3D Cloud Field Retrieval And Data Fusion

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Biography

Dr. Dan Cornford is a lecture in Computer Science and works in the Neural Computing Research Group at Aston University. Research interests are in the field of spatial statistics, space-time modelling and data assimilation.

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Introduction

Cloud base height (CBH), cloud thickness and cloud type are difficult properties to estimate automatically and accurately across cloud fields. Current methods of retrieval for these cloud properties are either highly inaccurate such as estimating CBH by cloud type, or are interpolated from point data sources such as radiosondes or ceilometers. Cloud thickness can be estimated from satellite data, which is capable of retrieving cloud optical thickness, though this suffers from problems created by multiple cloud layers and varying atmospheric, cloud and surface properties.

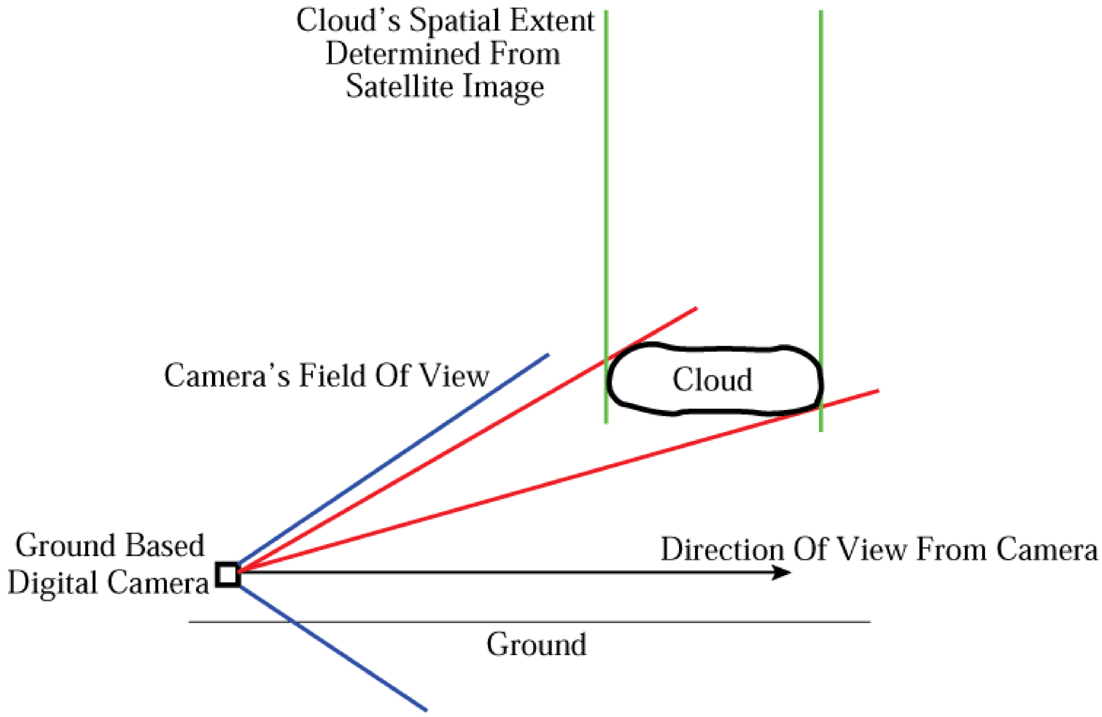

Figure 1, Simplified diagram of the relative perspectives of the satellite and digital camera images and how they can be used to produce 3D cloud models.

In this paper we develop a method for the automatic retrieval of the spatial cloud field using data fusion techniques within a probabilistic framework. We create a simple three dimensional cloud model describing cloud location, size, and shape. Our primary sources of data are geostationary satellites and images from ordinary 'off the shelf' digital cameras with known locations and orientations mounted at an oblique angle to the Earth's surface so as to acquire a 'window view', as shown in Figure 1. Other data sources such as ceilometer data, radiosonde data and manual synop reports taken at weather stations and airports can be incorporated into this model to further increase accuracy and validate results.

Extraction Of Vector From Raster Images

To extract vector data of clouds from our digital camera images we use active-contour image segmentation in which the energy of mutable splines is minimised around areas of an image based on the internal and external forces, defined by pixel intensities, acting on the spline (Cohen, 1991).

Extracting the spatial extent of clouds from satellite images is a better understood problem. When viewed from orbital platforms clouds tend to be spatially discrete at some scale and there is far less occlusion then when viewed from ground level. We use the OCRA method to extract cloud fields from whole earth images. OCRA involves building a multi-temporal cloud-free composite image from multiple scenes using individual pixel intensities to decide whether a pixel is cloudy or cloud-free. This is important since the final model we envisage must work over multiple space and time scales, although in this work we describe only results of local experiments.

Data Sources

The satellite data is obtained from the MeteoSat-7 geostationary platform, though we expect to migrate to MSG data when it becomes fully operational. We use only visible spectrum images in the current system, though further extension to incorporate useful data from other channels (particularly infra-red) may be realised as our method develops. Data recorded from our digital cameras is strictly limited to the capabilities of 'off the shelf' hardware, namely the integrated visible spectrum. Both satellite and digital camera image capture is temporally coincident.

Development And Continuation

Our method is still in the early stages of development and the majority of testing has been performed on generative data, where cloud fields are generated with known and exact spatial properties, the developed methods are then applied and resulting data compared to the known truth. An example of the very simple generative model can be seen in Figure 2. Results on real scenes will also be shown.

In future work we plan to build a space time model for the 3D cloud field, which will allow other sensors and satellites to be incorporated. In particular our method allows many extensions, such as incorporating multiple cameras over a wide area with overlapping fields of view to produce larger and more accurate cloud field models, using synoptic weather observations, radiosonde ascents and other reports, e.g. from planes (air-reps), although these have yet to be implemented.

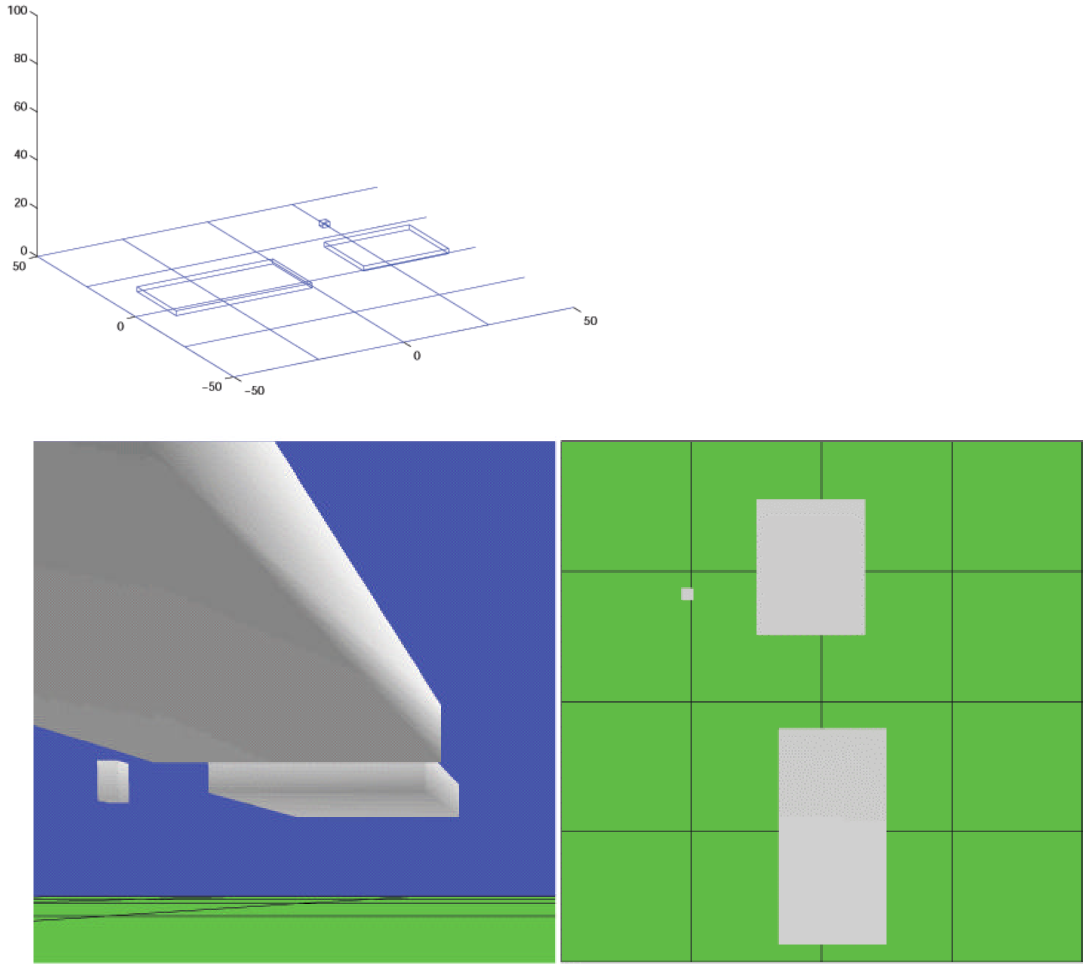

Figure 2, Images of simple generative data produced using Matlab showing form left to right; a simplified three dimensional wire-frame figure of the cloud model; simulated view of the same cloud model from a digital camera's perspective; and a simulated view of the same cloud scene from a satellite’s perspective.

References

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The preferred presentation format is oral.