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visIvis - Evaluation of Vision based Visibility Measurement

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I. Problem Statement and Related Work

In air traffic management (ATM) and monitoring of critical infrastructure, the exact description of the atmospheric state - and thus the visibility - is an indispensable basis for any further weather forecast. In order to overcome the drawbacks of the currently subjective reports from human observers, we present "visIvis", an innovative solution to automatically derive visibility measures from standard cameras by a vision-based approach.

Several research aims already target camera-based visibility estimation. E.g. the weather services of the Netherlands (KNMI [3]) rely on a few manually selected landmarks with known distances to derive the prevailing visibility. A variety of approaches uses physics-based models to derive a visibility measure (e.g. Koschmieder model or other measures of contrast [1] as well as models of light extinction [2]).

II. visIvis-System

Based on a small set of training images with very good and bad visibility conditions, the system visIvis detects fully automatic the best suited image regions for visibility derivation (e.g. buildings or orographic structures). At the same time the optimal parameters (e.g. image features and quality criteria) for the visibility recognition are derived. Assessment of visibility is done separately for each image region and displayed according to customer preferences (e.g. a red-green mask as illustrated in Figure 1)

The system further integrates a pixel-precise distance map by georeferencing the calibrated camera image and exploiting high-resolution elevation data derived from digital surface models (DSM). A statistical analysis of visible and non-visible image regions delivers a representative estimate of the prevailing visibility for the complete camera-covered area.

III. Practical Examples and Discussion

First installations of visIvis are already in use by ANSPs and weather services (e.g. AustroControl and Deutscher Wetterdienst) that proof the system's ability to support automated assessment of the weather situation by standard cameras.

Although the second example for the Hamburg application (Figure 1) is disturbed by raindrops, visIvis can reliable detect the correct prevailing visibility of > 10.000m. The raindrops cause some misclassifications of individual image regions, but due to the assessment of the complete image visIvis is very robust against such artefacts.

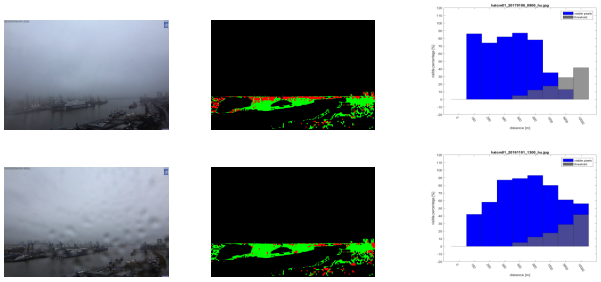

Fig. 1. visIvis results for the location Hamburg: deterministic visibility in top row is 1.500m, bottom row: > 10.000m. Raw image (left), visibility detection (red/green, middle), and corresponding visibility histogram (right), (courtesy of Deutscher Wetterdienst).

Figure 2 illustrates a span of 2 hour comparison between runway visual range sensors (black line), the visIvis result (green) and the officially stated observer report (black dots). It clearly indicates the value of the automated measurements that were used as a tool to check the plausibility of the RVR measurements.

References

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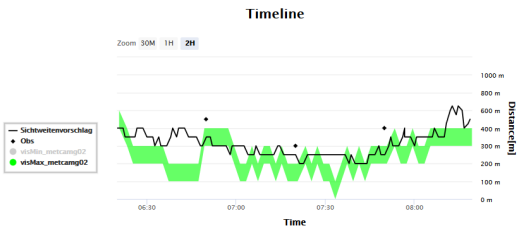

Fig. 2. Comparison of visIvis measurements with observer reports and RVR-sensors (courtesy of AustroControl).

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