Corner-based Tracking for Rigid/Non-rigid Objects Using Voting Space

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Problem:

Tracking of rigid/non-Rigid objects with size-adaptative bounding box using a method which could allow us to exploit the information of the tracking phase for futher analysis such as behaviour analysis.

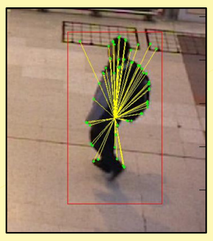
Our Proposed Solution:

Use corners as input features.
Creation of a model with selected features at initialization.
Use labeled voting mechanism to do a fast estimation of new reference point in consecutive frame.
Exploration in the voting space to refine translation estimation and selective filtering of observations corners.
Use spatial and voting space fitering to update model.
Use a variable bounding box that adapts to the model.

Initialization

In the first frame a bounding box is selected covering all the object to be tracked

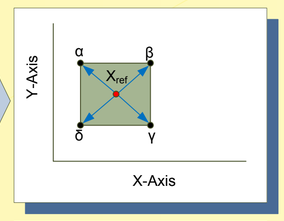
Model

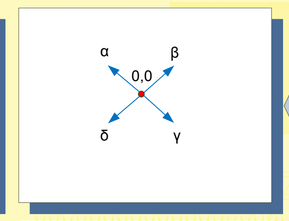


A model is created with the corners inside the bounding box

Exemplification of voting mechanism

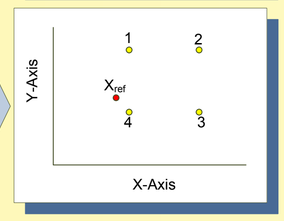
The model is created

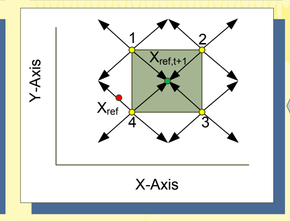




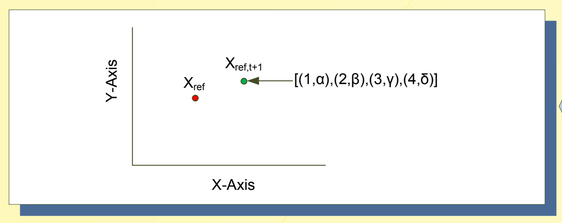
The center of the bounding box in initialization is taken as first reference point

Observation corners in next frame are adquared



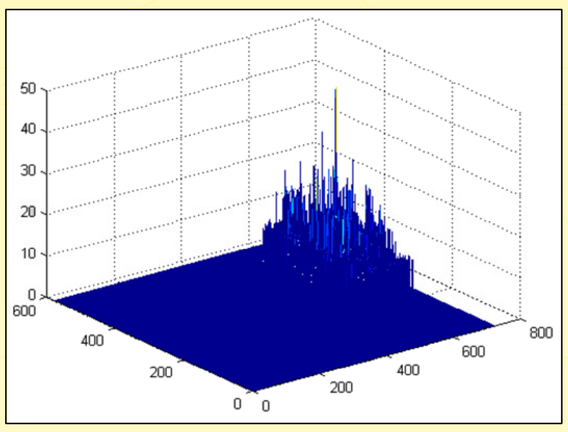


Voting Mechanism is performed



Association matrix keeps track of pair of model points and observation that voted for new refernce point

Voting



Voting Mechanism:

A voting space is built by making all observation corners acquired in the current frame vote for a new reference point as if they were every of the model points from the last frame using the persistency as a weighted vote.
Because is reasonable to think that a model point in the next frame could have a small distortion , we apply a regularization mask of 11x11 in the voting space to spot the zone with biggest number of votes.

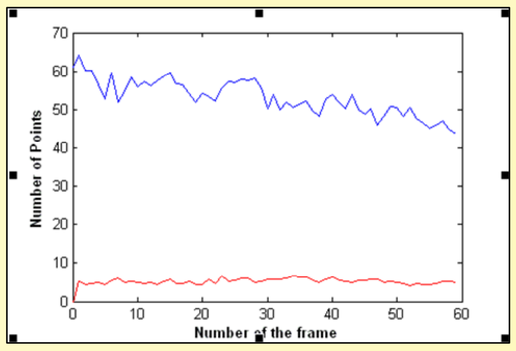
Displacement

Distortion

Update Phase:

As we assume that the new reference point represent the position where the model match better, we fix some small distortion that work as anchors. Then we compare the anchor with its last distortion to get a quantity of how similiar they are. We consider distortion that are similar with its last distortion as key anchor and then we propagate this distortion to model points that didn't find a direct observation in the current frame.

Compactness



	Avg. in BB	Avg. in SLGHT	%
M. Points	71.63	64.55	90.12
O. Corners	92.10	86.17	93.56

Why Using Voting:

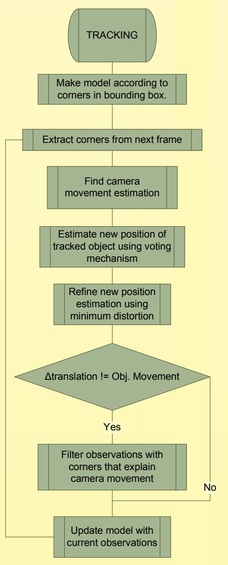
The figure demonstrates that the information from observation corners is considerably more compact in the voting space than the same distribution in the image plane.
In the table can be observed that if we explore in a 31 x 31 window (which equals to 5% of the bounding box) around the new reference point in the alternative space we can find more than 90% of the model points and observation corners that are in the bounding box.

Advantages of using labeled voting:

The transformed space has the advantage of letting us explore more easily different configurations of points because the distortions caused by choosing a certain reference point are easily found in this alternative space. In this way, the voting space acts as an organizer of information which give us a direct availability to different interpretations of the shape distortion.

If we would like to find similar distortion in the image plane, we have to iterate through the model points and observation corners to see if the distortion is between a threshold. Instead, in the voting space, pairs with similar distortion would be spatially close in the association matrix. For instance, all the model points that suffer from a distortion D once the new reference has been chosen can be found in the position (newRefPos+D) in the association matrix and the positions around contain the pairs with similar distortion.

Flow Diagram



Results:

The algorithm has been tested in some sequences getting promising results.
Because we are not forcing a specific bounding box size, stil some points of the model stick to background corners.The idea of not specifying a bounding box size comes from the premise that the algorithm should be robust enough to group together and avoid this situation.

Conclusions:

A corner-based method has been presented that makes use of a voting mechanism to easily estimate the next position of the tracked object. Also information in the labeled voting space is exploited to refine the estimation of the position of the model in the next frame and to Update the model.

Future Work:

Future work concentrates in giving robustness to the method in different scenes and moving camera, to exploit more information in the labeled voting space to detect occlusion by identifying group of spatially close observation corners that move with similar displacement.
Optimization of voting mechanism for multi-threaded and multi-processor architecture by parallelizing the procedure.