Video Inpainting and Implant via Diversified Temporal Continuations (Video Demonstration)

Timothy K. Shih, Nick C. Tang, Wei-Sung Yeh, and Ta-Jen Chen
Department of Computer Science and Information Engineering
Tamkang University, Taiwan
tshih@cs.tku.edu.tw

ABSTRACT
This video program presents several video inpainting/implant mechanisms implemented under different types of videos with diversified temporal continuations. We use an improved image inpainting method to remove foreground objects. Another set of objects are implanted into the inpainted video. Detailed algorithms are presented in a paper in the 2006 ACM Multimedia conference.

Categories and Subject Descriptors
I.4.4 Restoration, I.4.5 Reconstruction, I.4.3 Enhancement

General Terms
Algorithms, Design, Experimentation

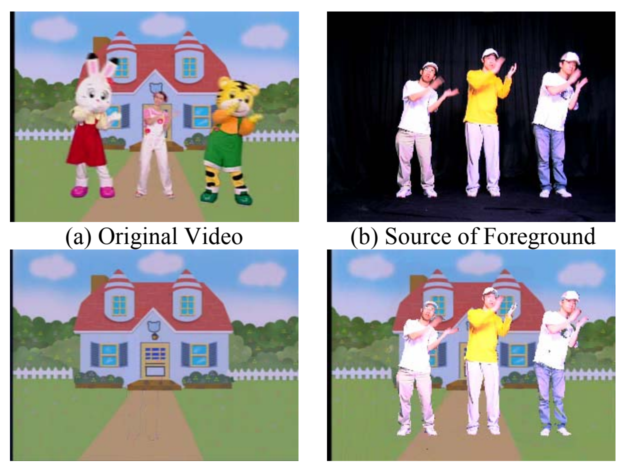
Keywords
Video Inpainting, Object Removal, Video Implant, Temporal Continuations, Object Tracking

1. BACKGROUND
Image inpainting mechanisms can be used to remove large objects from a picture. The mechanism can be used to repair damaged picture artifacts or to remove redundant areas in a photo. Most image inpainting mechanisms can produce visually pleasant results. However, removing objects from a video clip introduces another challenge issue. If video frames are inpainted individually by ordinary image inpainting techniques, due to the discontinuity of temporal property, a "ghost shadow" occurs. This video demonstration illustrates the problems and the solutions. Detailed algorithms can be found in [1]. Additional demonstrations are available at http://www.mine.tku.edu.tw/.

2. TEMPORAL CONTINUATIONS
Video clips can be generated by computer or taken by video camera. We consider both stationary and non-stationary videos since their temporal continuations of background are different. In addition, we consider different movements of foreground objects. We divide our demonstration into three portions. Each portion of demonstration is implemented with a different set of algorithm. However, three steps are taken in all videos: object tracking, inpainting, and object implant.

3.1 S*tationary Background with Moving Objects*
Objects in a stationary background are easy to be removed. Since the background is fixed in all frames, after identifying which portion in a frame to be removed, one common strategy is to find the best patches of background among all frames to inpaint the removed portion. However, if no patch is available, image inpainting algorithm is then used. Usually, the background completed is used in the entire video for object implant.

We use a video clip for teaching kids how to dance (figure 1a). Our students perform the same dance in a video studio with fixed light sources (figure 1b). Background is constructed (figure 1c) and tracked objects are implanted (figure 1d). Application of the technique can allow parents to make interesting video for their own kids.

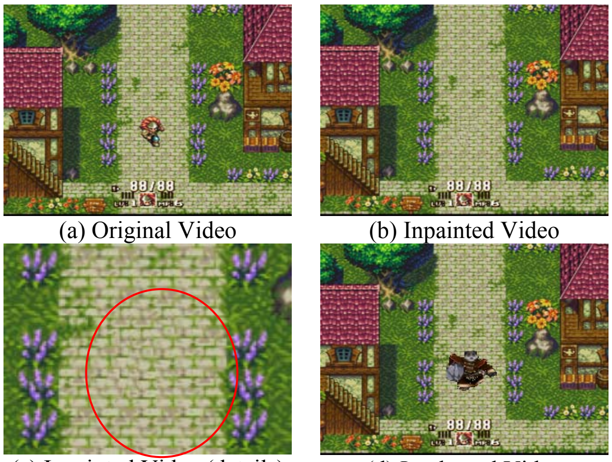


(a) Original Video (b) Source of Foreground
(c) Inpainted Background (d) Implanted Video

Figure 1. Video Implant with Stationary Background

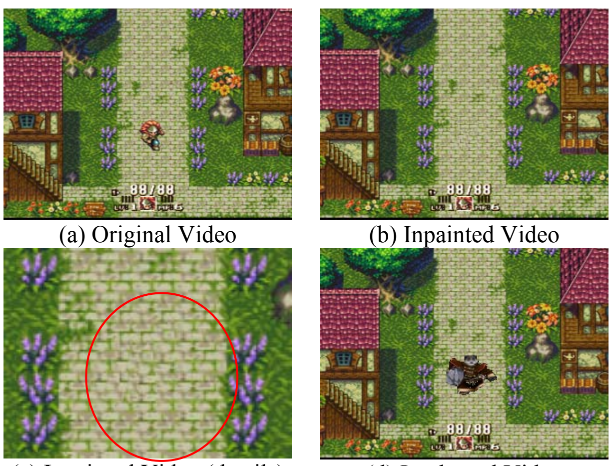
3.2 Non-S*tationary Background with Slow Foreground*
Temporal continuations of background should be encountered in non-stationary video. We produce video clips from video games. These video games have an avatar almost fixed in the same position (the center of screen). Thus, our strategy to estimate temporal continuations is applied to video background only. Backgrounds are divided into blocks. Motion vectors of blocks are computed via an ordinary block matching technique. The average vector is used to estimate the next possible movement of background. Estimated background is subtracted from the real background in the next frame. The difference is then inpainted using estimated information. We found that, with a correct estimated motion vector, the "ghost shadow" can be reduced.

In the second part of demonstration, we tested several video clips produced from video games. Avatars from different video games are implanted to produce interesting results. Figure 2 and figure 3 illustrate some results with enlarged inpainting results. Unfortunately, we are not able to show "ghost shadow" in the report. Interested readers should look at the video program.



(a) Original Video (b) Inpainted Video (c) Inpainted Video (details) (d) Implanted Video

Figure 2. Video Implant with Non-Stationary Background



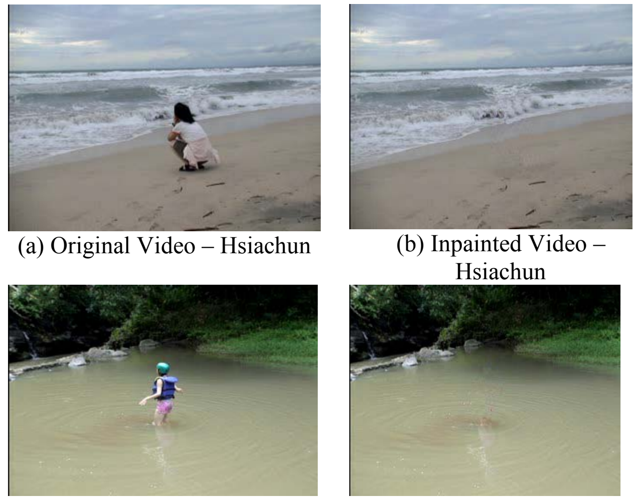
(a) Original Video (b) Inpainted Video (c) Inpainted Video (details) (d) Implanted Video

Figure 3. Another example of Video Implant

3.3 Non-S*tationary Background with Fast Foreground*

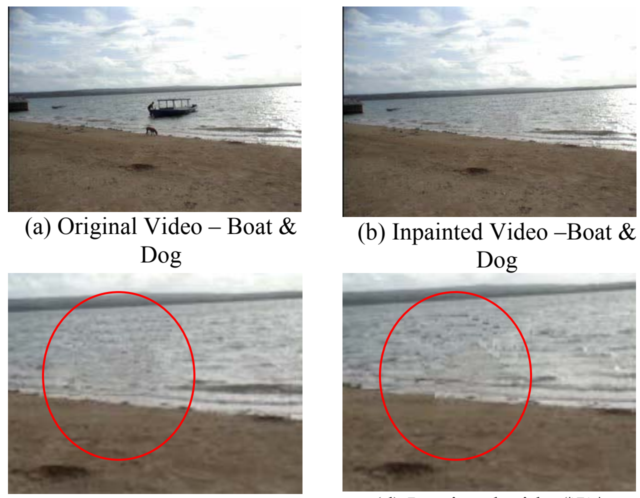
The motion vector estimated is critical to reduce "ghost shadows." However, in an unpredictable situation such as ordinary video taken by digital camera, it is hard to precisely compute the vector. Another difficulty is due to a fast moving foreground object. The object needs to be precisely tracked and an average motion vector needs to be computed. The motion vector of foreground object is combined with the vector of the background object to reduce "ghost shadows."

In the third part of demonstration, we use four scenery video clips (see figure 4 and 5). We found one critical factor which affects the result of inpainting significantly. If the size of patches is too large, even it is easier to find a good matching patch, the results of inpainting produces a boundary effect between two patches. On the other hand, if the size of patch is too small, it is harder to find a good matching match.



(a) Original Video – Hsiachun (b) Inpainted Video – Hsiachun (c) Original Video – Girl (d) Inpainted Video – Girl

Figure 4. Inpainting Results on Scenery Videos



(a) Original Video – Boat & Dog (b) Inpainted Video –Boat & Dog (c) Inpainted with ($|\Psi_p| = 5*5$) (d) Inpainted with ($|\Psi_p| = 10*10$)

Figure 5. Inpainting Results with Different Block Sizes

3. CONCLUSIONS

The video demonstration points out an interesting problem of video inpainting. To reducing "ghost shadow," one needs to consider different temporal continuations among frames. The demonstrated video still has some drawbacks, including boundary effect between patches and temporal discontinuity due to poor motion estimation. Another interesting problem is to adjust the movements of implanted objects, to precisely match the original objects.

REFERENCE

[1] Timothy K. Shih, Nick C. Tang, Wei-Sung Yeh, Ta-Jen Chen, and Wonjun Lee, "Video Inpainting and Implant via Diversified Temporal Continuations," in Proceedings of the 2006 ACM Multimedia conference, Santa Barbara, California, USA, October 23-27, 2006.