# Summary of Face Detection System for Smart Security Application

**Introduction:**

This paper delves into the development of a sophisticated and efficient face detection system for security purposes. The primary focus is on using various machine learning algorithms to detect human faces accurately, even in challenging scenarios such as partial face visibility or low-resolution images. This system is essential for enhancing security measures in sensitive areas like airports, banks, and high-security facilities.  
  
**Objectives and Methodology**  
The research aims to:  
1. Evaluate the current face recognition methods, identifying their strengths and weaknesses.  
2. Implement and test new parameters to enhance the efficiency and accuracy of existing face detection algorithms.  
3. Create an automated face recognition and mailing system that alerts users when an unknown individual is detected.  
  
The methodology involves the use of multiple machine learning algorithms, including:

**Local Binary Pattern Histogram (LBPH):**

Used for texture classification by comparing each pixel with its neighbors and encoding the result as a binary number.

**Support Vector Machine (SVM):**

A supervised learning model that finds the optimal hyperplane to separate data into different classes.

**AdaBoost:**

A boosting algorithm that combines multiple weak classifiers to form a strong classifier by focusing on difficult-to-classify examples.

**Haar Classifier**:

A widely used method in object detection, particularly in the Viola-Jones framework.

**Principal Component Analysis (PCA)**:

A technique for reducing the dimensionality of datasets while preserving essential information.  
  
**System Design and Implementation**  
The designed system integrates both hardware and software components. The hardware includes a camera for real-time video feed, while the software processes these feeds using the face detection algorithms mentioned above. The system's design also involves a cascade of classifiers, where each stage in the cascade is responsible for filtering out non-face regions, allowing the system to focus on potential face regions.  
  
**Results and Performance**  
The research involved testing the system's accuracy using a dataset collected from 627 images of Bangladeshi individuals, categorized into four groups: front face, front face with a mask, right side with a mask, and left side with a mask. The best results were achieved using the Multi-Task Cascaded Convolutional Network (MTCNN), which provided an accuracy of 96.2% for face detection. However, the system's performance dropped significantly when detecting faces from the side, with accuracies of 45.4% and 41% for left and right side detections with masks, respectively.  
  
**Discussion and Future Work:**  
The study acknowledges the challenges faced in partial face detection, particularly with limited training data and low-resolution images. Despite achieving high accuracy with the MTCNN model, the system still struggles with detecting faces from the side or with significant occlusions. The authors suggest that further improvements could be made by collecting more diverse and high-quality data, which would enhance the model's robustness in various conditions.  
  
Future research will focus on refining the face detection algorithms, expanding the dataset, and testing the system in more diverse environments. Additionally, there are plans to integrate the system with an automated email alert feature that notifies users of detected intrusions in real-time.  
  
**Conclusion**:  
The proposed face detection system represents a significant advancement in the field of security applications, offering high accuracy and efficiency in detecting faces even under challenging conditions. However, there is still room for improvement, particularly in scenarios involving partial or occluded faces. With further development, this system has the potential to become a valuable tool in enhancing security measures across various sectors.