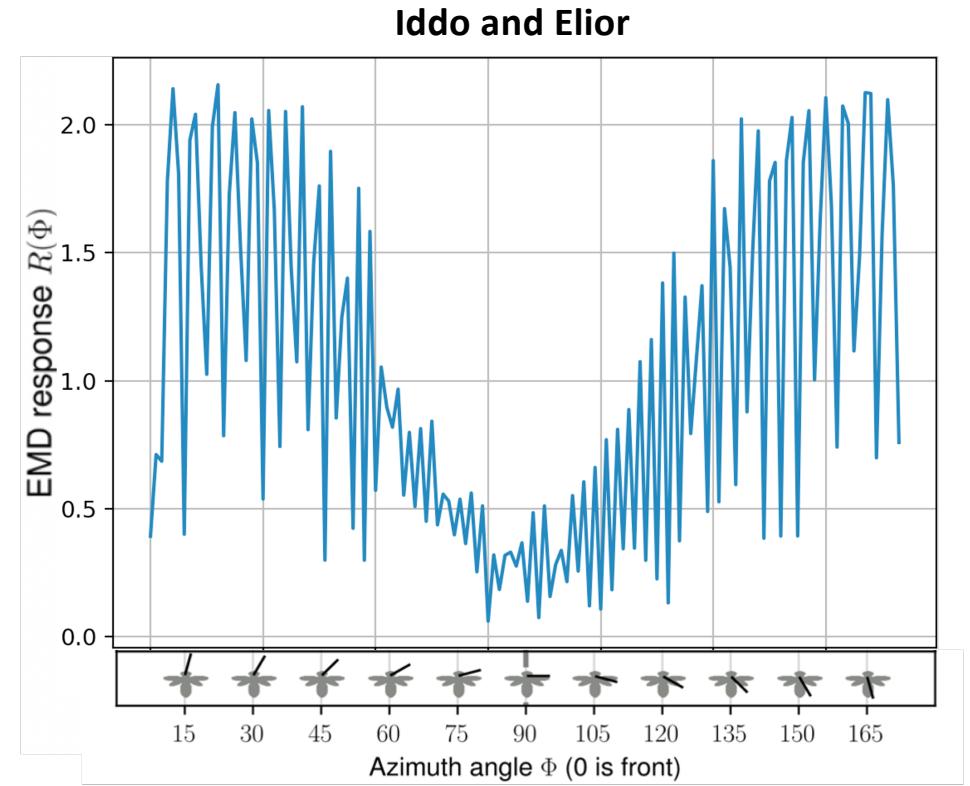
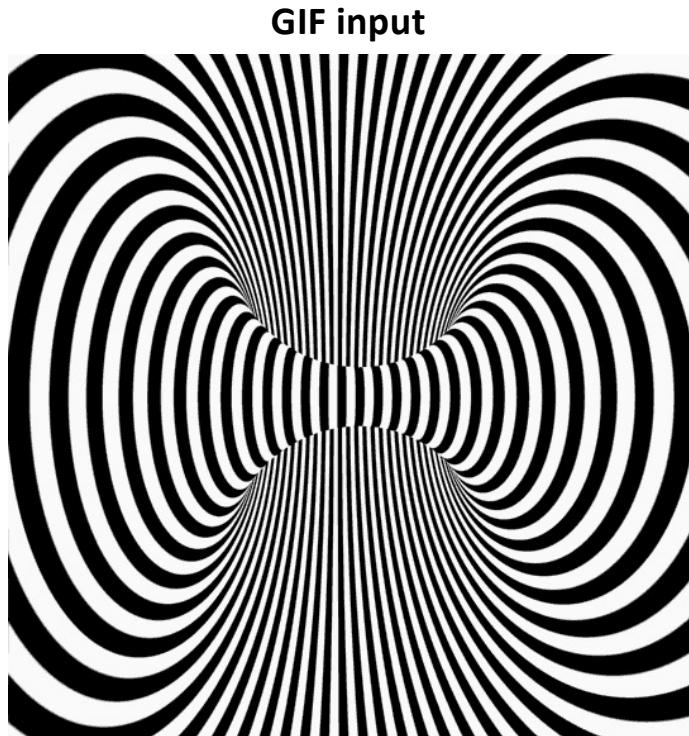
Right to Left Movement



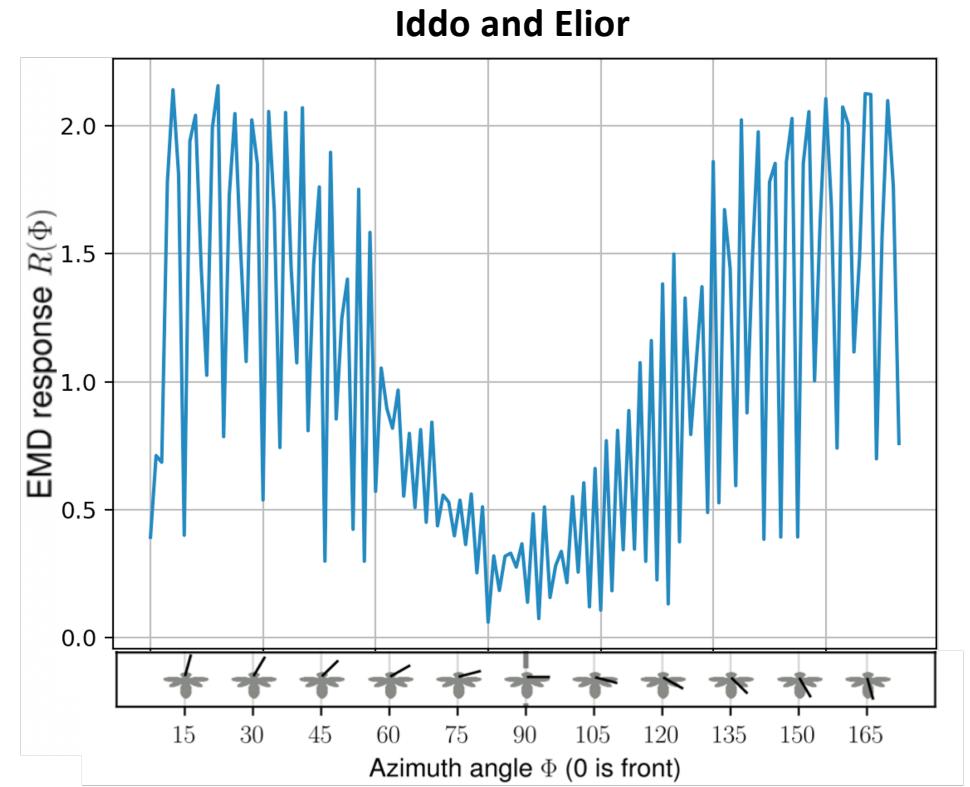
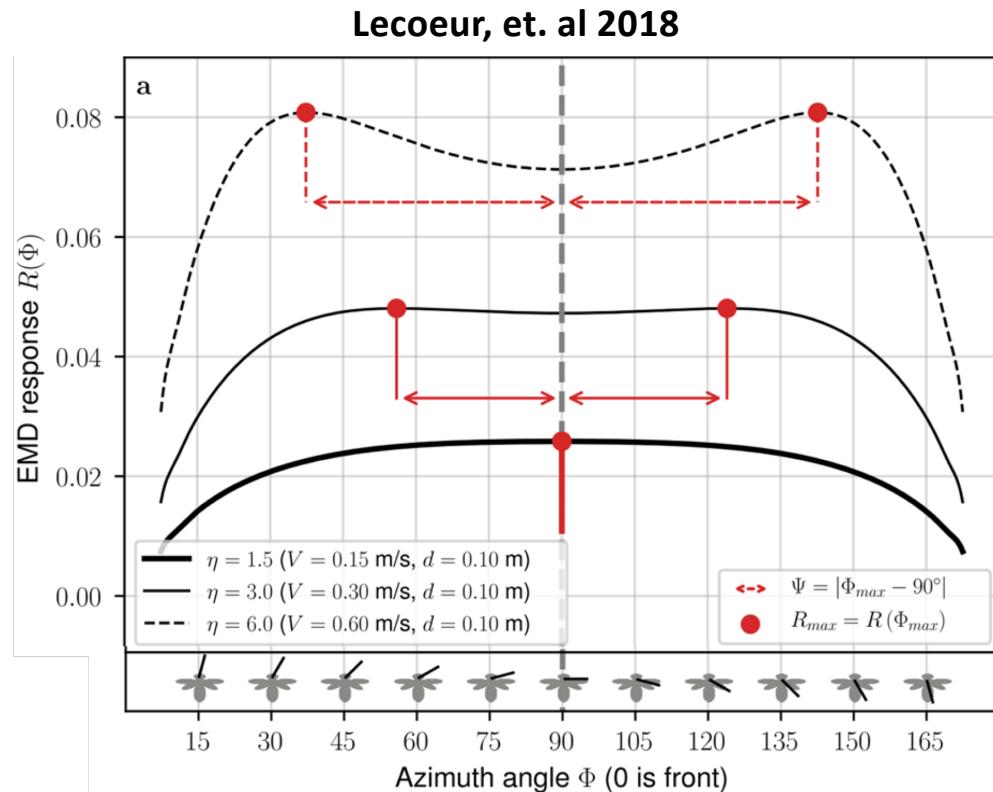
Left to Right Movement



# Results – EMD Response

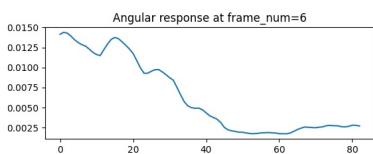
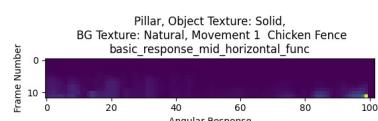
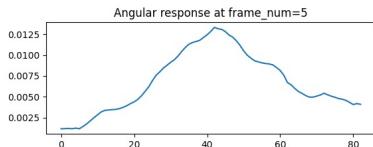
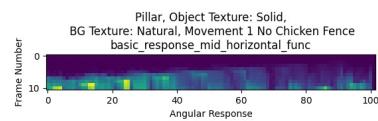


# Results – EMD Response

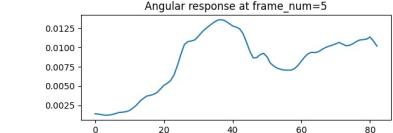
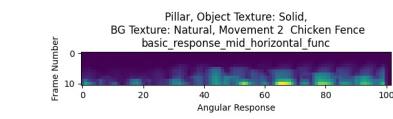
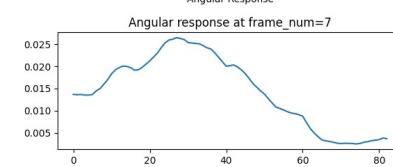
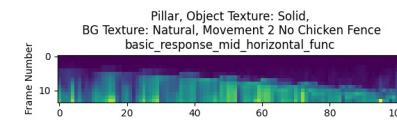


# Results

Left to Right Movement

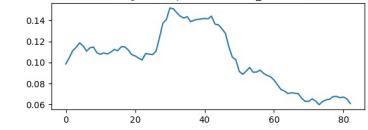
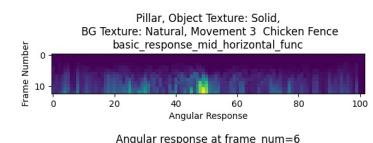
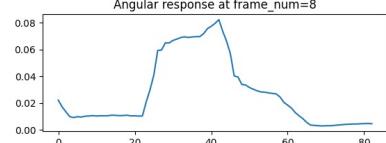
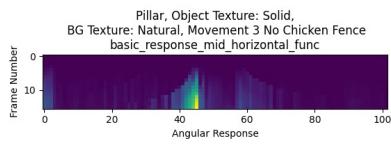
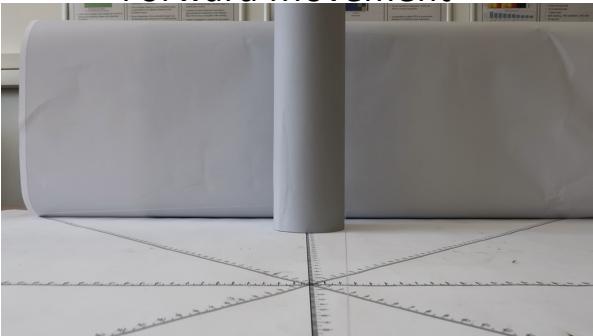


Right to Left Movement

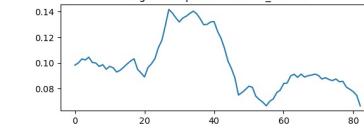
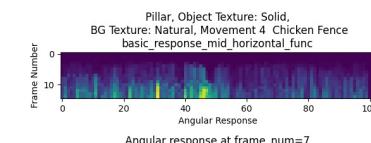
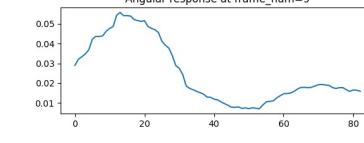
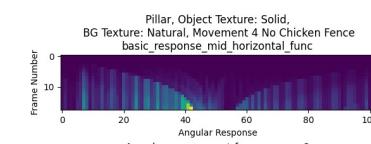
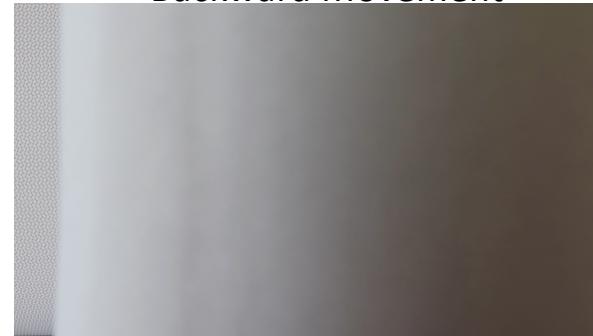


# Results

Forward Movement

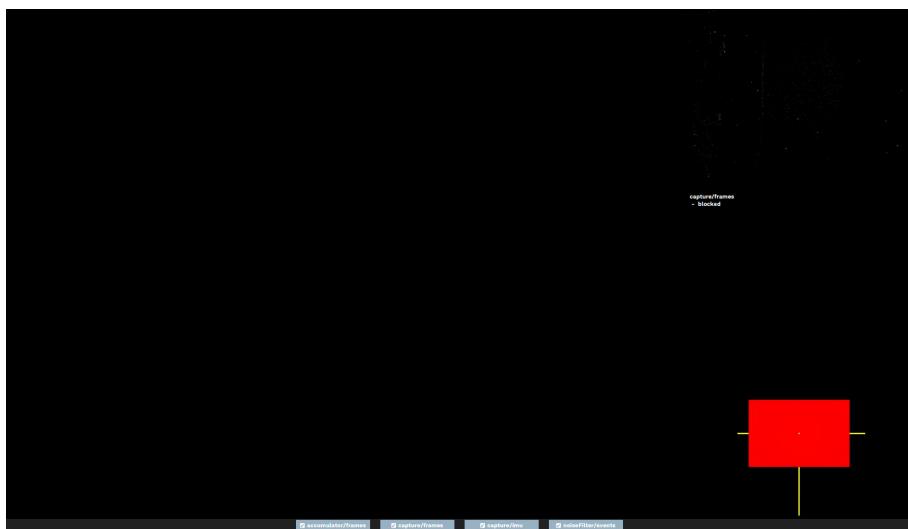


Backward Movement

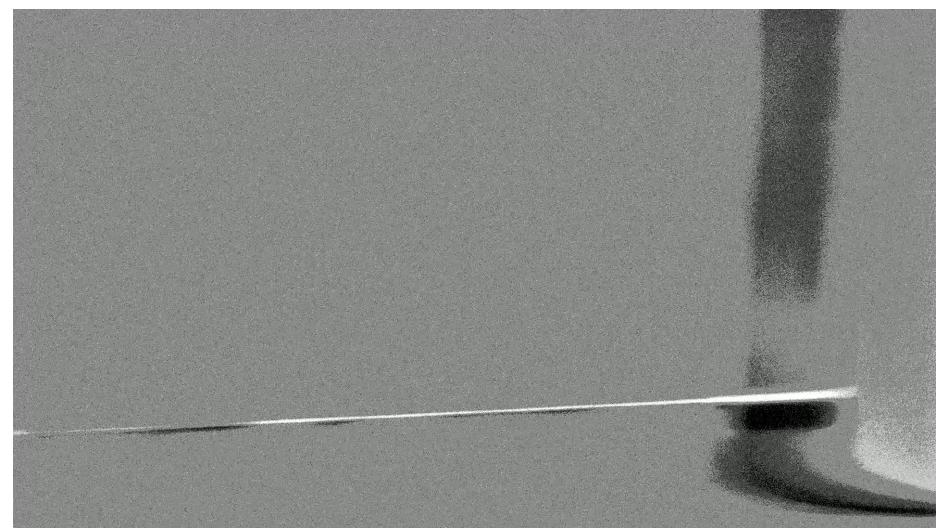


# Results – Event Camera

Left to Right

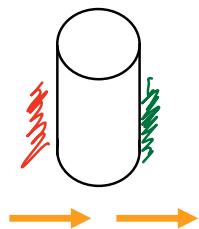


Left to Right

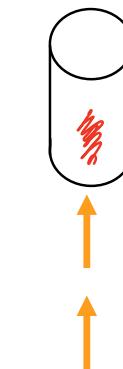


# Results – Event Camera

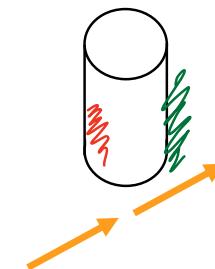
Left to Right



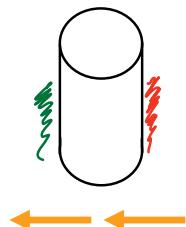
Forward



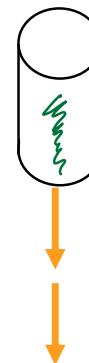
Right-Forward



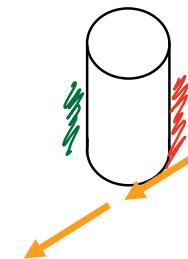
Right to Left



Backward

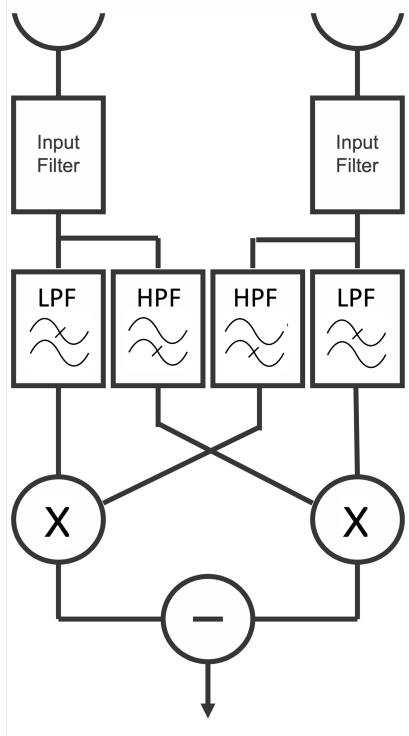


Left-Backward

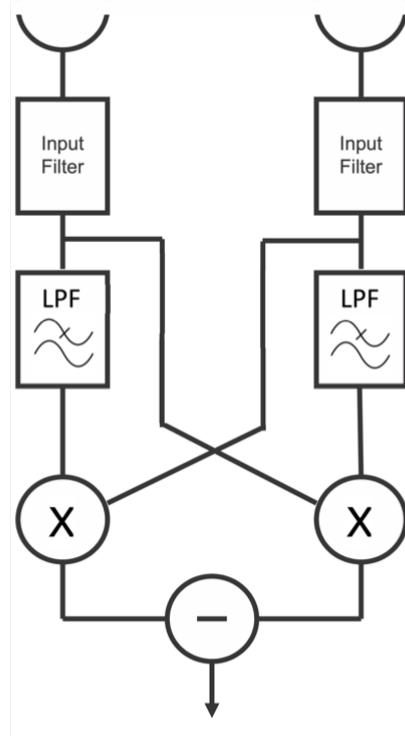


# Results – Various EMD Tested

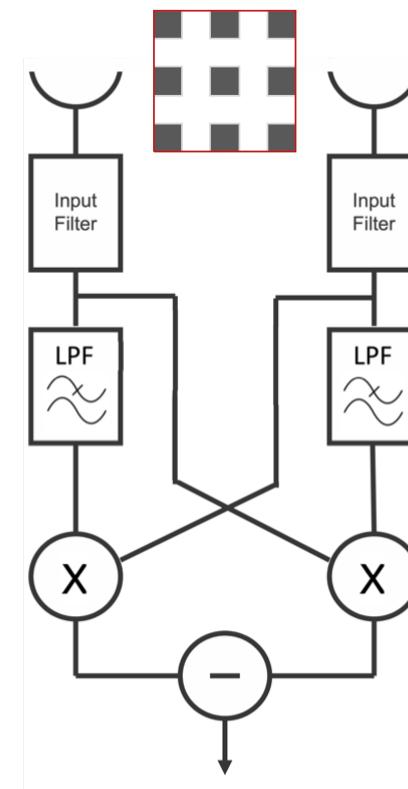
Reichardt



Leceour



Dilation



# Results – Signal Processing Blocks

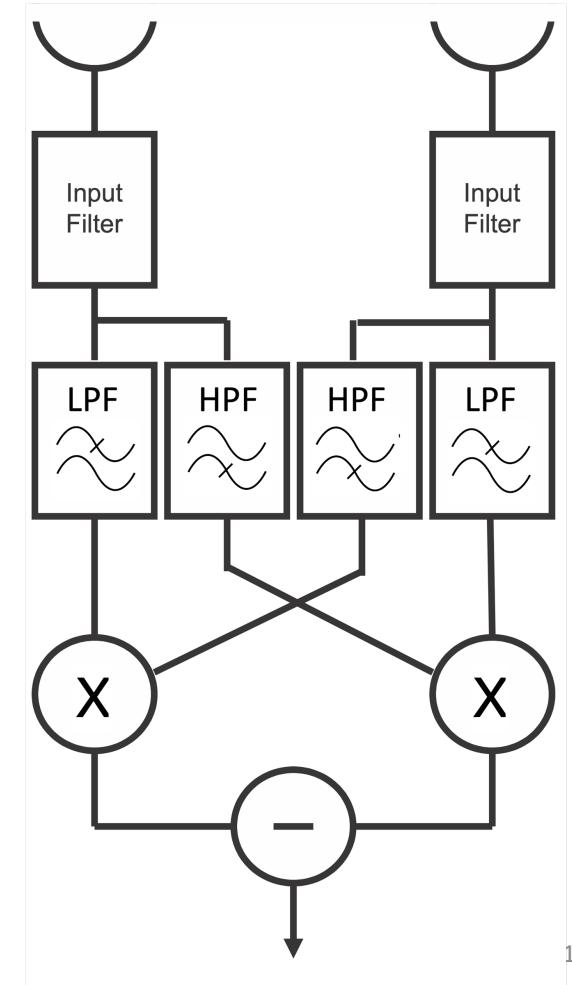
```

class SP_Block:
    """
    A signal processing block performs an action on one or more signal(s) and returns one or more result signal(s).
    """

    def __init__(self, action, inputs: int = 1, outputs: int = 1, **kwargs):
        """
        Initializer
        :param action: a callable function to be performed on the input signals. Should be passed as positional argument.
        :param inputs: The number of input signals expected. Should be passed as positional argument.
        :param outputs: The number of output signals expected. Should be passed as positional argument.
        :param kwargs: Any auxiliary data needed for the action function. should be passed with the correct keywords for the functions passed.
        """
        self.action = action
        self.inputs = inputs
        self.outputs = outputs
        self.kwargs = kwargs

    def __call__(self, *args):
        """
        Pass signals to the block.
        Syntax: <SP_Block instance name>(signal1, signal2, ...)
        :param args: The input signal(s) to be passed.
        :return: The result signal(s)
        """
        return self.action(*args, **self.kwargs)

```



## Conclusion

- Created an elementary dataset
- Implemented Various EMD models
- Event Camera Experiments

## Future Work

- Create more accurate and reliable dataset
- Extracting parameters using the data provided
- Implementing and combining EMD models
- Exploring Event Camera features



## Future Work - Documentation

- Documented code can be found on GIT
- Dataset is catalogued and uploaded to cloud

## References

1. Julien Lecoeur, Emily Baird and Dario Floreano. "Spatial Encoding of Translational Optic Flow in Planar Scenes by Elementary Motion Detector Arrays".  
DOI: <https://doi.org/10.1038/s41598-018-24162-z>
2. Alexander Borst, "Neural Circuits for Elementary Motion Detection".  
DOI: <https://doi.org/10.3109/01677063.2013.876022>
3. James E Fitzgerald, Damon A Clark. "Nonlinear circuits for naturalistic visual motion estimation".  
DOI: <https://doi.org/10.7554/eLife.09123>
4. Guillermo Gallego, Tobi Delbrück, Garrick Orchard, Chiara Bartolozzi, Brian Taba, Andrea Censi, Stefan Leutenegger, Andrew J. Davison, Jorg Conradt, Kostas Daniilidis, Davide Scaramuzza. Event-Based Vision: A Survey  
IEEE: <https://ieeexplore.ieee.org/document/9138762>