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Innovative Solutions for Currency Recognition Among the Visually Impaired

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ABSTRACT

Indian currency notes, issued by the Indian government, are necessary for financial transactions throughout the country. Presenting an efficient deep learning-based object detection system for recognising Indian rupee notes is the aim of the research. People who are blind or visually handicapped and cannot tell how much money they are holding benefit from being able to recognise cash notes. Consequently, an effective model that recognises currency notes and gives the human speech of the found currency note is developed. The notes are trained using the YOLOV5 model, and the results are compared to validation data. As the assessment indicators are tracked, model losses are minimised. After that, a new test set of data is considered as an inference for class recognition. The web application is designed using Flask, YOLOV5, and web technologies. The online application recognised Indian rupee notes with a bounding box probability greater than 0.80 for each class. With this model, each note's label is plainly visible and has a bounding box probability greater than 0.90.

I. INTRODUCTION

Object Detection is technique used in detection of real-time objects, in images and videos using either machine learning or deep learning and OpenCV. Object detection is applied in surveillance, image retrieval, security, Advanced Driver Assistance Systems (ADAS). Object detection includes image classification and object localization [1]. Based on WHO statistics, at least 2.2 billion people have a near or distance vision impairment. The leading causes for visual impairment include uncorrected refractive errors, cataract, diabetic retinopathy, glaucoma and age-related vision impairment [2] In 2017, National Center for Biotechnology Information (NCBI) reported that 253 million people globally were visually impaired among which 217 million had visualimpairment and remaining were identified as blind [3]. Visually impaired lack the ability to interpret bank-notes is very limited and usually depend on others. The aim is to overcome this difficulty and to provide easier currency detection for visually impaired. The currency notes are detected based on feature extraction, considering geometric size and characteristic texture [4]. In India, Indian Currency Recognition System currently uses CNN and OpenCV based recognition system to detect monetary notes [5]. This model has lower detection accuracy than the proposed system which uses YOLOv5 for object detection. The proposed system involves YOLOv5 algorithm to detect test images. The model is trained using transfer learning and is later inferenced against test data. A web-based application is designed using YOLOv5 and Flask. This app provides labels on the screen as well as audio file of detected currency note, when a currency note image is uploaded. The audio file can be listened to using play button provided in the web app. This will not only aid visually impaired, but also, provide easier way to recognize Indian currency notes to tourists and foreigners visiting India. The challenge is to design a web application based on YOLOv5 model to detect Indian currency notes accurately and provide optimized and efficient results, both on laptop and mobile.

II. LITERATURE REVIEW

S. Luo and W. Zheng, "You-Only-Look-Once-v5 Based Table Detection for Academic Papers," 2021 Int. Conf. Digit. Soc. Intell. Syst. DSInS 2021, pp. 53–56, 2021, doi: 10.1109/DSInS54396.2021.9670600.
Shenmei Luo and Wenbin Zheng (2021) proposed a table detection method for academic paper based on YOLOv5 (You Only Look Once v5) where detection accuracy and speed ofproposed approach are observed to be superior compared to other competitive approaches [6].
S. D. Achar, C. Shankar Singh, C. S. Sumanth Rao, K. Pavana Narayana, and A. Dasare, "Indian Currency Recognition System Using CNN and Comparison with YOLOv5," 2021 IEEE Int. Conf. Mob. Networks Wirel. Commun. ICMNWC 2021, pp. 1–6, 2021, doi: 10.1109/ICMNWC52512.2021.9688513.
Sagar et. al (2021) designed a system for detection of Indian currencies that aids visually impaired people to recognize and read out the possible Indian paper currencies with 79.83% accuracy [4]. The proposed model is based on YOLOv5, where it compares the efficiency of YOLOv5 with CNN algorithm for currency detection.
K. K. S. N. Reddy, C. Yashwanth, S. H. Kvs, P. A. T. V. Sai, and S. Khetarpaul, "Object and Currency Detection with Audio Feedback for Visually Impaired," 2020 IEEE Reg. 10 Symp. TENSYMP 2020,no. June, pp. 1152–1155, 2020, doi: 10.1109/TENSYMP50017.2020.9230687.
Sai Nadh et. al (2020) has developed a module for blind people and design mobile application for visually impaired Indian citizens to recognize currency value when held near android phone to predict the currency value so that currency can be recognized correctly [7].
P. Shreya, N. Shreyas, D. Pushya, and N. Uma Maheswar Reddy, "BLIND ASSIST : A One Stop Mobile Application for the Visually Impaired," 2021 IEEE Pune Sect. Int. Conf. PuneCon 2021, pp. 1–4, 2021, doi: 10.1109/PuneCon52575.2021.9686476.
Shreya et. al (2021) designed a mobile application for Visually Impaired Persons – Blind Assist [8] based on web technologies to scan currency note using device's camera and get its denomination using a voice assistant.
R. R. M. Et al., "Currency Detection for Visually Impaired Iraqi Banknote as a Study Case," Turkish J. Comput. Math. Educ., vol. 12, no. 6, pp. 2940–2948, 2021, doi: 10.17762/turcomat.v12i6.6078.
Raghad Raied Mahmood et. al proposed real-time Iraqi currency note detection system that aids visually impaired people using YOLO-v3 and gTTS to obtain audio output. custom Iraqi banknote dataset for detection and recognition of banknotes. The Iraqi notes were detected in a short time with high mAP of 97.405% [9].
M. Mahendru and S. K. Dubey, "Real time object detection with audio feedback using Yolo vs. Yolo_V3," Proc. Conflu. 2021 11th Int. Conf. Cloud Comput. Data Sci. Eng., pp. 734–740, 2021, doi: 10.1109/Confluence51648.2021.9377064.
Mansi Mahendru and Sanjay Kumar Dubey (2021) proposed system for visually impaired to detect multiple objects and prompt voice to alert person stating near and farther objects around them using gTTS and TensorFlow [10]. A comparison between YOLO and YOLO_v3 for object detection was tested under same criteria based on measures like accuracy and model performance.

III. SYSTEM ANALYSIS & SYSTEM DESIGN

EXISTING SYSTEM

In This Existing system methodproved tha tthe Mexican banknotes can be classified by extracting their texture features and colour. This technique uses the RGB colour model and the Local Binary Patterns for the identification process.

Theaccuracy of this method is very low. Junfang etal. Used an improved LBP algorithm, called block LBP algorithm for characteristic extract. It is based on the ordinary Local Binary Pattern (LBP) method. This method is very simple and has a low speed.

Proposed system and advantages

The proposed system involves YOLOv5 algorithm to detect test images. The model is trained using transfer learning and is later inferenced against test data. A web-based application is designed using YOLOv5 and Flask. This app provides labels on the screen as well as audio file of detected currency note, when a currency note image is uploaded. The audio file can be listened to using play button provided in the web app. This will not only aid visually impaired, but also, provide easier way to recognize Indian currency notes to tourists and foreigners visiting India.

IV. SYSTEM IMPLEMENTATION

Modules discription

Dataset and Experimental Environment:

Currency notes used in the experiment are collected from sources like banks and shops. The dataset comprises of old notes of ₹10, ₹20 and new notes of ₹50, ₹100, ₹200, ₹500 and ₹2000 images (in .jpg format), in equal proportions. The images data comprise 200 images per class, which are captured on different backgrounds and different visual settings.

Dataset Augmentation:

These 1400 images are then augmented using rotation, blur and shift transformation techniques to generate dataset with 5600 images.

Dataset Annotation:

These 5600 images are then manually annotated using MakeSense annotator tool. The annotations are then exported in YOLO format and stored in labels directory Split the entire dataset along with their labels in 70-30 split. The training dataset comprises 3920 images and their labels. Remaining 1680 images along with their annotations comprise the validation dataset.

Train the model:

The image size is set to 416. The model epochs are set to 30 and batch size is set to 32. Set the directory path for train dataset and configuration files. Then, run the python command to train the entire dataset using YOLOv5 model. The evaluation metrics are – Precision, Recall and mean Average Precision (mAP). The losses calculated for box, object and class for each epoch.

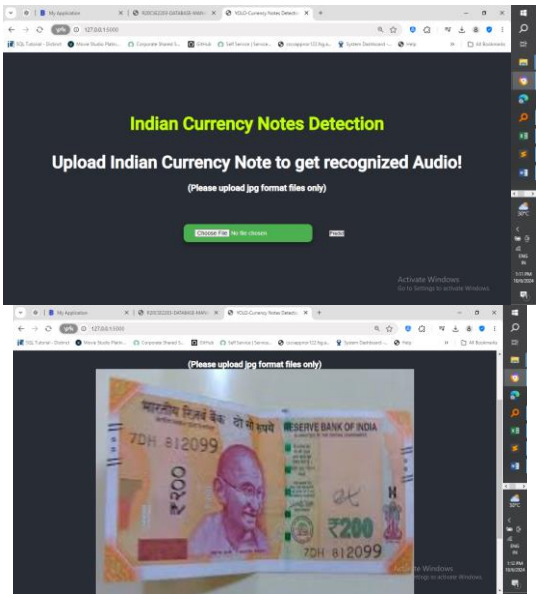
Inference the model against test data:

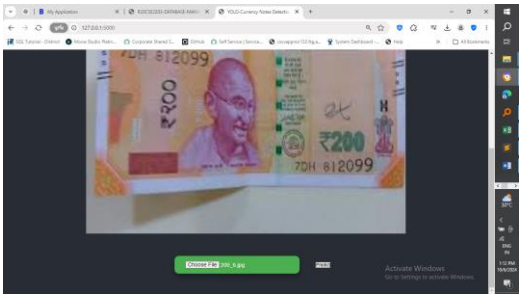
The model is inferenced using best.pt as model weight and setting the directory path of test data. The test data contains 100 images of all classes and video file containing currency note image frames.

Evaluation

The evaluation metrics used to analyse the results include – Precision, recall and mAP. Higher values of recall, precision and mAP (mean Average Precision) are preferred to detect the currency notes accurately. The other metrics include box loss, obj loss and cls loss. In a confusion matrix with True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN), the evaluation metrics Precision, recall and F1- score can be calculated.

V. OUTPUT SCREENS





VI. CONCLUSION

When it comes to money note detection, the proposed YOLOv5 model has a high mAP, recall, and accuracy. The model properly identified 85 of the 100 test data images. To detect currency notes, a web application with a high bounding box probability that is native to YOLOv5 was developed. The internet tool provides speech output files of recognised currency note labels in both Hindi and English. The model can be extended to recognise foreign money notes. Enhancing the system with optical character recognition (OCR) can help the model perform better.

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