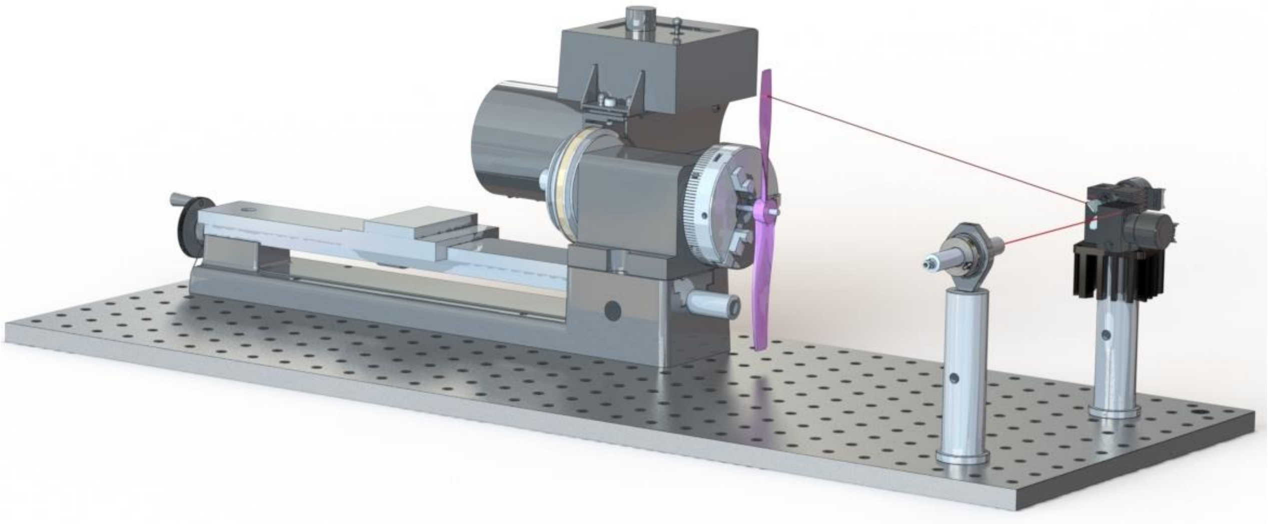
High-rate Challenge Group

Tuesday July 29th
3PM EST



Event Cameras for Structural Health Monitoring (SHM)

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[4]Department of Computer Science (CS)
Smart Management of Infrastructure Laboratory (SMILab) www.smilab.unm.edu

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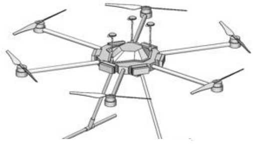
Smart Management of Infrastructure



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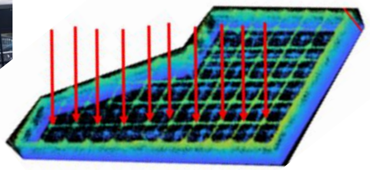
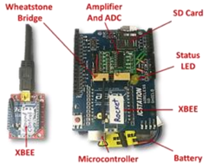
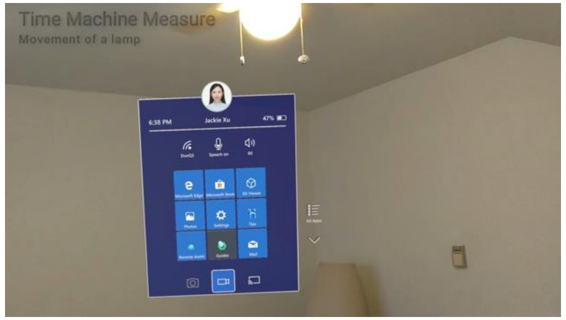
Smart Management
Infrastructure Laboratory



Outdoor Field Monitoring
Railroads, Bridges, and Tramways
Structural Health Monitoring
3D Point Cloud Scanning and Analysis

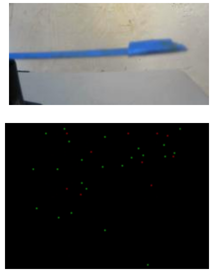


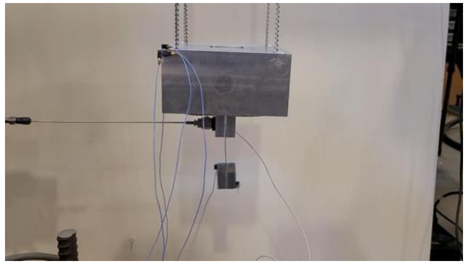
Autonomous Sensing
Wireless Smart Sensors
LEWIS Sensors for Rocket Trajectory and Testing

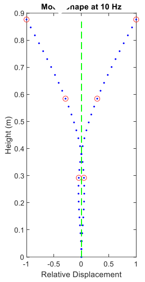


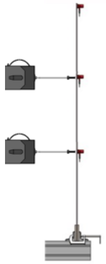
Human-Infrastructure Interfaces
Human Factors in Engineering

Cyber Physical Systems
Cybersecurity

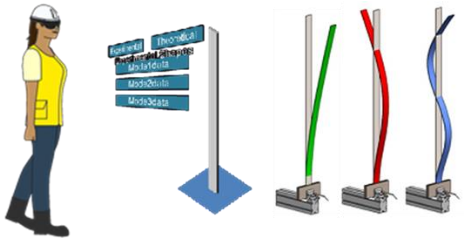




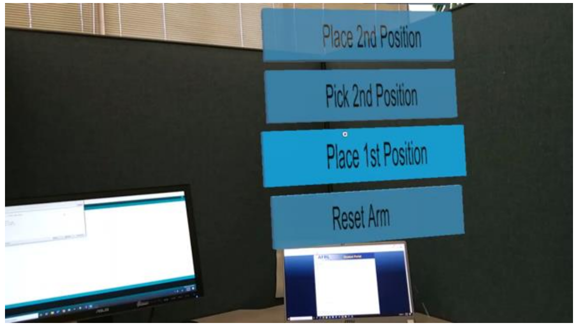




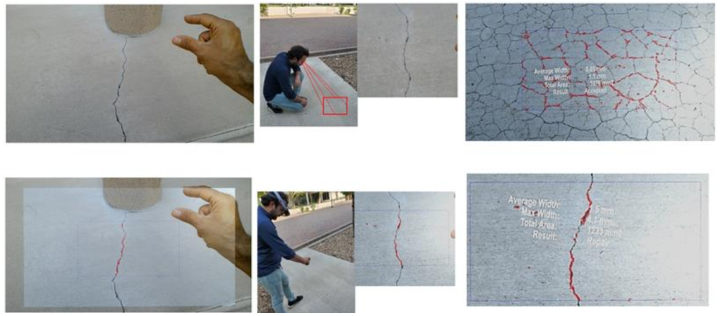
Neuromorphic Sensing
Non-linear Stabilization
Random Vibrations



Human-Infrastructure Interfaces



Human-Machine Interfaces



AI AR for automatic crack measurement

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Contents

Motivation

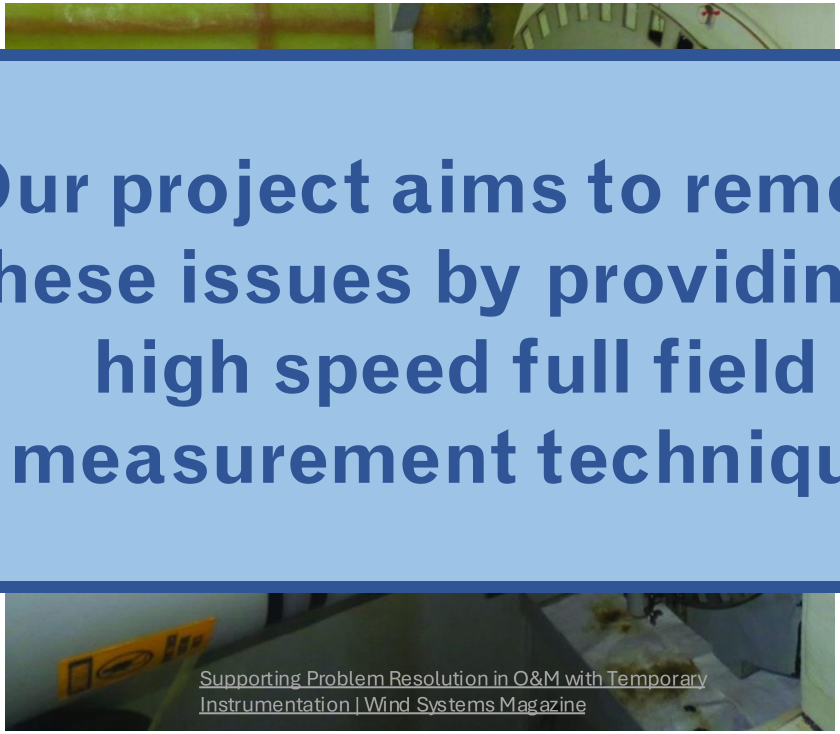
Why SHM on Rotating Propellers?

Structural Health Monitoring (SHM) is crucial for rotating objects in aerospace, wind energy, and marine industries.

Detects early defects, prevents failures, reduces maintenance costs, and extends component lifespan.

Current Techniques

Accelerometer



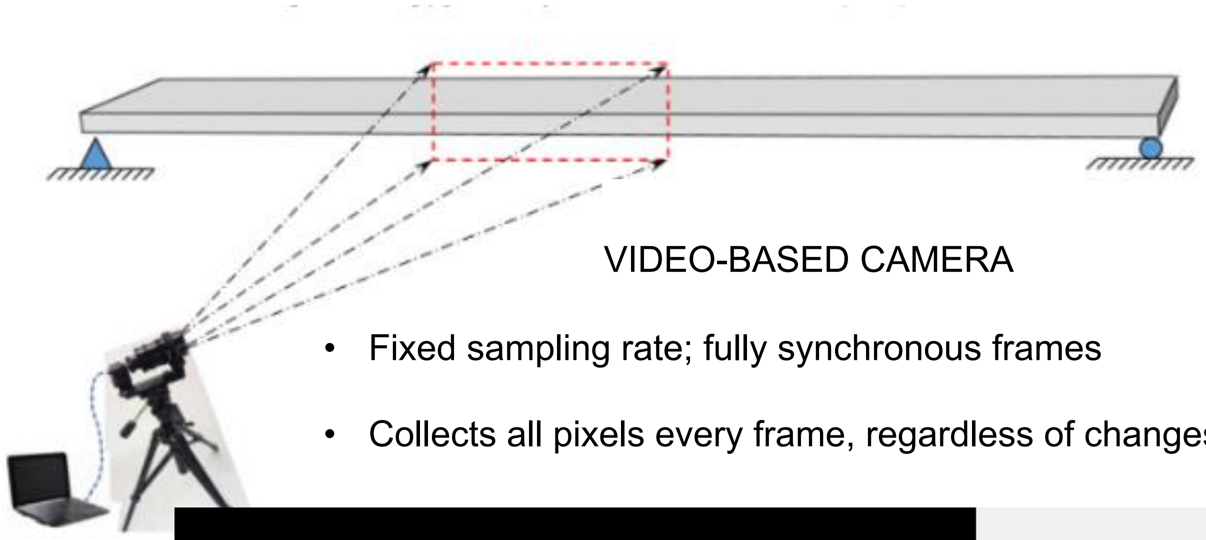
Strain gauge

LIDAR

Our project aims to remedy these issues by providing a high speed full field measurement technique

Neuromorphic Camera

Neuromorphic event-based vision

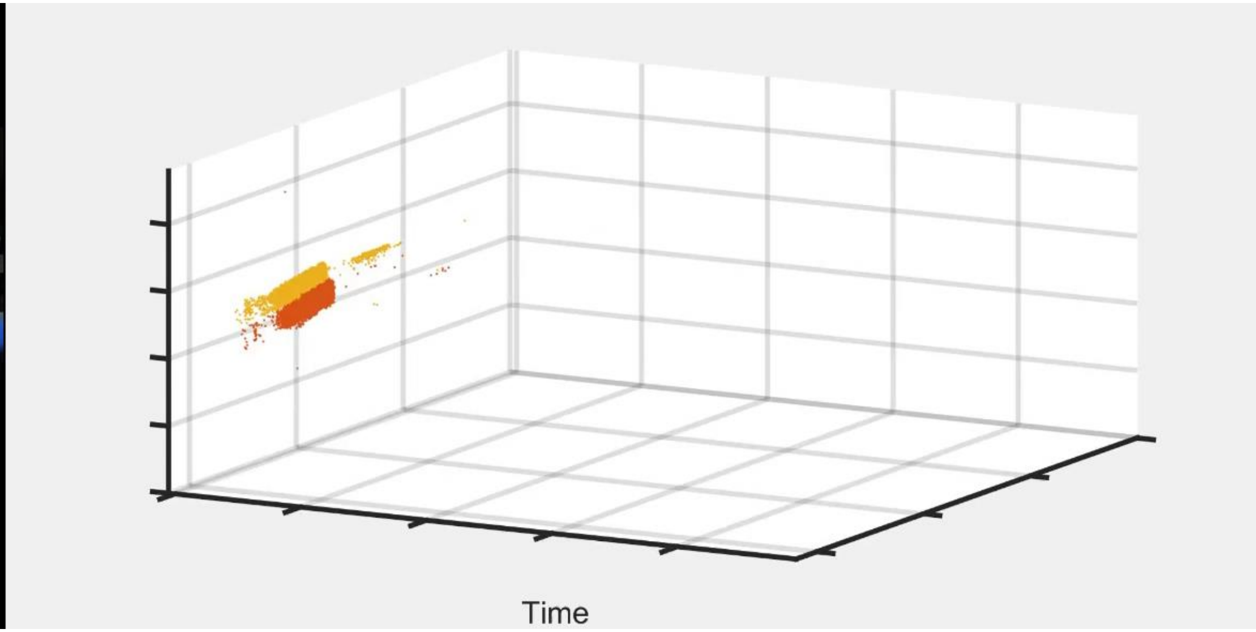


VIDEO-BASED CAMERA

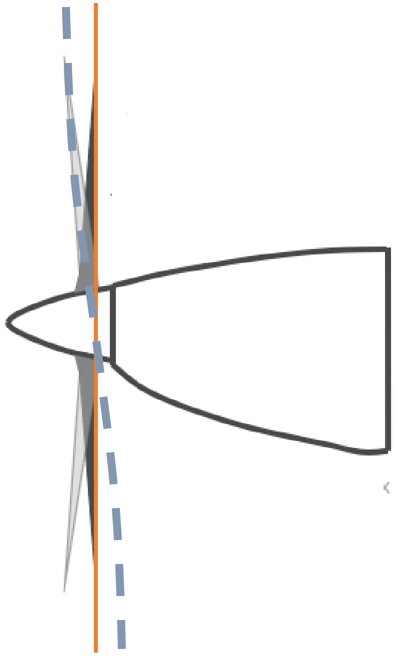
- Fixed sampling rate; fully synchronous frames
- Collects all pixels every frame, regardless of changes

EVENT-BASED CAMERA

- Asynchronous data collection between pixels
- Only collects data in pixels with change in light

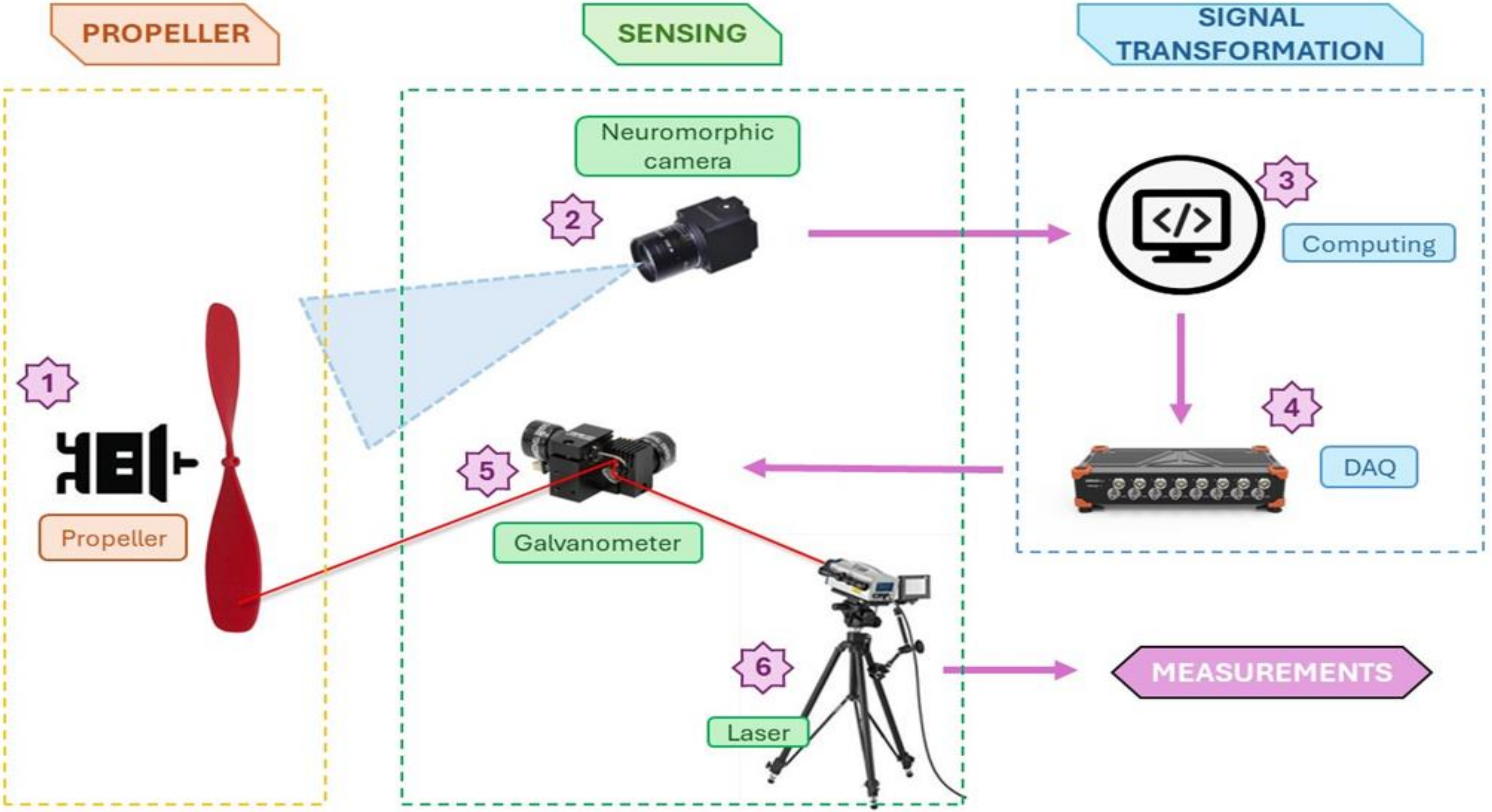


Methodology



Propellor rotatory movement → Neuromorphic camera sensing → Real-time position extraction → Signal conditioning & D/A conversion → Galvanometer movement → LDV measurement → **Out-of-plane Displacement Results**

Hardware Components


PROPELLER
SENSING
SIGNAL TRANSFORMATION
Neuromorphic camera
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3
Computing
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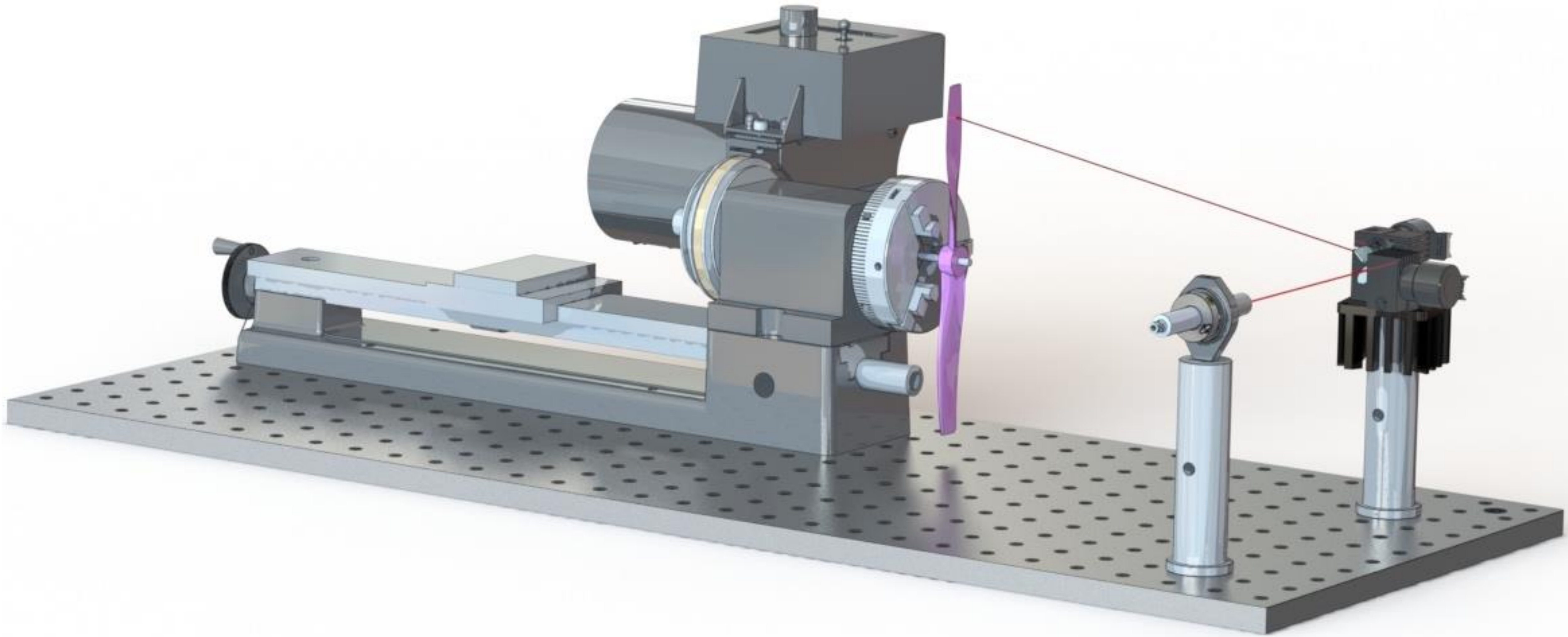
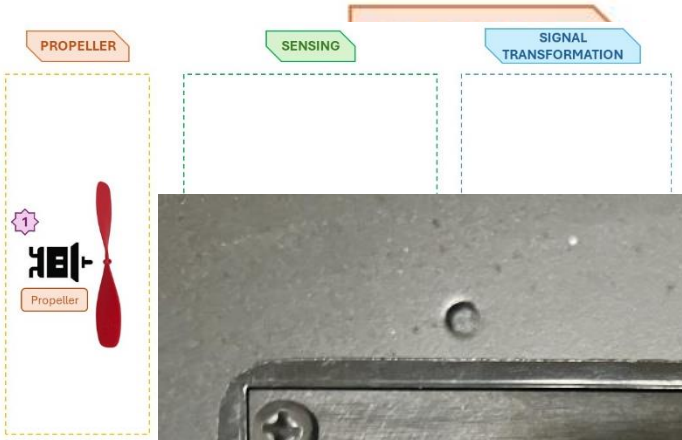
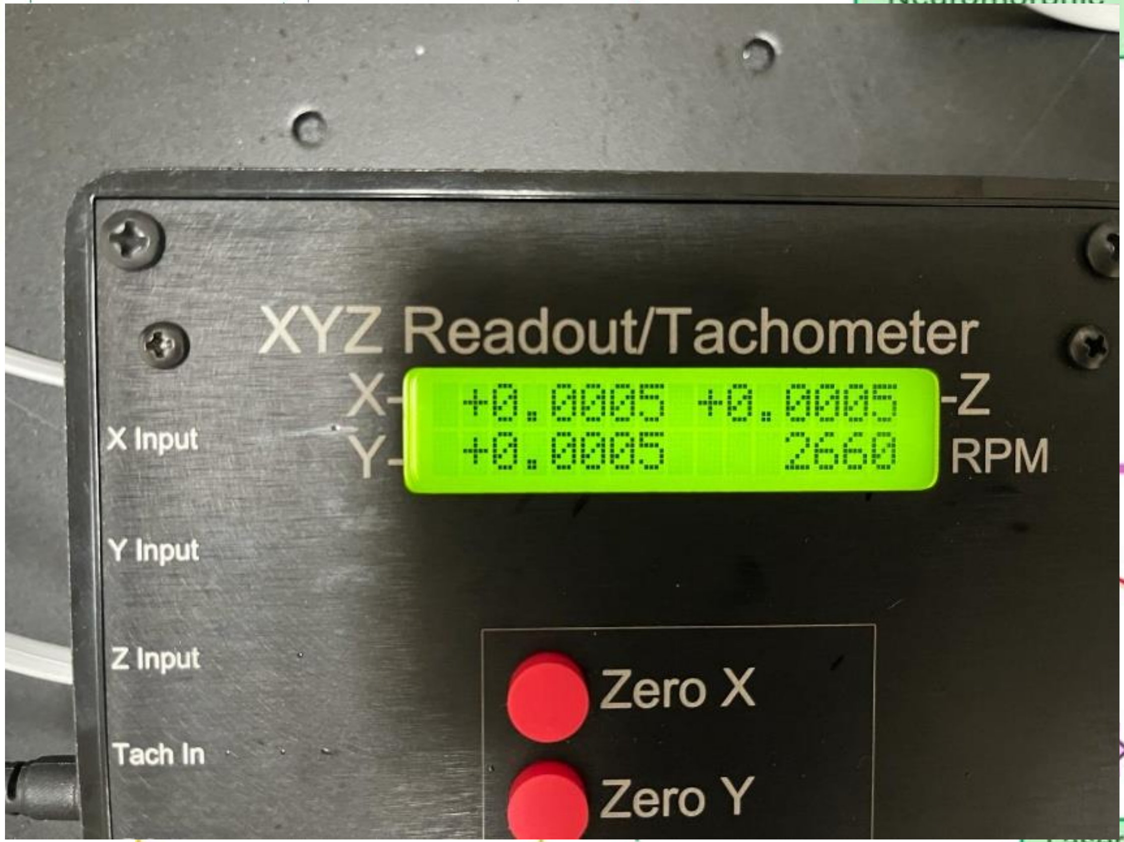
4
DAQ
Propeller
Galvanometer
6
Laser
MEASUREMENTS

Hardware Integration

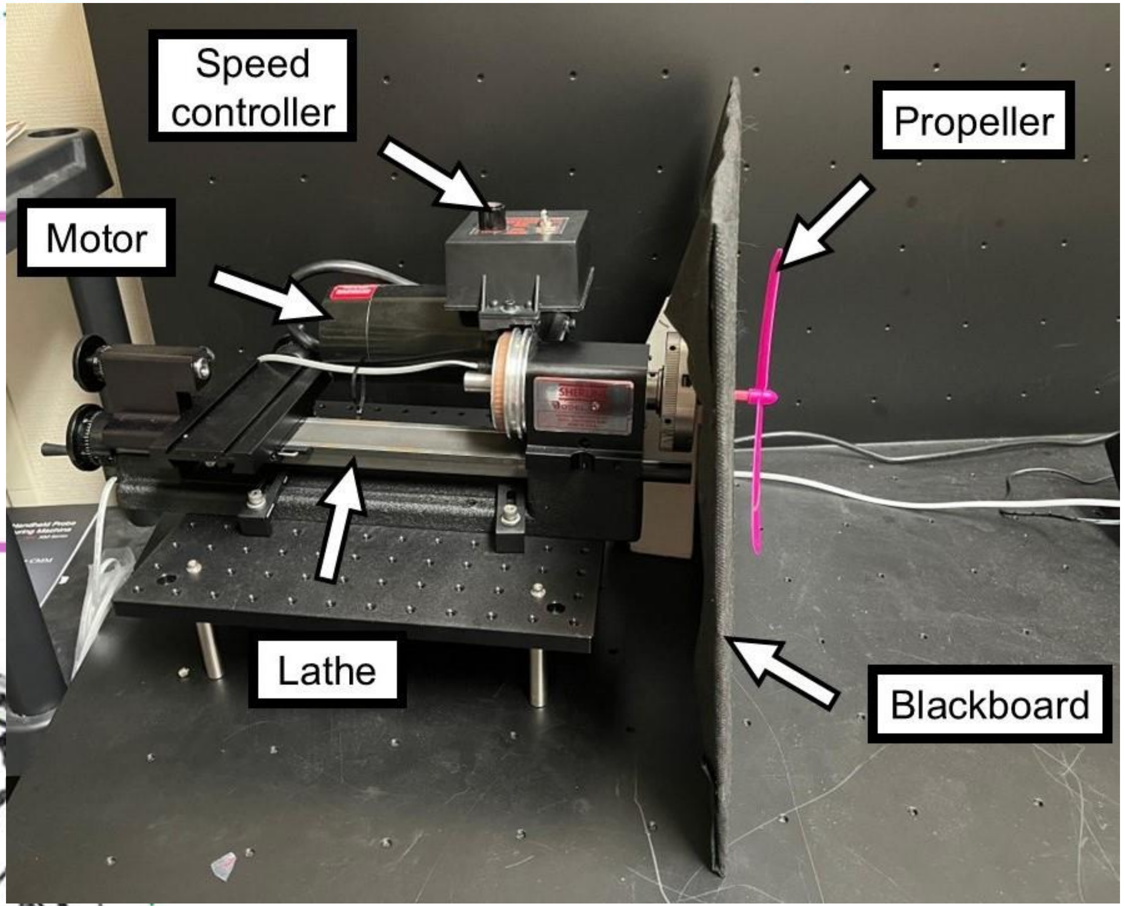


Propeller





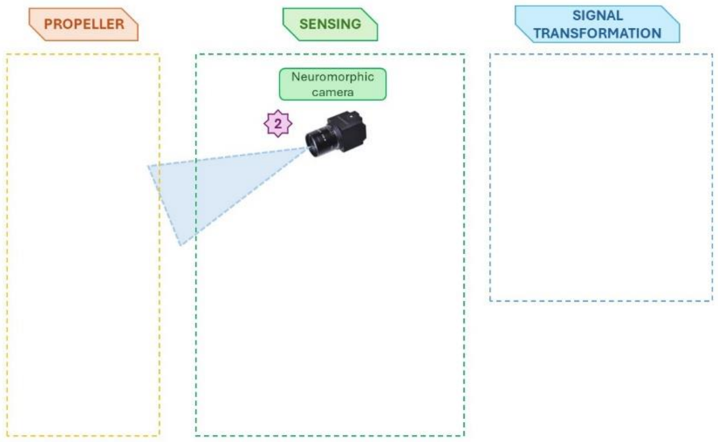
Tachometer

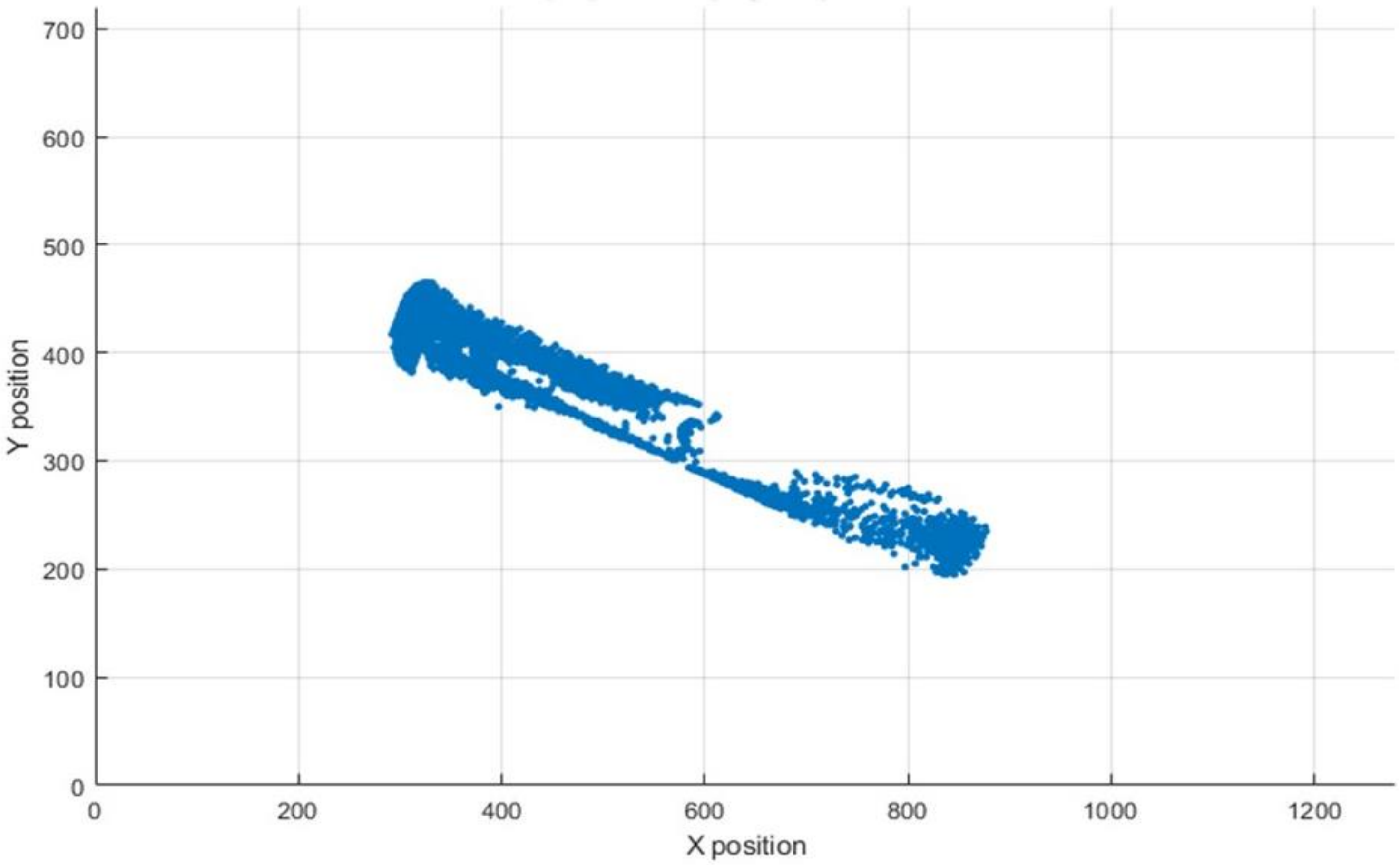


Propeller set-up

Experimental Setup

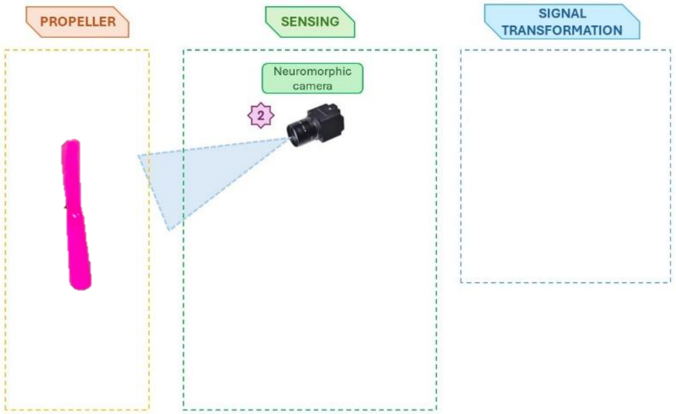
Neuromorphic camera raw data



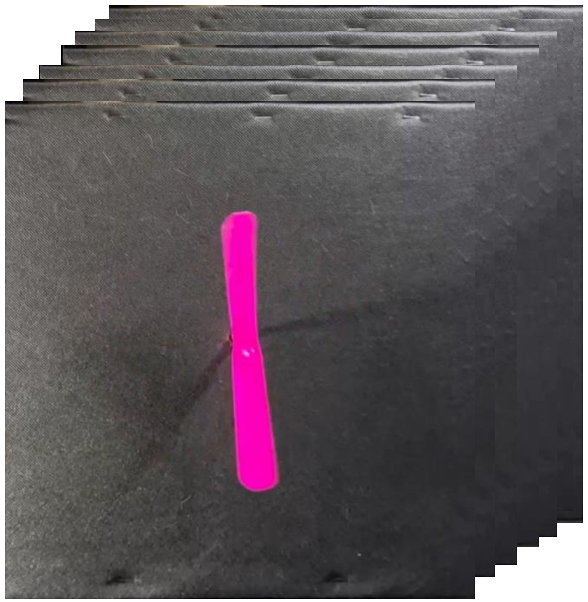


Point cloud

Comparison with Traditional Cameras



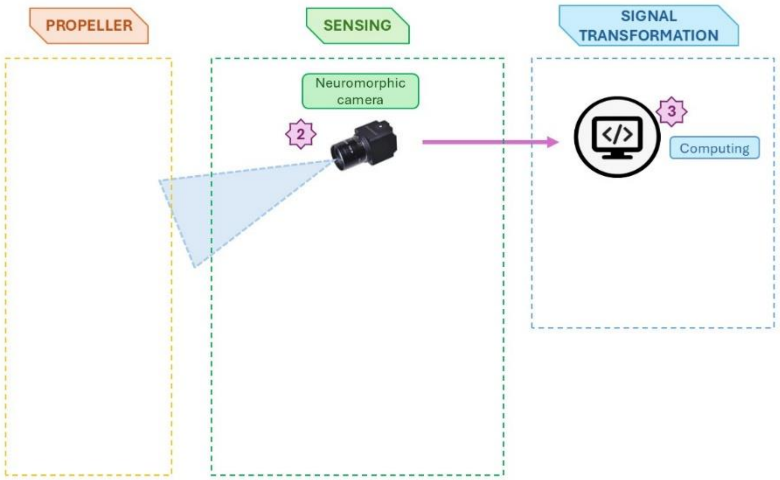
Conventional camera



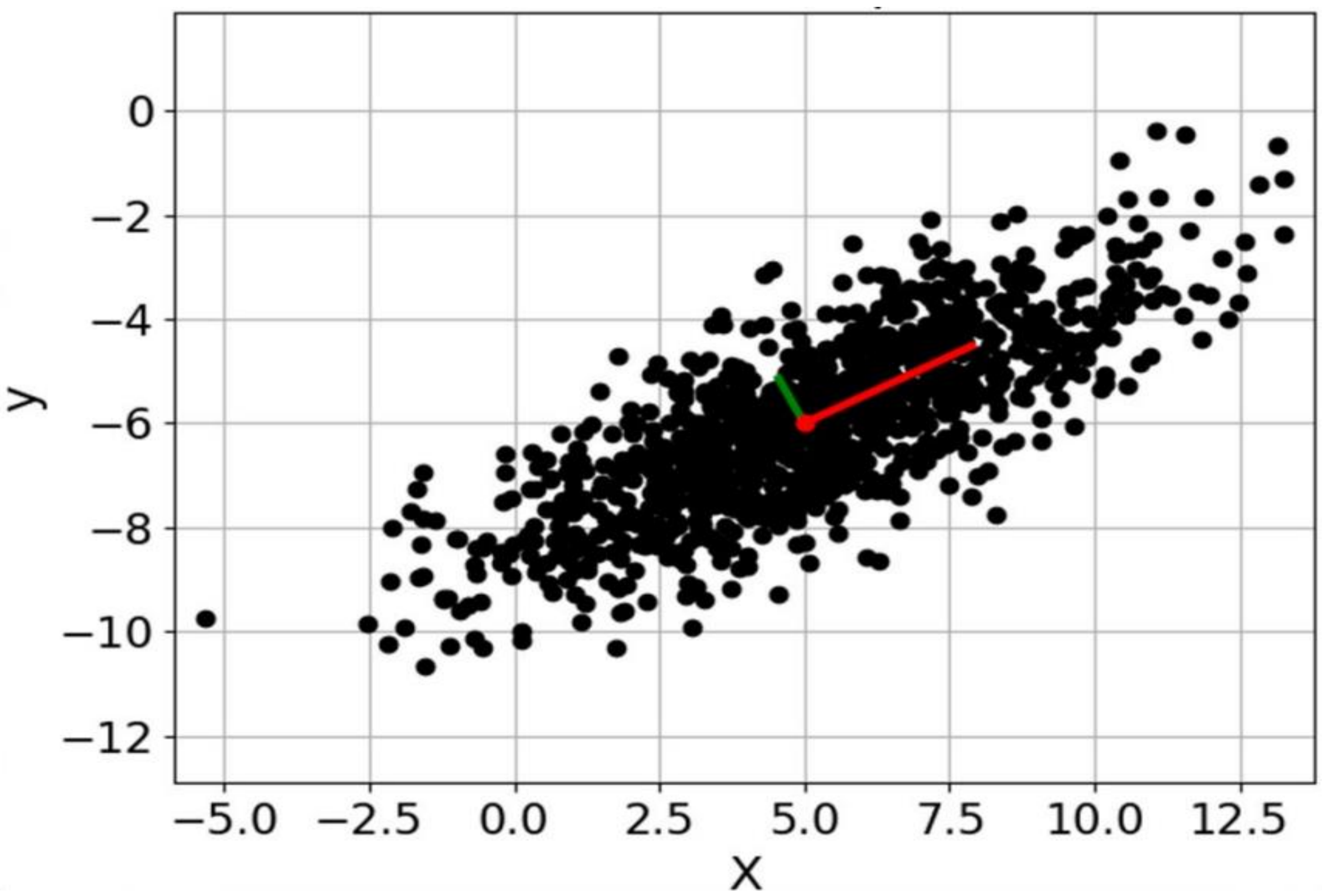
- Independent pixel activation
- Reduced output information
- Continuous low latency data

PCA Analysis

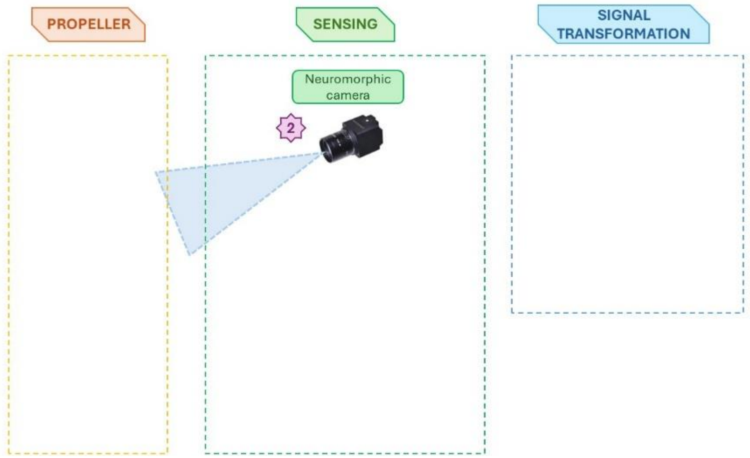
Principal Component Analysis

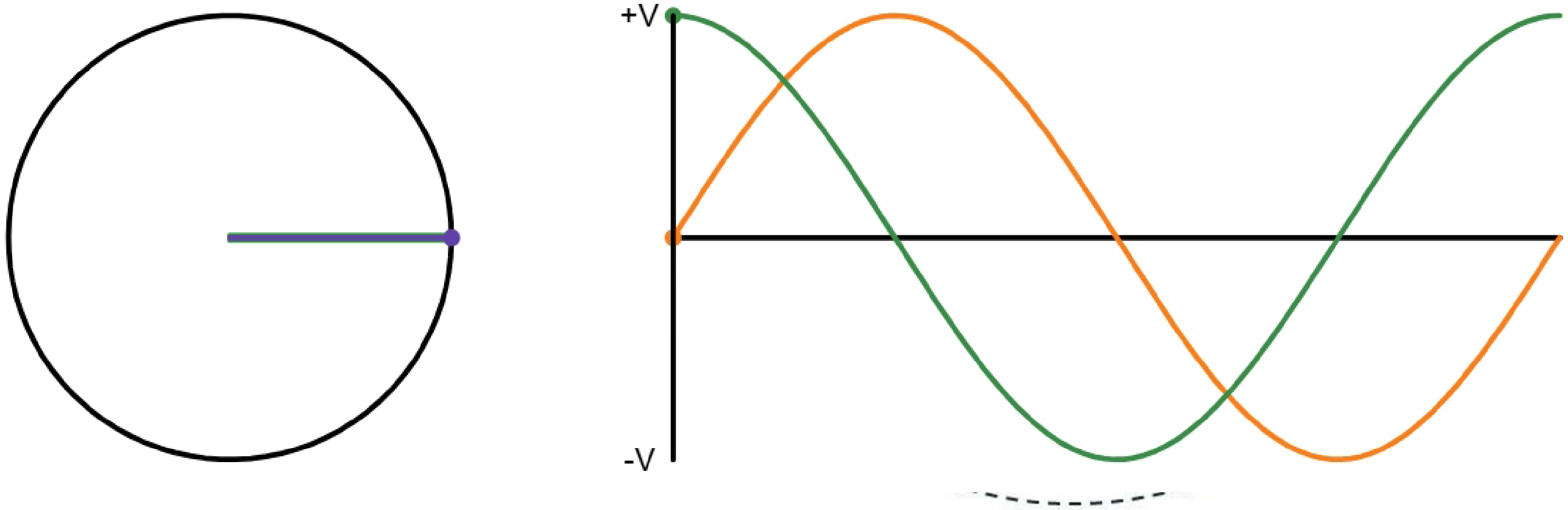


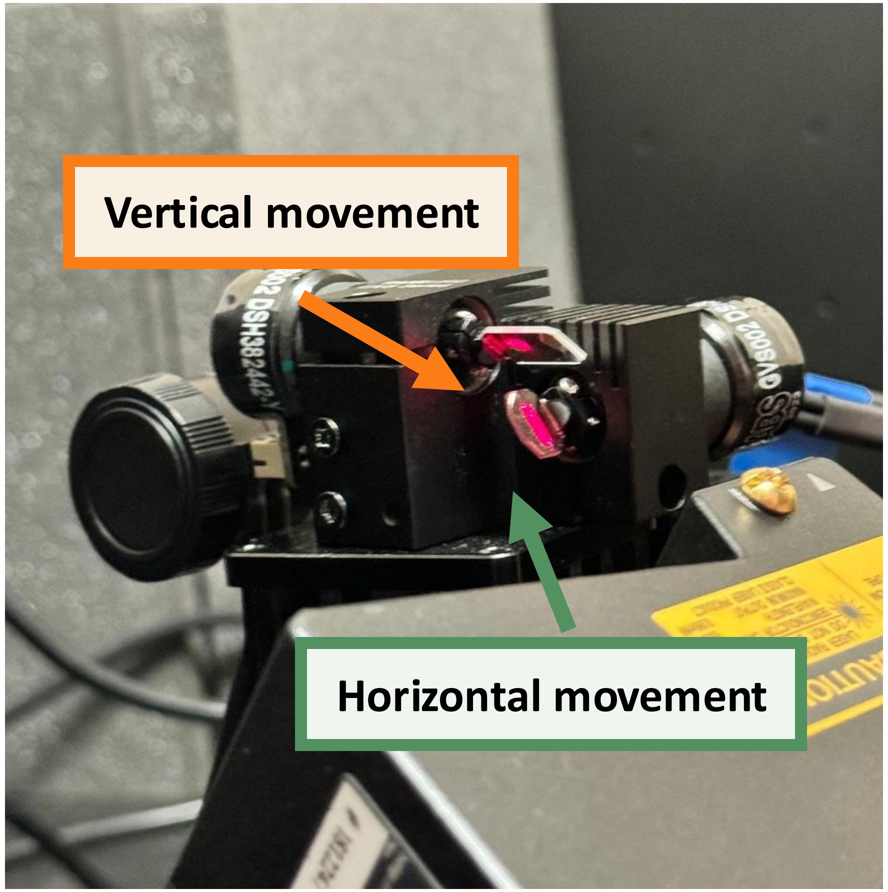
1. Group events are timestamps
2. Calculate PCA
3. Obtain dominant 2 directions



D/A Conversion for Galvanometer



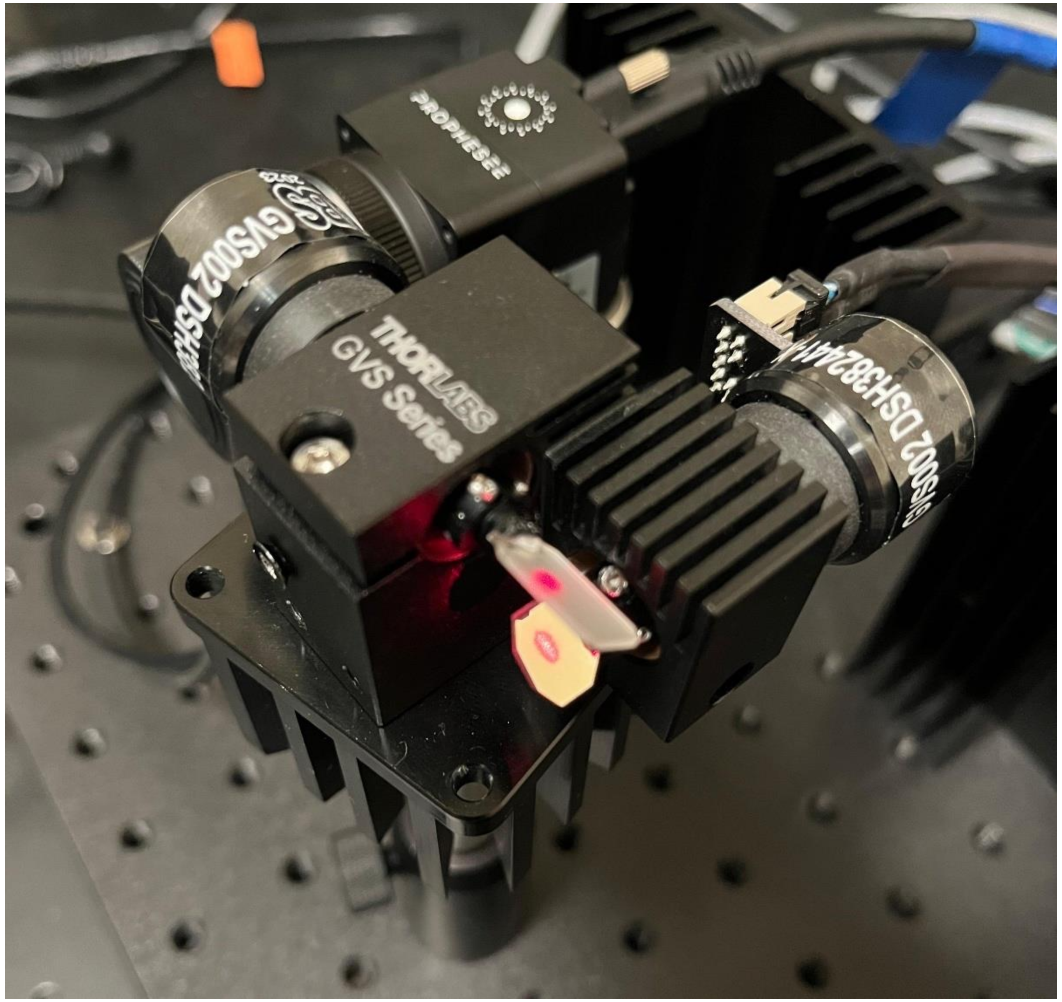




Out of Plane Sensing

Laser Doppler Vibrometer

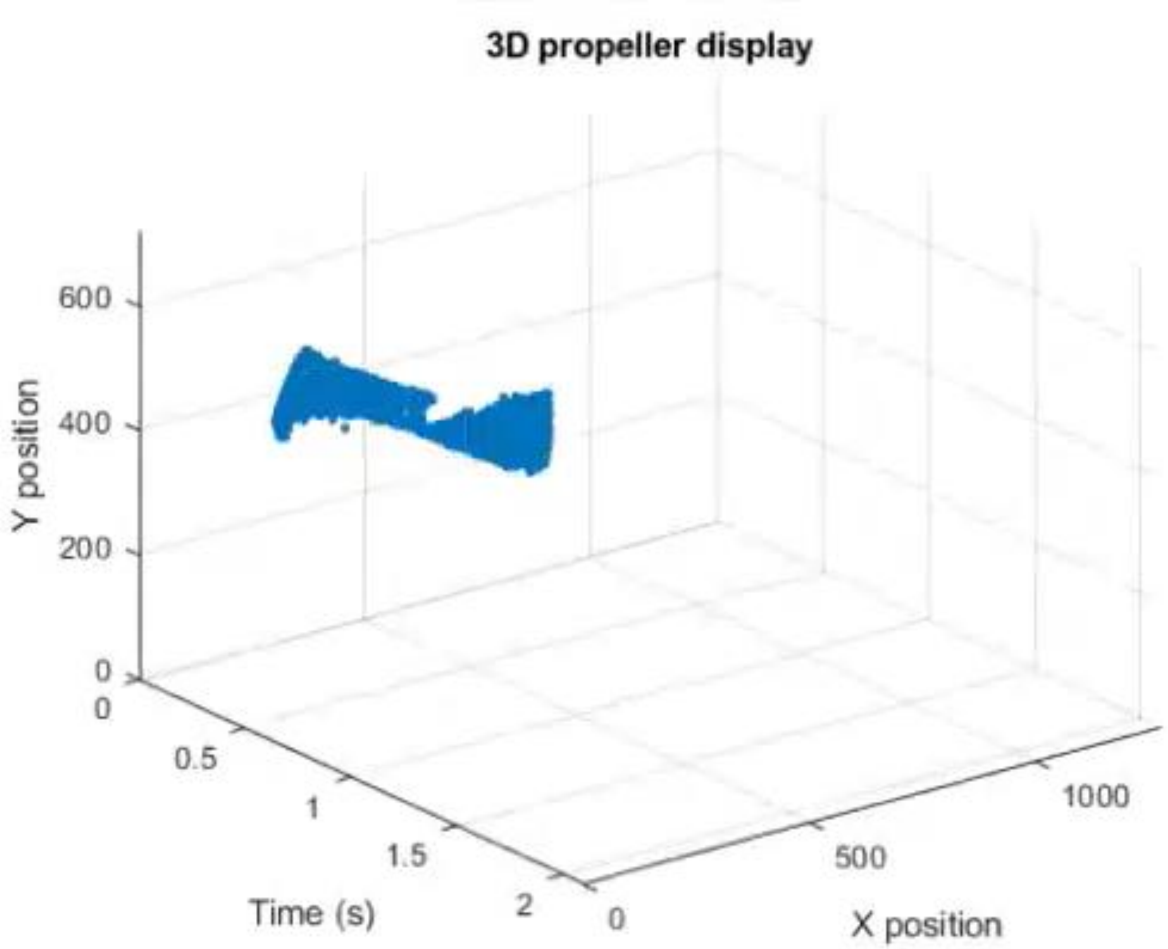
LDV

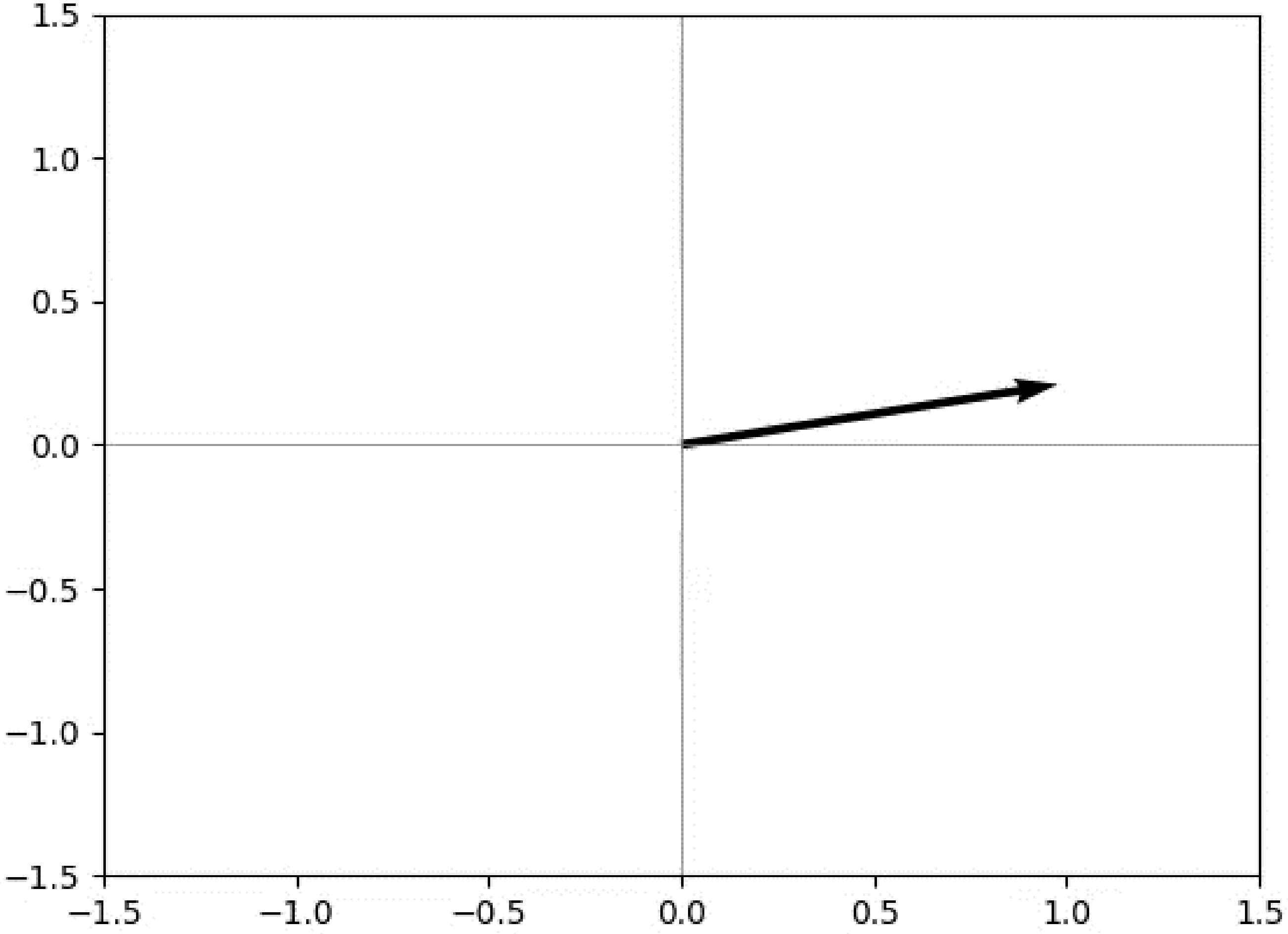


Laser through galvanometer

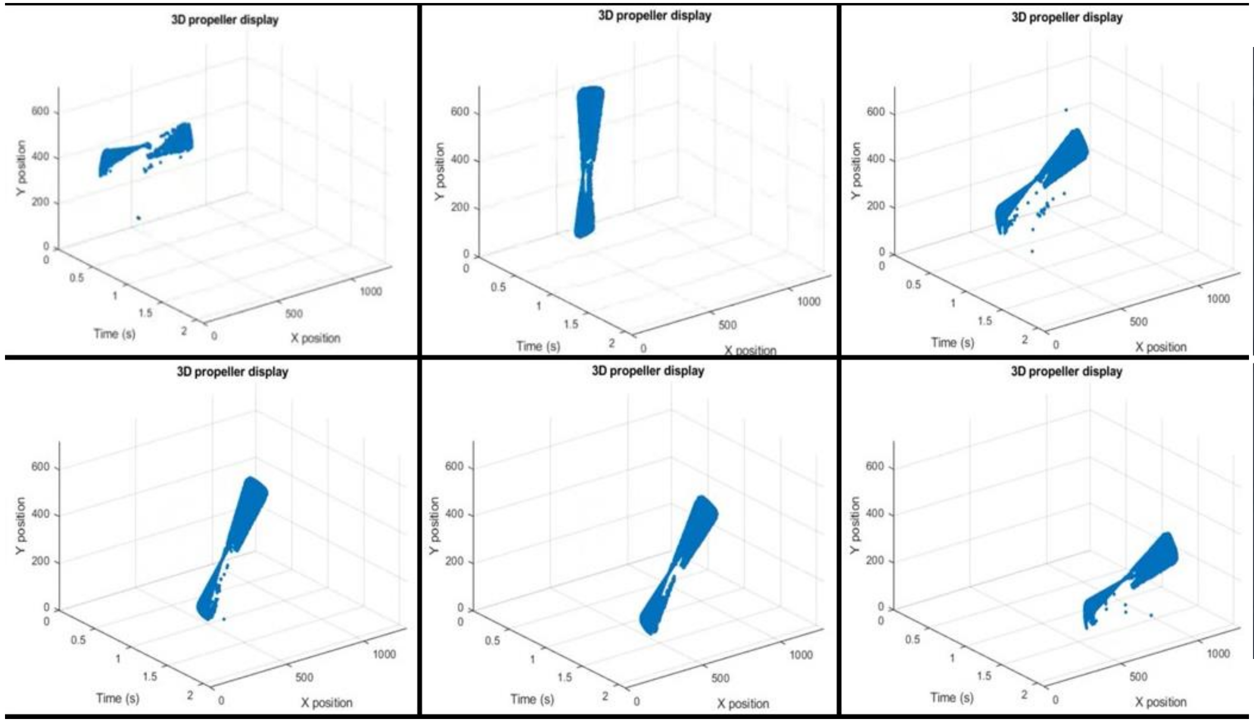
Experiment and Final Result

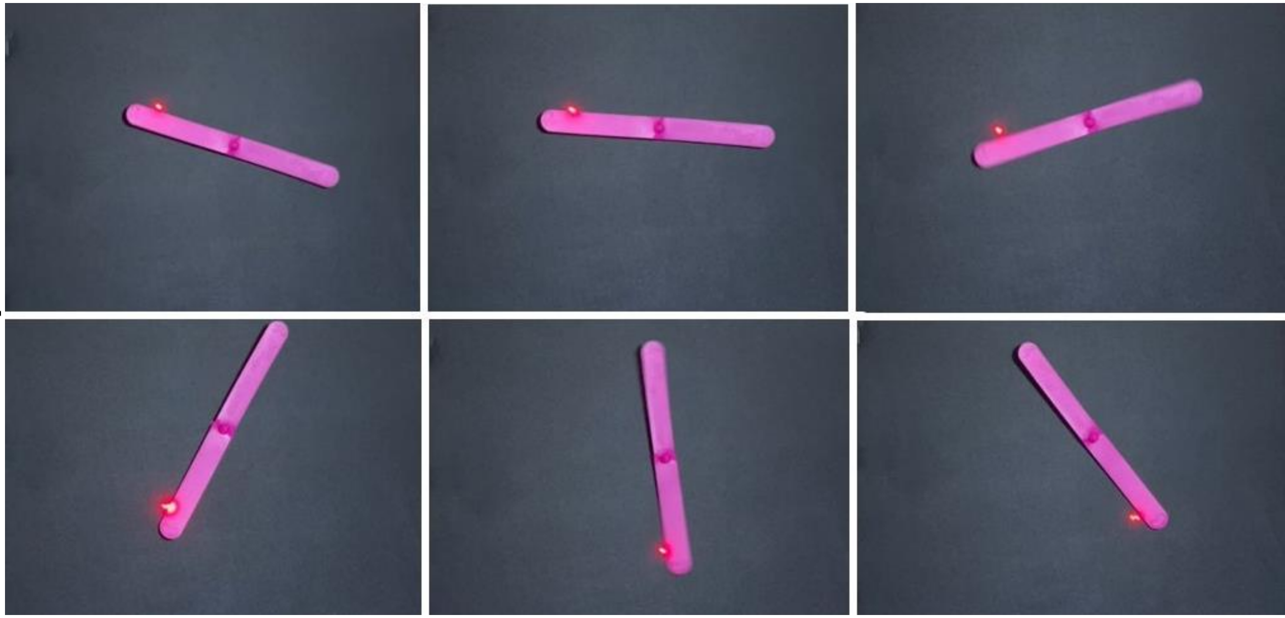
Tracking with PCA





Laser alignment with PCA





Conclusions

Conclusions

1. Successful use of neuromorphic sensing for asynchronous event tracking rotatory behavior at varying speeds

2. Results to date show automation capabilities as well as controlled latency up to 200 rpm

3. New opportunities towards the implementation of asynchronous control of nonlinear structures at the laboratory and the field.

Thank you!

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