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Identification of Indian Banknotes for Visually Impaired Individuals Using CNN

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Abstract:
This paper presents a novel approach to identifying Indian banknotes for visually impaired individuals using a MobileNetV2-based convolutional neural network (CNN) model. The proposed method leverages transfer learning and data augmentation techniques to classify Indian banknotes with high accuracy. The system is designed to assist visually impaired individuals in independently identifying the denomination of Indian currency, thereby promoting financial inclusion and independence.

Keywords: Banknote identification, convolutional neural network, MobileNetV2, visually impaired assistance, transfer learning.

1. Introduction:

Financial transactions may be difficult for visually challenged people, especially when it comes to distinguishing the denomination of bank notes. This research provides a deep learning-based method that uses a pre-trained MobileNetV2 model to reliably recognise Indian banknotes. The system strives to be accessible and user-friendly, including real-time help for visually impaired users.

2. Related Works:

Several machine learning algorithms have been developed for Indian cash detection, benefiting both sighted and visually challenged people. Notable works include Reddy et al. (2020), who achieved 95.6% accuracy with CNNs, Sharma et al. (2019), who achieved 91.2% accuracy with SVM, Patel et al. (2022), who achieved 96.8% accuracy with deep learning, Mehta & Shah (2018), who achieved 94.3% accuracy with deep learning for visually impaired users, and Pandey et al. (2020), who achieved 93.7% accuracy using a hybrid technique. These strategies improve financial accessibility for everyone, including people with visual impairments.

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3. Methodology:

Prediction of Currency Denomination is challenging due to the numerous variables involved. To address this, the dataset must be preprocessed, combining essential features into a single feature set. Following this, an appropriate deep learning algorithm will be used for image classification and currency denomination identification. The development of the Currency Denomination Identifier Application involves the following steps:

A. **Data Collection and Preprocessing:** The dataset comprises images of Indian banknotes in various denominations, divided into two categories: old and new series. Data augmentation techniques, such as rotation, shifting, and zooming, are applied to enhance the model's robustness.


```
base_model = MobileNetV2(weights='imagenet', include_top=False, input_shape=(224, 224, 3))

base_model.trainable = False

model = Sequential([
    base_model,
    GlobalAveragePooling2D(),
    Dense(256, activation='relu'),
    Dense(10, activation='softmax')
])
```

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Fig2: Model Architecture.

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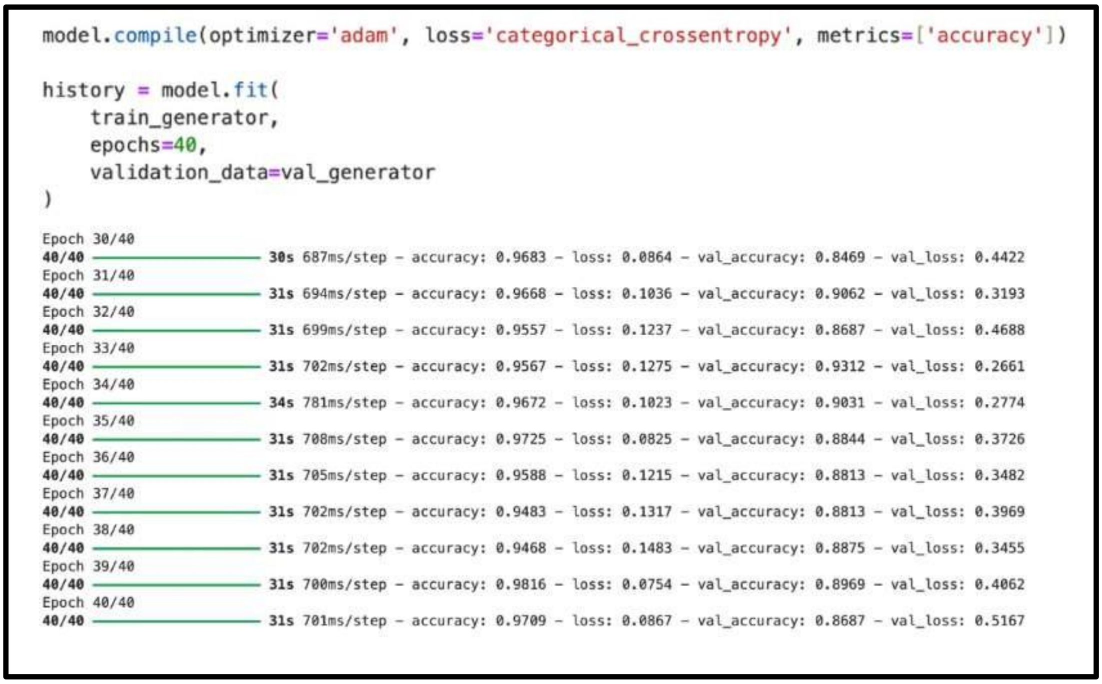
C. Training: The model is trained using the Adam optimizer with categorical cross-entropy loss. Data augmentation is employed to improve generalisation, and the dataset is split into training and validation sets with an 80-20 ratio. The accuracy obtained is 97.09% on training data and 86.87% on validation data.



```
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

history = model.fit(
    train_generator,
    epochs=40,
    validation_data=val_generator
)

Epoch 30/40
40/40 ──────────── 30s 687ms/step - accuracy: 0.9683 - loss: 0.0864 - val_accuracy: 0.8469 - val_loss: 0.4422
Epoch 31/40
40/40 ──────────── 31s 694ms/step - accuracy: 0.9668 - loss: 0.1036 - val_accuracy: 0.9062 - val_loss: 0.3193
Epoch 32/40
40/40 ──────────── 31s 699ms/step - accuracy: 0.9557 - loss: 0.1237 - val_accuracy: 0.8687 - val_loss: 0.4688
Epoch 33/40
40/40 ──────────── 31s 702ms/step - accuracy: 0.9567 - loss: 0.1275 - val_accuracy: 0.9312 - val_loss: 0.2661
Epoch 34/40
40/40 ──────────── 34s 781ms/step - accuracy: 0.9672 - loss: 0.1023 - val_accuracy: 0.9031 - val_loss: 0.2774
Epoch 35/40
40/40 ──────────── 31s 708ms/step - accuracy: 0.9725 - loss: 0.0825 - val_accuracy: 0.8844 - val_loss: 0.3726
Epoch 36/40
40/40 ──────────── 31s 705ms/step - accuracy: 0.9588 - loss: 0.1215 - val_accuracy: 0.8813 - val_loss: 0.3482
Epoch 37/40
40/40 ──────────── 31s 702ms/step - accuracy: 0.9483 - loss: 0.1317 - val_accuracy: 0.8813 - val_loss: 0.3969
Epoch 38/40
40/40 ──────────── 31s 702ms/step - accuracy: 0.9468 - loss: 0.1483 - val_accuracy: 0.8875 - val_loss: 0.3455
Epoch 39/40
40/40 ──────────── 31s 700ms/step - accuracy: 0.9816 - loss: 0.0754 - val_accuracy: 0.8969 - val_loss: 0.4062
Epoch 40/40
40/40 ──────────── 31s 701ms/step - accuracy: 0.9709 - loss: 0.0867 - val_accuracy: 0.8687 - val_loss: 0.5167
```

Fig3: Training Results.

D. Evaluation: The model achieved high accuracy on both training and validation datasets, demonstrating its effectiveness in classifying Indian banknotes. Figures 1 and 2 illustrate the training and validation accuracy and loss curves, respectively.

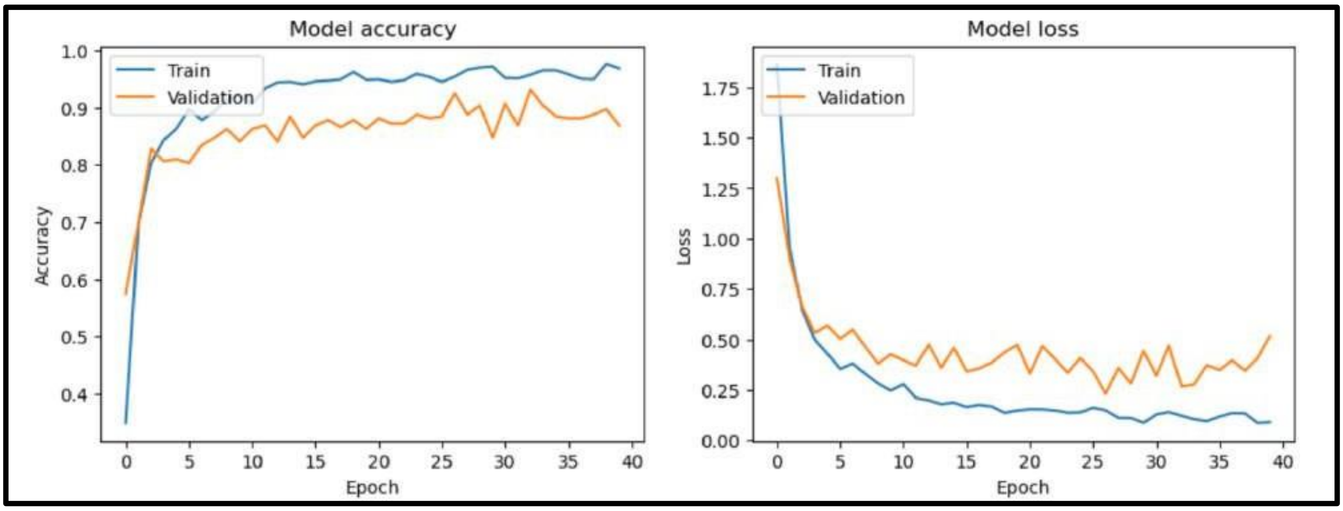


Fig4: Accuracy and Loss graph.

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E. Prediction: A preprocessing pipeline is developed to prepare input images for prediction. The system predicts the denomination of the input image and displays the result.

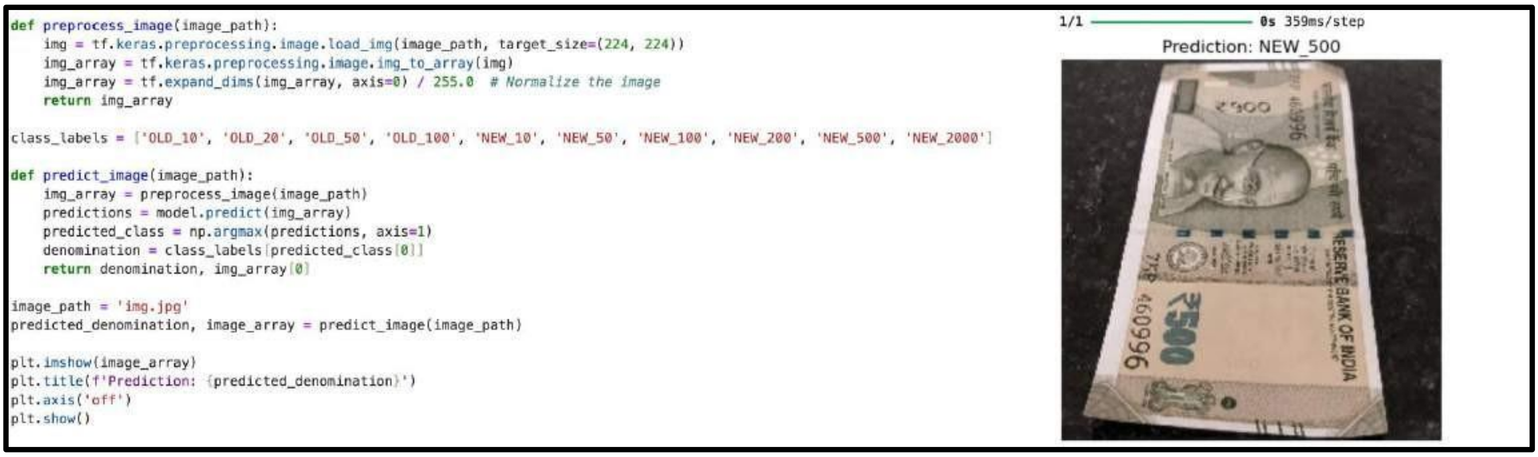

Fig5: Prediction.

4. Conclusion and Future Scope for work:

This study presents a robust deep learning-based system for identifying Indian banknotes, designed to assist visually impaired individuals. Utilising MobileNetV2 and transfer learning, the model achieves high accuracy and generalisation, making it suitable for practical applications. Future work will focus on developing a real-time mobile application with voice assistance, extending support to other currencies, and enhancing the model's robustness under diverse conditions. Additionally, extensive user experience testing, multi-language support, offline functionality via edge computing, and stringent security measures will be pursued. Collaborations with organisations supporting visually impaired individuals will further refine the system and expand its accessibility, promoting financial inclusion and independence.

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