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Object Recognition Application for Education using Transfer Learning

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Abstract - In today's technology-driven world, fostering a love of learning and nurturing curiosity in young minds is essential. This project introduces an object recognition application designed to enrich young learners' educational experiences. The app focuses on identifying fruits, vegetables, and flowers using the EfficientNetB0 model, known for its proficiency in image recognition. By leveraging transfer learning from the pre-trained ImageNet dataset, the application achieves high accuracy in recognizing these objects. Beyond identification, the app integrates interactive games such as guessing, matching, and memory games with identical object cards, providing engaging ways to develop vocabulary and cognitive skills. This research explores fine-tuning EfficientNetB0 for targeted tasks and designs an intuitive interface to support positive learning experiences, potentially impacting children's educational journeys.

Key Words: Transfer Learning, education, games, application

1. INTRODUCTION

In today's technology-driven world, educators are constantly looking for new ways to inspire a love of learning and spark curiosity in young people. Traditional classroom approaches may struggle to capture students' attention and cater to diverse learning styles. This difference highlights the need for collaborative and interactive learning tools that can complement traditional learning. This study proposes the development of a product recognition application specifically designed to enhance student learning. The application will focus on identifying fruits, vegetables, and flowers, which are an important group for early childhood development. By leveraging the power of transfer learning, the application will achieve efficient and accurate object recognition. Transfer learning leverages previous learning techniques such as EfficientNetB0 trained on large datasets such as ImageNet. This allows the application to harness the existing knowledge of these models and adapt it to the specific task of recognizing fruits, vegetables, and flowers. This approach not only reduces training time and resources but also ensures high accuracy in object identification. The proposed application goes beyond simple identification. It aims to create a truly engaging and interactive learning experience. Integrating learning games such as guessing, quizzes and memory games, the app will improve vocabulary, improve product knowledge, and support students' cognitive development. The application will also include a special training section with interactive videos. These videos will leverage the power of visual learning to present engaging content about the identified objects. Children can learn interesting facts, explore the growth process, or discover fun recipes associated with fruits, vegetables, and flowers. This multi-faceted approach caters to different learning styles and provides a richer learning experience for young users. This useful tool has the potential to be an asset in the classroom and at home; It encourages a love of learning and arouses curiosity in young people.

2. LITERATURE SURVEY

Paper Name: Image and Object Recognition System Apps for Kids Learning. [1]

Noruddin and Razali (2021), [1] explores the development of educational mobile apps for children using deep learning and object recognition. Their paper, "Image and Object Recognition System Apps for Kids Learning," focuses on AI-based tools for identifying objects and improving processing quality. TensorFlow is used for model training and deployment, while Google Colab offers free cloud GPU support for data processing. Android Studio is employed to create Android Application Packages (APKs) for mobile devices. This project supports parents and teachers in fostering children's growth through interactive AI-based learning features.

Paper Name: Fruit image classification model based on MobileNetV2 with deep transfer learning technique. [2]

Gulzar (2023), [2] The author investigates deep transfer learning for fruit image classification using a customized MobileNetV2 model. The study uses a dataset of over 26,000 images across 40 fruit types and introduces a modified head to MobileNetV2. TL-MobileNetV2 achieves 99% accuracy, surpassing traditional models like AlexNet, VGG16, InceptionV3, and ResNet. The research highlights the benefits of transfer learning and dropout techniques in improving classification performance and reducing overfitting for automated fruit classification in horticulture.

Paper Name: Transfer Learning Based Effective Approach for Classification of Flowers. **[3]**

Nithin et al. (2022), [3] This paper studies the use of deep learning for flower classification, using VGG19 and EfficientNetV2L architectures. They address the challenge of classifying flowers with similar shapes and colors by fine-tuning models and pre-processing images. EfficientNetV2L achieved an accuracy of 96.28% over 20 epochs, outperforming other proposed architectures on the Kaggle dataset. The research demonstrates the effectiveness of transfer learning and deep learning in classifying various flower species, providing insights for AI applications in this domain.

3. PROPOSED SYSTEM

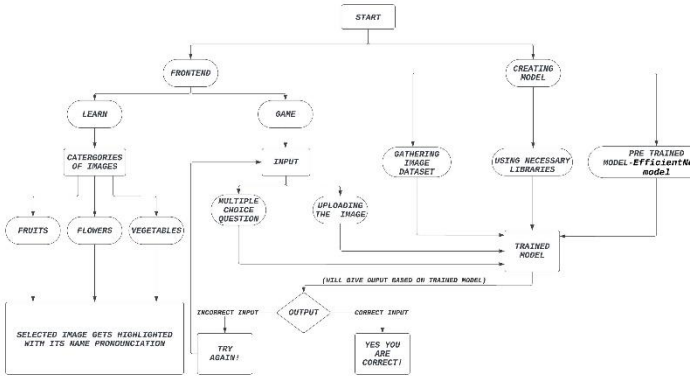

Figure 1. Proposed Algorithm

Application flow chart is shown in Figure 1. This project proposes an object recognition application designed to promote learning and engagement in young children. The application leverages transfer learning with a pre-trained EfficientNetB0 model to accurately classify fruits, vegetables, and flowers – categories commonly encountered during early childhood development. The proposed approach includes these main aspects: EfficientNetB0 Model: Utilizing a pre-trained EfficientNetB0 model offers a balance between accuracy and computational efficiency. This is crucial for ensuring smooth application performance, especially on devices with limited resources that might be used by children. Transfer Learning: By leveraging knowledge gained from the massive ImageNet dataset through transfer learning, the model can be effectively adapted to the task of classifying fruits, vegetables, and flowers with a limited amount of training data specific to this domain. Focus on Specific Object Categories: Focusing on a well-defined set of object categories allows for tailored learning content and interactive games specifically designed for young learners. This can include incorporating age-appropriate vocabulary, engaging visuals, and interactive elements that cater to their developmental needs. Educational Content and Engagement: The project goes beyond basic object recognition by incorporating elements that enhance the learning experience for children: Interactive Games: Games like "Guess the Object," "Match the Object," and a memory game adapted with fruits, vegetables, and flowers can transform learning into a fun and engaging activity. Visual and Audio Cues: Presenting the identified object name on the screen, playing an audio description, or even highlighting the object within an image can cater to different learning styles and reinforce object recognition skills. Feedback Mechanisms: In games like "Guess the Object," providing feedback on children's choices can guide them towards the correct answer and solidify their learning. Technology Stack: The project leverages a combination of technologies to deliver a user-friendly and effective learning tool: TensorFlow: This popular deep learning framework is used to train and deploy the EfficientNetB0 model for object recognition. HTML, CSS, and JavaScript: These web development technologies create the user interface (UI) of the application, ensuring a visually appealing and interactive experience for children. Flask: This Python web framework integrates the back-end model with the front-end UI, enabling dynamic content generation based on user interactions and model predictions. This proposed project offers a promising solution for developing an engaging and educational tool that leverages object recognition technology to support early childhood learning. The focus on efficient model architecture, transfer learning, and age-appropriate learning content can contribute to a positive learning experience for young children.

3.1 IMPLEMENTATION

This section describes the technical aspects of the object recognition application designed for educational purposes, specifically targeting young learners. The application leverages transfer learning with a pre-trained EfficientNetB0 model to classify fruits, vegetables, and flowers.

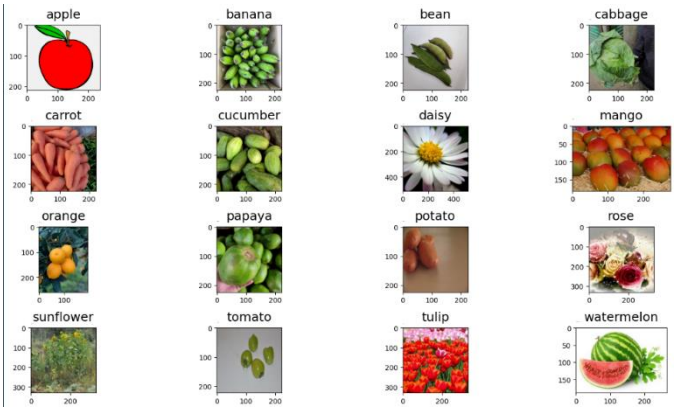

Figure 2. Data Preprocessing

Data and Preprocessing: The application utilizes a pre-existing dataset of images containing fruits, vegetables, and flowers. This dataset is sourced from Kaggle, a popular platform for data sharing. The dataset is divided into 2 parts training and testing sets. The training set is used to train the model, while the testing set is used to evaluate the model's performance. Images within the dataset are pre-processed to ensure compatibility with the model. This includes resizing the images to a target dimension of 224x224 pixels and normalizing pixel values between 0 and 1.

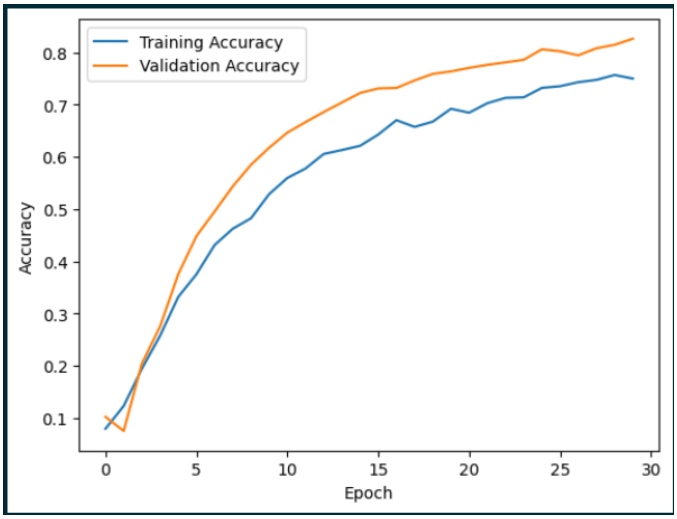

Figure 3. Accuracy Graph

Object Recognition with EfficientNetB0: The application utilizes a pre-trained EfficientNetB0 model, a convolutional neural network (CNN) architecture known for its efficiency and accuracy. The EfficientNetB0 model is loaded with weights trained on the massive ImageNet dataset, providing a solid foundation for object recognition tasks. To prevent overfitting and improve model generalizability, only the final layers of the pre-trained model are fine-tuned during the training process. This means the earlier layers, which have learned general image features, remain frozen, while the final layers are adapted to the specific task of classifying fruits, vegetables, and flowers.

Figure 4. Fruits Learning

Figure 5. Interactive Videos

***Output and Educational Content*:** Once an image (from the pre-existing dataset) is processed, the model predicts the most likely object category from the 16 defined classes (e.g., apple, carrot, sunflower).The application presents the identified object to the children in a user-friendly format. This can include displaying the object name on the screen, playing an audio description of the object, or even highlighting the object within a sample image. To enhance the educational experience for young learners, the application can incorporate additional content beyond just object identification.

Learning Games and Activities: The application goes beyond basic object recognition by incorporating interactive games and activities to engage young learners:

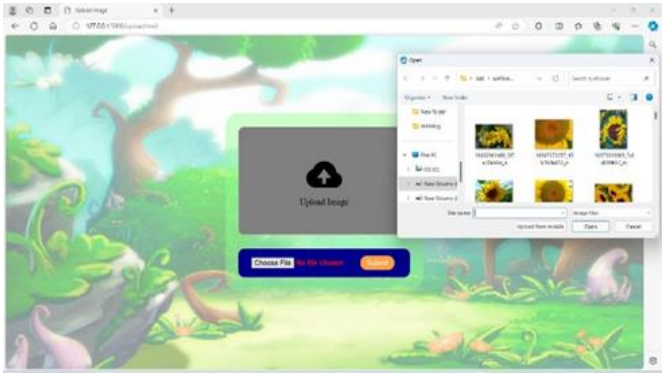

Figure 6. Upload & Recognize

Upload Image: Incorporating an upload image and recognize game, users can engage in an interactive experience where they upload images of fruits, vegetables, or flowers, prompting the application to swiftly identify and provide relevant information about the objects detected, fostering curiosity and learning in an enjoyable manner.

Figure 7. Matching Game

***Match the Object*:** The application displays an image of an object (from the pre-existing dataset) and prompts children to match it with the corresponding name from a list of choices. This interactive game helps solidify object recognition skills and can be adapted to different difficulty levels by varying the number of choices presented.

Figure 8. Memory Card

***Memory Game*:** This classic memory game can be adapted to utilize images of fruits, vegetables, and flowers from the pre-existing dataset. Children flip cards to reveal objects and attempt to match pairs, promoting memory and visual recognition skills.

4. FUTURE SCOPE

In envisioning the future scope for this project, several avenues emerge for expansion and refinement. Firstly, while the current focus lies on fruits, vegetables, and flowers, diversifying the object categories to encompass a broader spectrum of everyday items, animals, or even historical artifacts could enrich the learning experience and cater to a wider audience. Secondly, the integration of adaptive learning algorithms could enable the application to tailor its content and difficulty levels based on individual user progress, fostering a more personalized and effective learning journey. Moreover, exploring the integration of emerging technologies such as augmented reality (AR) could elevate the user experience by allowing for immersive interactions with virtual objects in real-world environments. Collaborations with educators and child development specialists could provide valuable insights for refining content, ensuring alignment with educational standards and best practices. Continuous updates and iterations driven by user feedback and advancements in technology will be pivotal in ensuring the sustained relevance and impact of the application in cultivating curiosity and facilitating cognitive growth in young learners.

5. CONCLUSION

In conclusion, this research project has explored the potential of object recognition technology for developing educational applications aimed at young learners. By leveraging the power of transfer learning with a pre-trained EfficientNetB0 model, the project has addressed the computational demands often associated with deep learning models in object recognition. The focus on a specific set of objects – fruits, vegetables, and flowers – allows for the creation of tailored learning content and interactive games, fostering a more engaging and effective learning experience for young users. Additionally, the potential for future expansion to include variations in object pose and lighting conditions aims to overcome limitations related to dataset diversity and generalizability observed in some existing research. This project contributes to the growing body of work on

educational technology by demonstrating the effectiveness of object recognition for promoting learning in young children. Future research directions could explore the integration of additional modalities, such as audio descriptions, to further enhance the learning experience.

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