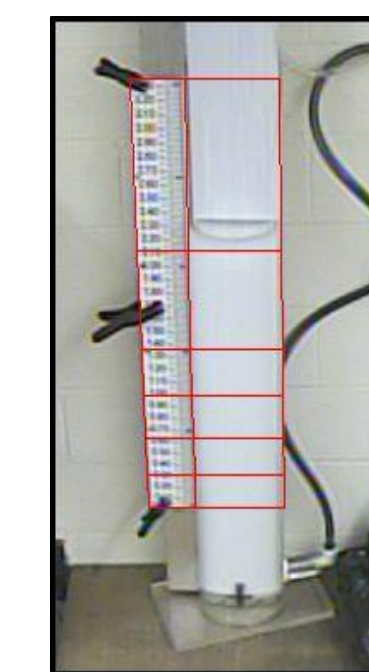
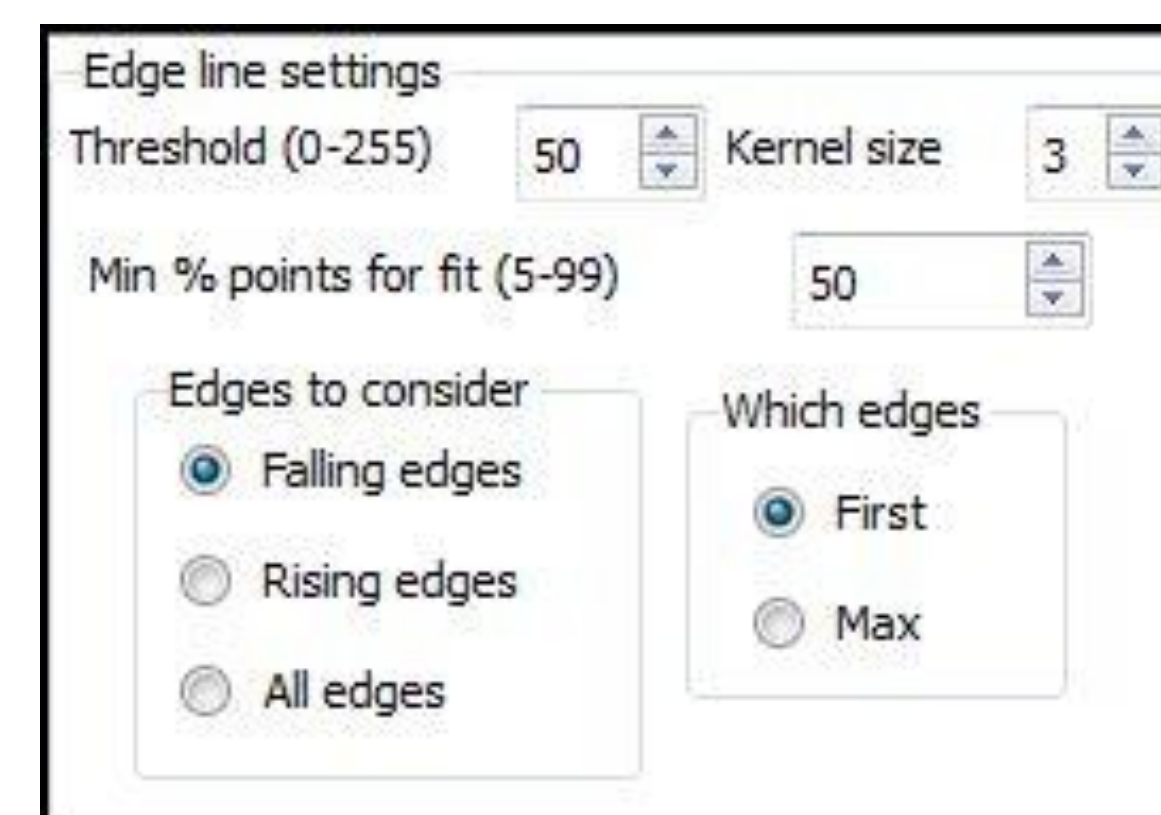


Introduction

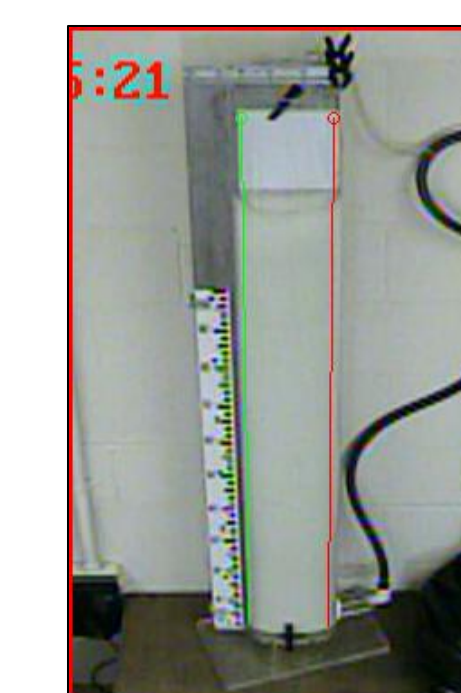
- Water level is currently measured indirectly using floats or transducers.
- We hypothesize that an image-based method can be utilized to detect stream stage as well as water level in agricultural and industrial settings.
- A visual, image-based water level measurement system would provide the following advantages over traditional systems:
 - Non-contact measurement
 - Remote, visual verification of water level
 - Remote calibration
 - Archived images can be reprocessed to recover data
 - Low-cost system using open-source (GPL) software and off-the-shelf camera



Research Toolbox



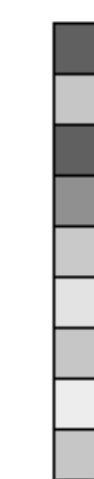
Calibration Grid



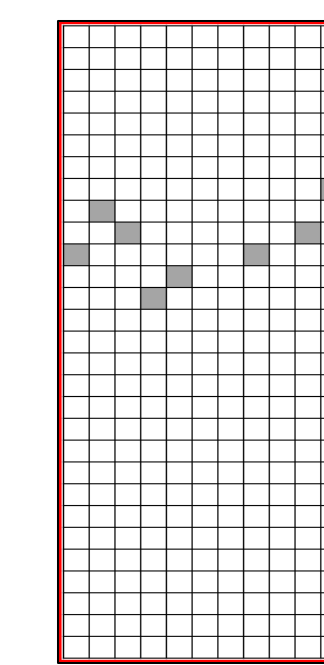
Search Region



Threshold –
Sensitivity to
grayscale variability



Kernel –
Difference in sum of
grayscale values above
and below center pixel



Min Percentage –
Percentage of columns
containing an edge point

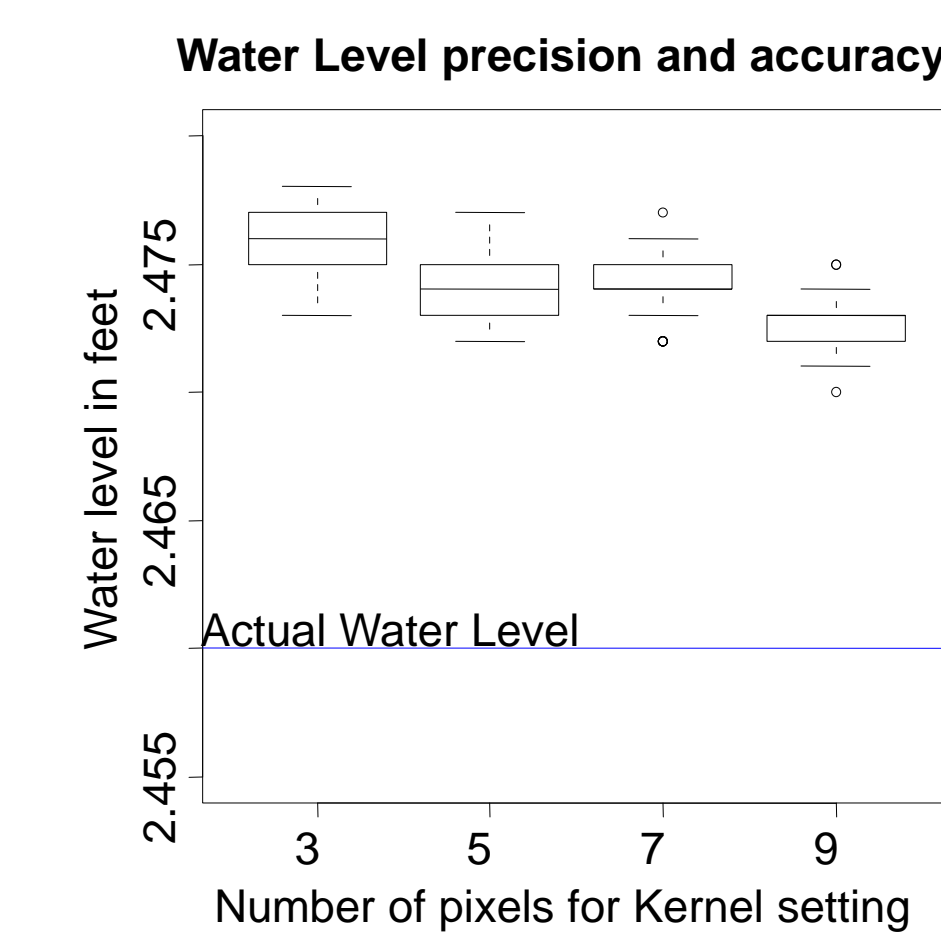
Future Toolbox Components

- Time domain tools
- Background suppression
- Hough
- Automatic fiducial find/calibration
- Determination of field disruptions

Preliminary Results

Conditions

- Using Microseven Systems M7-RC550WS (Sony CCD)
- Camera located 12 feet (3.66 meters) from bench
- Stationary water level with white background
- Ambient and artificial light sources



Results

Actual Water Level	Measured Water Level	Bias	Standard Deviation
(ft)	(ft)	(%)	(ft)
2.46	2.474	+0.58%	0.0012
(mm)	(mm)	(m)	(mm)
750	754.2	+0.58%	0.35

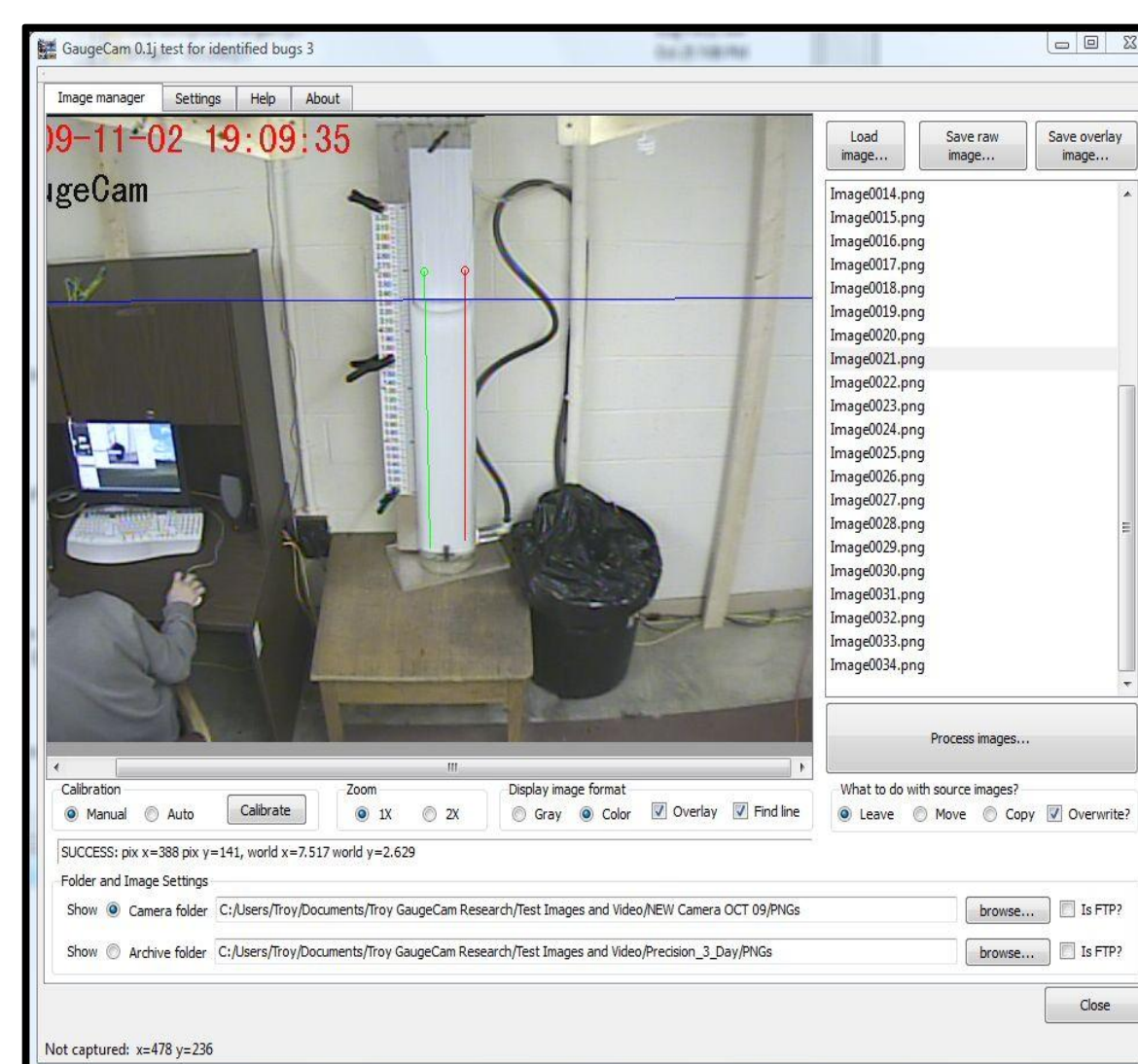
Pending Research

- Automated illumination tests to assess impact of glare, shadows
- Evaluation of system using bench with interchangeable backgrounds (effects of color, capillary action)
- Evaluation of system using wave generation
- Field application to evaluate performance relative to USGS stream gauge
 - Evaluation of bias when using IR illumination and other light sources
 - Development of web-based data management tool



Current Research

- Bench-scale evaluation of precision and accuracy
- Use of infrared (IR) illumination for night-time measurements
- Application of GaugeCam Remote Image Manager (GRIM), based on open-source (GPL) KamVu libraries
- Determination of GRIM research toolbox robustness for water level application



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