In this paper we propose a novel feature extraction technique and show its application in tracking in low resolution videos. The aspects that make tracking particularly challenging are global camera motion, large target movement, poor gradient and texture information and absence of color information. Global camera motion is reduced or eliminated by registering the images from frame to frame employing SURF (Speeded Up Robust Feature). The proposed method is based on intensity histogram, but with a variant that encodes both spatial and intensity information. The method is evaluated on CLIF (Columbus Large Image Format) data. The robustness of the feature eliminates the need for background subtraction in videos. A performance comparison of our approach with other object descriptors such as HOG (Histogram of Gradients), SURF and SIFT (Scale Invariant Feature Transform) shows the effectiveness of the proposed descriptor.

Keywords: Aerial Images, CLIF Data, Low Resolution Object Detection, Tracking, Wide Area Surveillance.

1. INTRODUCTION

Finding reliable features for visual tracking in low resolution imagery is a hard problem. The proposed method focuses finding robust features for detection and tracking in wide area motion imagery. This problem is of immense interest in the area of Wide Area Surveillance. Although there are several feature extraction techniques available for high resolution images, these methods fail in low resolution scenarios. The method described in this paper is evaluated on Columbus Large Image Format (CLIF) data [1]. The data is captured using cameras mounted on flying platforms at a height of approximately 7000 ft. The camera captures images of size 2672 x 4008 at a rate of 2 frames per second. Targets of interest span only a few pixels.

In object recognition, any available cue is of interest. They include—

**Physical characteristics:** Color, texture, physical structure, location, orientation, depth map etc. These features are not in CLIF data.

**Behavioral Patterns:** This includes the behavioral patterns such as the gait of a person, the trajectory, acceleration and speed of a vehicle etc. Low video frame rate in this data results in large variations between consecutive frames making trajectory prediction hard.

**Environment Context:** This includes the physical environment features. For example, a car is likely to be on a road or a parking spot rather than on the top of a building. Such contexts are very useful for effective search and recognition of objects. However in this data, areas such as road cannot be reliably extracted since there is very little texture information.

There are two sub-areas in object recognition—
A Local Histogram Based Descriptor for Object Tracking in Wide Area Motion Imagery

Bhattacharya coefficient is

\[ \rho(p, q) = \sum_{i=1}^{m} \sqrt{p_i q_i} \]  

Using Equation 7, the distance between the two distributions is defined as

\[ d(y) = \sqrt{1 - \rho(p, q)} \]  

Figure 9 shows tracking three targets using mean-shift. As can be seen only one target is tracked correctly. This is because mean-shift tracking cannot cope with large target movements. For the computation of the mean-shift vector, successive target locations need to be overlapping. Figure 10 shows a target image, part of the background region and the reference image. For the target to be matched correctly with the reference, the distance between the reference and the target has to be less than that between the reference and the background. Table 1 shows a comparison of the metric used in our method, using chi-square metric without dividing the image into regions and the metric used in mean-shift tracking (Equation 8). Dividing the image into grids is the key to correct matching and localization. As noted in Table 1, the target cannot be correctly matched when the histograms are compared with chi-square metric without dividing the image or when the metric used in mean-shift tracking is employed. Figure 11-13 shows the pixel errors for three targets.

5. CONCLUSIONS

We have presented a novel feature extraction technique that addresses the problem of detection and tracking in low resolution domain. A comparison with other techniques such as HOG, SURF, SIFT and mean-shift tracking shows that our descriptor is far superior to such techniques when there is very little textural and structural information. In addition, since the approach is based on histogram, it is less computationally intensive than most other methods. We have shown the effectiveness of our approach in tracking in wide area CLIF data. A scheme that uses cross bin similarity metrics instead of bin-bin similarity metrics like chi-square is currently being developed.

REFERENCES

Table 1
Performance Comparison of Histogram Similarity Metrics.

<table>
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<th>Our Method</th>
<th>Undivided Image Histogram</th>
<th>Metric in Mean shift Tracking</th>
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<tr>
<td>Dist(reference,target)</td>
<td>3.1654</td>
<td>0.2968</td>
<td>0.3252</td>
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<tr>
<td>Dist(reference,background)</td>
<td>4.2863</td>
<td>0.2902</td>
<td>0.3120</td>
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</table>

Figure 11. Error Plot for Target 1

Figure 12. Error Plot for Target 2
A Local Histogram Based Descriptor for Object Tracking in Wide Area Motion Imagery

Figure 13. Error Plot for Target 3

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