Cloud Imaging Using Ground-based Sky Cameras

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Introduction

• Fine scale cloud monitoring needed for a variety of applications: weather observation, solar energy generation.
• Whole Sky Imagers (WSIs) are ground-based cameras that captures images at regular intervals [1].
• We use WSIs to detect clouds for automatic cloud coverage computation, recognizing cloud types, small-scale tracking for cloud prediction and 3D cloud volumetric estimation.

WAHRSIS: Our custom-built sky camera

• Commercial WSIs are expensive, have low image resolution and limited flexibility.
• We build our own sky-camera model called WAHRSIS: Wide Angle High Resolution Sky Imaging System [2].

Figure 1: Several versions of WAHRSISs have been designed and deployed at various rooftops of our university campus.

Cloud Segmentation

• Existing algorithms are based on threshold-based methods.
• We propose a threshold-free, learning-based segmentation algorithm [3], and release SWIM-SEG: a large-scale cloud segmentation database.

Figure 2: Input image, Binary output, 3-level output, probabilistic output image [From L to R].

Cloud Classification

• We propose a texton-based approach integrating both color and texture of clouds [4].
• We also release an annotated sky/cloud image categorization database called SWIMCAT comprising 784 images.

Figure 3: Various sky/cloud patterns in SWIMCAT: clear sky, patterned clouds, thick dark cloud, thick white clouds and veil clouds [From L to R].

Cloud Base Height

• Fish-eye images are undistorted using camera calibration.
• Stereo-calibration of imagers are performed using sun’s position and trajectory.
• We perform cloud feature point detection and matching to generate 3D models of cloud base.

Figure 4: Undistortion of fish-eye lens in a stereo-camera setup.

Motion Prediction

• We perform fine-scale, short-term cloud motion prediction.
• Using optical flow techniques on two successive captured frames, we predict its future location.

Figure 5: Prediction with lead time of 2 minutes.

References