

**NATIONAL UNIVERSITY SCIENCE AND TECHNOLOGY (NUST)**

(**High Impact Skills Development Program for Gilgit Baltistan**)

**Project Title: Expression Classification from Facial Images Learning**

**A Project Report**

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**GitHub:** <https://github.com/Aly-salman/Facial_recognization/blob/main/Copy_of_CVPROJ.ipynb>

**Overview:**

Learning discriminative features for expressions from facial images captured in the wild is a nontrivial task due to intra-class variations and inter-class similarities. Furthermore, background clutter, illumination changes, large pose variations, and partial or full occlusions make it more challenging. The goal of this project is to design and develop a computer vision system that can classify facial expressions. Such a system can have several real-world applications. For example, expressions can be useful for Human-Computer Interaction based recommendation systems to determine whether to push product information or not. It can also be used to determine the psychological state of a person during online interviews. Overall, this project will provide students with a practical opportunity to implement the concepts learnt during the module. It will also allow them to understand practical problems where computer vision can provide solutions. Students will engage in the identification of tools and techniques that can be employed to solve those problems.

**Literature Review:**

1. **Article 1:**
   * **Title:** "Advancements in Facial Expression Recognition Using Deep Learning"
   * **Summary:** This article discusses recent advancements in facial expression recognition using convolutional neural networks (CNNs).
   * **Data Used:** Various datasets including the ExpW dataset.
   * **Accuracy Reported:** Achieved an accuracy of 85%.
   * **Pros:** High accuracy and robust model performance.
   * **Cons:** Computationally intensive and requires large datasets.
2. **Article 2:**
   * **Title:** "Impact of Data Augmentation on Facial Expression Recognition"
   * **Summary:** This study explores how different data augmentation techniques can improve the performance of facial expression recognition models.
   * **Data Used:** A combination of public datasets, including the ExpW dataset.
   * **Accuracy Reported:** Improved baseline accuracy by 5% with data augmentation.
   * **Pros:** Demonstrated effectiveness of data augmentation in enhancing model performance.
   * **Cons:** Increased training time and complexity in preprocessing.

**Models Used**

**Architecture:**

* **Convolutional Layers:**
  + Conv2D (32 filters, 3x3 kernel, ReLU activation)
  + MaxPooling2D (2x2 pool size)
  + BatchNormalization
  + Conv2D (64 filters, 3x3 kernel, ReLU activation)
  + MaxPooling2D (2x2 pool size)
  + BatchNormalization
  + Conv2D (128 filters, 3x3 kernel, ReLU activation)
  + MaxPooling2D (2x2 pool size)
  + BatchNormalization
* **Fully Connected Layers:**
* Dense (512 units, ReLU activation)
* Dropout (0.5 probability)
* Dense (7 units, softmax activation)

**Dataset Used:**

**Statistics:**

* **Total Images:** 28,822
* **Categories and Image Counts:**
  + Angry: 3,993 images
  + Disgust: 437 images
  + Fear: 4,103 images
  + Happy: 7,164 images
  + Sad: 4,938 images
  + Surprise: 3,205 images
  + Neutral: 4,982 images

**Data Division:**

* **Training Set:** 60%
* **Validation Set:** 20%
* **Test Set:** 20%

**Hyperparameter Tuning:**

* **Learning Rate:** 0.0001
* **Batch Size:** 32
* **Epochs:**
  + Initially trained with 40 epochs
  + Retrained with 50 epochs

**Results and Evaluations:**

**Training Results:**

* **Accuracy and Loss:** Tracked over epochs.
* **Confusion Matrix:** Provides insight into classification performance across categories

**Analysis of Results:**

**Good Results:**

* High accuracy on categories such as happy and surprised expressions, indicating the model's effectiveness in recognizing these emotions.

**Bad Results:**

* Lower accuracy on categories like disgust and fear due to the limited number of samples and the similarity between expressions.

**Confusion Matrix:**

* Helps in identifying where the model is misclassifying expressions.

**Further Improvements:**

1. **Enhanced Data Augmentation:** Applying more advanced data augmentation techniques to increase the variety of training samples.
2. **Fine-Tuning Pre-Trained Models:** Leveraging pre-trained models such as ResNet or MobileNet for transfer learning.
3. **Increasing Dataset Size:** Collecting more data, especially for minority categories like "disgust" to balance the dataset