average gray values of sub-regions. Each sub-region is a square block containing neighboring pixels. We take the side length L of the block as a parameter, and the computational process can be expressed in Equation 1.

$$B = \sum_{k=0}^{w} g_k$$
$$MCS-LBP = \sum_{n=0}^{3} S(B_n - B_{n+4})2^n \quad , \qquad (1)$$
$$s(x) = \begin{cases} 1, x \geq T \\ 0, otherwise \end{cases}$$

Where 'g′ is the gray value of individual pixels and B is the sum of the nth value,

After calculating the sum of the pixels of the blocks, computed center-symmetric pairs of blocks (B) are compared, such as (B_0,B_4), (B_1,B_5), (B_2,B_6), and (B_3,B_7) In order to simplify the computation, we use the sum instead of average of gray values of each sub-region. A 3x3 MCS-LBP detailed procedure is explained in Fig. 1.

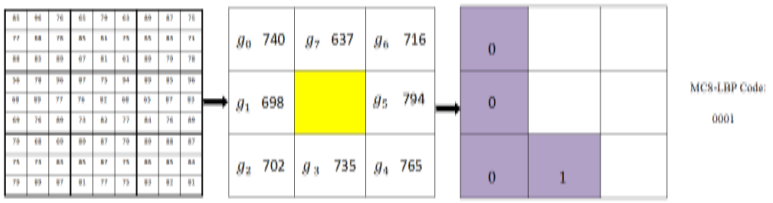

Fig. 1. The MCS-LBP operator. (a) The original 3x3 gray values. (b) Computation of the sum of gray values of each block. (c) Comparison of center-symmetric pairs of pixels and derivation of MCS-LBP code.

Further processing is needed for classification of point of view [2]. In this paper, Chi-square Distance (X2) is delicately used. This has been successfully used for texture and face classification, near-image identification, local descriptors matching, shape classification, and boundary detection. It is defined as follows:

$$\chi^2(x,y) = \frac{1}{2}\sum \frac{(x_i - y_i)^2}{(x_i + y_i)} \qquad (2)$$

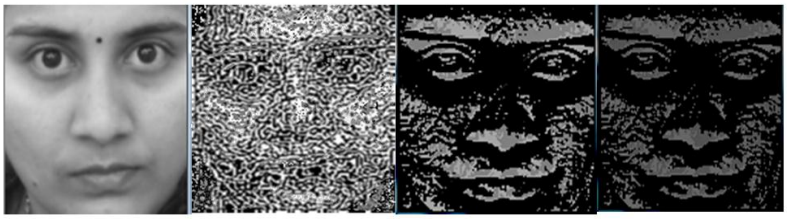

Fig. 2. MCS-LBP filtered images with different scales: (a) Original image, (b) Filtered image by 3x3 , (c) Filtered image by 9x9 MCS-LBP , and (d) Filtered image by 15x15x3 MCS-LBP operators.

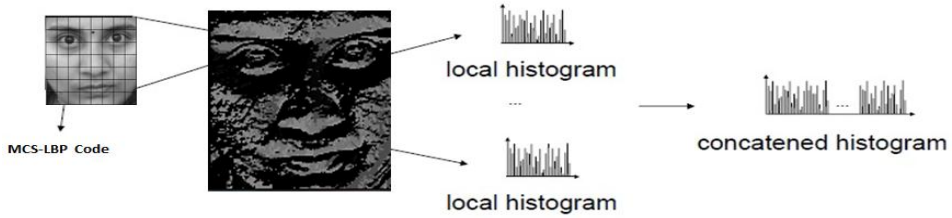

Fig. 3. Histogram extraction for 15 x 15 regions.

To build the system, we collected 600 images from nearly 30 persons a database. So The database included frontal and near frontal views of a person.

Fig. 4. Examples of face images from the face database considered in the experiments.

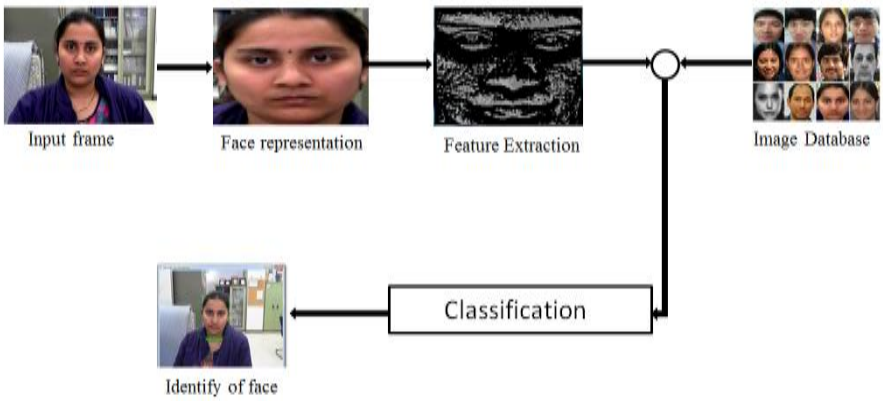

Fig. 5. Step-by-step process of system

Table 1. Recognition accuracy of proposed method compared with other methods

Method	Accuracy (%)
LBP	88.7
CS-LBP	92.8
MCS-LBP	96.3

3 Conclusion

In this paper, MCS-LBP based operator for robust image representation was presented. In the MCS-LBP, the comparison between single pixels in CS-LBP was replaced with a comparison between average gray values of sub-regions and added threshold T was added to the operator. MCS-LBP significantly outperformed the LBP and CS-LBP methods.

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References

1. Marko Heikkila, Matti Pietikainen, Cordelia Schmid.: Description of interest regions with local binary patterns. Pattern Recognition, vol. 42, no. 3, pp. 425--436(2009)
2. Y. Rubner, C. Tomasi, L. J. Guibas.: The earth mover's distance as a metric for image retrieval. International Journal of Computer Vision, vol. 40, no. 2, pp. 99--121(2000)