Object Detection and Tracking in Intelligent Video Surveillance Systems

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Intelligent video surveillance systems have become a vital part of the environmental protection systems of the public security. These intelligent surveillance systems can help prevent threats by offering an early warning based on visual information from IP camera networks. With recent advances in the field artificial intelligence, an increasing number of intelligent video surveillance systems are applying neural network models for training and analyzing videos to achieve the goal of object recognition and object tracking. However, the architecture for conventional neural network training requires a large amount of manually labeled data to train the learning model and to analyze the object automatically. The high computational cost and complex training process make it difficult to use in real-time.

In this study, we use a foreground detection method and behavior modelling techniques to reduce the computational complexity. In order to recognizing object events in continuous images to infer regular or irregular behavior, the proposed system utilized a foreground detection method to locate the objects of the image, extract the features of the objects, and analyze the features and to model the behavior by machine learning classification techniques. Several conventional methods such as background subtraction, optical flow, and hybrid foreground detection were applied for foreground detection. However, these methods are only effective in controlled environment. More parameters and features need to be considered if the system is to be used in real-time scenarios.

We followed the ensemble learning techniques to ensemble different foreground detection methods in this study. The detection methods were applied to different foreground detectors to detect foreground information such as momentum, dynamic background, and static scene clues. Next, the proposed system computes the scene indicator, learning rate, and weights of the detectors. Finally, the system uses the ensemble learning to integrate the adaptive combination of the detectors to so that they may be used in complex, real-time scenarios. Furthermore, the feature extraction algorithm can be applied to extract texture, color, shape, size, and motion velocity and regarded as features of a specific image. Although all features have different discrimination ability, the study considered computation cost and the characteristics of physical world to select the essential features to improve the behavior modeling. The proposed system can reduce the computation load by using few key information. After extracting key features, we applied the support vector machine algorithm to project binary data to the high dimensional space using kernel functions. This is done to compute the maximum margin of the hyper-plane to learn the classification model and judge irregular behavior.
In order to verify the performance of the proposed system, we used the UMM, UCSD, and CDnet 2014 datasets to conduct a series of experiments. The experimental results show that the proposed system can not only detect the human movements in the foreground but also can detect irregular behavior such as abandonment left in the environment. Future work will involve research into improving accuracy, flexibility, and immediacy of intelligent video surveillance system to meet the complicated environmental challenges.

Keywords: Intelligent Video Surveillance System, Ensemble Learning, Environmental Monitoring

