Fast sky and road detection for video context analysis

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Video surveillance technology has become a highly relevant tool associated with security systems applications. Correct interpretation of the events occurring in video has a key role in the improvement of video surveillance systems and the desired automatic decision making. Interpreting events, however, is a complex task, as the same gesture or motion can be understood in several ways. Current research, such as in the European ViCoMo project is aiming at improving the decision making by supplying additional information such as context. Accurate analysis of the context of the scenes in a video can contribute to the semantic understanding of the video. Context analysis involves not only determining the general conditions such as daytime or nighttime, indoor or outdoor environments, but also region labeling [1] and motion analysis of the scene. Sky and road are among the objects of high visual importance, appearing often in surveillance video sequences. Color-based sky and road detection algorithms have been already presented in the literature. However, because of little sunlight even during daytime, some surveillance videos of the outdoor environments, such as those in the Netherlands, lack sufficient color. Hence, to prevent system failures, it is important to explore sky and road detection without relying much on their characteristic color features.

In this paper, we present our research on context analysis on video sequences focusing on fast automatic detection of sky and road. Regarding road detection, the goal of the present study is to develop a motion-based context analysis to annotate roads and to restrict the computationally heavy search for moving objects to the areas where the motion is detected. Summarizing, our effort concentrates on finding the road object with alternative features other than color, and the same time do this with high efficiency to limit the implementation cost.

In our road detection approach, we avoid using color and texture properties and design a novel road detection technique based on two parts: (1) heat map-based motion analysis and (2) straight line detection. The motion heat map represents “hot`` and “cold`` areas on the basis of motion intensities caused by moving vehicles and objects and other traffic participants [4]. The Hough transform algorithm which can extract lines effectively [5] is applied. We add the detection of straight lines as a second feature, since they appear regularly in two ways: straight line markings on the pavement and the direction of the movement map where cars are normally driving.
Our sky detection approach (adopted from Zafarifar *et al*. [2]) consists of two phases: (1) the training phase where the color model, texture properties at multi-resolution and vertical position are defined, (2) the detecting phase which adapts the color model and vertical position and calculates texture properties.

To evaluate the results, the average Coverability Rate (CR) for the two data sets is used. Results of the road detection algorithm are promising with CR = 0.97 in a single highway video sequence. Regarding sky detection, the accuracy of our earlier sky detection algorithm is evaluated using two different data sets which contain images of different nature: the Watervision data set and the data set of Schmitt [3]. The Watervision data set presents mostly natural scenes that contain vegetation, water and ships. The data set of Schmitt is composed of urban scenes where we observe buildings, pavements and little vegetation. Results of the sky detection algorithm are comparable with the results presented in the literature [3]. We illustrate that our algorithm performs well for both data sets, showing a CR of 0.98. This paper presents our first results on road detection obtained with our approach and its performance evaluation is still ongoing. For future work, it is interesting to explore more data sets containing more complex roads in different scenes. Experiments show that our sky detection algorithm performs equally well as the algorithm of Schmitt, while being more flexible as it uses adaptive thresholds and does not limit itself to a particular type of scene.

References

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