Study on Human Related Analysis in Privacy Protected Videos

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（プライバシー保護ビデオにおける人物解析の研究）

区　　分　：甲

論　文　内　容　の　要　旨

Human related analysis using surveillance cameras is prevalent in crime prevention, condition monitoring, abnormal behavior detection etc.. These surveillance cameras are ideal tools for these purposes, since they are cheap and any person within the monitoring scopes can be monitored. However, privacy protection issue has been bothering people when using them. The reason is that the recorded videos containing privacy may be abused before effective privacy protection. Because of the privacy concerns, the deployment of surveillance cameras encounters resistance from the public in many countries. To protect privacy for surveillance cameras is in urgent need.

To protect privacy in surveillance videos, mostly adopted approach is based on post processing. This approach hides the privacy manually or by some algorithms after capturing the privacy included data. However, since the data with privacy are transmitted, processed or stored, there is a vulnerable time for privacy leakage. To solve this, an optical level anonymous image sensing system has been proposed, which hides the facial regions optically at the video capturing stage. When it works, firstly, it finds the facial locations in the scene using a privacy-safe thermal image. Then, masks corresponding to these facial locations are generated and displayed on a spatial light modulator (SLM), which controls the light rays into an RGB image sensor. By this way, light rays from the faces in the scene are blocked from coming into the RGB image sensor. The output from the RGB image sensor does not contain any facial information (with facial regions black), thus the risk of privacy leakage is avoided. From the working process we see, finding the facial regions in thermal images is important for effective privacy protection. To improve the system effectiveness, we should better detect facial regions in thermal images. Furthermore, we also intend to apply the system to a typical human activity analysis: abnormal behavior detection. For these purposes, this thesis tackles two human related analytical issues based on privacy protected videos: 1) face detection in privacy-safe thermal videos; 2) abnormal behavior detection in facially masked RGB videos.

For the first human related analytical issue, the author proposed two approaches: 1) new feature types by extending MB-LBP. By these extensions, the feature robustness and effectiveness are improved; 2) a mixed feature training algorithm based on AdaBoost. By this algorithm, cascade classifiers with multiple feature types for improved discrimination ability can be obtained. The

author captured a dataset of 8400 thermal images from 21 participants. Using a hold-out validation, the author showed that the proposed approaches are effective. The author also did a field experiment and showed the factors which affect the face detection performance for using both thermal and RGB images.

For the second human related analytical issue, the author proposed a neural network called C3D-AE. The C3D-AE consists of two steps: 1) feature extraction; 2) classification based on the extracted features. C3D-AE uses a 3D convolutional neural network called C3D for feature extraction and an autoencoder for classifying. In training, the fully connection layers of pre-trained C3D network are firstly removed and concatenated with an autoencoder. Then the autoencoder is trained by using the features extracted from video clips with normal behaviors by the pre-trained C3D. In predicting, the reconstruction error of the autoencoder is compared with a threshold to predict abnormal behavior. The author performed three experiments, a hold-out validation experiment and two field experiments. In the hold-out validation experiment, the author captured a dataset from 22 participants. The author showed the effectiveness of C3D-AE, compared it with other methods using videos with/without facial masks. In field tests, the author showed the applicability for abnormal behavior detection in real scenarios with robustness.