# Metric Mixtures for Mutual Information Tracking

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The tracking of features as they vary in appearance during a video sequence is an important and difficult problem in machine vision, as the large amount of research in this area implies Template matching is one method of tracking features and involves the movement of a template or kernel over a region in the image and locating the area in the image which best matches that kernel

Lucas and Kanade made one of the earliest attempts to locate a representative feature (template) in another image[5] They limited the processing by using a Newton-Raphson method to traverse the search space Although translations were considered, they mentioned how the method could easily be adapted to optimise other transforms such as rotation Indeed, later research extended this method to consider rotation, affine translation and warping [1] In addition new minimisation methods have been applied, which have faster convergence and greater likelihood of finding the global minimum, such as the Levenberg Marquardt method [2]

It is natural to extend feature detection to tracking a feature over a motion sequence This leads to a further problem: how and when to update the template If the template is never updated, tracking will only work as long the template closely represents the current appearance of the feature This assumption is generally safe for several frames after the one from which the feature was extracted Eventually however, the template does not represent the feature sufficiently well and a catastrophic failure ensues: ie the error suddenly becomes very large One alternative to this is to update the template after every frame However, subpixel errors inherent to each match are stored in each update These drift errors gradually accumulate and the template drifts off the original feature

This poster presents a new statistical method for updating a template that is based on building up a model of the feature appearance As tracking proceeds a library of templates is built up, to which a Gaussian Mixture Model (GMM) is fitted similar to the approach used by KaewTrakulPong and Bowden in [3] An online or incremental maximisation inspired approach constructs a template that matches the feature the best [8] uses an exemplar based approach to learn appearance and dynamics from a training set of examples We use a similar metric space to build a probability density of appearance on the fly without any a priori knowledge Given sufficient samples, the feature appearance will be as close to optimal as the available data allows The Gaussians in the mixture model are weighted according to how many recent matches have been made and old obsolete portions of the model are aged out This approach does not count on the first template being a good representation of the feature Instead, it uses an initial template to seed the model, from which more reliable templates are later extracted Drift error is limited by the fact that templates with accumulated sub-pixel errors will generally not be close to a Gaussian s mean For clarity, the proposed method is presented in the context of a brute force method of traversing the solution space Also, translation is the only transformation considered

The similarity between the template and regions in the serach window is quantified using the mutual information between them Mutual Information has the advantages of having pronounced maxima and being more robust to variations in lighting conditions than other measurement methods such as Sum of Squared differences (SSD)

The method was compared to various other template update methods and as the results in Figure 1 and Figure 2 show, the GMM tracker performed well The algorthm was also tested on two other motion sequences and similar results were obtained Currently attempts are being made to incorporate Lucas Kanade type optimisations into the algorithm

Figure 1: Tracked Feature position at various stages in the motion sequence

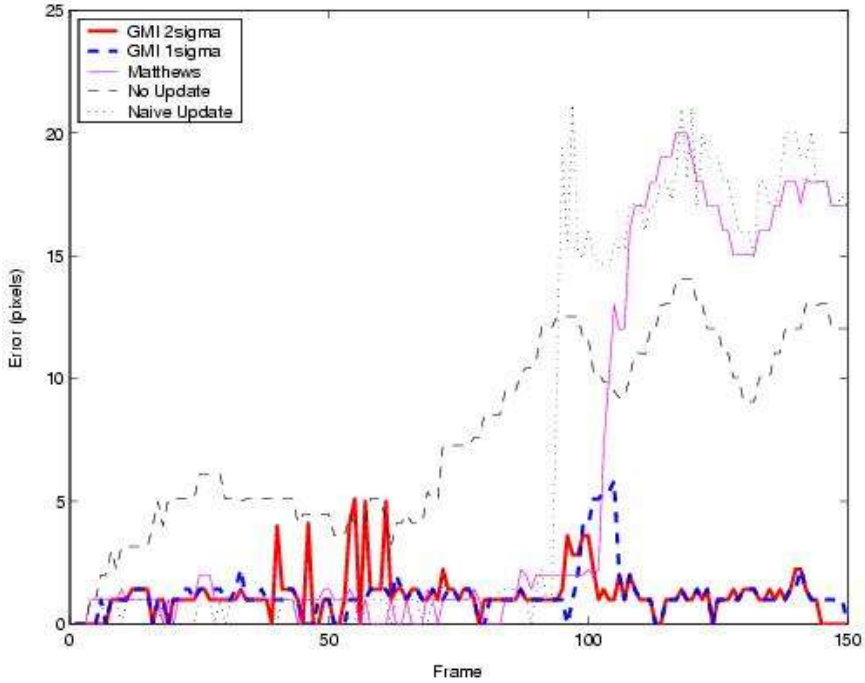

Figure 2: Error Rates for the following update methods: GMMI, Matthews, none and nave