



# Deblotching old Movies

By Anil Kokaram, Francis Kelly and Hugh Denman.

<http://www.mee.tcd.ie/~sigmedia/>

## 1. What are blotches?

Blotches are one of the most common degradations appearing in archived footage. Large pieces of dirt, holes in the film emulsion, and dust on the film are all perceived as blotches.

Because blotches are only present in one frame (i.e. for  $1/25^{\text{th}}$  of a second), they appear and disappear very rapidly, and so are particularly distracting. The longer the film has been in storage, the more blotches will develop.

Figure 1.



Fig 1: Some examples of blotches in *Rory O'More*

## 2. Blotch Detection: Motion Estimation

In general, any object that appears for one frame only is a blotch. Our blotch detection method compares each region in frame  $n$  with the corresponding regions in frames  $n+1$  and  $n-1$ ; if it is different from both, it is a blotch.

### Corresponding Regions

To find which region in frame  $n$  corresponds to which region in frame  $n-1$ , we must attempt *motion estimation*: establishing for every pixel which direction it is moving and how fast.



Fig 2: Motion estimation in a single frame

### Fast, Difficult Motion

Some kinds of motion are very difficult to estimate correctly; where an object is moving or changing shape very quickly, estimating region correspondences can become impossible. People dressing, splashing water, and explosions all tend to confuse the motion estimator. We try to detect this *pathological motion* and make sure that it is not treated as if it was a blotch.

## 3. Blotch Removal

Knowing which parts of a frame are blotches, and which regions in the nearby frames correspond to the blotch region, we can fill in, or *interpolate*, the missing data. For example, if part of a face has been damaged by a blotch, we can take the data for the face from the previous and subsequent frames and use it to reconstruct the face in the current frame.

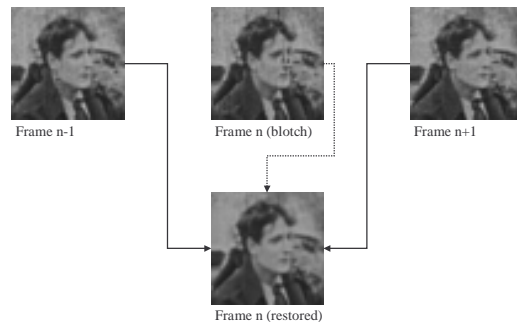


Fig 3: Three-frame blotch reconstruction

## 4. Noise

Noise in film refers to small, random fluctuations in individual pixels. It looks like a grainy kind of flicker. Noise is quite common in old footage, and has a strong effect on the perceived quality of the film. Furthermore, the presence of noise in the film makes blotch removal harder – however, noise reduction is very difficult in blotchy film! Our deblotching process therefore treats noise and blotches simultaneously, using a *Markov Chain Monte Carlo* (MCMC) technique. The Sigmedia group is one of very few using MCMC for practical video processing.

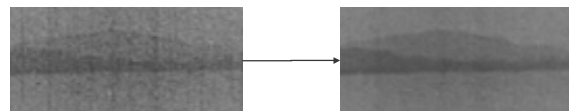


Fig 3: Example of noise reduction. The scene depicts mountains on the edge of a lake

## 5. Speed

Because this stage incorporates motion estimation, noise reduction and blotch removal, it is the most time-consuming. It took around five CPU-days to process the *Rory O'More* sequence.

## 6. Results!



Fig 4: Deblotched frames