HOUSE FLY (*MUSCA DOMESTICA*) INSPIRED COMPOUND VISION SENSOR AND BIO-MIMETIC SIGNAL PROCESSING

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Key Idea

- Compound Vision Sensors based on the vision of common housefly possess motion hyperacuity and detect inter-pixel movement.
- The aim is to design a novel sensor to outperform existing technologies in specific real world applications
- Common Housefly Vision design allows better edge detection and near instantaneous object tracking.
- Reason: The photoreceptors image a point on the space with overlapping field of view.

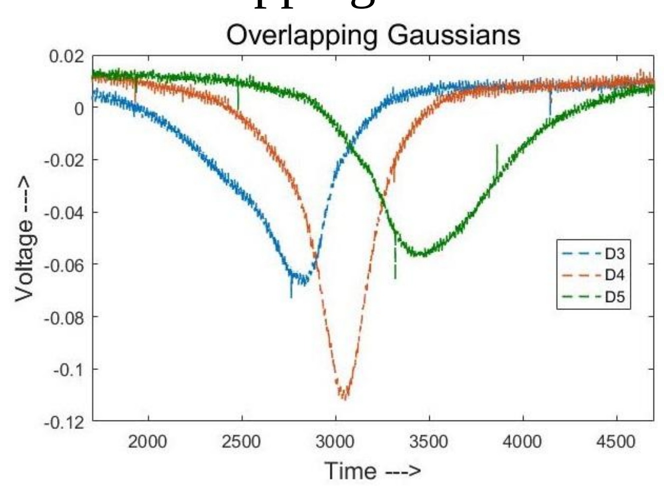

Figure 1: Ideal response to moving target. It shows overlapping Gaussian waveforms for channels D3, D4, and D4 in the fly eye vision sensor.

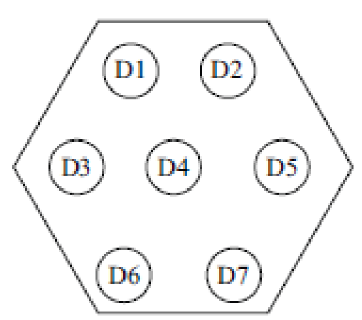

Figure 2: Layout of seven channels in the fly eye vision sensor.

Problem Domain

- Developing the hardware necessary to processes numerous parallel channels at high rates of speed.
- Developing signal and image processing techniques that leverage overlapping sampling.

Specific Problems Addressed

- Removal of Signal Artifacts generated by bio-inspired light adaptation system.
- Generate a digital equivalent fly eye vision sensor based on three parameters:

1. Location of Digitization
2. Sampling Rate
3. Resolution

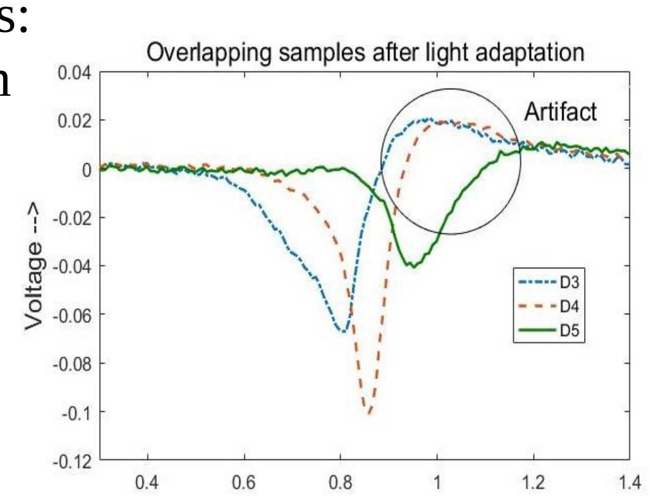

Figure 3: The marked region in the light adapted overlapping samples show the artifact after light adaptation. Even after using a low pass filter, these artifacts still exist.

Methodological Approach

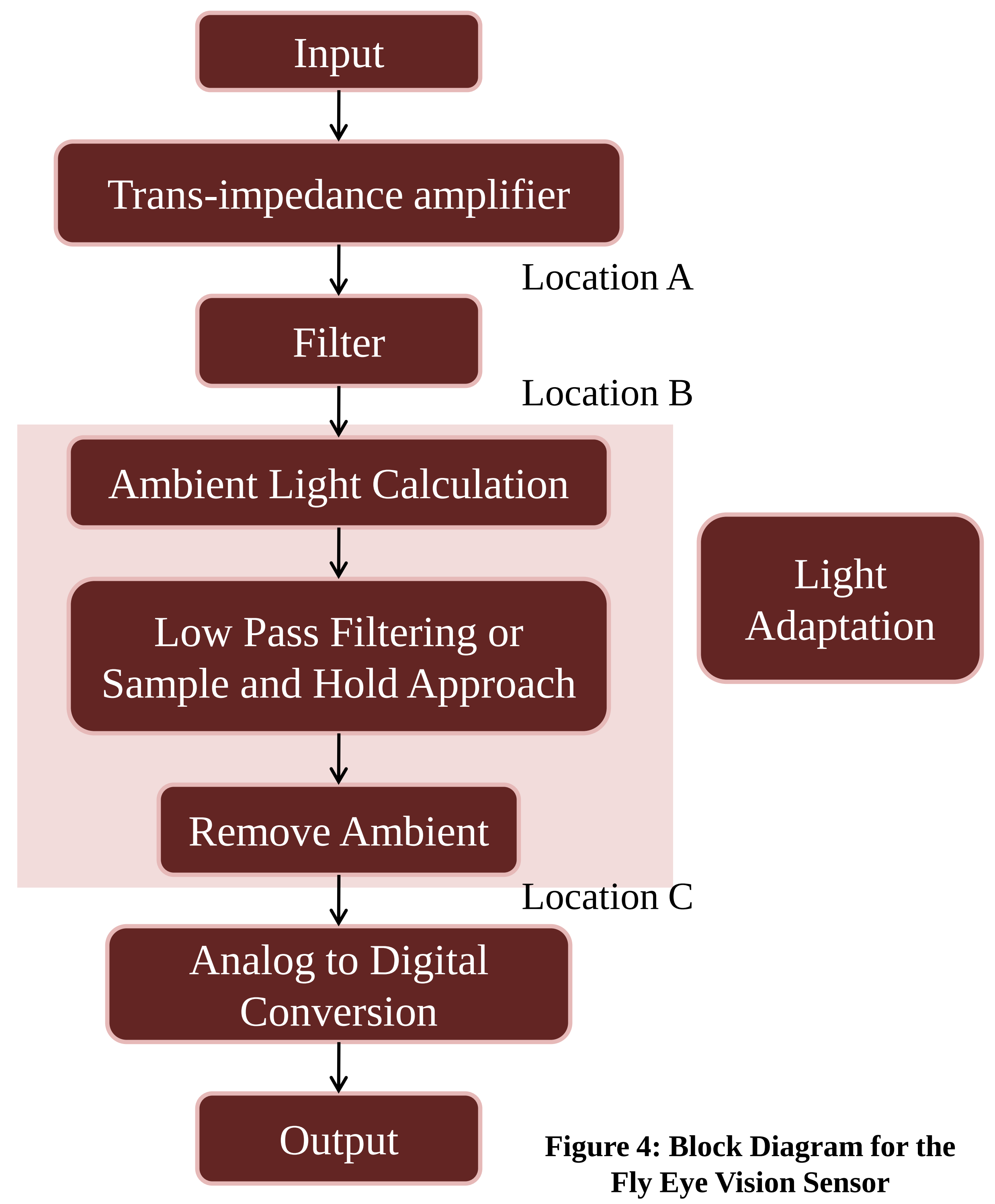

Figure 4: Block Diagram for the Fly Eye Vision Sensor

Theoretical Results

- For 15V power rails, the generated output signal have a dynamic range of ± 1V, when digitized at location C.
- The minimum number of bits needed (resolution) to detect the change in light intensity due to moving object is 6 bits.
- The minimum distance that the object has to move, for the fly eye vision sensor to detect motion is 72µm for an object 0.3m away from the sensor.
- The maximum speed of object permissible for the sensor to detect motion is directly related to the sample rate of the A/D converter by:

$$max.\ velocity\ of\ object = 72\mu m * sample\ rate$$

Graphical Results

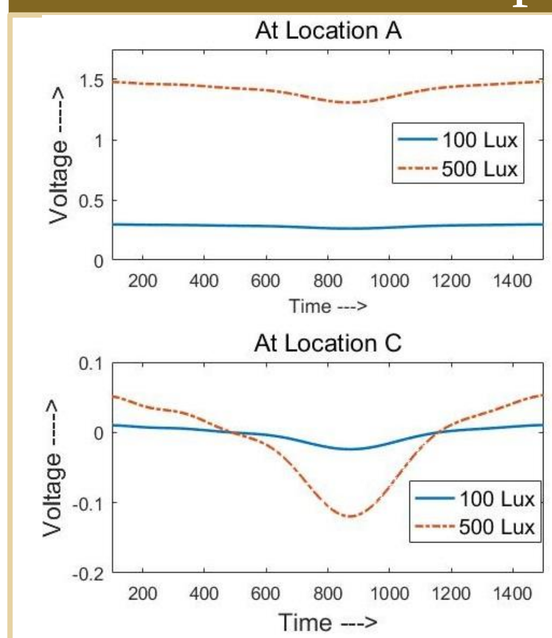

Figure 5: Output peaks corresponding to Location A and Location C for digitization at 100 Lux and 500 Lux.

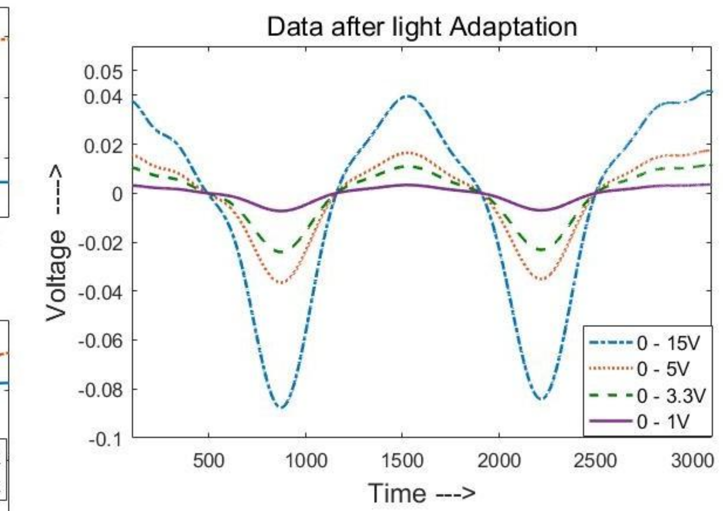

Figure 6: Output peaks corresponding to different power rails at same light intensity (333 Lux).

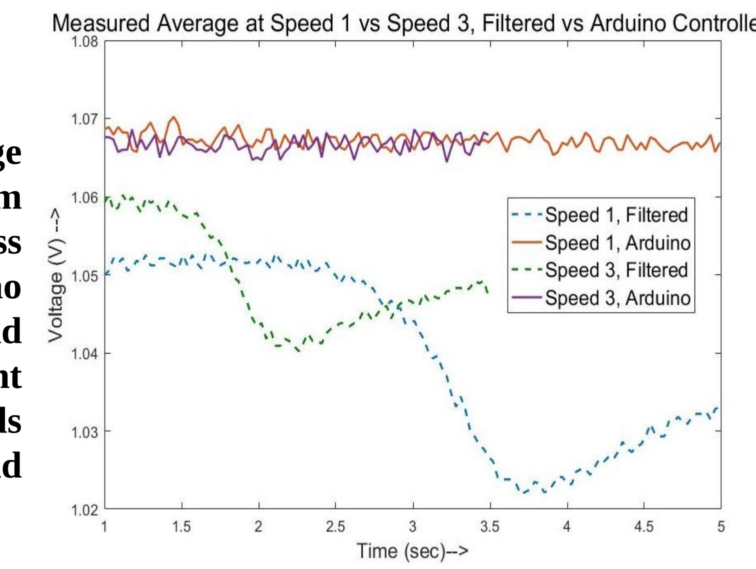

Figure 7: Average signals obtained from D3 after low-pass filtering and Arduino controlled sample and hold approach in light adaptation at speeds 0.677 m/sec (left) and 0.26 m/sec (right).

Future Work

- Implementation of designed digital equivalent of fly eye vision sensor.
- Test the applicability of digital fly eye vision sensor on edge and motion detection applications.
- Different algorithms could be developed to improve the results obtained from the existing algorithms for edge and motion detection.
- Efforts can also be made to digitize the signal after trans-impedance amplifier or filter which would enable implementation of following blocks on a FPGA or DSP board.

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