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Guillaume Khenchaff's Measure for clustering method

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RESUME

I have just finished my studies in the 2nd year of Master in Mathematics, Computer Science and Applications, image and interaction course at the University of Toamasina. My plan is to continue my studies up to Doctorate level, in order to realize my dream of becoming a lecturer and specialist in the field of computer vision. Currently, I am looking for a Masters or Doctorate scholarship, in order to achieve my goal.
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OUTLINE

- INTRODUCTION
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- CONTEXT
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- CONCLUSION AND FUTURE WORK

INTRODUCTION

- The successive images processing of a video stream make it possible to incrementally reconstruct a precise 3D model of the scene. In image processing, most of the change detection approaches are based on the interpretation of the difference between a current (or previous) image and a background (image without change or object of interest).

- Several works focused on updating the background of the image or background subtraction methods. However, these approaches are subject to a drift in the estimation of the pose of the moving camera and therefore in the estimation of the movement of salient objects on the scene in a vast environment.

RELATED WORK

- **Visual object tracking for online :**
  - **Fast Visual Object Tracking with Rotated Bounding Boxes** [B. X. Chen et al., 2019].
    - Ellipse fitting to estimate the bounding box rotation angle and size with the segmentation(mask) on the target.
    - SiamMask_E method.
  - **Fast Online Object Tracking and Segmentation: A Unifying Approach** [Q. Wang et al., 2019].
    - Perform both visual object tracking and semi-supervised video object segmentation, in real-time, with a single simple approach.
    - SiamMask method.

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- **Visual object tracking** can be done Online or Outline.

RELATED WORK

- **Visual object tracking for outline :**
  - **Realtime Vehicle and Pedestrian Tracking for Didi Udacity Self-Driving Car Challenge** [A. Buyval et al., 2018].
    - Novel approach to fuse data from various sensors (camera, LIDAR, radar, IMU) for pedestrian and vehicle tracking.
    - Extended Kalman Filter method.
  - **Realtime human objects tracking for smart surveillance at the edge** [R. Xu et al., 2018].
    - Moving human detection based on Histogram of Oriented Gradients (HOG) and linear Support Vector Machine (SVM).
    - multi-object tracking algorithm based on Kernelized Correlation Filters (KCF).

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RELATED WORK

- **Clustering of static-adaptive correspondences for deformable object tracking** [G. Nebehay et al., 2015].
  - Dissimilarity measure between correspondences that takes into account their geometric compatibility.
  - Static correspondences from the initial appearance of the object.

- **Texture Superpixel Clustering from pathch-based nearest neighbor matching** [R. Giraud et al., 2019].
  - Nearest Neighbor-based Superpixel Clustering (NNSC) method.
  - clustering framework using patch-based nearest neighbor matching.

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- In general, these approach need other techniques such as a contrario which allow them to efficiently group the pixels of the image of the real scene.

CONTEXT

- **Test platform**
  - **System : Android,**
  - **Version : 6.0.1,**
  - **Processor: Quad core 1,6 Ghz,**
  - **RAM : 1 Go,**
  - **Memory : 8 Go,**
  - **Camera : 8.0 Mpx.**

- For a tracking application to work properly on mobile devices, the grouping module must have a technique capable of extracting information from the real scene.

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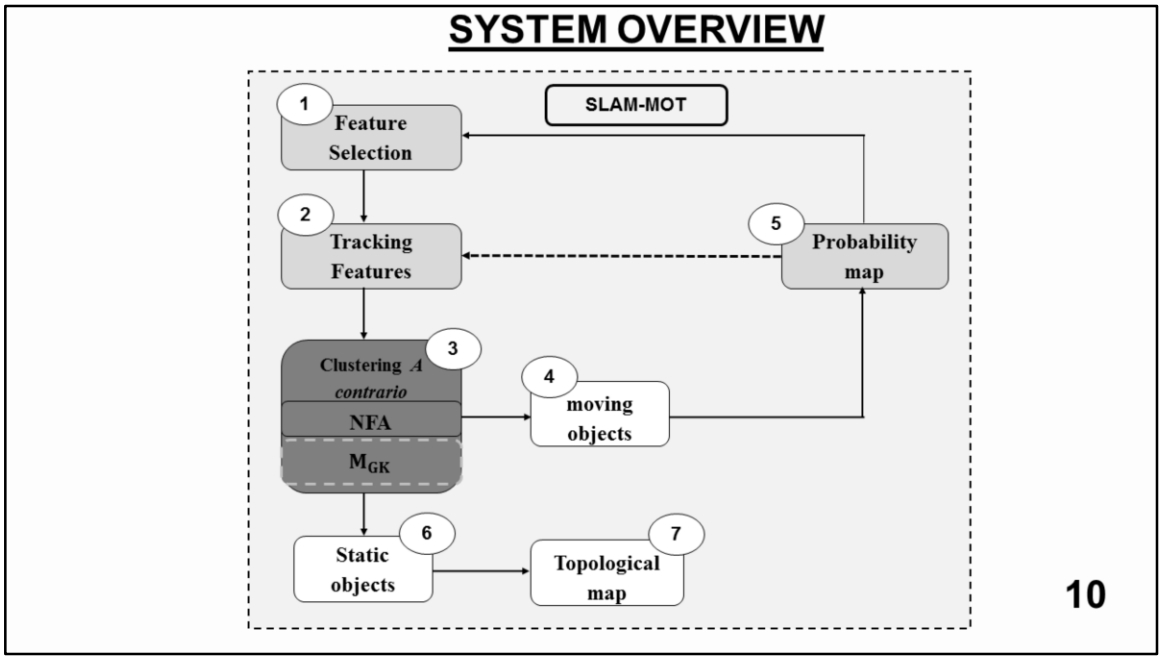
- To do this, we use the Kanade-Lucas-Tomasi (KLT) technique proposed by Lucas et al [13] and then, modified by Shi et al [16].

CONTRIBUTION

- **Definition**
  - M_{GK} [Feno et al.] :
    - Was inspired by Loevinger's measurement with its ability to identify areas of attraction and repulsion, and guided by the desire to overcome the drawbacks of the Confidence measure, in particular the drawback of selecting rules located in the repulsion zone between the premise X and the consequence Y of an association rule X⟶ Y.
  - **A contrario [**Patraucean et Al.] :
    - Gives the mathematical support which makes it possible to predict the perceptions associated with a digital image.
    - Gestalt laws.
    - Helmboltz principle.

- A contrario: take inspiration from gestalt laws to describe what is observable as shape in an image, and use the Helmholtz principle to establish general thresholds of detectability.
- These steps are necessary to arrive at algorithms for detecting shapes, free from any specific setting of parameters.



- In this Figure the KLT module is formed by 1,2,5 components (in lightgray color).
- And the Cluster module is formed by 3 (gray color), it is in this module that we have made our contribution.

➢ Évaluation of the backgroud model

- The objective of the “a contrario” is to group points of interest having a coherent movement along a short sequence of images. Here, the consistency criterion refers to motion vectors which have roughly similar magnitudes and directions for all the points of the group.
- The method receives a set V of input vectors (x, y, v, Θ | t) where x and y represent the magnitude and v the orientation, which is defined in R^4. The latter contains the scattered optical flow accumulated points of interest over time. In the vector V, the variable t is added just to indicate the moment when these points were selected (start of the tracking time).

➢ **Kanade-Lucas-Tomasi (KLT) approach > *scattered optical Flow***

- This module is dedicated to the analysis of images acquired by the Smartphone camera. This one gives as result a set of points of interest characterized in R^4 obtained from the partial results of the process :
  - Selection of points of interest (*Give the position (x, y) of the N best points of interest in the image*) ;
  - Monitoring of points of interest (*Find the position (x, y) of the points in the next image and get their speed in the x and y directions* (v_x, v_y)) ;
  - Insertion of moving points in the probability map (*Keep the cell position centered on each detected point of interest (x, y) in the image*).

- Next, we describe how we used the contrario method invented by [T. Veit et al.].

➢ **Clustering approach > *grouping a contrario***

- Hypothesis 1: Any group of pixels which does not follow the random distribution of the background model is considered to be a group with independent movement.
- In order to obtain a quantitative value for the evaluation of this hypothesis 1, we use a measure called Number of False Alarms (NFA) that of for each group in the binary tree and considers that a group is significant if:
- ***Dynamic object : NFA(G) ≤ 1***.
- Hypothesis 2: Any group of pixels which follows the random distribution of the background model is considered to be a static group.

To solve the problem of extracting information from the real scene, we have established two hypothesis:

- Firstly to detect and distinguish mobile objects among static objects, all the nodes in the binary tree as well as the space of the *H* regions are analyzed.
- This second hypothesis attracts our attention, which we push to integrate the technique of probabilistic measurement of quality M_{GK}.

➢ **Clustering approach** > ***Probabilistic Quality Measurement*** M_{GK}

- The quality probabilistic measurement technique M_{GK} is a very well-known technique in the field of data mining thanks to these mathematical properties which satisfy the five normalization standards.

- This is why we have chosen it as a measure of the degree of dependence between the static object and the mobile object, so that our approach can be combined with the Sumultaneous Localization And Mapping and Moving Objects Tracking (SLAM-MOT) method.

- So, to validate hypothesis 2 that we talked about earlier, we established as events of interest.

➢ **Clustering approach > *Probabilistic Quality Measurement M_{GK}***

- Patterns:

  S : the group in the binary tree is static ;

  A : the group in the binary tree is considered mobile or accepted by NFA.

- $M^f{}_{GK}(S \rightarrow A) = \frac{P_S(A) - P(A)}{1 - P(A)}$ et $M^f{}_{GK}(A \rightarrow S) = \frac{P_A(S) - P(S)}{1 - P(S)}$.

- Acceptance interval is between **[0, 1].**

- To reach our objective, we chose to use the favorable component of M_{GK} which is based on the equations that of [D. R. Feno].

➢ **Clustering approach > *Probabilistic Quality Measurement M_{GK}***

- **Proposition:**
  If $\propto$ is between [0.95, 1], then we really accept that the groups that have an ***NFA(G)***$\leq\propto$ value are accepted as mobile; Otherwise, we accept the first ***NFA(G)***$\leq$**1** evaluation.

- That is, at this threshold the group G in the binary tree is considered to be mobile, and it is sent to the probability map which is used to track dynamic objects in the following process.
  All groups that do not meet this condition are considered static. They will be the subject of the construction of a topological map of SLAM-MOT.

- This proposition giving after the comparison of results of calculation of the favoring component. We take $\propto$ as the final value.

RESULTS

➢ **Environment with rigid moving objects**

(a) Initial image

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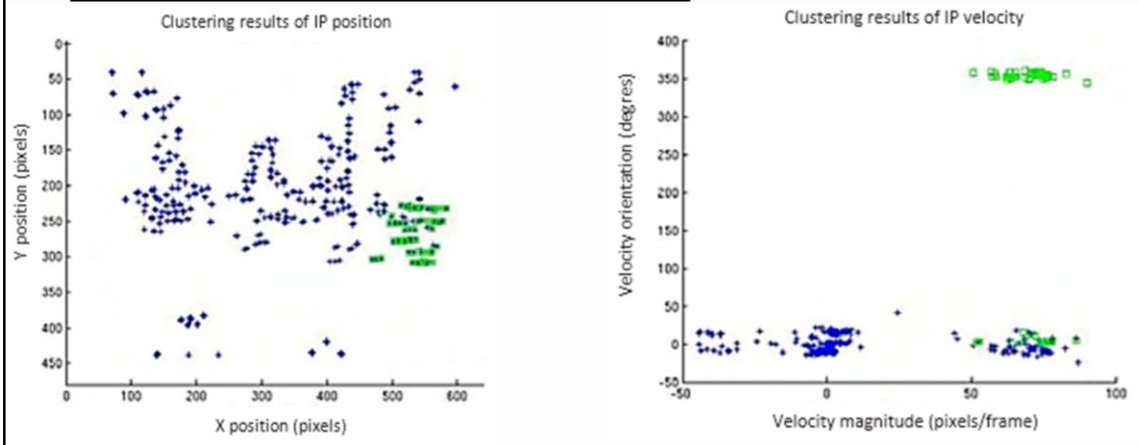
Initially, 150 points of interest are detected (shown in yellow in Fig. a).

- Then, these points are followed along 6 consecutive images.

RESULTS

➢ **Environment with rigid moving objects**



(b) Grouping of positions (c) Speed grouping

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- Fig. b shows in blue the position on the image of all the accumulated points and in green the only group of mobile points identified as a dynamic object. The position of these points corresponds exactly to the position of the points on the car which enters the field of view.
- Fig. c shows the magnitude and orientation of the velocity of the points. The green dots that correspond to the detected object all have the same orientation value since the orientation is around 0 and 360 degrees. Therefore, they correspond to the same direction.

RESULTS

- **Environment with non-rigid moving objects**

(a) Initial image

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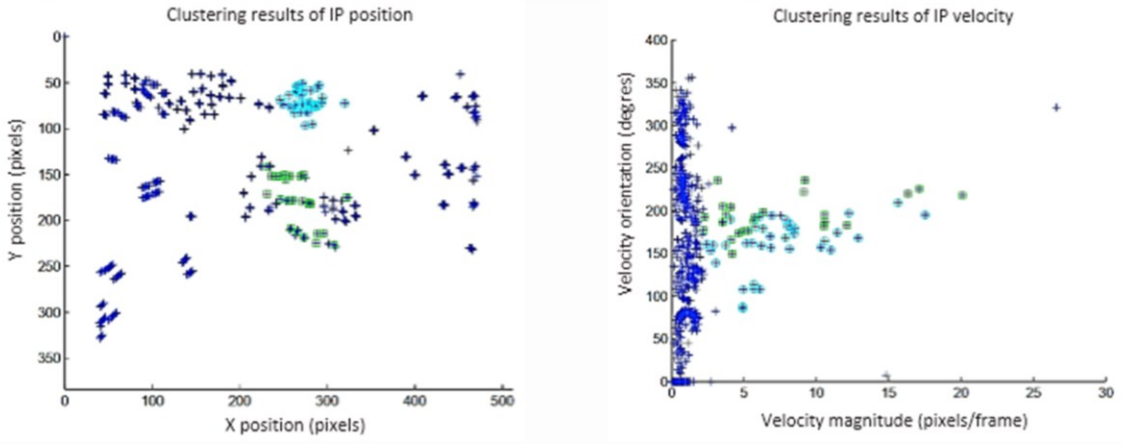
For this test, we initially selected 150 points of interest, which were followed for 20 consecutive images.

RESULTS

➢ **Environment with non-rigid moving objects**



(b) Grouping of positions (c) Speed grouping

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- The position of the points as well as the two groups of dynamic points found are shown in Fig. b. Thus, two groups are found despite the fact that there is only one pedestrian in the scene. The person's head and body are identified as a single object, shown in cyan, and the legs are detected as another object, which appears in green. By analyzing this result, we find that the points corresponding to the upper part of the body have different directions of movement from those corresponding to the lower part.
- Regarding the speed in Fig. c, the magnitude and the orientation are dispersed for the two groups because the upper part of the person is not the same movement as the lower part.

CONCLUSION AND FUTURE WORK

- **Contribition**
  - A new grouping technique which could be used with the SLAM-MOT method ;
  - Integration of the technique Probabilistic Quality Measurement M_{GK}.
- **Future work**
  - Add a motion compensation technique, improve the disturbance due to camera movements ;
  - Exploitation of a method of measuring dissimilarity between correspondences, in order to solve the problem of tracking deformable objects.