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Comment on egusphere-2022-735

Frank Engel (Referee)

Referee comment on "Adaptively monitoring streamflow using a stereo computer vision system" by Nicholas Reece Hutley et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-735-RC2, 2022

The authors present an interesting and novel hardware/software package for computing river streamflow using camera imagery. In their package called the Computer Vision Stream Gauging (CVSG) system, they deploy a stereoscope camera paired with an edge computing device to capture stereo video in order to process into velocities, cross sectional geometry, and water surface plane determination. The CSVG is unique in that it does not require ground control points to perform image velocimetry analysis. Also, the CVSG uses a machine learning technique to improve results over time at a site as the equipment is allowed to collect more measurements. The CVSG seems to perform at least as well as other commercially available image-based velocity software. In one particular case, the CVSG completely outperforms other techniques, in part because it can interpret complex water surface profiles, such as cases with standing waves or other extreme conditions which normally highly degrade other common image velocimetry approaches. The authors do a good job evaluating the performance of the CVSG velocity and dishcarge results against standard/conventional methods and show excellent agreement. Where the system performs worse than conventional methods, the authors explain the limitations of the system. The authors should consider explaining a bit more about the approach for computing learned water surface plane and cross-sectional shape with the stereoscopic imagery. As with other non-contact streamflow methods, the detection of error in cross-sectional error is difficult. Since the CVSG system can presumably develop information about the cross-sectional geometery owing to the steroescopic camera approach, the authors may consider expanding the work a bit to describe, if applicable, the performance of the CVSG to determine or evaluate changes in cross-sectional area compared to a priori knowledge (e.g., input surveys of the cross-section). Otherwise, I believe this manuscript describes a useful advance in non-contact streamflow techniques.

In addition to the comments above, I note several comments below, organized by line number. After consideration, I would happily recommend that the manuscript be accepted with some minor revisions.

Line 65: I agree. In part this is because there have been few available quality software products to aid in adoption by hydrometric agencies. This is starting to change, but it is a slow process.

Line 105: It would be very helpful to report the CVSG power consumption information. I would presume that the camera is a significant portion of the power budget.

Line 118: IMUs are notorious for drifting when position is fixed for a long period of time. Can you describe how the CVSG accounts for this? Do you observe IMU drift? Owning to the requirement of seeing a horizon line, are you correcting IMU drift from the horizon?

Line 140: I am presuming that this requirement is to avoid glare? Can you expand on this statement?

Line 141: So this would indicate a high-oblique view? As in the sky is not visible in the field of view? If so, does this eliminate the possibility of IMU calibration using the horizon line?

Line 145: Can you provide details about how the stereoscopic camera determines the the land surface? What quality assurance methods are in use? What is the accuracy of the stereoscopic transformation...the parallax of the camera in use is fairly small, so I would expect that there is potentially significant errors in the transformation process. What about obstructed views owing to shadows, obstructions, etc. (e.g. boulders or even cobbles may present "shadows" unseen by the stereo camera ... what are the impacts to cross-section geometry accuracy from these sorts of artifacts?)

Line 161: Because you are using an IMU and stereo camera to determine the water plane, is there potential that the CVSG would be able to better handle high-slope systems, where the typical mono-lens camera approaches solve for a water surface plane that is oriented parallel to the Z coordinate (which respect to gravity)? This would be a useful differentiation between typical camera-matrix solution approaches for rectification vs epipolar geometric approaches using stereo cameras.

Line 183: How is averaging of the flow field stack able to suppress motion artifacts? Wouldn't a median be better?

Line 187: Would would these erroneous motions indicate physically? For example, would camera motion (e.g., wind for example buffeting the instrument) be one of these extraneous motions?

Line 228: This is an improvement over the standard approach of one alpha value per section. I agree with this approach.

Line 245: Although I understand the scope of this paper is to compare the CVSG to other commercially available image velocimetry approaches, I think it would strengthen the work to also show results using some of the other well-adopted approaches in the literature, for example Patalano's RIVeR (https://doi.org/10.1016/j.cageo.2017.07.009) Perk's KLTIV (https://doi.org/10.5194/gmd-13-6111-2020)

Figure 2: It would be helpful to annotate these images to include the region of interest used by each method for computation of discharge. For example, your results demonstrate that the CVSG dramatically outperforms other methods for the irrigation channel in NSW. I'd like to know where the STIV search lines were placed? What is the ROI for the SSIV processing?

Line 292: Perhaps reword to indicate "diffuse light" rather that "softly lit" -- The light diffusion leads to reductions in shadows, making this dataset a great test for these methods.

Figure 3:

It would be helpful to indicate that the ADCP data are the near-surface cell values. Additionally, label the plot to indicate these are surface velocity profiles. Although this is indicated in the text, it should also be included in the caption and/or figure legend.

Additionally, panel D may benefit from also including a residual plot. It seems that there is visually a trend in the CVSG results of under-predicting lower and over-predicting higher Qs. Alternatively, linear trend-lines could be added to show whether this is the case or not.

Line 479: This makes sense, because of potential errors in the determination of WSE from the stereo cameras.

Line 500: Was this primarily caused by clear water? Relatedly, does the CVSG manage to see any of the bed through the water? Perhaps if so, there might be some value in attempting to extract bed geometry, assuming a suitable correction for refractive properties can be found.

Line 561: The ability to capture low flow (high clarity water) image velocimetry measurements accurately continues to be a substantial challenge.

Line 674: Based on the findings of this paper, I agree with the later concept that CVSG ca nhelp identify low-flow site suitability. I am less convinced that CVSG (or any other image velocimetry approach) will inform low flow conditions.

Section 5: Conclusions: One thing not discussed in this paper is the errors associated with cross-sectional area. It seems that since the CVSG is able to extract stereographic elevations of the low flow channel (or better yet dry channel), that there should be a way to consider changes in cross-sectional area ratings. Maybe something for a future paper?

Line 706: add a period to the end of the code availabilty sentence.