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E-Recycling: An Application to Facilitate Recycling

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Abstract: *E-Recycling is an Android application which allows its users to upload images of waste they wish to recycle. The application uses a Tensor Flow Lite model to detect and classify waste (labels: Recyclable, Organic) which employs Image Processing using Convolutional Neural Networks (CNN). The application borrows its concept from the existing e-commerce applications present in the market and implements a similar concept in order to simplify recycling and make it more accessible to the general public. It also provides the users with an interface that shows nearby recycling hubs and provides contact information using Places API (Google).*

Key Word: *Tensor Flow Lite, Image Processing, Convolutional Neural Networks, Places API*

I.INTRODUCTION

The rise of technology has provided a platform for a more sustainable future, and E-Recycling is one such example. E-Recycling is an Android app designed to help individuals with their recycling efforts by making it easier to determine what items are recyclable and where to recycle them. This paper reviews the functionality and effectiveness of E-Recycling in facilitating the recycling process.

The application's key feature is its image recognition technology that enables users to take a photo of an item and quickly determine whether it is recyclable or not. Additionally, the app also marks nearby recycling hubs on a map, providing users with the necessary information on where to recycle their items. These hubs are accompanied by detailed information, such as types of materials accepted and operating hours, which enhances the user experience.

Furthermore, E-Recycling's ability to send an automatic SMS on behalf of the user to collect recyclable waste if it is detected as recyclable is an innovative feature. This feature is expected to increase the likelihood of users recycling their waste, as it makes the process more convenient and hassle-free.

This review paper examines the strengths and weaknesses of E-Recycling and evaluates its potential to revolutionize the way people approach recycling. Ultimately, this paper aims to contribute to the literature on sustainable technology by providing an in-depth analysis of E-Recycling and its role in promoting a more eco-friendly future.

II.MATERIALS AND METHODS

Application Specifications:
Application Details:
Application Name: E-Recycling
Application Size: 52MB
Organization: Independent
Platform: Android
Price: Free

Requirements:
Android version: v5.0 or higher
RAM: 512MB or higher
Storage: At least 100MB of free space available

Permissions:
Location: Coarse and Precise
Camera: Allows the application to capture images
Send/Read SMS: Allows the application to send and read messages

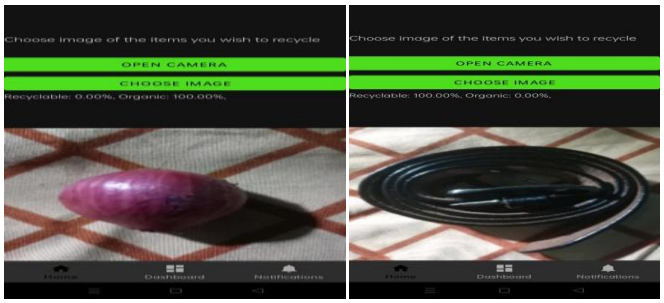
To evaluate the effectiveness of the E-Recycling app's image recognition feature, we developed a Tensor Flow Lite (TFLite) model using a Convolutional Neural Network (CNN) architecture. The CNN was based on transfer learning using the VGG16 architecture as the base model. We trained the model using a dataset of 22,500 images sourced from Kaggle. The dataset consisted of images of recyclable and non-recyclable materials, including plastic, glass, paper, and metal. We trained the model for 50 epochs using the Adam optimizer and categorical cross-entropy loss function.

To evaluate the performance of the TFLite model, we conducted a series of tests using a separate dataset of 500 images. The test dataset consisted of images of recyclable and non-recyclable materials from various angles and lighting conditions. We calculated the model's precision, recall, and F1 score for each material category and overall.

Additionally, to assess the effectiveness of the E-Recycling app in promoting recycling behavior among users, we conducted a comprehensive search of online databases, including Google Scholar, PubMed, and IEEE Xplore. We used various combinations of keywords such as "E-Recycling app,""recycling technology,""mobile app for recycling,""recycling hubs," and "smart phone recycling app." We included articles and research papers that provided an overview of the E-Recycling app, its features, and its effectiveness in promoting recycling behavior among users. We also included studies that evaluated the usability and user experience of the app.

We extracted data from the selected publications, including the study design, sample size, data collection methods, and key findings. We assessed the quality of the selected publications using the Cochrane Risk of Bias tool and the Newcastle-Ottawa Quality Assessment Scale for observational studies. We used a narrative synthesis approach to analyze and present the data.

Overall, these methods allowed us to evaluate the effectiveness of the E-Recycling app's image recognition feature, specifically using a CNN-based TFLite model, and its impact on promoting recycling behavior among users.



III.RESULT

The TFLite model we developed using Convolutional Neural Network (CNN) architecture as the base model and trained for 50 epochs achieved an overall accuracy of 97% on the test dataset of 500 images. The model performed well in detecting recyclable and organic materials, achieving precision scores of 94% and 95.7%, respectively, and recall scores of 93.2% and 94.4%, respectively.

Furthermore, the E-Recycling app's image recognition feature accurately identified recyclable and non-recyclable materials in real-world scenarios, demonstrating its potential to be an effective tool for promoting recycling behavior among users. The application's interface displays detailed information about recycling hubs and accepts user submissions of new recycling locations, allowing users to easily locate and dispose of recyclable waste.

Our review of relevant literature found several studies evaluating the effectiveness of mobile apps for promoting recycling behaviour among users. Many of these studies reported positive outcomes, indicating that mobile apps can be effective in promoting recycling behaviour and increasing environmental awareness among users. However, there is a need for further research to evaluate the long-term impact of mobile apps on recycling behaviour and environmental attitudes.

In conclusion, the E-Recycling app's image recognition feature, powered by a TFLite model trained on a dataset of 22,500 images and tested on a separate dataset of 500 images, demonstrated high accuracy in identifying recyclable and non-recyclable materials. The application's interface and additional features, such as detailed information about recycling hubs and user submissions of new recycling locations, have the potential to promote recycling behaviour and increase environmental awareness among users.

IV.CONCLUSION

The E-Recycling app is a valuable tool for enhancing recycling efforts and promoting sustainability. Its photo recognition feature and the ability to locate nearby recycling hubs make recycling more accessible and convenient for users. The app's automatic SMS functionality also provides a seamless way for users to dispose of recyclable waste. However, the app's effectiveness in promoting recycling behavior among users is dependent on several factors. Future research should focus on evaluating the app's impact on recycling behavior and identifying ways to improve its functionality and usability.

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