Experiments using Gabor wavelet method are implemented on the Yale database to calculate the performance of the system. The Yale database involves 165 individual images of 15 different persons with 11 different images under different exposure, light, and perspective for each person. The resolution of the images is 243 x 320 pixels of 265 gray levels per pixel; samples of the images are shown in the Figure below.
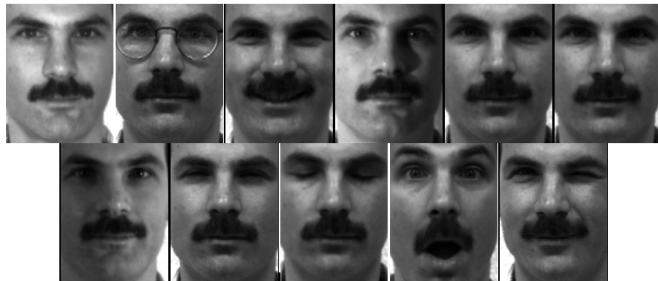

Fig.6 Samples of Face Image

The database is divided into train and test sets. In the train, seven images of class one (S1) to class thirteen (S13) are taken. On the other hand, the remaining four images of class one (S1) to class thirteen (S13), in addition to all eleven images in class fourteen (S14) and fifteen (S15), are selected as test images. In this way, 91 images have been used for training, and 74 images have been used for the test. In the testing process, the methodology of face recognition run on some test images where the results are known previously. Then the same method is tested on some new images to consider the robustness, accuracy, and speed of the methodology. The testing proved that the accuracy is acceptable, with a percentage of above 98.7% of success. Table I. presents a comparison between our proposed method with the others implemented in the literature review.

TABLE I
COMPARISON OF ACCURACY BETWEEN DIFFERENT METHOD

No.	Method	Accuracy
1	Our proposed method	98.7%
2	Gabor-PCA	87.5%
3	Gabor-KPCA	86.67%
4	ACFN	96%
5	LMG	96.4%

IV. CONCLUSION

As a result of the method and design of the face recognition system described in this research paper, a robust and accurate system was developed for face recognition. Our experiments outperformed the methods used in a literature review by 11.2% compared with Gabor-PCA, 12.03%, 2.7%, and 2.3% with Gabor-KPCA, ACFN, and LMG, respectively. We can conclude that combining the methods used in preprocessing, feature extraction, classification, and recognition can produce better results. The aggregation of Gabor wavelet transforms, Principal Component Analysis (PCA), and Support Vector Machine (SVM) is effective in this face recognition system.

REFERENCES

[1]   Yukti Bakhshi, Sukhvir Kaur, and Prince Verma, "An Efficient Approach in Face Recognition for Invariant Faces using SIFT, SURF, and PCA," *International Journal of Signal Processing, Image Processing and Pattern Recognition*, Vol.9, No.5, pp. 99-108, 2016.

[2]   S. Sharma, "Face Recognition using PCA and SVM with Surf Technique," *International Journal of Computer Applications*, vol. 129, no. 4, pp. 41–46, 2015.

[3]   W. Wang, X. Sun, S. Karungaru, and K. Terada, "Face Recognition Algorithm Using Wavelet Decomposition and Support Vector Machines," *IEEE International Symposium on Optomechatronic Technologies (ISOT)*, pp. 1-6, Oct. 2012.

[4]   Alpa Choudhary and Rekha Vig, "Face recognition using multiresolution wavelet combining discrete cosine transform and Walsh transform," *Proceedings of the 2017 International Conference on Biometrics Engineering and Application*, 2017, pp.33-38.

[5]   Priyanka, Dr. Yashpal Singh, "A Study on Facial Feature Extraction and Facial Recognition Approaches," *International Journal of Computer Science and Mobile Computing*, vol. 4, pp. 166-174, 2014.

[6]   D. Gabor, "Theory of communication," *J. Inst. Elect. Eng.*, vol. 93, no. 26, pt. III, pp. 429–457, 1946.

[7]   S. Linlin, and L.Bai. "A review on Gabor wavelets for face recognition." *Pattern analysis and applications,* vol. 9, no. 2-3, pp. 273-292, 2006.

[8]   S. Tang, "Face recognition method based on Gabor wavelet and memetic ecological algorithm," *Biomedical Research*, vol. 29, no. 0, pp. 1-1, 2017.

[9]   A. Vinay, V. S. Shekhar, K. N. B. Murthy, and S. Natarajan, "Face Recognition Using Gabor Wavelet Features with PCA and KPCA - A Comparative Study," *Procedia Computer Science*, vol. 57, pp. 650-659, 2015.

[10] B.S. Oh, K.A. Toh, A. Teoh, and Z. Lin., "An analytic Gabor feedforward network for single-sample and pose-invariant face recognition." *IEEE Trans. Image Process.* Vol. 27 no. 6, pp. 2791–2805, 2018.

[11] L. A. Cament, F. J. Galdames, K. W. Bowyer, and C. A. Perez, "Face recognition under pose variation with local Gabor features enhanced by active shape and statistical models," *Pattern Recognition*, Vol. 48, no. 11, pp. 3371-84, Nov. 2015.

[12] M.Turk and A. Pentland, "Eigenfaces for Recognition", *Journal of Cognitive Neuroscience*, Vol. 3, pp. 71-. 86, 1991.

[13] C. Liu and H. Wechsler, "Independent component analysis of Gabor features for face recognition," *IEEE Trans. Neural Networks*, vol. 14, no. 4, pp. 919-928, 2003.

[14] M. Haghighat, S. Zonouz, M. Abdel-Mottaleb, "CloudID: Trustworthy cloud-based and cross-enterprise biometric identification," *Expert Systems with Applications*, vol. 42, no. 21, pp. 7905-7916, 2015.

[15] Bayezid Islam, Firoz Mahmud, Arafat Hossain, Md. Sumon Mia, Pushpen Bikash Goala, "Human Facial Expression Recognition System Using Artificial Neural Network Classification of Gabor Feature Based Facial Expression Information," *IEEE 4th International Conference on Electrical Engineering and Information & Communication Technology (iCEEiCT), 13-15 September 2018.*

[16] Zhifeng Li and Xiaoou Tang, "Bayesian face recognition using support vector machine and face clustering," *Proceedings of the 2004 IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 2004, Vol. 2, pp. II-374-II-380.

[17] Mustafa Zuhaer AL-Dabagh, Dr. Firas H. ALMukhtar." Breast Cancer Diagnostic System Based on MR images Using KPCA-Wavelet Transform and Support Vector Machine", *International Journal of Advanced Engineering Research and Science (ISSN: 2349-6495(P) | 2456-1908(O))*, vol.4, no. 3, pp.258- 263, 2017.