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Department of Biological and Agricultural Engineering

GaugeCam:

An Image-Based System to Measure Water Levels in Streams

Troy Gilmore, François Birgand,
Kenneth Chapman, Andrew Brown

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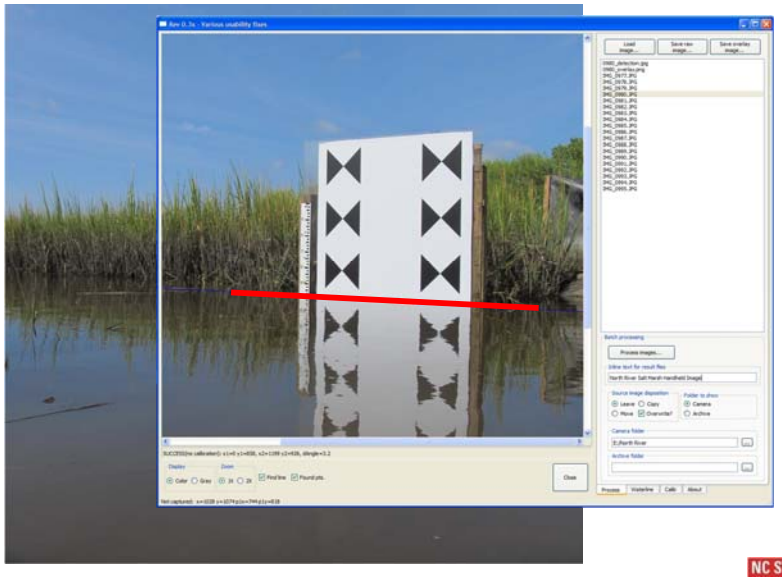
Can we detect water level?



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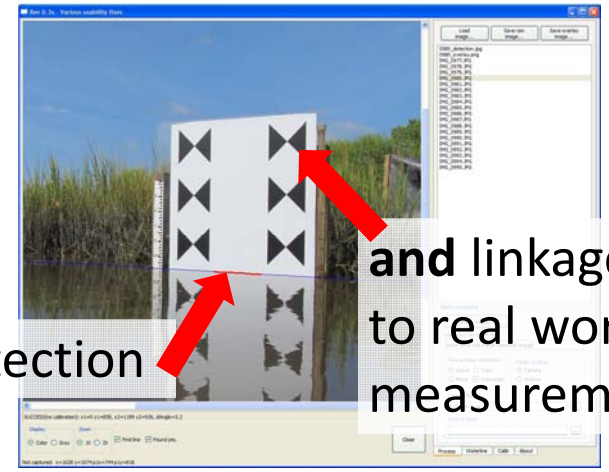
Can we *measure* water level?



Detection

and linkage to real world measurement

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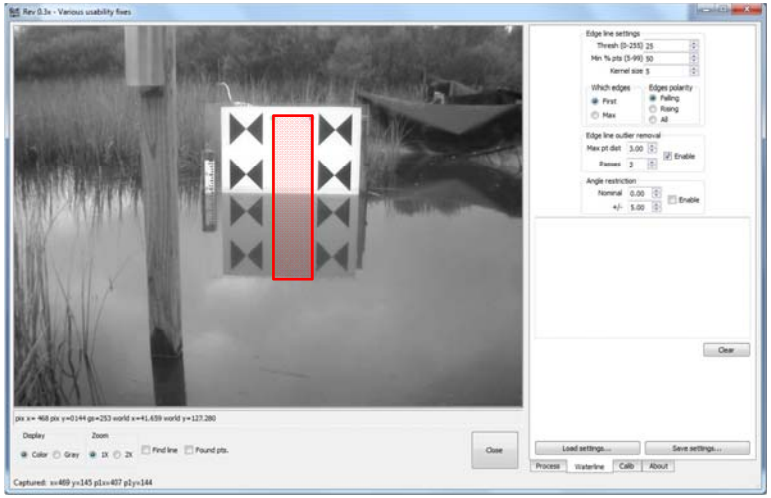
The System: Edge Detection



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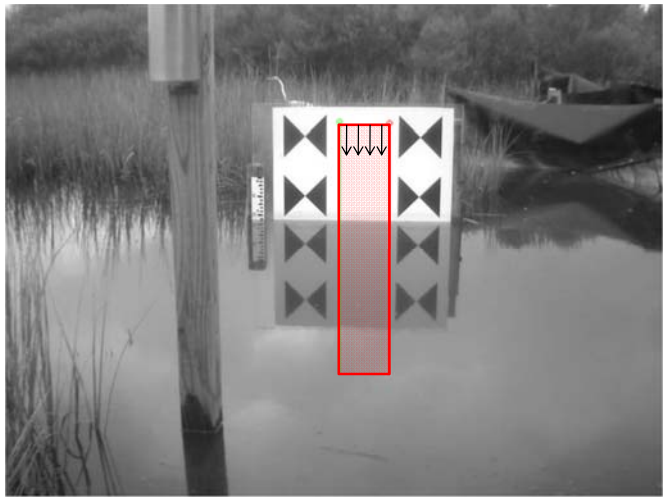
The System: Edge Detection



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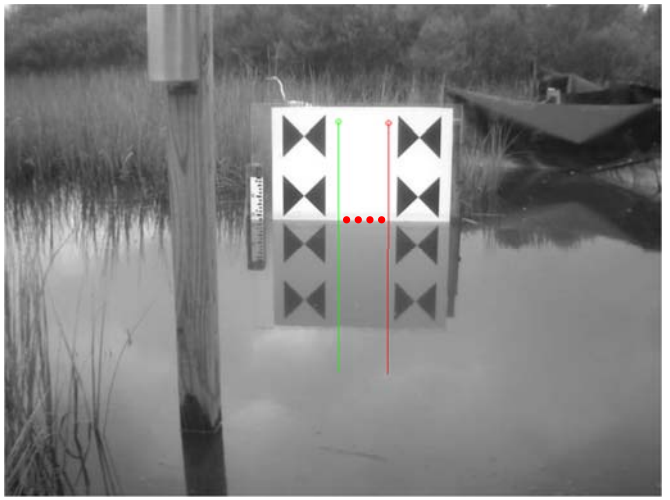
The System: Edge Detection



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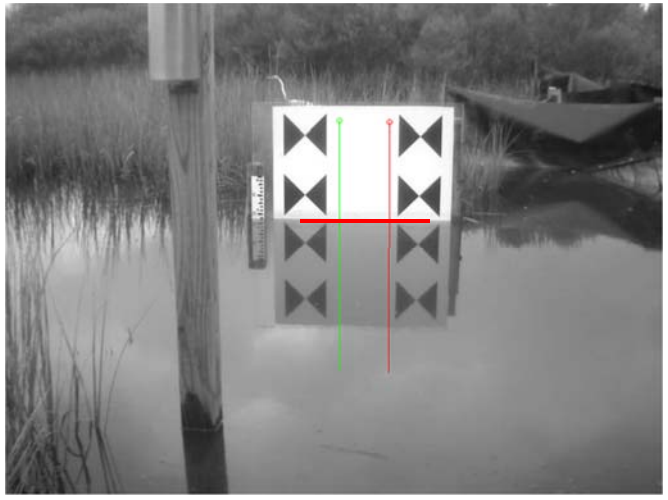
The System: Edge Detection



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The System: Calibration

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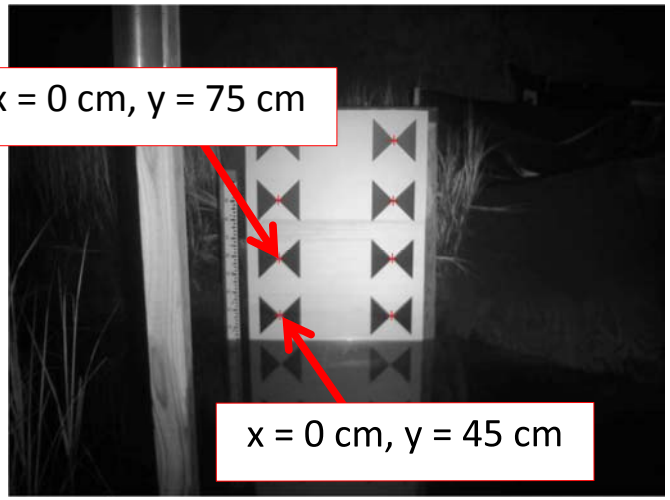
The System: Calibration



Lab Research Objective:

Quantify source and magnitude of uncertainty when measuring water level with images

Uncertainty: Sources

1. Image Resolution
2. Lighting effects
3. Perspective
4. Lens distortion
5. Water meniscus

Uncertainty: Three Experiments

- Benchmark I
- Benchmark II
- Water Level

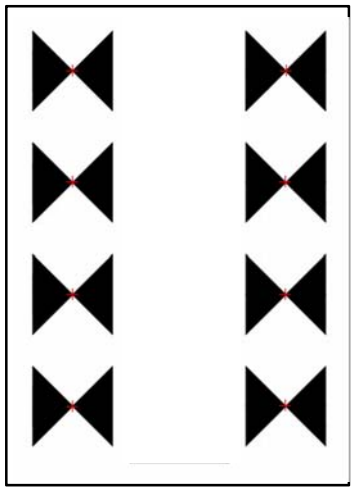
1. Image Resolution
2. Lighting effects
3. Perspective
4. Lens distortion
5. Water meniscus

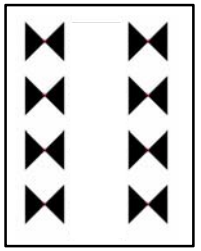
Uncertainty: Three Experiments

Benchmark I

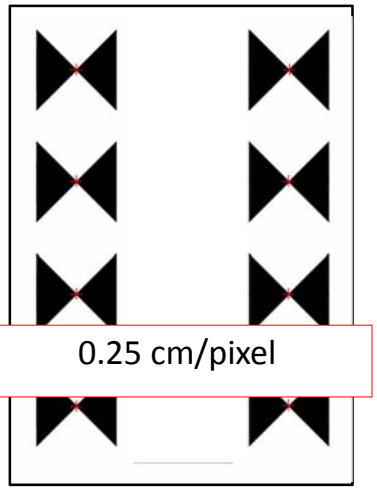
1. Image Resolution
2. Lighting effects
3. Perspective
4. Lens distortion
5. Water meniscus

Uncertainty: Benchmark I

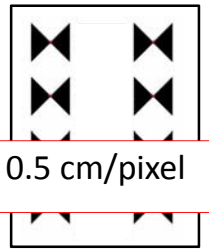




Uncertainty: Benchmark I

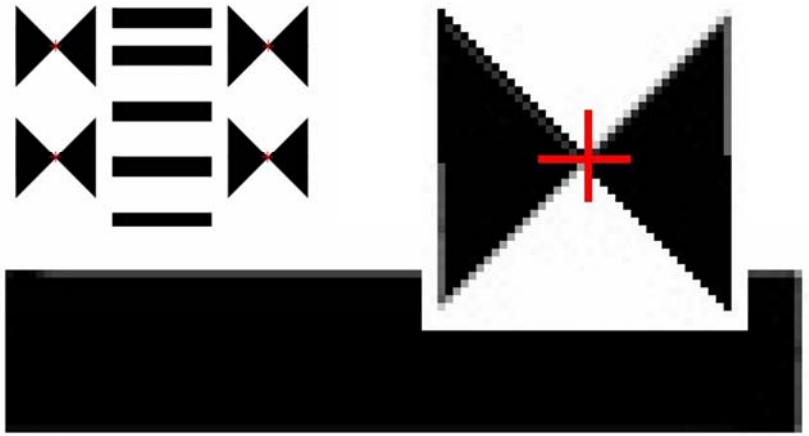


0.25 cm/pixel



0.5 cm/pixel

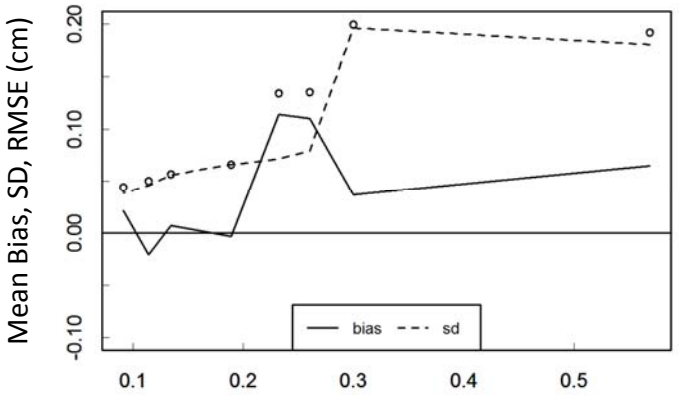
Uncertainty: Benchmark I



Uncertainty Calculation

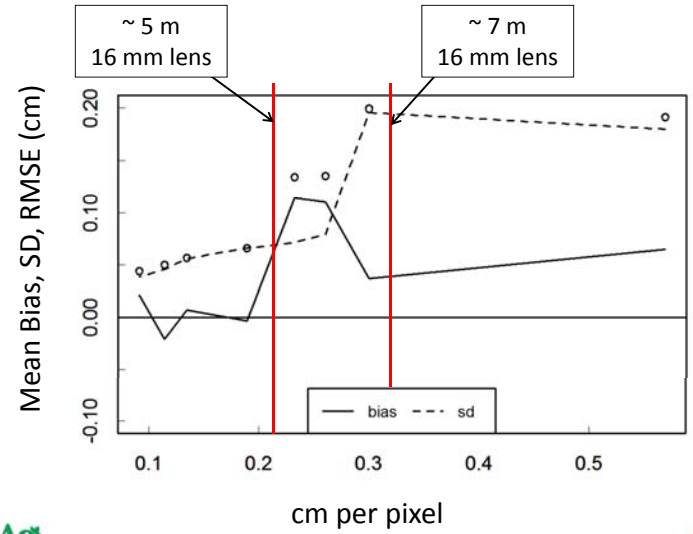
- Many images per resolution
- Error = measured – known value
- Calculated distribution of errors for each resolution
- Calculated bias, SD and RMSE of each distribution

Benchmark I: RESULTS



High res cm per pixel Lo res

Benchmark I: RESULTS



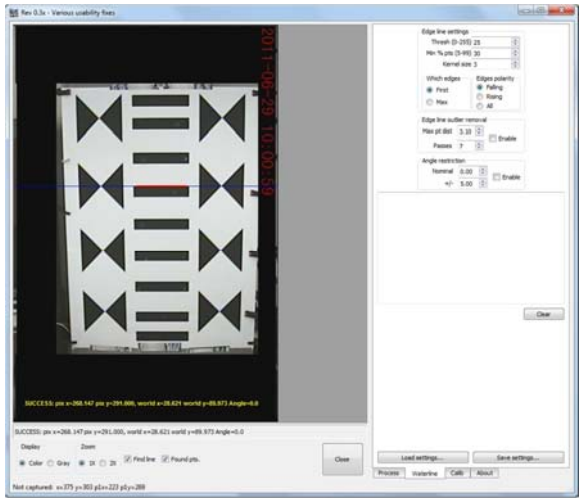
Uncertainty: Three Experiments

Benchmark I

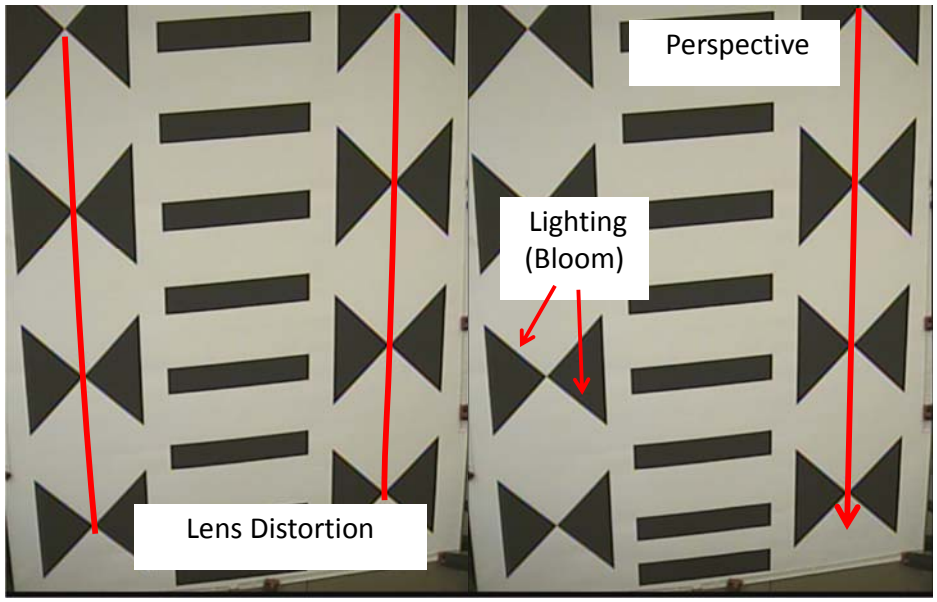
Benchmark II

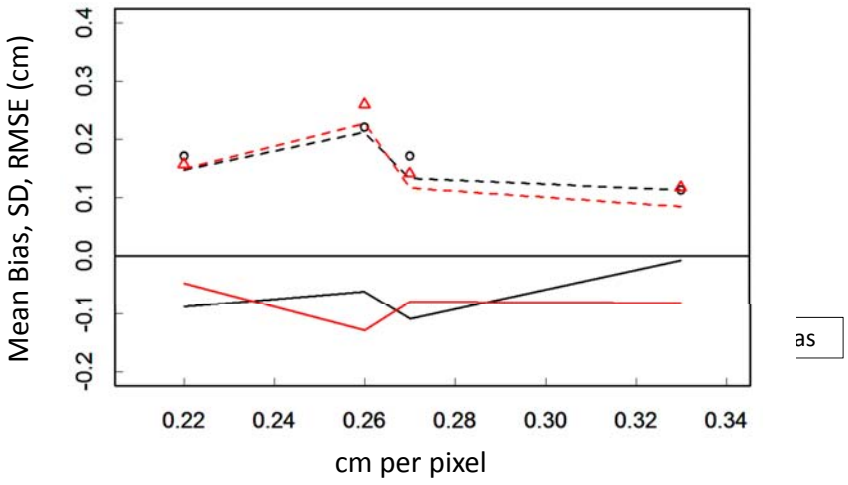
1. Image Resolution
2. Lighting effects
3. Perspective
4. Lens distortion
5. Water meniscus

Benchmark II

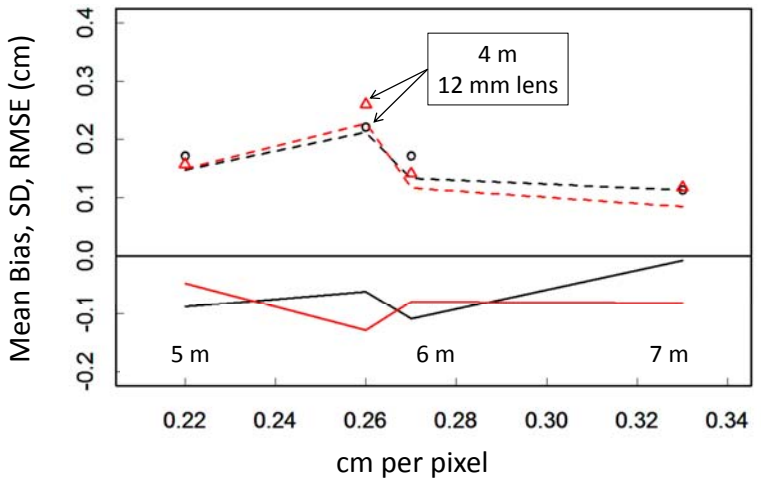


Uncertainty: Sources





Benchmark II: RESULTS



Uncertainty: Three Experiments

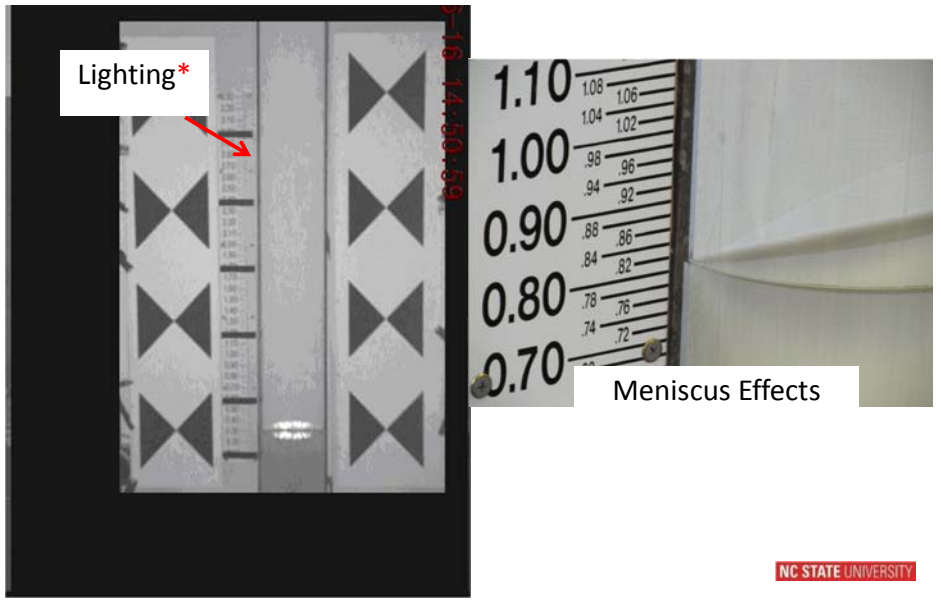
Benchmark I

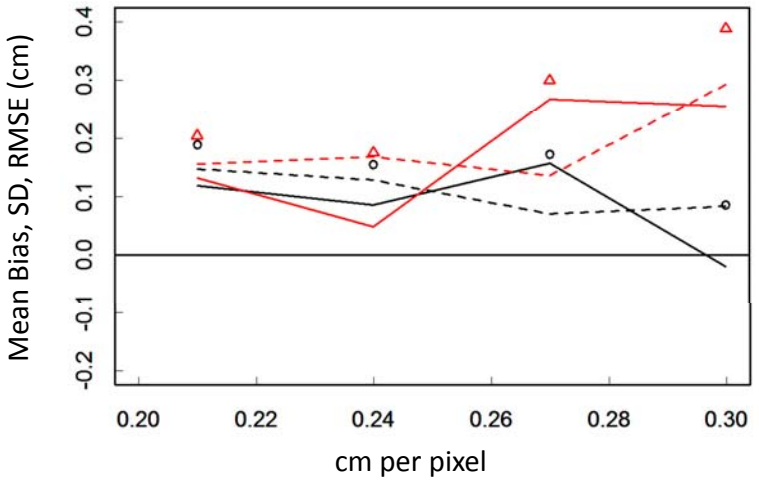
Benchmark II

Water Level

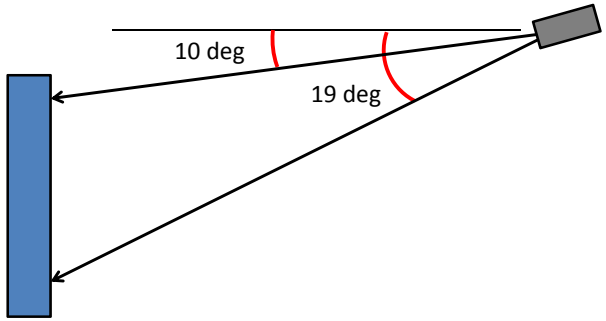
1. Image Resolution
2. Lighting effects*
3. Perspective
4. Lens distortion
5. Water meniscus

Uncertainty: Camera effects



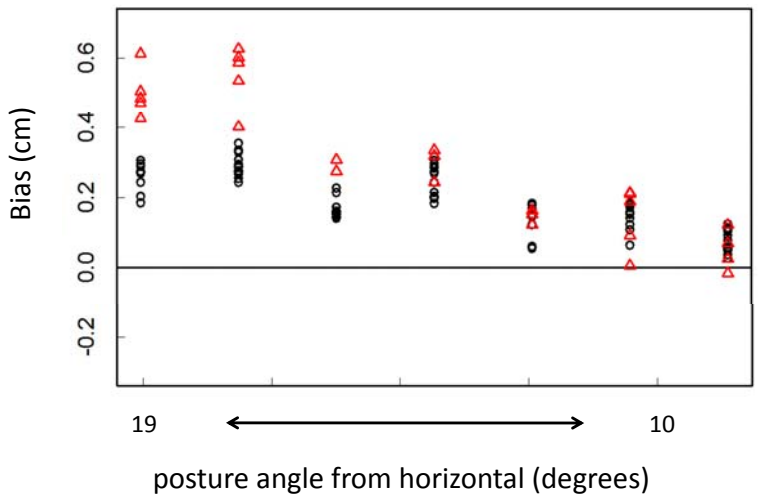


Water Level: Posture Angle



For camera at 6 meters

Water Level: 6m, 16mm lens



Conclusions

1. Lens distortion must be minimized
2. Posture angle may interact with meniscus
3. With reasonable precautions, accuracy of +/- 3 mm (0.01 ft) is achievable in the lab

Acknowledgements

Salt Marsh Images:
Randall Etheridge, Brad Smith

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Kelly Chapman

Camera Equipment:
www.Microseven.com
www.Colorado-Video.com

Software:
www.GaugeCam.com

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