Real-Time Object Tracking and Novelty Detection

Implementing Background Modeling and Evolving Fuzzy Rule-Based Classifier

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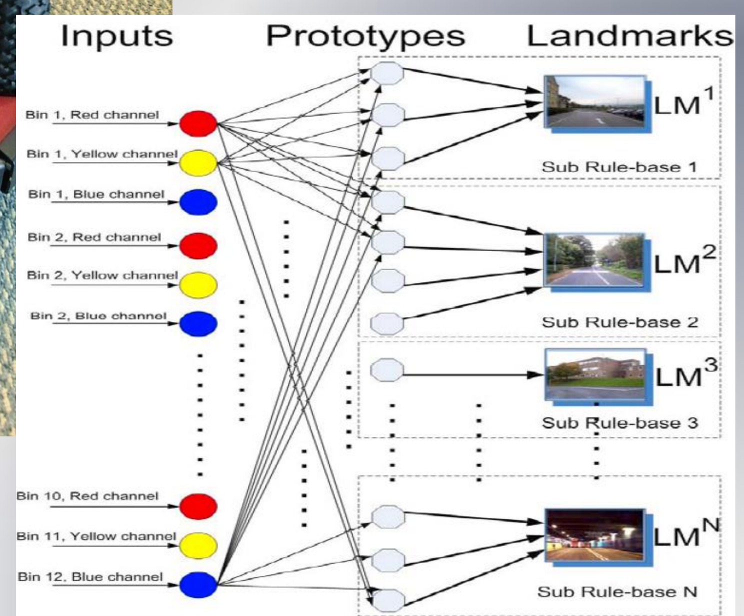
Year: 2006 – 2007
Course: DSP in Communication Systems

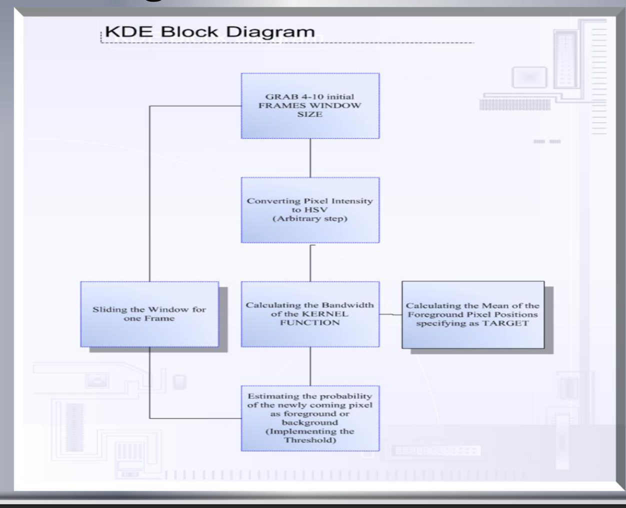
INTRODUCTION

Object tracking and novelty detection is performed in many automated and sophisticated visual surveillance and defense systems. This project is aimed to implement various object tracking algorithms like Non-Parametric Kernel Density Estimation for background-foreground modeling and Evolving Fuzzy Rule based Classifier for clustering the portions of observed scenes. These algorithms help the surveillance systems to work completely autonomously and unsupervised as well as performing in Real-Time. In order to track the moving object in a scene using these algorithms no operator is needed to initially specify the object for the systems to be tracked. These methods are to be implemented on the ActiveMedia Pioneer – 3DX Robots available at Communication Systems Department of Lancaster University. In the first method, a model of background is determined in the scene in order to detect whatever is not a background and is probably moving, using kernel density estimation by approximating the probability of each pixel in the frame as foreground or background. Probability estimation technique is also compared with different background subtraction methods in this project as like mean difference. The second method has been inspired from Image Segmentation using Evolving Clustering. In a constant picture, e-Clustering would segment the image into different portions specifying each allotment with a unique centre. Using the same methodology it is possible to compare each pixel of a frame with the same position pixels in the other frames and distinguishing that particular pixel as a foreground in case of being allocated to a different cluster. These methods on overall could be merged with prediction algorithms like Kalman Filtering or ex-TS in order to predict the next steps of the object and execute object tracking and/or novelty detection.



Kernel Density Estimation for Background Modeling

Considering a sequence of video frames or pictures, each many contain events occurring in a frame and fade out after a while or even remain in the scene. The portions of a scene where remain constant with no or slight motions are considered as background and the rest are classified as a foreground. The aim of this method is to build a statistical representation of background which supports sensitive detection of moving objects in the scene as well as building a foreground representation in order to comply and support the tracking. This algorithm considers the density of each pixel which is the color presentation of the pixel comparing with the same position pixels but in consecutive frames. Forming the statistical color distribution function called Kernel Function (Gaussian in this project) in the feature space, enables the program to evaluate the probability of each newly pixel for being specified as a foreground or background making use of a threshold.



KDE Experimental Results

KDE Conclusion

This method performs authentically even under bad climate conditions where the scenes contain rain or snow and background has slight motions as like tree branches displacements.

Evolving Fuzzy Rule-based Classifier

This method calculates the potential of each data in the data spatial density in Real-Time and unsupervised. Starts from one data considering it as a centre of an initial formed cluster. Having one fuzzy rule per class, extracts successive data and classify all in the same cluster or new formed clusters based on the potential of data. This method is used firstly in this project as Image Segmentation grabbing each frame and clustering the data into various segments. Using this methodology it is possible to pass the sequence of same position pixels in different frames to the system on-line in order to classify them. Therefore if a certain pixel does not get allocated in the identical class as the other same position pixels, it would be foreground. This approach (eClass) could be used in landmark recognition as well. Each frame grabbed by the system will be assigned with certain cluster centers, therefore any new frame entering the system with almost the same centers would be again identified as the same landmark and could be discarded from the memory and newly formed centers will be new landmarks. This method is fully unsupervised, and even cluster labeling is done autonomously.

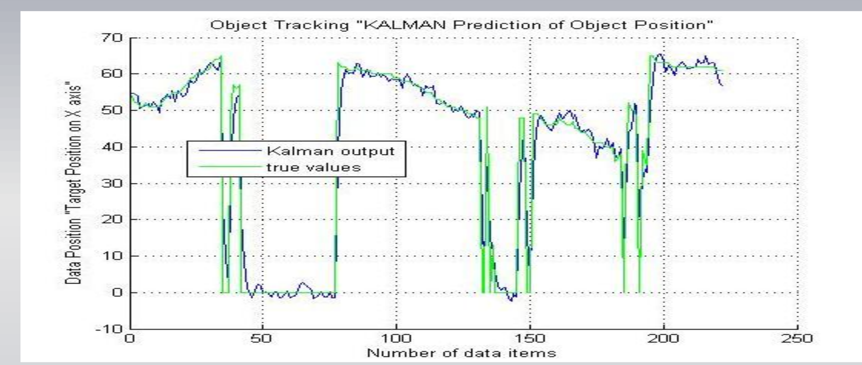
eClass Experimental Results

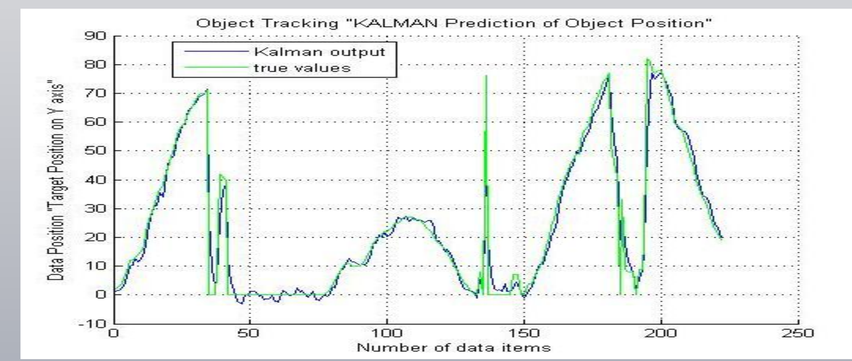
eClass Conclusion

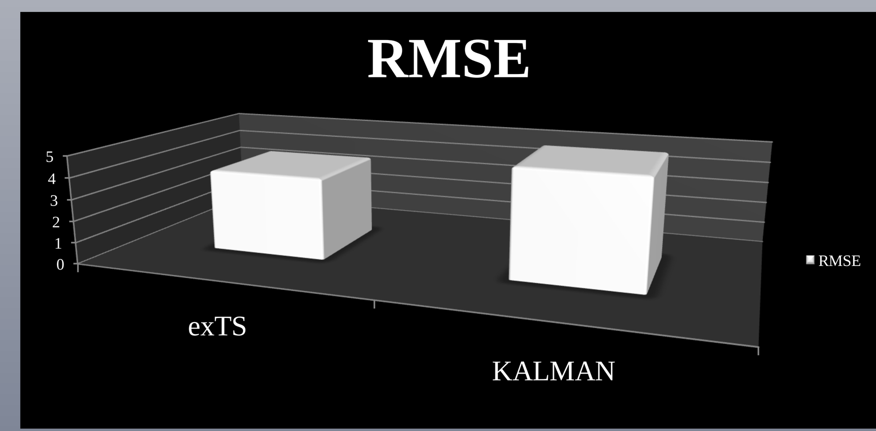
This algorithm have been introduced basically for data clustering and in this project is used for image processing and background modeling in order to track the target. Comparing to KDE is ratter faster and less memory consuming, due to discarding all the data apart from centroids.

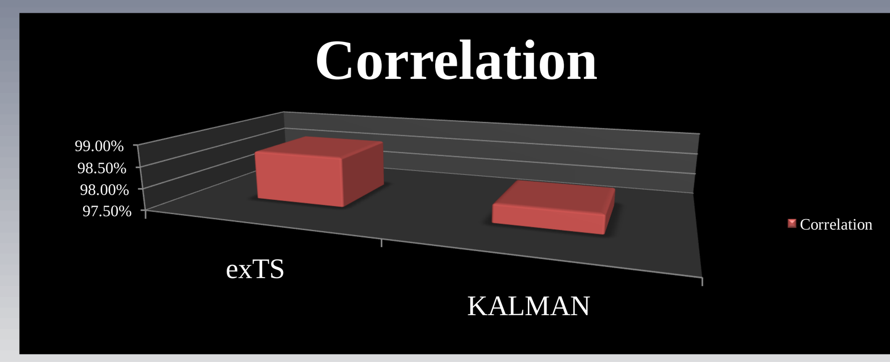
Prediction Algorithms

Previous algorithms could be combined with prediction methods. While object tracking systems performs, it is possible to predict the next position of the target using Kalman Filtering or evolving eXtended Takagi Sugeno (exTS). Kalman filter starts predicting randomly initially by importing the first data item and after realizing the second discrete data, it starts modifying the filter parameters adaptively in order to reduce the error. Evolving property of exTS is to adapt and modify the parameters and weights of the Takagi-Sugeno system network to minimize the error combining both zero and first order TS and not like fixed ANN or Fuzzy rule-based systems has fixed structure. Therefore it can improve over time and is considered as a fast on-line algorithm. In this project, the initial positions of the target is fed to Kalman and exTS systems and the next target situation is predicted.









Major References

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Acknowledgements

This is a chance to express my gratitude to my professor and supervisor, Dr. Plamen Angelov for his successive support and guidance as well as my dear friend and supervisor Xiaowei Zhou for his efforts and helps during the implementation of this project.

I would like to thank Communication Systems Department of Lancaster University for providing the required facilities and useful teaching throughout the academic year 2006-2007.