

M.B.M UNIVERSITY , JODHPUR
NEURAL NETWORK LABORATORY REPORT
MINI PROJECT 1

TEAM NAME : INVINCIBLE

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OBJECTIVE :

Build an image dataset that contains grayscale images of leaves of various plants/trees growing in MBMU campus. Perform necessary preprocessing steps to make the dataset uniform and ready for training. Train a deep autoencoder network that can reproduce any random image of a leaf from MBMU campus.

Bonus: Can we use this network to identify if a leaf is from MBM Campus or not?

DATASET PREPARATION AND STRATEGY :

- 7 leaf species folders - Neem , Mango , Jamun , Sadabahar , Lily , Paper flower , Gulmohar collected by all team members .
- Location: MBMU campus
- Total teams: 8
- Species per team: 2 species per team
- Images per species: 100-120 images
- Species assigned to our team :
 - o Crinum asiaticum (Poison Bulb / Nagadamani)
 - o Catharanthus roseus(Madagascar Periwinkle / Sadabahar)
- Format: Collect images in RGB format.
- Aspect Ratio: Maintain a 1:1 aspect ratio while capturing images.
- Image format: JPG
- Lighting Conditions: Capture images in both sunlight and artificial light.

PREPROCESSING :

- Resized all images to 256 * 256 resolution .
- Converted all images to jpg format .
- Applied adaptive gaussian thresholding on all images .
- Contouring - Detects external contours and filters tiny noisy contours .
- Bitwise or operation is performed .
- **Augmentation:**
 - Rotations: 0°, 90°, 180°
 - Contrast adjustments: 1.0 (original), 1.3
 - Total of **6 images** per original.

- Final Dataset:
 - Train_7sp: Augmented thresholded training set contains **5 species** .
 - Test_7sp: Augmented thresholded test set contains **2 species** .

MODEL ARCHITECTURE:

Encoder Architecture:

- Conv2D layer: 32 filters, kernel size = (3,3), activation = ReLU, padding = 'same'
- MaxPooling2D: pool size = (2,2), padding = 'same'
- Conv2D layer: 64 filters, kernel size = (3,3), activation = ReLU, padding = 'same'
- MaxPooling2D: pool size = (2,2), padding = 'same'

Decoder Architecture:

- Conv2D layer: 64 filters, kernel size = (3,3), activation = ReLU, padding = 'same'
- UpSampling2D: size = (2,2)
- Conv2D layer: 32 filters, kernel size = (3,3), activation = ReLU, padding = 'same'
- UpSampling2D: size = (2,2)
- Output Conv2D layer: 1 filter, kernel size = (3,3), activation = **Sigmoid**, padding = 'same'

Output Size: $256 \times 256 \times 1$ (Reconstructed Grayscale Image)

HYPERPARAMETERS

- **Epochs:** 10
- **Batch Size:** 10
- **Learning Rate:** (0.001)
- **Optimiser :** Adam
- **Loss function :** Mean squared error

Bonus Classification

- **Threshold MSE for Classification:** 0.0105
- **Class 0:** Leaf belongs to MBMU ($MSE \leq 0.0105$)
- **Class 1:** Leaf does not belong to MBMU ($MSE > 0.105$)
- Collected and preprocessed 5 unseen species for unseen data .

DESCRIPTION OF CODE :

1. Load Dataset from Folder :
 - Reads images from each subfolder, converts to grayscale, normalizes pixel values to [0,1], and reshapes to (256, 256, 1) for model compatibility.
2. Autoencoder Model is Defined
 - Encoder and decoder is defined
3. model.compile() - Creates and compiles model with MSE loss and Adam optimizer.
4. Performance of model is evaluated using MSE and R2 SCORE and train and test and **reconstruction accuracy** of autoencoder .
5. Train the Autoencoder in which model learns compressed encoding and reconstruction simultaneously .
6. Evaluate Model on Test Set - Predicts on test data, and computes evaluation metrics.
7. Save Accuracy & Loss Plots and model to Google Drive .
8. Reconstructed 5 images and plotted them .
9. Forward pass :
 - Inputs the image and regenerates image and computes mse loss .
10. Backpropagation :
 - Gradients of MSE are propagated back from output to encoder using chain rule.
 - Weights are updated using Adam Optimizer .

PERFORMANCE EVALUATION

Evaluation Metrics Used:

- Mean Squared Error (MSE)
- R² Score
- Reconstruction accuracy

Training Metrics (Epoch 10):

- Train MSE: 0.009919
- Train R² Score: 0.843129

Test Set Performance:

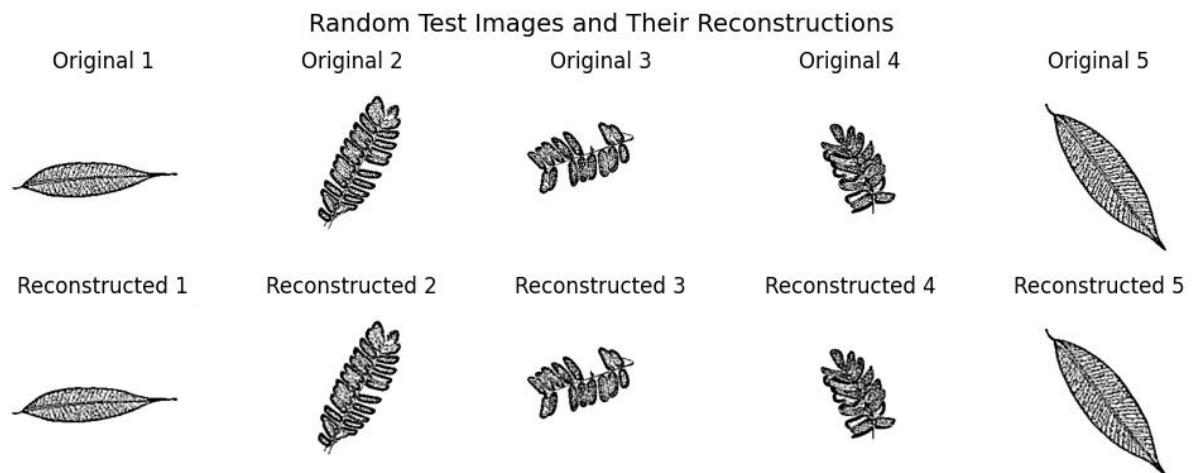
- Test MSE: 0.010353
- Test R² Score: 0.813000

Reconstruction accuracy

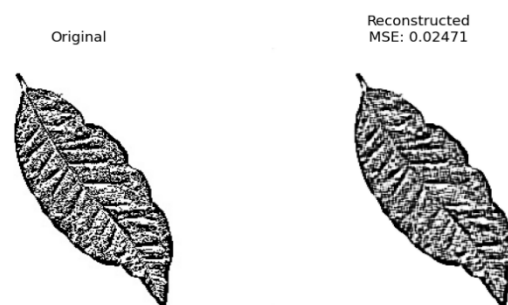
- Train Reconstruction Accuracy: 90.58%
- Test Reconstruction Accuracy: 91.01%

Visualizations:

- Train loss curve (MSE) and train accuracy curve R2 based were plotted across epochs.
- Reconstruction accuracy of autoencoder is calculated on train and test set .
- Five random test images were selected and their reconstructions were visualized.



- Bonus Task :
- **Threshold MSE for Classification:** 0.0105 , evaluated on 2 folders seen_leaves and unseen_leaves
- **Class 0:** Leaf belongs to MBMU ($MSE \leq 0.0105$)
- **Class 1:** Leaf does not belong to MBMU ($MSE > 0.0105$)
- Reconstruction accuracy = $(\text{accurate_pixels} / \text{total_pixels}) * 100$
- **Model correctly classifies :**
 - Class 1 : unseen 792 images out of 1200 , recn acc = 88.75%
 - Class 0 : unseen 616 images out of 1200 , recn acc = 90.09%



- Sample test image :

LIMITATIONS AND SCOPE OF IMPROVEMENT :

- Accuracy of model can further be improved by increasing the number of convolutional layers in model .
- Further we look forward to work towards improving Bonus task classification by improving dataset quality using preprocessing .
- Also we can improve data collection process while capturing the images .