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Recovering Blur Target of Video Using Mean Shift Tracking and Harris Corner Detector

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Abstract: One of the main problems of the video processing is a blur, since, the blur makes the target is non-clear. This research focus on the intentional blur of the target. Intentional blur is concentrated on the way of the application programs in order to create a blur to hide the target. This application programs may have weaknesses for covering the target. Some time, the blurring is not covering all target in the video where parts of the target may have appeared in serial of frames in that video. The proposed method is implemented in two stages. Firstly, tracking of the target using "mean shift" technique for finding parts of the target that might appear. Secondly, the stage is stitching of parts using Harris corner detector. High accuracy have been proved in the results when the parts have overlap between them.

Key words: Mean shift technique, Harris corner algorithm, image stitching, interest point, homography, SANSAC and blend

INTRODUCTION

Image blur is general artifacts in image processing and it makes or become unclear or less distinct. The blur makes the target in the video is not clear. There are many cases which create blur on the target such as (out of focus, motion blur, box blur and Gaussian blur). Generally, there are two types of blur (intentional blur or unintentional blur) (Ankawala *et al*., 2015; Singh and Sahu, 2013). Intentional blur makes the part or all the target blurred to some reasons such as (security cases). Intentional blur is creating by application programs such as (editor video, Camtasia program and Wonder share Fillmore, etc). This type of blur cannot be treated by traditional methods. Therefore, the proposed system is exploiting a weakness of these application programs which create, blur on the target. This weakness is appearing in the tracking of the target in the video. The application programs are creating blur in the target where the user determines the location of blur on target. When the target is moving through the video, it might appears parts of the target through that video. The simplest example here is shown in Fig. 1. To recovery, blurred target must track this target and collect the parts that appeared.

Target tracking is a very important subject in the application of computer vision. Tracking is defined as the problem of estimating target trajectory of a video. To track of a target, must locate and follow the moving from frame to frame in that video (Lakshmeeswari and Karthik, 2016).

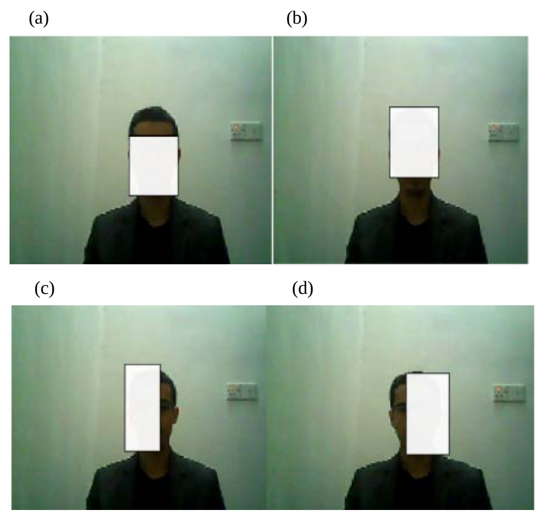

Fig. 1: Position of the blurring or hiding region that appears of the target object: a) Upper part; b) Bottom part; c) Right part and d) Left part

There are many techniques for tracking of the target. Some of these techniques depend in the appearance and some depend in the histogram. For example about these techniques is (block-matching and KLT tracking, etc.) (Lakshmeeswari and Karthik, 2016). Tracking is the first step in this research because the tracking has given capacity for detection the best parts of target that appeared. Next step is stitching parts of target this operate is called panorama.

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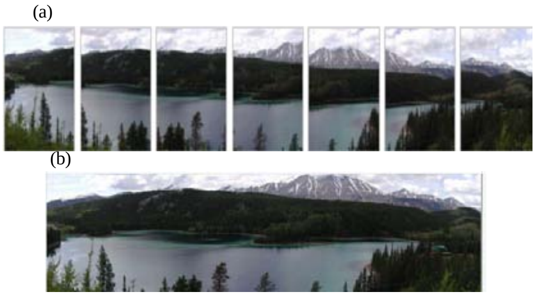

Fig. 2: Panorama technique using stitching; a) Set of images before stitching and b) Image panorama after stitching of images

Panorama is stitching set of images which have overlap between them (Fig. 2). Image Panorama after stitching of images. Image stitch is depending on following the steps. Firstly, interest point detection in images. Secondly, feature matching between interest points. Finally, blend images (Hassaballah *et al*., 2016).

In this research, using the mean shift to track the target and collect parts that appeared as well as this research using Harris corner detection to detect interest points of images.

Literature review: First review prior work of the video tracking and image stitching related to (Rawat and Raja, 2016) the proposed is tracking object detection using background subtraction and tracking single motion of object using modified mean shift and Kalman filter. Talmale and Janwe (2016) proposed is monitoring of shift set of rules (mean shift tracker) which using shift set of rules on sequences of different video. This proposed is not needed parameter estimation.

Our aim in this research is using the mean shift algorithm by selecting the Region of Interest (ROI) where the region of interest means the window of rectangular which located in the first frame in the video. Next phase is compute distance between two-color distributions by Bhattacharya coefficient.

Iqbal *et al*. (2016) proposed a captured frames from video images are registered. The feature extracts from images that registered using Scale Invariant Feature Transform (SIFT). These images are stitching by geometrically.

Li *et al*. (2017) addressed the use of quasi-homograph warp that is balanced in non-overlapping region between images. Further, quasi-homograph used for blend images. In this study, we use Harris corner detector to detect interest points in images. Moreover, finding the correlation between interest point in images and blend images.

MATERIALS AND METHODS

The following Fig. 3 explains the main steps of the mention method.

Input video file: The first step of the method is taking video file that has extension "AVI" and it must be of high quality. The reason of that is related to the detection of the interest points depend on the type and the quality of that video. The interest points are a very important for stitching the parts of the target that might appear.

Picking frame: The video file consists a series of frames (images). This wok takes all frames (images) in the video file to track and find the best parts of the target that might appear.

Mean shift tracking: This stage divided in to set steps that explain in the following:

Selecting the blur region manually in the first frame (first images): This step determines only blur region that it must be tracking, the example shown in Fig. 4. The blurring of target is varied in degree of blur in some time transparent or dark blur. This step is a very important in the proposed method because it is reduced consume time to analyze the video to detect the blur target region and representation the blur region.

Drawing the large window around blur region (search window): Search window that around blur region it has two functions that explains in the following, the example shown in Fig. 5. Firstly, it is using in mean shift tracking that is explaining in step (3-3-3). Second, it is using to focus search only in parts of the target that might appear in beside of the blur region, the example shown in Fig. 6.

Algorithm; Mean shift algorithm:

Mean shift algorithm depends on the following main steps:

A. Selecting a search window size that explained in step (3-3-2) and locating the position of this window.
B. Finding the mean position in this window
C. Finding the center of the search window at the mean position that it's found in step (B)
D. Repeat step B and C until the position of mean moves less than a threshold or until achieved convergence

In the proposed method, using the color histogram to target model and candidate model. Candidate model is

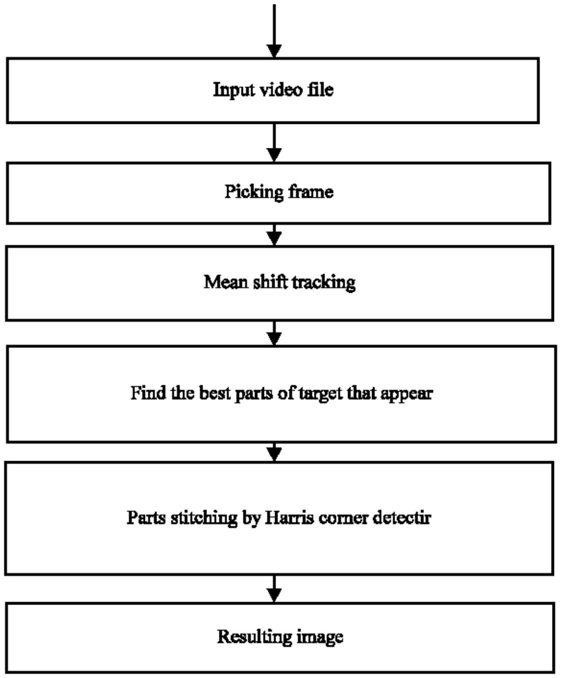

Fig. 3: Block diagram of the proposed method

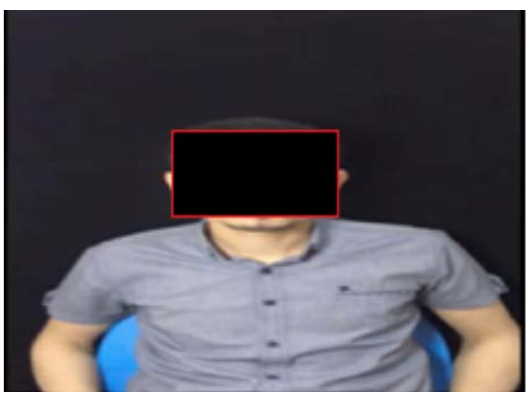

Fig. 4: Locating the blur region

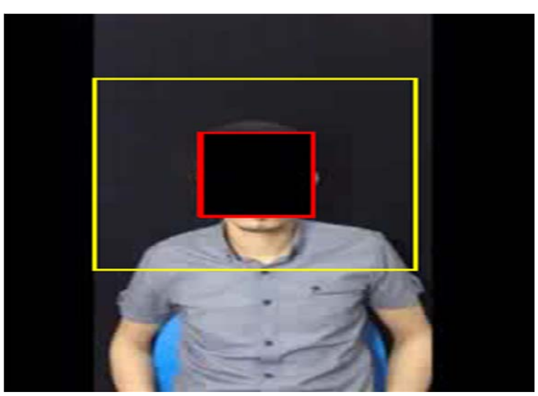

Fig. 5: Determining window is greater than the blur region as the index in yellow

Fig. 6: An example showing the region of the search window with yellow color and this window is used to search for the parts that may appear

found in the search window. Another step computes similarity measure of histograms (target model and candidate model). A similarity measure used Bhattacharyya coefficient that it metrics for the similarity of two probability distribution by Eq. 1:

$$\rho(p, q) = \sum_{u=1}^{m} \sqrt{puqu} \quad u=1, 2, ..., m \tag{1}$$

Where:

p, q = Probability distance between two histograms

m = Number of bin in histogram

RESULTS AND DISCUSSION

Finding the best parts of target that appear: There are main steps to find the best parts of the target that appear. As explained in the following: From the first frame, take only the search window that extracted from previous steps. As the first frame is a background frame (reference frame) by Eq. 2.

$$B(x,y) = A(x, y) \tag{2}$$

Where:

B (x, y) = Background frame pixel by pixel

A (x, y) = The pixels of search window in the first frame

Next, reading the video frames sequentially and subtract the frame of search window from each current frame subtraction each frame is coming A (x, y) with background frame B (x, y) and it depends on the threshold (thre. 1). After that, the result convert into a binary image by Eq. 3.

$$C(x, y) = \begin{cases} 1 \text{ if } B(x,y)-A(x,y) > \text{thre. } 1 \\ 0 \quad \text{otherwise} \end{cases} \quad (3)$$

where, C (x,y) are the pixels that changed. Threshold (thre. 1) value is (15) and it can be set manually. After that counting the number of pixels that are white color in each frame(search window).If pixels count of the white color large or equals to threshold (thre. 2) then this the frame is taken to another process or leave. Finally, collect the frames that are differing from the background frame that depending on threshold (thre. 2). The threshold (thre. 2) in the proposed method is (0.05) by it's proving the best result and it can be set manually.

After collecting the frames (only search windows) that are differing from background frame. Next step the frames are divided into four parts (left, right, up, down) each background frame and the frames only differed. After that, compared each part in the background frame against part of another frame that is differing. The aim of this compare is discovering locate each part that appears and its locate . The resulting of this process is only four parts (left, right, up, down). The four parts are using in the study (3.5) for blending of parts. The example shown is in Fig. 7.

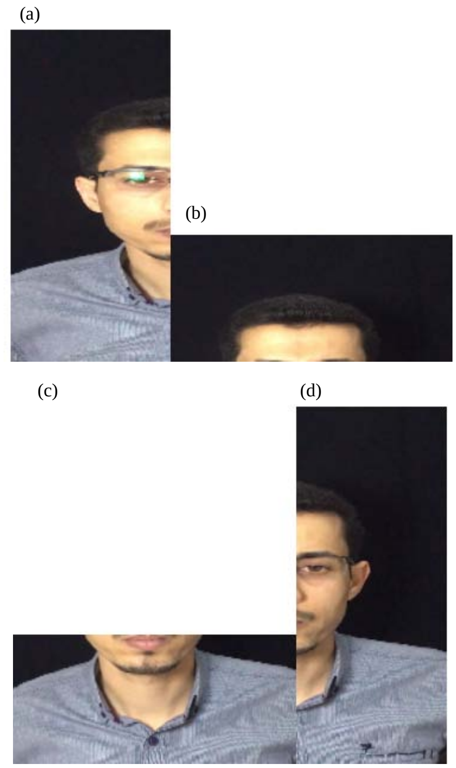

Fig. 7: The best parts have been found: a) Left part; b) Upper part; c) Bottom part and d) Right part

Parts stitching by Harris corner detector: Parts stitching need the overlap and identical illumination between parts that must be stitching to get the perfect outcome. Parts stitching are divided into steps that explain in the following:

The interest points detector by Harris corner algorithm: Harris corner algorithm is using to detect the interest points in each part (image). During computing autocorrelation matrix technique. Auto-correlation matrixis computing by Eq. 4. The 2×2 symmetric autocorrelation matrix used for detecting the interest point in each part (image):

$$M(x,y) = \sum_{u,v} w(u,v) * \begin{pmatrix} I_x^2(x,y) & I_x I_y(x,y) \\ Ix_x I_y(x,y) & I_y^2(x,y) \end{pmatrix} \quad (4)$$

where, I_x and I_y are local part derivatives in the x and y directions. The w (u, v) represent window weight over an area (u, v). The eigenvalue of the matrix M is using to find the interest point by computing this matrix for each pixel in part (image). If both eigenvalues are large that means is interesting point (corner). The shown in Fig. 8 to classification of the image point by autocorrelation matrix using corniness measure C (x, y) for each pixel by Eq. 5.

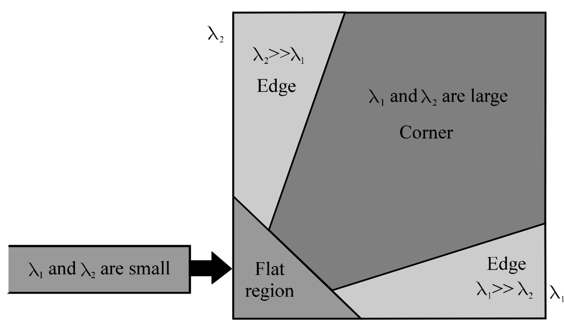

Fig. 8: Classification eigenvalue of the autocorrelation matrix

$$C(x,y) = \det(M) - K(\operatorname{trace}(M))^2 \quad (5)$$

The k is constant parameter; λ_1 and λ_2 are eigenvalue of autocorrelation. The phase of the correlation between the interest points in each part (two images).

This stage is calling the feature matching. The feature matching is using maximum correlation to match between the parts that require for stitching. The cross-correlation works by checking the pixels that around every point in the first part and check correlation with the pixels that around every other point in another part (image). For the interest point in locating at (x, y) with another located at $[X-W_i, X+W_i]*[Y-H_i, Y+H_i]$ where W_i and H_i are typically 10 or 20% of the image. The points that have maximum correlation in bidirectional will be taken as identical pairs.

The phase homography and RANSAC: A homography is using after detection of the interesting point by Harris corner algorithm and a find the correlation the interesting point between the parts (images). The proposed method is finding a model that translate points from set to the other. This translate is one of the types of image transformations which can be used to project one of the parts on top of the other part while matching most of the correlation of the interesting point. Homography matrix is working for the processing. The homography matrix is kind of transformation that using projective geometry. In this method is using homography matrix as a 3*3 matrix. In the homogeneous coordinate will represent it tipple <X, Y, W> where X, Y is coordinate (location) and W is scale parameter in this method assume initially W = 1. By $I_{XY} = \langle X, Y, 1\rangle$. The Homogenous coordinate is used to perform image project by Eq. 6:

$$\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{bmatrix} * \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ w' \end{bmatrix} \quad (6)$$

All projected points must be calculating by Eq. 7:

$$\frac{\langle x', y', w'\rangle}{w^1} = \left\langle \frac{x'}{w^1}, \frac{y'}{w^1}, \frac{w^1}{w^1} \right\rangle = \left\langle \frac{x'}{w^1}, \frac{y'}{w^1}, 1 \right\rangle = \langle x'', y'' \rangle = Pxy \quad (7)$$

where, P×y is new project point. Homography matrix is transformation model but it needs to estimate robust model to treat with noise or outlier. Therefore, RANSAC is treated with this problem. RANSAC is an abbreviation for random sample consensus. RANSAC is iteration method for parameter estimation to fit a mathematical model to set the interest points. The steps of RANSAC for estimating homograph are the following: SSD (pi, H pi)<ε.

The RANSAC loop:

- The four features (interest points) of the pairs are chosen randomly
- Compute homography H
- Compute inliers where SSD $(p_i, H\,p_i) < \varepsilon$
- Largest set of inliers are keeping
- Re-compute least-squares H estimate on all of the inliers

The blend the parts after computing homograph matrix. Blend is using linear gradient alpha blending from the center of once part to the other.

Experimental: The project implementation has three main stage. The first stage selects blur region and it is tracked, the shown in Fig. 6. The second stage is detecting the best part that appeared by dividing image to four part and compare it, the shown in Fig. 7. This dividing is given the best result from any another dividing. The third is stitching of the parts by Harris corner algorithm that detects the interesting point in each part and computes the correlation between these parts. The parts stitch is depending in the overlap between parts (images) that must be 15-30%. The type of video must be AVI that must be high quality. Harris corner algorithm cannot detect the interesting point in the flat image. The image of resulting also is depending in parts that appear the shown in Fig. 9. The steps of stitching the left part with above part that the shown in Fig. 10. The

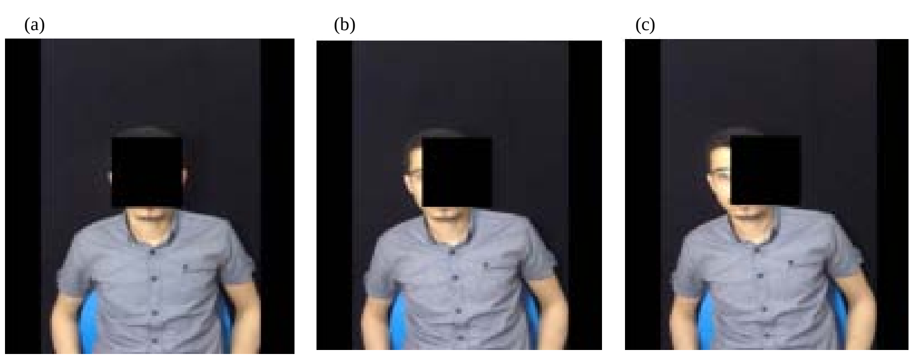

Fig. 9: Continue

Fig. 9: The shot that means a sequence of frames in the same scene

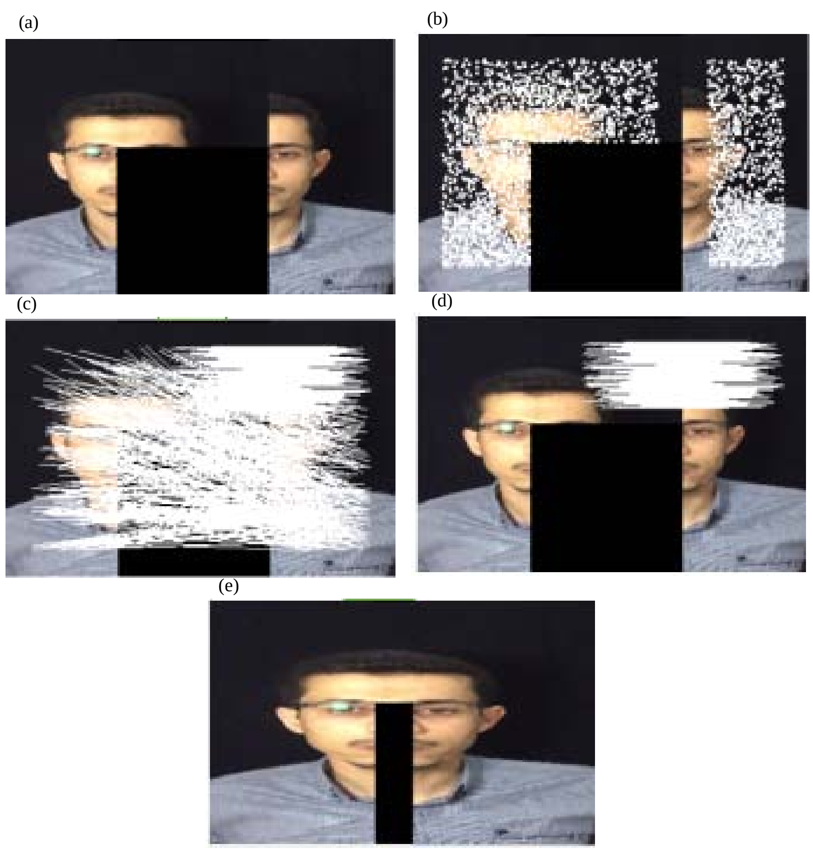

Fig. 10: Stages of parts stitching: a) Two part (left, upper); b) Detection the interest points by Harris corner algorithm; c) Correlation between two parts and d) RANSAC and f) Blend the two parts

steps of stitching the previous result with right part the shown in Fig. 11. The steps of stitching the previous result with down part the shown in Fig. 12. The image resulting is high quality when parts that appear are large.

(a) (b) (c) (d) (e)

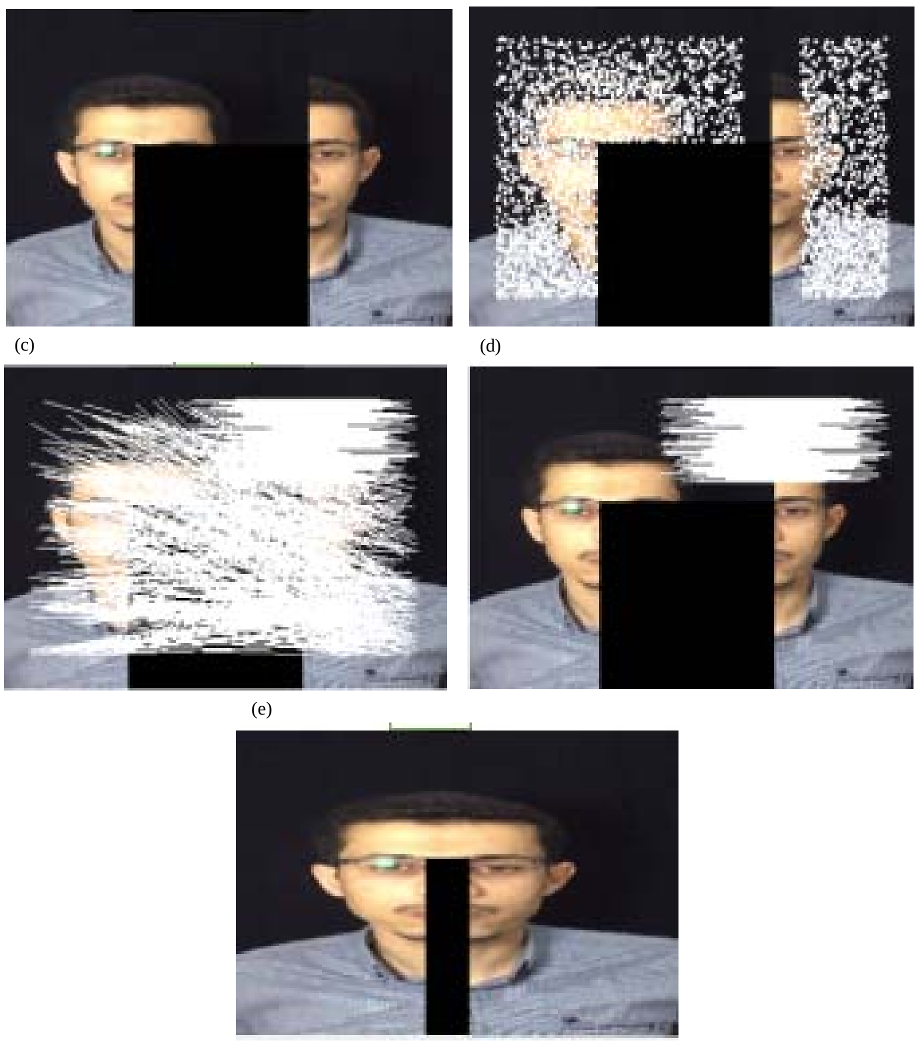

Fig. 11: Stages of parts stitching: a) Two part (the previous result, right); b) Detection the interest points by Harris corner algorithm; c) Correlation between two parts; d) RANSAC and f) Blend the two parts

(a) (b)

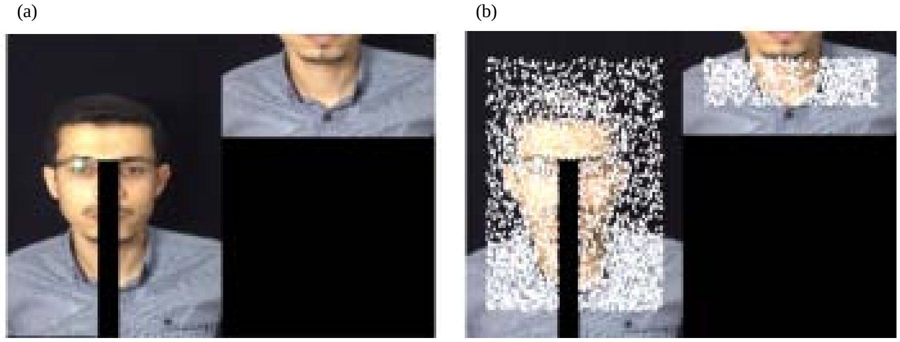

Fig. 12: Continue

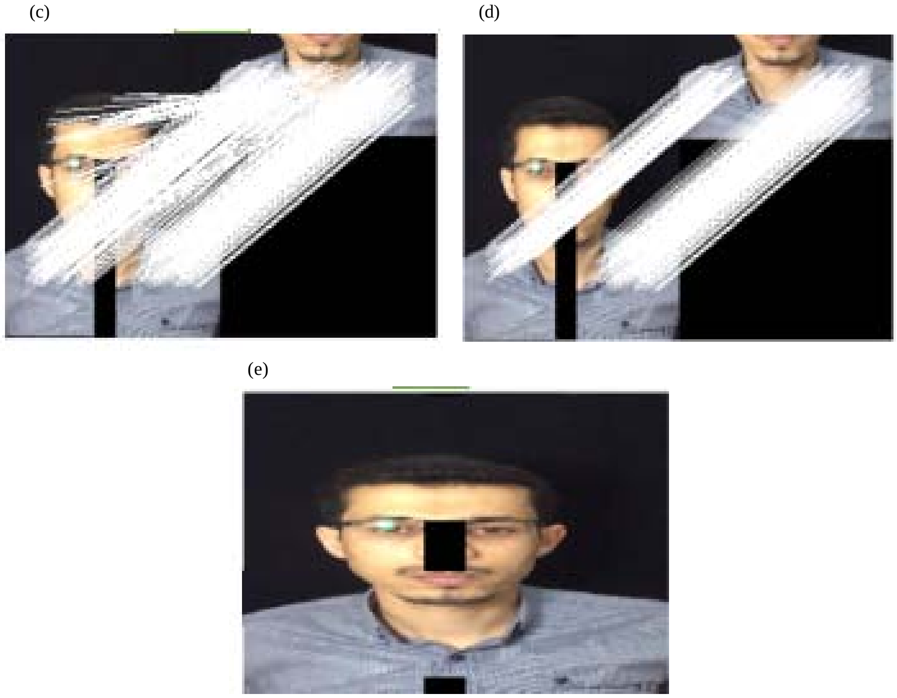

Fig. 12: Stages of parts stitching: a) Two part (the previous result, bottom); b) Detection the interest points by Harris corner algorithm; c) Correlation between two parts; d) RANSAC and f) Blend the two parts

CONCLUSION

The proposed system is an automatic stitching of parts that appear. The main shift algorithm is using to track the target by selecting blur region manually and tracking large window to find the parts. The parts detection is subtraction each new frame with the first frame to determine frame that differs by depending on the threshold. After that, the finding of the parts stitching is using Harris corner algorithm. There are some conditions for stitching of parts to get image high accuracy, the first condition, it must be the overlapping between parts from 15-30% and the second condition the file of video is high quality. The proposed system can be developing to use another technique for stitching of parts. The proposed system is given the resulting image which its high quality and accuracy, its depend on the parts that appear.

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