Intelligent Visual Privacy Protection using Context-Aware Patch based Inpainting with Markov Random Field (MRF) Modelling

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***Abstract*-Video surveillance is a quickly growing industry. Now-a-days, video surveillance equipment can be mounted at any place with larger storage space and greater ability to recall. At the same time, the individual's privacy protection is major concern. Varieties of methods are implemented to protect and preserve the privacy of individual's appearing in videos and images. One of the efficient ways is by the removal of object/people appearing in an image or a video. When removing an object/people from an image, a hole is left. This hole has to be filled in order to create seamless image. To repair regions with damages, inpainting methods are used. These methods can be used for visual privacy to remove people that do not commit suspicious activities from video surveillance recordings. In this paper, context-aware patch-based image inpainting is proposed for removal of private objects. Test results shows that the proposed method gives better performance when compared with conventional methods.**

***Keywords*-Visual privacy protection, Segmentation, Inpainting, Markov Random Field, Contextual Descriptors, Region Labeling**

I. INTRODUCTION

It tends to be seen that total population is maturing. With the expansion in population, to counteract wrongdoings, to battle against psychological warfare and others, utilizing camcorders in open spots is energized. For the most part, camcorders are utilized in open spots for reconnaissance benefits in boulevards, parking garages, banks, airplane terminals, train stations, strip malls, historical centers, sports establishments and numerous others.

In ordinary video reconnaissance frameworks, cameras are taken care of by human administrators that always monitor the screens searching for specific activities or incidents. Be that as it may, utilizing human administrators does not avert maltreatment of these frameworks. Likewise, expanding the quantity of cameras introduced in open spots are raising worries about people security.

In future, it is normal that cameras will encompass us in both open and private spaces. Intelligent observing frameworks undermine person's privilege to security due to programmed checking. These frameworks can hold an assortment of data about individual's habits, visited spots, connections, etc. A few frameworks as of now utilize facial acknowledgment innovation. Along these lines, these frameworks may construct a profile for every native in which the general population personality and related touchy data is uncovered. Thusly, this advancement of intelligent monitoring frameworks makes the general population to have the sentiment of being always observed.

In the light of the above, it is clear that the protection of the individual's privacy is of special interest in video surveillance, Video conferencing and telemedicine applications regardless whether they operate in

private or public spaces. Therefore, privacy requirements must be considered in intelligent monitoring systems by design.

Yuta Nakashima et al (2016) evaluated the privacy protection capabilities of basic image processing techniques (blurring and blocking out eye regions) based on two factors namely familiarity and conspicuousness. Finally, they found that the conventional blurring and blocking out eye regions methods are almost incapable of protecting privacy.

Lili Jia et al (2017) used a structure propagation inpainting algorithm for reconstructing the missing information to protect the individual's privacy in video sequences. But this method is suffered with so many limitations. The main limitations are a) the reconstruction of textural and structural parts are very difficult when sufficient details are not available & b) this method works well when the missing structures are represented by set of simple curves.

II. PROPOSED METHODOLOGY

The flow diagram of Markov Random Field (MRF) based inpainting in feature domain to intelligently remove private objects/people from real time video for visual privacy protection is given in Figure 1. The flow diagram involves different steps to meet the object removal and inpainting requirements as shown in Figure 1.

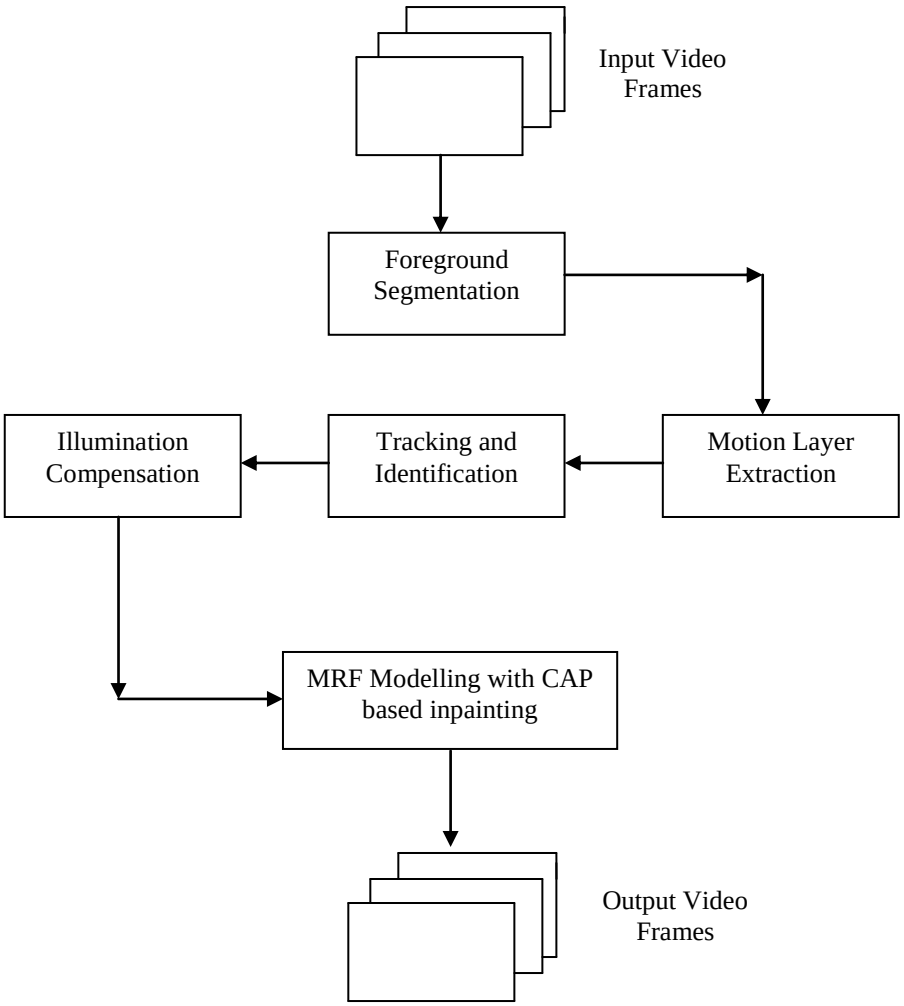

Fig. 1 Flow Diagram of Visual Privacy protection

A. Foreground Segmentation

To segment the foreground regions, the Background Subtraction is carried out initially. Then to detect the objects, region labeling algorithm is used.

B. Motion Layer Extraction

The static and moving layers are individually segmented from the foreground using adaptive background model. This is very useful to detect occlusions and track moving objects.

C. Occluded Object Segmentation

Occluded object segmentation is a very difficult task. For that reason, the objects are separated by using the motion layers obtained from the motion layer extraction step.

D. MRF Modelling with Context Aware Patch Based Video Object Inpainting

Finally, the private objects will be removed by the proposed Markov Random Field (MRF) modeling with Context Aware Patch based inpainting with following steps.

a) Context Aware Patch Selection

b) Initialization

c) Label Pruning

E. Inference: Illumination Compensation

Eventually, the scene illumination varies because of variations such as lights being switch on (or) camera functions like white balance. These variations have an effect on the inpainting as the background model will not match the current scene. So, an algorithm is used to compensate for this by using the lightness channel of the non linear CIE L^*, u^*, v^* color space.

III. RESULTS AND DISCUSSIONS

The proposed context aware patch based inpainting with MRF modeling is tested with the data set "Caltech Pedestrian". From this data set, 10 hours of 640×480 30 Hz video taken from a vehicle driving through regular traffic in an urban environment is considered for testing. The test results are shown in Figure 2. The proposed method is applied to each frame and the spatial-temporal coherence of the video is preserved by using this method. So the proposed method gives better working performance and low complexity when compared with state-of-the-art approaches.

Fig. 2 Sample Results of Particular Frame for Visual Privacy protection

IV. CONCLUSION

In this paper, the framework for an intelligent visual privacy protection using context aware patch based inpainting with MRF modeling is proposed. This framework can able to preserve the spatio-temporal coherence between video frames and able to give stable results. The outcomes prove that the proposed method has improved the performance when compared with existing methods.

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