

Figure 1: Architecture of system

3. Hand Gesture Recognition

Typically, Gesture recognition methods contain three major steps; 1) Skin detection, 2) Features extraction and 3) Gesture recognition/Behavior analysis.

3.1 Skin Detection

For hand detection, skin detection algorithm is used for detecting the hand region in the frames captured through webcam. The skin detection algorithm is useful for detecting the skin area in the frame and avoiding area that is not a skin. Skin detection is one of the segmentation techniques that separate the hand region from other moving objects. HSV color model is used in our system for detection of skin color of hand region. The HSV color space is used here because it is more likely as the skin color. Thresholding is applied on input frames for segmenting hand region from background. Median filter [2] is applied on binary image to remove the noise from binary image.

After skin detection we need to outline the skin region to represent the hand area and to find other features of hand. Contour finding means finding the points that represent the curve in an image. Contour is used for searching the human hand and discarding other skin colored objects that are present in the frames. For contour drawing on the objects that are in frames, it is common to nearly correct the contour that represents a polygon with another contour which has less vertices.

3.2 Feature Extraction

After obtaining contour of hand region, we need to extract some features from contour. Fingertips are used as good features of hand. For performing mouse events using hand we can use fingers to indicate the gestures. For fingertip point's extraction, convexity analysis of contour is used. By using convex hull with convexity defects we can get the shape of contour or object. For resolving the complex object shapes, convexity defect is used. Opencv library of image processing is used for skin detection, contour, and finding fingertips of hand. Figure 2(A) shows the contour of hand, (B) shows convex hull and (C) shows the convexity defects on hand and (D) is the final image which contain the hand region.

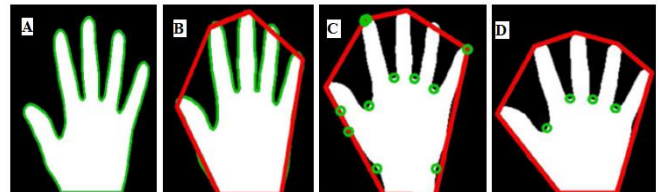


Figure 2: Features of Hand

3.3 Gesture Recognition

For recognition of gesture, there are some algorithms such as hidden markov model, artificial neural network, principle component analysis, decision tree algorithm, finite state machine, conditional random field etc. In our work we have used decision tree algorithm because it is able to classify gestures quickly. Decision tree algorithm is trained for carrying out events indicated by user. For detection of events we have train the decision tree classifier as; if 4 fingers are shown then mouse move operations will start and 5 fingers for existing from mouse moving operations. When we are using mouse move operations, we can move it to required place by using fingers like 1 finger for moving mouse upward, two fingers are used for moving mouse downward etc. 1 finger is used for left click and 2 for right click operations after existing from mouse move operations. Events classifications are done through the decision tree are shown in figure 3.

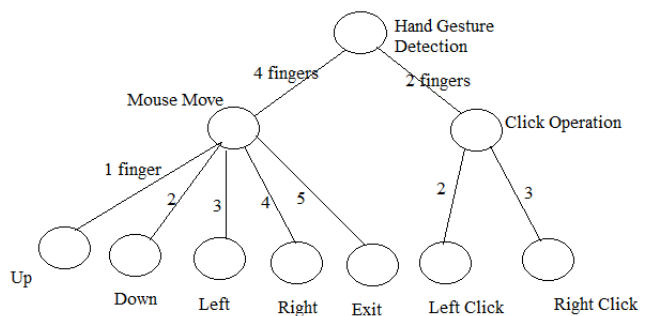


Figure 3: Event classification using decision tree

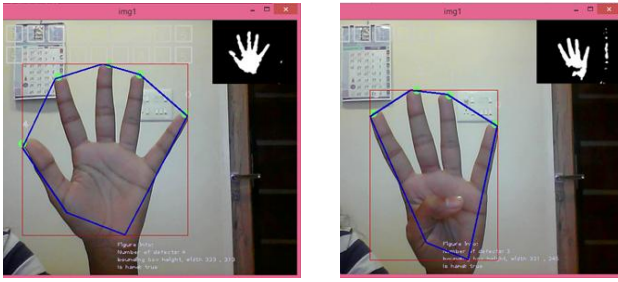


Figure 4: Results of hand gesture recognition

Figure 4 shows the hand gesture results obtained using this system. Red color box shows in image is the bounding box, and green points are the finger points. Blue curve shows the convex hull.

4. Image Restoration

Image restoration mainly used to remove or reduce the degradation that is present in images. The noise and blurriness is reduced from image to improve the quality of image. Noise means unwanted electrical fluctuations or signal that are present in images. Noise comes mainly in digital image during image transmission or image digitization. During acquiring images, the main common source of noise in image is the sensor temperature. Common noise models are uniform noise, gamma noise, Gaussian noise, salt & paper noise, Rayleigh distribution etc.

For removing or reducing noise, filtering methods are studied [8] that are linear filter and non-linear filter. Mean filter is used for removing the impulsive noise but it does not preserve the details of images. Median filter is used for denoising different noises. wiener filtering is used for filtering the noise that has the corrupted signals. Non local kernel regression algorithm is used in this work for removing noise and blur from images. A non-local kernel regression uses local structural regularity and non-local similarity for restoration of images. The non-local uniqueness finds the same patches present in image. These patches regularize the noisy patches/pixels using local structural regularity that are found using the non-local similarity search. By exploiting both these methods we get the more robust results than other filtering methods.

In patch searching method, for finding similarity several color are used such as red color for more similarity of patch, green for low and blue for least similarity. The local structural kernel method forms the regression kernel to the structure at each position where similar patches found and reweight them depending on the uniqueness. By combining the results of local structural regularity and non-local resemblance information, NLKR calculate the value for given location. The image denoising superiority can be improved by using non local kernel regression iteratively [1].

Image Denoising Algorithm

1. Input: Noisy image and No.of iterations
2. Initialize estimation of current denoising
3. For 1 to N do
4. For every pixel location on the grid of image do

- a. Estimate index set of similar patches according to denoising estimation
- b. Compute structural kernel
- c. Estimate weight matrix using structural kernel
- d. Compute regression coefficient
- e. Update estimation of denoising
- f. Update image gradient
5. End
6. End
7. Output: Denoised Image

Structural kernel and regression coefficients are computed in same manner as in [1]. Gaussian kernel is as shown below is used for assigning weights to the pixels that are nearer to the patch.

$$w_{ij} = \exp\left(\frac{-\|R_{x_i}y - R_{x_j}y\|^2}{2\sigma^2} w_G\right) \quad (1)$$

Where w_{ij} is calculated among the location x_i of interest and another location x_j of similar patch. From Gaussian kernel weight matrix, w_G is constructed which gives larger weights to nearer pixels.



Before denoising After Denoising

Figure 5: Image denoising

Digital images get blurred due to atmospheric disturbances and Poor quality of focus. To check the blurriness in image, the process of blurring needs to be converted into frequency form. For checking frequencies present in the image Fast Fourier transformation is applied. If low amount of high frequencies is present then the image includes blurriness. If high frequencies amplification is present, noise amplification can occurs. Wiener filtering method [1] is used for noise filtration. Single image deblurring process is as follows:

$$n = Hc + \epsilon = h * c + \epsilon \quad (2)$$

Where, c represents clean image, n represent noisy, blurry image and H is the operator for blurring. ϵ is a Gaussian noise. Frequency Domain representation of single image observation is as follows:

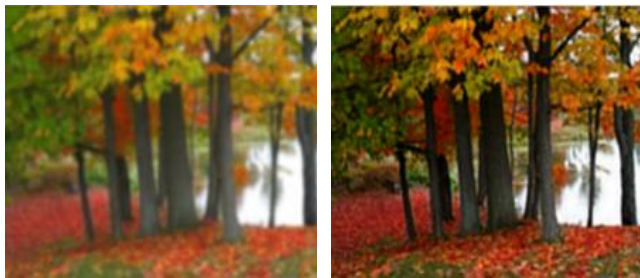
$$N(u, v) = H(u, v)C(u, v) + \epsilon(u, v) \quad (3)$$

Image Deblurring Algorithm:

1. Input: Blur image, blur kernel
2. Estimate frequency representation using fast Fourier transformation.
3. Perform filtering using wiener filter
4. Produce spatial domain estimation by applying inverse FFT

5. Perform non local kernel regression denoising to generate the final deblurring result
6. Output: Deblurred image

Figure 6 shows deblurring results by using non local kernel regression algorithm.



Before Deblurring After Deblurring
Figure 6: Image Deblurring

Table 1: Hand Gesture Recognition Accuracy

Gestures	No of Images Tested	Correctly Recognized	Incorrectly Recognized	Accuracy
1	21	19	2	90.47%
2	20	18	2	90%
3	25	23	2	92%
4	20	19	1	95%
5	20	19	1	95%

By using properties of both similar patch searching and structural kernel estimation, we get good results for image denoising and deblurring as compare to other algorithm reviewed in literature. Less time is required for removing noise and blurriness from image as compared to NL means, local mean and iterative convolution algorithm.

5. Conclusion

Real time hand gesture recognition system is developed whose goal is to create a system that can identify human generated gestures and use this information for device control and various operations on image restorations. For classification of gestures decision tree algorithm is used. This system is useful for users who lack the strength and precision used to operate the traditional input devices. Denoising and deblurring image restoration operations are performed using non-local kernel regression method. Future work would include developing faster algorithm for hand gesture recognition and image restoration. We can develop hand gesture recognition for controlling other applications and gadgets.

References

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