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Atmospheric Measurement Techniques Discussions

Interactive comment on "All-sky photogrammetry techniques to georeference a cloud field" *by* Pierre Crispel and Gregory Roberts

Anonymous Referee #1

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General Comments:

The submitted manuscript deals with the application of stereo-photogrammetry to image data obtained from a pair of all-sky cameras and aims at the geolocalization, i.e. the determination of geographically meaningful coordinates, and identification of individual shallow cumulus clouds. While the exact geographic position of a cloud is not relevant for parameters such as cloud area, base height or cloud evolution, it is relevant for in-situ measurements, for example via the mentioned UAV-based sensors, or remote sensing with cloud radars or satellites. In general, geolocalization is implicitly given when operating a stationary camera pair, e.g. by using stars or landmarks as orientation, as is done in related studies. However, the problem is much more significant in the case of a mobile camera pair, where such sources of orientatioin are difficult if

not impossible to include. The article describes in detail the full procedure, starting with the applied camera calibration step, stereo-rectification, matching and 3-D reconstruction, including a theoretical and empirical uncertainty analysis. The article should be published after dealing with the following remarks.

Specific Comments:

- In section 1, page 3 line 24, the authors write that their approach to derive the relative orientation is based on the "visual sight, with no obstacles between the cameras“. On the other hand, in section 2.3, page 7 line 12, the authors describe that the relative orientation is "achieved with vertical sights on the camera housing“. I suppose that this aims at retrieving an initial relative orientation estimation before refining it using the SIFT features. Given the fact, that this is a central step in this study and a major difference to other studies that use stars or landmarks, this procedure should be described in more detail and clarity. Is the visual sight used to eliminate the remaining degrees of freedom in the relative orientation? Maybe an additional figure or an extension of Fig. 4 might be useful here. In addition, the two figures in Fig. 4 could be merged quite easily, i think.

- Regarding the segmentation step described in section 2.6, page 9 line 29, the authors mention that the technique is applied "when the situation allows it(e.g. cumulus cloud field)“. Altough the authors mention on page 15 line 16, that the current method has some limitations in case of cloud overlap and propose to use cloud height values for compensation, the images shown in Fig. 8 (t, t+15 min) suggest that even in a cumulus case, a clear separation of clouds using such contour-based methods alone might be difficult, resulting in a merged contour rather than two separate ones. Maybe the authors could write an additional sentence about this problem in section 2.6 already. This does not touch the presented case studies of the segmetation, which are fine.

- In section 2.2, page 6 line 22, the authors mention the blur effect in the peripheral regions of the rectified image. To my understanding, the blur effect results from the mapping of a given image region of the fisheye image onto a larger projection area in the rectified image. I find the term "interpolation“ misleading, because the rectification itself is performed in reverse, from given rectified image coordinates for which the corresponding coordinates in the fisheye image are computed. Since such an image mapping generally never hits the center of a pixel in the target image exactly, an interpolation is applied as a normal procedure (e.g bilinear).

- There seems to be a minor error in equation 7, where the two vectors are written as row vectors, but have the transposition applied as in the normal co-linearity equation, which generally assumes column vectors. As far as i can see, the rest of the article uses column vectors (e.g. page 7 line 17). Hence, the row vector on the right side of the essential matrix must be a column vector and vice versa.

- In section 2.3, page 8 line 11, a constraint for the matrix R is introduced, which enforces R to be the identity. In general, the matrix R is to be computed in the relative orientation estimation procedure and should not be the identity matrix. Of course, the relative orientation of the cameras in a frontally aligned pose should be the identity, but not the matrix R, which is to be computed.

- In section 2.4, page 9 line 5, the authors describe a method to filter out outlier in the reconstruction by introducing a lower and upper limit of a valid height. This might work well for zenith regions, but for larger incidence angles mismatches introduce a larger error in the horizontal location rather than the vertical, even of the lower and upper limits for the height value are satisfied. In other words, a depth value error moves from a vertical error to a more and more horizontal error as the incidence angle grows larger. This limitation should be mentioned here.

Technical Corrections:

- Page 3 line 19+20: This sentence should be reformulated. For example: "The calibration of each camera encompasses a mathematical description of the projection of an incident optical ray onto the image.“

- Page 10 line 2: "contour detection and segmentation using the binarized image: ..“

- Page 10 line 18: ". . ., until a distance -w-here the quality...“

- Page 13 line 3: "undistorsion“ - > "undistortion“

- Page 13 line 14: Should the delta_h be sigma_h?

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