**Convolutional Neural Network Based Partial Face Detection**

**Introduction:**

The paper discusses the development and evaluation of a machine learning model aimed at accurately detecting partial human faces in images. This research is particularly important because of the increasing reliance on facial recognition technology in various applications, such as security systems, entertainment, and biometrics. Traditional face detection systems often struggle with identifying faces that are partially obscured, leading to poor accuracy in real-world scenarios. The study conducted by the authors focuses on overcoming these limitations by employing advanced convolutional neural networks (CNNs).

**Background and Objectives**

Face detection is a crucial aspect of many modern technologies, ranging from security systems to personal devices. However, existing methods often fail when faces are partially obscured, whether due to poor camera angles, masks, or other obstructions. The primary objective of this research is to create a robust machine learning model that can accurately detect faces, even when they are only partially visible. The authors collected a dataset of 627 images from Bangladeshi individuals, categorized into four angles: front face, front face with mask, right side with mask, and left side with mask. The dataset was manually curated to ensure quality and relevance.

**Methodology**

The researchers employed several machine learning models to address the challenge of partial face detection. The models used include:

**Convolutional Neural Network (CNN):**

A type of deep learning model particularly suited for analyzing visual data.

**Cascaded CNN:**

An advanced version of CNN designed to improve object detection by refining candidate windows through successive stages.

**Haar-Cascade:**

A traditional machine learning algorithm known for its efficiency in object detection, although it is less effective with complex data like partial faces.

**Deep CNN:**

An enhanced CNN model with multiple layers, capable of more complex data analysis.

**Multi-Task Cascaded Convolutional Networks (MTCNN):**

A specialized network designed to detect and align faces in images, which proved to be the most effective in this study.

Data preprocessing was a critical step in the research, involving noise reduction, dimensionality reduction, and pixel brightness transformations to enhance image quality. The dataset was split into training (80%) and testing (20%) sets to evaluate the performance of the models.

**Results and Discussion**

The study's results indicate that the MTCNN model outperformed the other algorithms, achieving an accuracy of 96.2%. This was significantly higher compared to the Cascaded CNN (71%), Deep CNN (70%), CNN (68%), and Haar-Cascade (65%). The MTCNN model was particularly effective in detecting faces from different angles and with varying degrees of obstruction, such as masks. However, the model's accuracy dropped when detecting faces from the side, with accuracies of 45.4% and 41% for left and right side detections with masks, respectively.

The research highlights that while MTCNN is effective, there is still room for improvement, particularly in scenarios where the face is heavily obscured. The authors suggest that collecting more diverse and high-quality data could help improve the model's performance in future studies.

**Conclusion**

The research concludes that the MTCNN model is a promising solution for partial face detection, outperforming traditional models in accuracy and robustness. However, the study also acknowledges the challenges associated with detecting faces that are heavily obscured or viewed from extreme angles. Future research will focus on expanding the dataset and further refining the model to address these challenges.