Project Report

on

Currency Detector Android Application for Visually Impaired People

Submitted to

Sant Gadge Baba Amravati University

In partial Fulfillment of the Requirement

For the Degree of

Bachelor of Engineering in

Computer Science and Engineering

Submitted by:

Anand Agrawal, Vinita Tiwari,
Himanshu Jamwal, Nikita Shrinath,
Priya Diwnale

Under the Guidance of

Prof. C. M. Mankar

Department of Computer Science and Engineering

Shri Sant Gajanan Maharaj College of Engineering,

Shegaon – 444 203 (M.S.)

2021-22

SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING,

SHEGAON – 444 203 (M.S.)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that **Mr. Anand Agrawal, Ms. Vinita Tiwari, Ms. Nikita Shrinath, Mr. Himanshu Jamwal** and **Ms. Priya Diwnale,** students of final year B.E. in the year 2020-21 of Computer Science and Engineering Department of this institute has completed the project work entitled **"Currency Detector Android Application for Visually Impaired People"** based on syllabus and has submitted a satisfactory account of his work in this report which is recommended for the partial fulfillment of degree of Bachelor of Engineering in Computer Science and Engineering.

Prof. C. M. Mankar
Project Guide

3-3/1/21

Dr. S. B. Patil
Head of Department

Dr. S. B. Somani
Principal

Head of Department Principal

SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING,

SHEGAON – 444 203 (M.S.)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project work entitled "**Currency Detector Android Application for Visually Impaired People**" submitted by **Mr. Anand Agrawal, Ms. Vinita Tiwari, Ms. Nikita Shrinath, Mr. Himanshu Jamwal and Ms. Priya Diwnale** students of final year B.E. in the year 2020-21 of Computer Science and Engineering Department of this institute, is a satisfactory account of his work based on the syllabus which is recommended for the partial fulfillment of the degree of Bachelor of Engineering in Computer Science and Engineering.

Internal Examiner **External Examiner**

Date: **Date:**

Abstract

Not everyone in this world can see the colors or even the light from his/her eyes. These people are known as visually impaired people. Visually disabled people are partially sighted or completely blind. These types of people face many problems in their day-to-day life, including transactions through money. Every category of currency is different from the others, and the difference can be noticed through the naked eye. For visually challenged people, it is hard for them to differentiate between the notes. Higher organizations or institutions like Banks have expensive hardware machines that can easily determine the difference between original and fake notes. The technology used in those machines is not handy or cost-efficient. So, to overcome this issue, this project can help the visually disabled person recognize the currency notes using a mobile camera. The system will be developed as an Android application and will use image processing techniques to achieve high accuracy.

Keywords: Currency identification, visually disabled, TensorFlow, Android application, Image processing techniques

Acknowledgment

The real spirit of achieving a goal is through the way of excellence and lustrous discipline. I would have never succeeded in completing my task without the cooperation, encouragement, and help provided to me by various personalities.

I would like to take this opportunity to express my heartfelt thanks to my guide ***Prof. C. M. Mankar****, for his esteemed guidance and encouragement, especially through difficult times. His suggestions broadened my vision and guided me to succeed in this work. I am also very grateful for his guidance and comments while studying part of my seminar and learned many things under his leadership.*

I extend my thanks to ***Dr. S.B. Patil*** *Head of the Computer Science & Engineering Department, Shri Sant Gajanan Maharaj College of Engineering, Shegaon for their valuable support that made me a consistent performer.*

I also extend my thanks to ***Dr. S. B. Somani****, Principal Shri Sant Gajanan Maharaj College of Engineering, Shegaon for their valuable support.*

Also, I would like to thank all teaching and non-teaching staff of the department for their encouragement, cooperation, and help. My greatest thanks are to all who wished me success, especially my parents, and my friends whose support and care make me stay on earth.

Anand Agrawal, Vinita Tiwari,
Nikita Shrinath, Himanshu Jamwal,
and Priya Diwanle
Final Year B. E. Sem-VIII, CSE
Session 2022-23

Contents

List of Figures

Abbreviations

CNN	Convolutional Neural Network
DNN	Deep Neural Network
PSAI	Proctoring System using AI
BP	Back Propagation
GD	Gradient Descent
MSE	Mean Square Error
RL	Reinforcement Learning
tanh	Hyperbolic Tangent
ReLU	Rectified linear Unit

Chapter 1
INTRODUCTION

1.1 PREFACE

Of the 295 million visually disabled people in the world, 62 million are from India (about 18 million are completely blind). A petition by NGO called All India Confederation of Blind said that visually impaired people were affected and recognized the new Rs 50, Rs 200, Rs 500, Rs 2000 banknotes. They showed that the new currency is different in size. The plea said that this trouble can lead to difficulty in the transaction for the visually impaired. Identifying each note correctly is a challenge for anyone with visual impairment. Because they are disabled, they are repeatedly scammed with fake currency.

Therefore, the need for a simple system to help in detecting notes is important. In August 2019, RBI also realized this problem and came up with the idea to offer an Android app for the visually impaired. The concept of this Android application is that it will work on voice command, firstly the user will open the application through voice command and then the user will simply take out the note and place it behind the camera, within 2-3 seconds, a voice will be heard telling which note the user had held. Hence, our motivation is to help visually disabled people in India. This application will be easy to use and hence require less computation power.

1.2 BACKGROUND OF THE STUDY

In modern society, cashless transactions are becoming increasingly popular. However, paper currency still plays an essential role in everyday life. For visually impaired individuals, distinguishing between different denominations of paper currency can be a challenging and time-consuming task. This can lead to errors, inconvenience, and even vulnerability to fraud.

Therefore, there is a need for a solution that can assist visually impaired individuals in recognizing different denominations of paper currency. One possible solution is the development of a currency detector app for smartphones. This app would use the phone's camera to scan and recognize currency notes and then provide audio feedback to the user, announcing the denomination of the note.

Several technologies can be used to develop such an app, including computer vision and machine learning. Computer vision can be used to analyze the features of different currency notes, such as size, shape, and color, and distinguish between them. Machine learning can be used to train the app to recognize various currencies accurately, even as new notes are introduced.

There have been some previous attempts to develop currency detector apps for visually impaired individuals. However, these apps have had limited success due to issues such as low accuracy and slow response time. Therefore, this study aims to develop an accurate and efficient currency detector app using advanced computer vision and machine learning techniques.

The currency detector app has the potential to provide significant benefits to visually impaired individuals, improving their independence, confidence, and safety in handling paper currency. It can also promote financial inclusion, ensuring that everyone can participate in financial transactions equally.

1.3 PROBLEM STATEMENT

The problem statement for the currency detector app for visually impaired people is that they face difficulties in identifying currency notes due to their inability to see. This leads to potential fraud and inconvenience as they rely on others for help in identifying the currency. Traditional methods of identifying currency, such as relying on tactile features or asking for assistance, are not always reliable or practical. As a result, visually impaired individuals face challenges in performing routine tasks and maintaining independence. Therefore, there is a need for an accessible and reliable solution to help visually impaired people identify currency notes. The proposed solution is to develop a mobile app using machine learning algorithms that can accurately identify different currency notes and communicate the information to the user through audio or haptic feedback. The app should also be user-friendly and accessible to visually impaired individuals, taking into consideration their unique needs and limitations. The goal is to improve the quality of life for visually impaired individuals by providing them with a tool to easily and independently identify currency notes.

1.4 OBJECTIVES

1. The prime goal of this project is to help visually disabled people to help recognize the currency.
2. Another goal is to get precise results in different lighting conditions and follow the Android app using voice commands with a simple Graphical User Interface (GUI).
3. The system will work completely with voice commands, so it will be easy to use, practical, and economical for the visually disabled.

When we use this approach to focus on the blind, many additional problems arise. Users are unaware of c onditions such as lighting, contrast, saturation or even whether the paper is visible in the camera. The

system requires changes to many of the images that will be taken by the user. Using the app should be easy for visually impaired people. It must have cameras that must be activated by voice command, and they must not have a single-user login. Therefore, the issue requires innovative ideas that can trust and validate invoices in various environments.

1.5 SCOPE

1. Develop a mobile application that can detect currency and convert it into speech for visually impaired people.

2. Implement image processing techniques such as image segmentation, feature extraction, and object recognition to identify the currency denomination accurately.

3. Train and test various machine learning models such as Support Vector Machines (SVM) and Convolutional Neural Networks (CNN) to improve the accuracy of currency detection.

4. Design a user-friendly interface for the currency detection app, including features such as text-to-speech conversion, vibration feedback, and a simple user guide.

5. Conduct user testing and feedback sessions to evaluate the usability and effectiveness of the currency detection app.

6. Explore the possibility of integrating the currency detection app with other assistive technologies for visually impaired people, such as voice assistants and navigation systems.

The scope of this project is to develop a practical and reliable solution for currency detection for visually impaired people using machine learning and image processing techniques. The project aims to improve the quality of life and independence of visually impaired individuals by providing them with a tool to accurately identify and manage currency.

1.6 ORGANIZATION OF PROJECT

Chapter 1: It gives an Introduction of the project.

Chapter 2: Literature Survey of the research papers referred to get an idea of the previous work

Chapter 3: After reviewing, the methodology of how the project can be executed.

Chapter 4: How the project was deployed on Flask.

Chapter 5: The conclusion derived from this project.

Chapter 6: Details of the research papers referred.

Chapter 2

LITERATURE SURVEY

Many researchers have made distinct contributions to the advancement of currency recognition techniques.

The research by Pratiksha Ganjave et al.,[1] focused on various algorithms for image processing (SIFT-Scale Invariant Future Transform, FAST- Features from Accelerated Segment Test, ORB- Oriented Fast and Rotated Brief, and SURF- Speeded Up Robust Feature) for an image-processing-based currency detection system. In feature extraction and matching, these methods are applied. This particular study concentrates on Indian currency notes. The algorithms have been studied, and it has been discovered that each algorithm has benefits and drawbacks.

To address the issue of visually challenged persons being able to recognize notes, Srushti Samant et al.,[2] created a system wherein cash recognition is achievable by employing several image processing techniques.

To assist blind people in their daily lives, Snehal Saraf et al.,[3] proposed a mobile app for currency recognition that can recognize Indian currency form solving blind people's difficult problems. Regional audio is the output format for this project. The SIFT algorithm outperforms the current HOG in terms of performance and recall. Compared to other algorithms, the SIFT algorithm is reasonably efficient.

Shweta Yadav et al.,[4] developed a solution to help blind people in their daily life, solve problems faced by blind users, and created a smart cash app for Indian rupee detection. YoloV3 has a superior recall value and performance.

Venkata Sai Teja et al.,[5] proposed a system that would allow a visually impaired person to know the accuracy of the results shown when using the proof. When my MATLAB method is executed with a scanner or camera on a Raspberry Pi, it will capture the paper currency and process the image as defined in the project to determine the true and false HSV values of the currency, which in front gives the ability to a person with disabilities to detect it.

CHAPTER 3
METHODOLOGY

Mostly the methods of currency recognition are hardware methods, so to make it more feasible for people, having a software system will be beneficial. A software solution includes a camera that can be activated by voice command and does not require user input once activated.

Some constraints for image identification are Fluorescence, Intaglio, Serial number, and Reserve Bank of India logo.

The following figure depicts the proposed system:

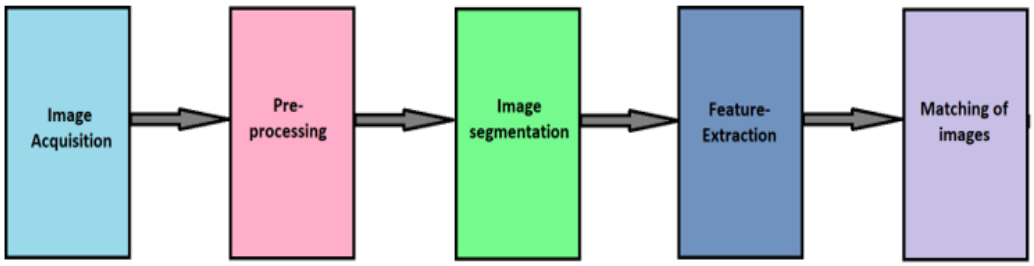


Figure 1. Conceptual Model Architecture Diagram

The methodology proposed in this paper consists of the following steps:

1)Image Acquisition

2)Pre-processing

3)Image segmentation

4)Feature Extraction

5)Matching of images

Image acquisition:

Image acquisition is the process of capturing images using a camera or other imaging device. In the case of currency detection, the image acquisition process would involve taking a picture of a piece of currency using a camera or a smartphone camera. The camera should be positioned directly over the currency to minimize distortion and ensure that the image is as clear as possible.

It's important to ensure that the lighting conditions are optimal for capturing high-quality images of currency. Adequate lighting can help to minimize shadows, glare, and other distortions that can affect the accuracy of currency detection. To achieve this, a well-lit area with consistent lighting conditions is recommended.

In addition to lighting, the camera settings should be optimized for capturing high-quality images. This might include adjusting the focus, exposure, and other settings to ensure that the image is clear and detailed.

Once the image has been captured, it can be used as input for the pre-processing, segmentation, feature extraction, and matching steps of the currency detection process. These steps involve various algorithms and techniques to analyze the image and extract relevant features, such as color, texture, and shape, that can be used to identify the currency.

Pre-processing:

Pre-processing is a crucial step in any computer vision application, including currency detection. The purpose of pre-processing is to enhance the quality of the input image by removing any noise or distortions that may affect the accuracy of the detection algorithm. Here are some common pre-processing techniques used in currency detection:

1.Image resizing: This involves resizing the input image to a specific size to ensure consistency across all images. This also reduces the computational load required for subsequent image processing steps.

2.Image normalization: This involves adjusting the contrast and brightness of the input image to improve its overall quality. This can be done using techniques such as histogram equalization, where the image's intensity distribution is stretched to cover the full range of pixel values.

3.Noise reduction: Images acquired from real-world environments can often contain noise and other

artifacts that can interfere with currency detection. Techniques such as Gaussian smoothing and median filtering can be used to reduce these artifacts.

4.Edge detection: This involves identifying the edges of objects in the image, which is useful for detecting the edges of currency notes. Common edge detection techniques include Canny edge detection and Sobel edge detection.

5.Color conversion: In currency detection, it is important to distinguish between different types of currency notes based on their color. Color conversion techniques such as RGB to grayscale or RGB to HSV can be used to extract color information from the input image.

Overall, pre-processing plays a critical role in currency detection by improving the quality of the input image and preparing it for subsequent processing steps

Image Segmentation:

Image segmentation is the process of dividing an image into multiple segments or regions, each of which correspond to a different object or part of the image. In the case of currency detection, the objective of image segmentation is to identify the regions in the image that contain the currency note, and separate them from the background and any other irrelevant objects.

The following steps can be used for image segmentation in currency detection:

1.Thresholding: The first step is to convert the input image to grayscale and apply thresholding to obtain a binary image where the currency note is in white and the background is in black.

2.Morphological operations: Morphological operations such as erosion and dilation can be applied to the binary image to remove noise and fill gaps in the currency note region.

3.Contour detection: Contours can be detected in the binary image using edge detection algorithms like Canny edge detection. These contours can be used to identify the boundary of the currency note region.

4.Contour filtering: Contours that do not correspond to the currency note can be filtered out based on their size and shape.

5.Bounding box: A bounding box can be created around the remaining contour to mark the location and size of the currency note region in the image.

By performing these steps, the currency note region can be identified and separated from the background

in the input image, which can be further processed for feature extraction and matching to identify the currency denomination.

Feature Extraction:

Features are special properties that describe the image. Extract features to distinguish images.
Images are made up of pixels. So, in feature extraction, we find which parts of the image are special, suc h as lines, corners, and special patches, which can uniquely identify the image. Feature extraction helps r educe the amount of redundant information in a dataset.
The ORB (Oriented FAST and Rotated BRIEF) algorithm is a good example of feature detection.

Feature extraction is the process of selecting and extracting specific information from an image that is relevant for a particular task. In the case of currency detection, this involves identifying and extracting features that are unique to each denomination of currency, such as the size, shape, color, and texture of the banknotes.

One common approach to feature extraction in currency detection is to use image processing techniques such as edge detection, corner detection, and blob analysis to identify the boundaries and key features of the banknotes. For example, edge detection can be used to extract the outline of the banknote, while corner detection can identify the corners and edges of the banknote that are unique to each denomination.

Another approach to feature extraction is to use machine learning algorithms such as deep neural networks to automatically learn and extract relevant features from the images.

This approach can be particularly effective for detecting subtle differences between banknotes that may be difficult to identify using traditional image processing techniques.Overall, the goal of feature extraction in currency detection is to extract a set of features that are unique to each denomination of currency and can be used to accurately classify and identify the banknotes.

Based on the parameters mentioned, the feature extraction process for currency detection can involve the following steps:

1) Currency value area:

In this step, the value of the currency note is extracted by identifying the area where the value is printed on the note. This can be done by using image processing techniques such as edge detection, contour detection, and template matching.

2) Reserve Bank of India logo:

The Reserve Bank of India logo is an important feature that helps in identifying the authenticity of the currency note. The logo can be extracted by using image segmentation techniques such as thresholding, edge detection, and region growing.

3) Security Thread:

Security threads are embedded in currency notes as a security feature to prevent counterfeiting. The thread can be extracted by using image segmentation techniques such as thresholding and morphological operations.

4) Serial number:

The serial number is a unique identifier that is printed on each currency note. It can be extracted by using OCR (optical character recognition) techniques that can recognize the text in the image.

5) Mahatma Gandhi logo:

The Mahatma Gandhi logo is a watermark that is printed on the currency note. It can be extracted by using image processing techniques such as edge detection, thresholding, and region growing.

6) Satyamev Jayate logo:

The Satyamev Jayate logo is another watermark that is printed on the currency note. It can be extracted by using image processing techniques such as edge detection, thresholding, and region growing.

Once all these features are extracted, they can be used for matching the images of the currency notes. This can be done by using machine learning algorithms such as Support Vector Machines (SVM), Random Forest, and Convolutional Neural Networks (CNN). These algorithms can be trained on a dataset of authentic currency note images to learn the features and patterns that are specific to each note.

Once trained, the algorithm can be used to match the features of a new currency note image with those in the dataset and determine whether it is authentic or counterfeit.

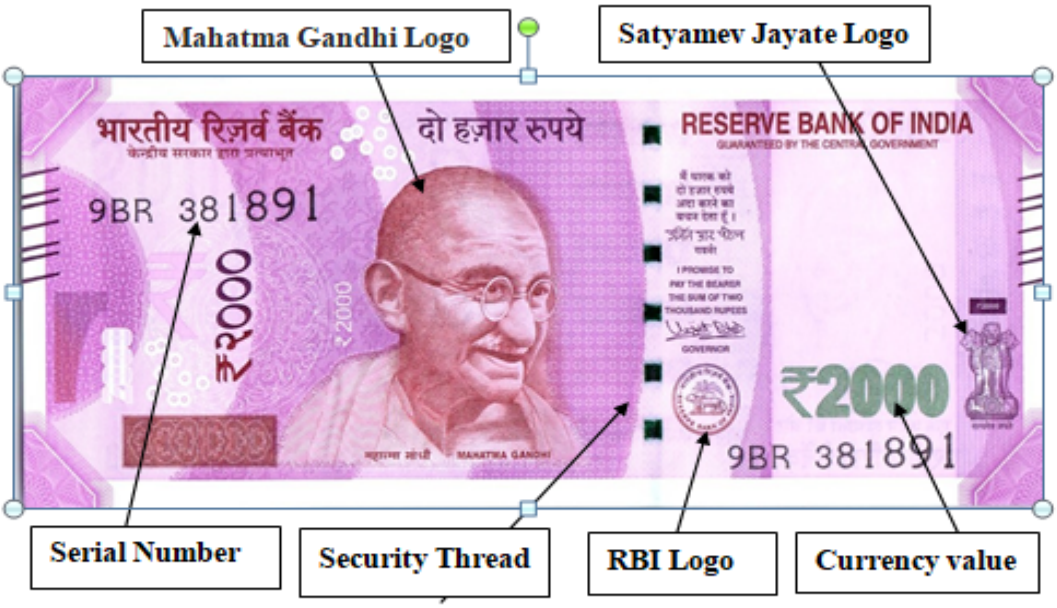


FIGURE 2. DIFFERENT FEATURES OF INDIAN CURRENCY NOTE

Matching of images:

Matching of images is the final step in the proposed methodology for currency detection. This step involves comparing the features extracted from the query image with the features extracted from the reference images of known currency notes. The similarity score between the query image and the reference images is calculated using a matching algorithm, and the currency note with the highest similarity score is identified as the result.

There are several matching algorithms that can be used for this task, such as Euclidean distance, correlation coefficient, and normalized cross-correlation. The choice of the matching algorithm depends on the type of features extracted and the characteristics of the images.

One common approach for matching images is to use a nearest neighbor search, where the query image is compared to a database of reference images, and the image with the closest feature vector is selected as the match. Another approach is to use machine learning techniques such as support vector machines or neural networks to learn a mapping between the feature space and the class labels (currency notes).

Matching of images is the final step in the proposed methodology for currency detection. This step involves comparing the features extracted from the query image with the features extracted from the reference images of known currency notes. The similarity score between the query image and the reference images is calculated using a matching algorithm, and the currency note with the highest similarity score is identified as the result.

There are several matching algorithms that can be used for this task, such as Euclidean distance, correlation coefficient, and normalized cross-correlation. The choice of the matching algorithm depends on the type of features extracted and the characteristics of the images.

One common approach for matching images is to use a nearest neighbor search, where the query image is compared to a database of reference images, and the image with the closest feature vector is selected as the match. Another approach is to use machine learning techniques such as support vector machines or neural networks to learn a mapping between the feature space and the class labels (currencynotes).During this matching, the best value that matches the data tells it to match the currency. I t also provides audio information for visually impaired people.

Proposed System:

The methods that can be used to detect currency notes are generally non-public hardware systems.

The novelty of the system is that it is cheap and easy to use for blind people in India. For the visually impaired, the app should be easy to use. It will have a camera that will be activated by voice command and will not require user input when activated. In short, the challenge requires new cost-effective, robust, and efficient models in many areas. Newer systems with better GUIs may well meet these needs. Authentication results are quite easy to use, as shown in Figure 3, with the Android app open, tap the screen to open the camera. After opening the mobile phone's camera, the user can tap anywhere on the screen to take a picture. The application system will be designed to detect different notes of 10, 20, 50, 100, 200, 500, and 2000 rupees. The app will provide audio output of the results. The system only outputs satisfactory results that match the original results and displays results instantly and accurately.

Here are some additional details that could be added to the proposed system:

1) The app could have a user-friendly interface with clear audio instructions and feedback to help visually impaired users navigate the app and understand the results.
2) The app could also have a feature that allows users to save and organize their currency detection results for future reference.
3) To enhance the accuracy of the currency detection, the system could use machine learning algorithms such as convolutional neural networks (CNN) for feature extraction and classification.
4) The system could also include a database of images of genuine currency notes to use as a reference for comparison, and perform image analysis and processing techniques such as edge detection and image enhancement to improve the accuracy of the results.
5) The app could be designed to work offline, without requiring an internet connection, to ensure that it can be used in areas with limited connectivity.
6) To ensure the security and authenticity of the results, the app could use encryption and authentication protocols to protect user data and prevent fraud or misuse.

Figure 3. Currency Recognition System Android Application

System Flowchart:

In the flowchart of the system, the first target user captures images. In this case, there are two major decisions that the system must make to work. The first is to check if the photo taken by the user is free of noise and if there are unique features in the photo that identifies the note. Otherwise, the user will receive an error message of sound type. This flowchart is a physical tool that summarizes the activities to be performed in the currency recognition system.

After the user takes a picture, the image goes through a pre-processing step to enhance the image quality and remove any noise present in the image. Then, the image is segmented into different regions based on the parameters that were previously identified as important for currency detection, such as the currency value area, Reserve Bank of India logo, security thread, serial number, Mahatma Gandhi logo, and Satyamev Jayate logo.

Next, feature extraction techniques are applied to the segmented regions to extract relevant information, such as the color, texture, shape, and size of the regions. The extracted features are then compared to a pre-defined set of features for different denominations of Indian currency notes using image matching algorithms, such as template matching or feature matching.

If the extracted features match with any of the pre-defined features, the system will provide an audio output to inform the user about the denomination of the currency note. If there is no match, the user will receive an error message of sound type.

Overall, the system flowchart outlines the step-by-step process of how the currency recognition system works and how it helps visually impaired individuals identify different denominations of Indian currency notes.

The flowchart of the currency recognition system is given below:

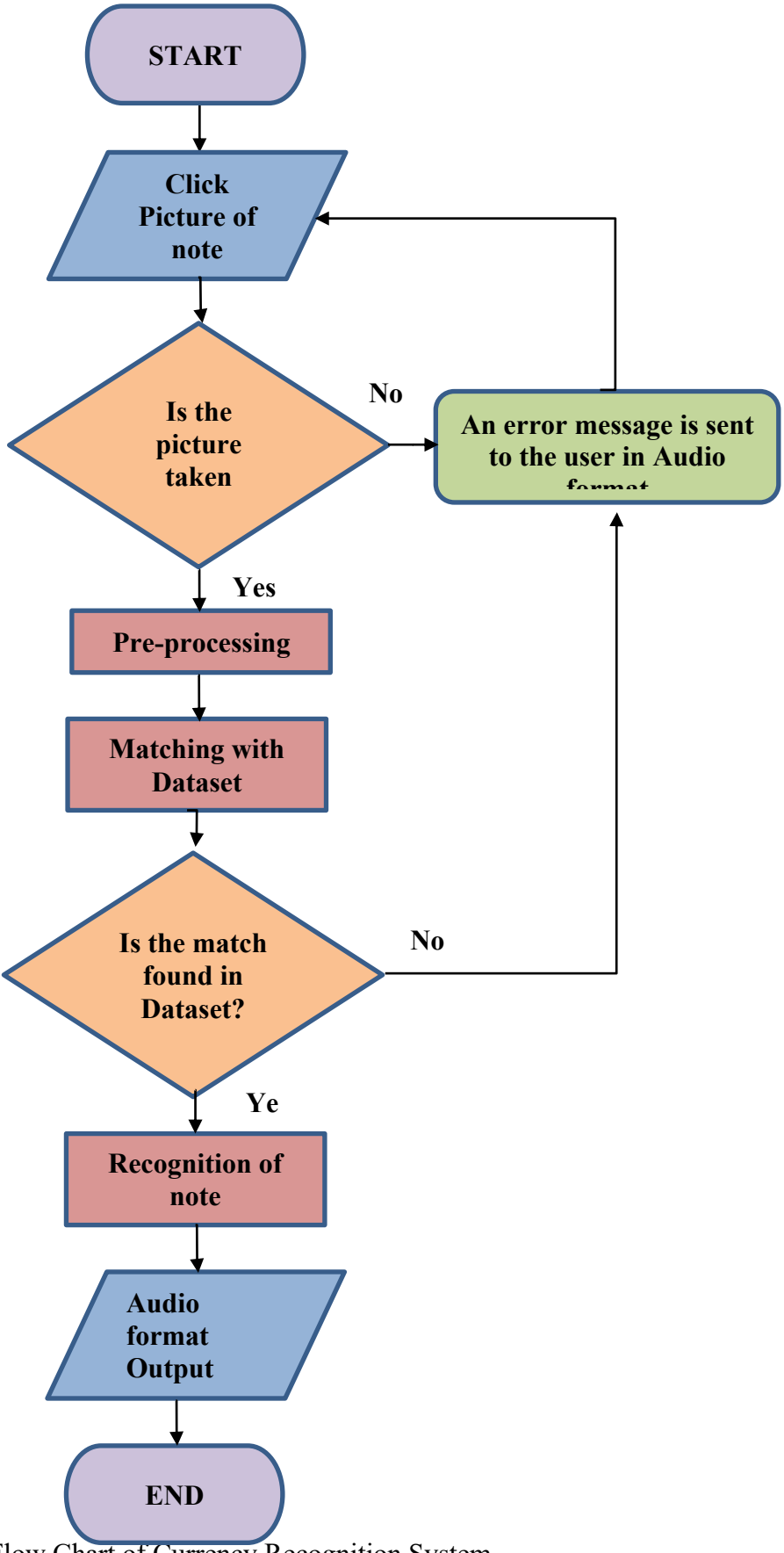


Fig.4 Flow Chart of Currency Recognition System

Figure 4. System Flowchart for currency recognition

CHAPTER 4
WORKING OF SYSTEM

4.1 SYSTEM ARCHITECTURE

The currency recognition system is designed to detect different denominations of Indian currency notes using image processing and machine learning algorithms. The first step in the system architecture is to capture images of the currency notes using a camera. The captured images are then processed using image processing techniques to extract important features such as the currency value area, Reserve Bank of India logo, security thread, serial number, Mahatma Gandhi logo, and Satyamev Jayate logo. These features are then used for classification of the currency notes.

In the next step, the preprocessed images are fed into a machine learning model that has been trained on a dataset of different denominations of Indian currency notes. The machine learning model uses a set of processing nodes that represent mathematical operations, with edges representing the multidimensional data (tensors) that communicate between them. The model makes predictions based on the extracted features and outputs the denomination of the currency note.

The proposed system is designed to be cost-effective and user-friendly for visually impaired users. The system is activated using voice commands and requires no user input when activated. The system is designed to provide audio output of the prediction results for easy use by the visually impaired. The accuracy of the system is evaluated based on the performance of different machine learning algorithms such as logistic regression, support vector machine, random forest, and K nearest neighbors. The algorithm with the best accuracy is selected as the model for predicting the denomination of Indian currency notes.

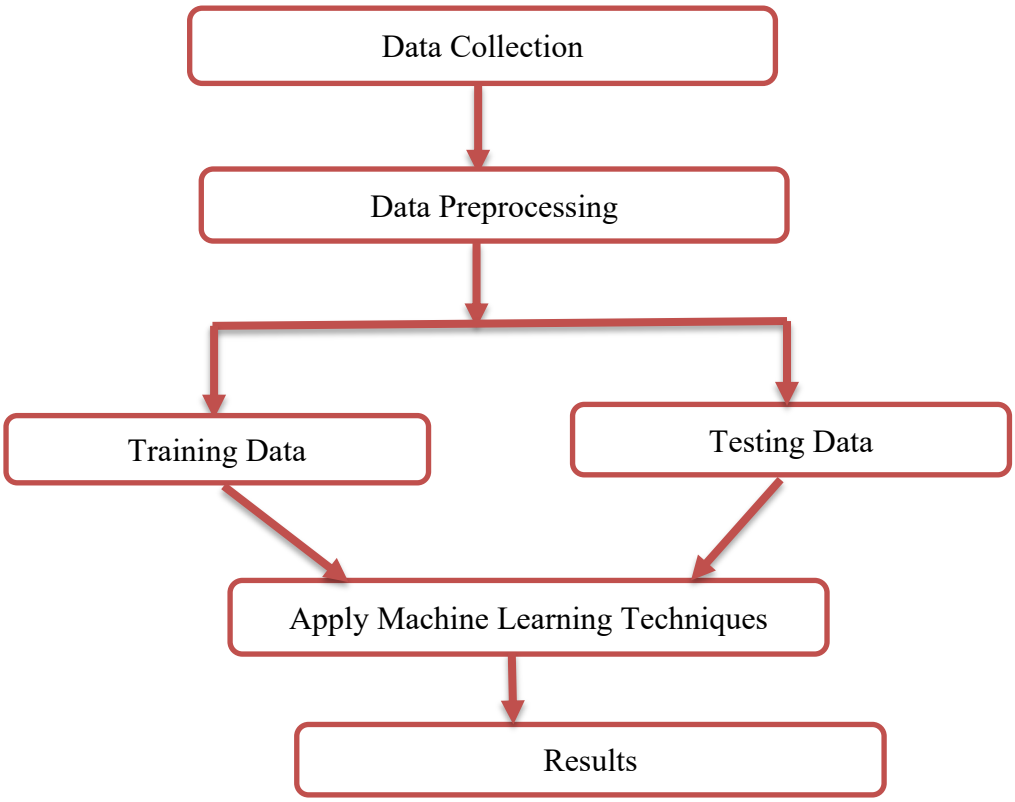


Fig. 5 flowchart of process

4.2 MODEL BUILDING: -

The currency recognition system architecture consists of four major components: input module, image processing module, feature extraction module, and classification module.

Input Module: The input module is responsible for capturing the image of the currency note using a camera or scanner. The captured image is then fed to the image processing module.

Image Processing Module: The image processing module is responsible for preprocessing the captured image to remove noise, correct orientation, and adjust lighting conditions. This module enhances the quality of the image to make it suitable for further processing.

Feature Extraction Module: The feature extraction module extracts relevant features from the preprocessed image. The extracted features are used to identify the currency note. Feature extraction algorithms used in the system

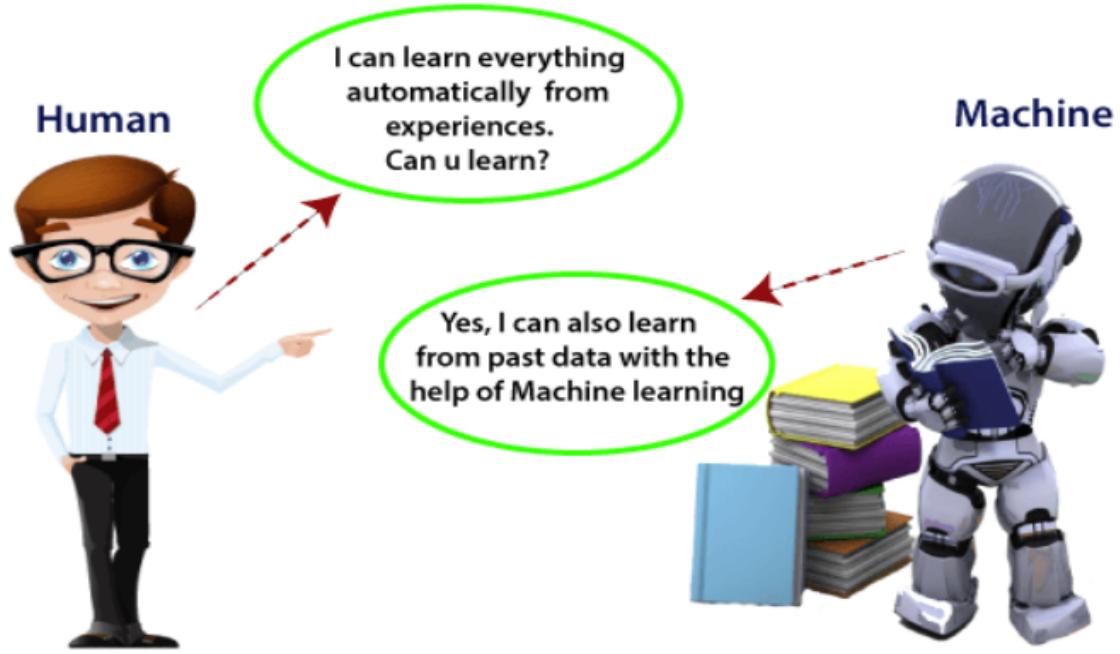
include Histogram of Oriented Gradients (HOG), Local Binary Patterns (LBP), and Scale Invariant Feature Transform (SIFT).

Classification Module: The classification module is responsible for classifying the currency note based on the extracted features. The system uses machine learning algorithms such as Support Vector Machines (SVM), Random Forest, and K-Nearest Neighbors (KNN) to classify the currency note. Once the note is classified, the system provides the denomination of the currency note as output.

Overall, the system architecture includes the four major components working together to recognize the currency note accurately.

4.3 MACHINE LEARNING

In the real world, we are surrounded by humans who can learn everything from their experiences with their learning capability, and we have computers or machines which work on our instructions. But can a machine also learn from experiences or past data like a human does? So here comes the role of **Machine Learning**. Machine Learning is said as a subset of **artificial intelligence** that is mainly concerned with the



development of algorithms which allow a computer to learn from the data and past experiences on their own. The term machine learning was first introduced by **Arthur Samuel** in **1959**. We can define it in a summarized way as: Machine learning enables a machine to automatically learn from data, improve performance from experiences, and predict things without being explicitly programmed.

With the help of sample historical data, which is known as **training data**, machine learning algorithms build a **mathematical model** that helps in making predictions or decisions without being explicitly programmed. Machine learning brings computer science and statistics together for creating predictive models. Machine learning constructs or uses the algorithms that learn from historical data. The more we will provide the information, the higher will be the performance.

4.4 MACHINE LEARNING ALGORITHMS

We have also use various algorithms in our project to train the model and they are following:

1) K-Nearest Neighbors.
2) Logistic Regression.
3) Random Forest.
4) Support Vector Machine.

4.4. 1 . K-NEAREST NEIGHBORS:

K-Nearest Neighbour is one of the simplest Machine Learning algorithms based on Supervised Learning technique.

K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories. K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm.K-NN algorithm can be used for Regression as well as for Classification but mostly it is used for the Classification problems.

K-NN is a **non-parametric algorithm**, which means it does not make any assumption on underlying data. It is also called a **lazy learner algorithm** because it does not learn from the training set immediately instead it stores the dataset and at the time of classification, it performs an action on the dataset. KNN algorithm at the training phase just stores the dataset and when it gets new data, then it classifies that data into a category that is much similar to the new data.

Example: Suppose, we have an image of a creature that looks similar to cat and dog, but we want to know either it is a cat or dog. So for this identification, we can use the KNN algorithm, as it works on a similarity measure. Our KNN model will find the similar features of the new data set to the cats and dogs images and based on the most similar features it will put it in either cat or dog category.

KNN is also a supervised machine learning algorithm. KNN helps to solve both the classification and

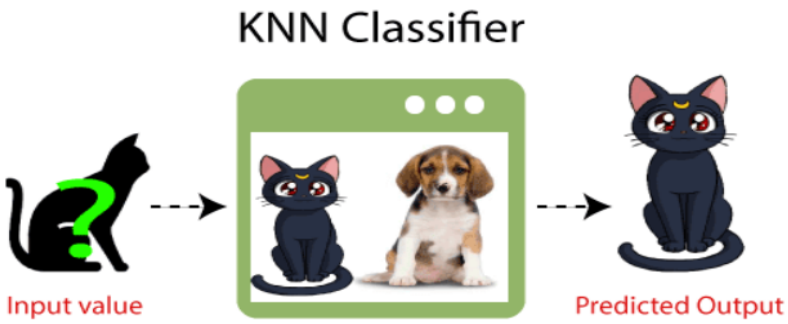


Fig.6 KNN Classifier

$$d(x,\ y)\ =\ \sqrt{\sum_{i=1}^{n}(y_i - x_i)^2}$$

regression problems. KNN is lazy prediction technique. KNN assumes that similar things are near to each other. Many times data points which are similar are very near to each other. KNN helps to group new work based on similarity measure. KNN algorithm record all the records and classify them according to their similarity measure. For finding the distance between the points uses tree like structure. To make a prediction for a new data point, the algorithm finds the closest data points in the training data set — it's nearest neighbors. Here **K**= Number of nearby neighbors, it's always a positive integer. Neighbor's value is chosen from set of class. Closeness is mainly defined in terms of Euclidean distance. The Euclidean distance between two points P and Q i.e. P (p1,p2, …. Pn) and Q (q1, q2,..qn) is defined by the following equation:

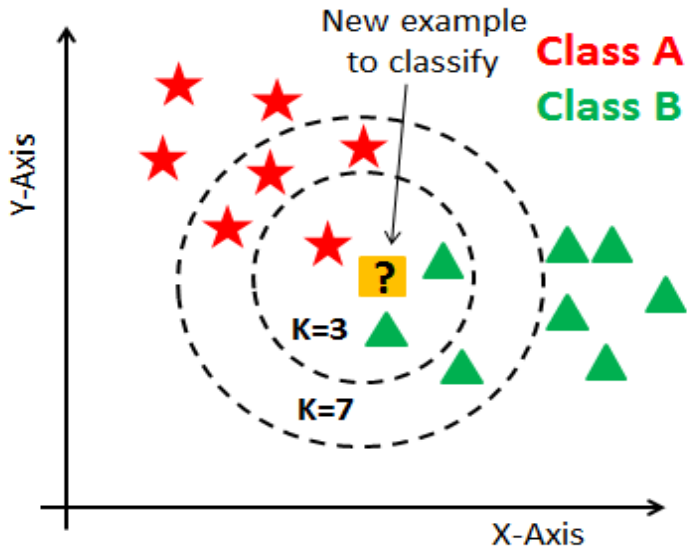


Fig8. KNN Classifier Graph Representation

ALGORITHM :

- Take a sample dataset of columns and rows named as Pima Indian Diabetes data set.
- Take a test dataset of attributes and rows.
- Find the Euclidean distance by the help of formula :-

$$EculideanDistance = \sqrt{\sum_{i=1}^{y}\sum_{j=1}^{m}\sum_{l=1}^{n-1}(R_{(j,l)} - P_{(i,l)})^2}$$

- Then, Decide a random value of K. is the no. of nearest neighbors
- Then with the help of these minimum distance and Euclidean distance find out the nth column of each.
- Find out the same output values.

If the values are same, then the patient is diabetic, otherwise not.

ADVANTAGE OF KNN :

- It is simple to implement.
- It is robust to the noisy training data
- It can be more effective if the training data is large.

4.4.2 .LOGISTIC REGRESSION

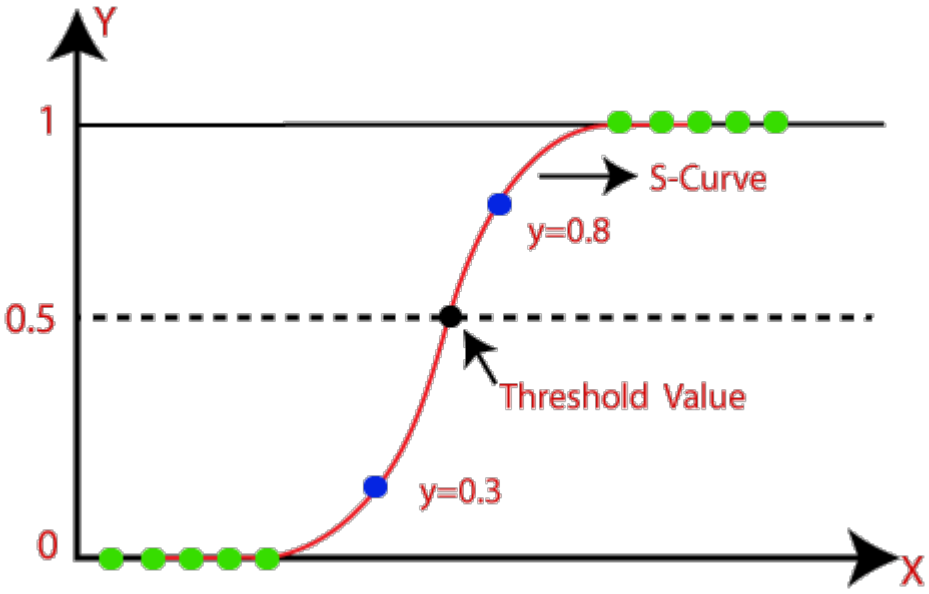
Logistic regression is one of the most popular Machine Learning algorithms, which comes under the Supervised Learning technique. It is used for predicting the categorical dependent variable using a given set of independent variables. Logistic regression predicts the output of a categorical dependent variable. Therefore the outcome must be a categorical or discrete value. It can be either Yes or No, 0 or 1, true or False, etc. but instead of giving the exact value as 0 and 1, **it gives the probabilistic values which lie between 0 and 1**.

Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas **Logistic regression is used for solving the classification problems**.In Logistic regression, instead of fitting a regression line, we fit an "S" shaped logistic function, which predicts two maximum values (0 or 1).The curve from the logistic function indicates the likelihood of something such as whether the cells are cancerous or not, a mouse is obese or not based on its weight, etc.

Logistic Regression is a significant machine learning algorithm because it has the ability to provide probabilities and classify new data using continuous and discrete datasets. Logistic Regression can be used to classify the observations using different types of data and can easily determine the most effective

variables used for the classification. The below image is showing the logistic function:

LR is a type of regression analysis. So, before we delve into logistic regression, let us first introduce the general



concept of regression analysis.

Regression analysis is a type of predictive modeling technique which is used to find the relationship between a dependent variable (usually known as the “Y” variable) and either one independent variable (the “X” variable) or a series of independent variables. When two or more independent variables are used to predict or

explain the outcome of the dependent variable, this is known as multiple regression.

Regression analysis can be used for three things:

1. **Forecasting the effects or impact of specific changes**. For example, if a manufacturing company wants to forecast how many units of a particular product they need to produce in order to meet the current demand.
2. **Forecasting trends and future values.** For example, how much will the stock price of Lufthansa be in 6 months from now?
3. **Determining the strength of different predictors**—or, in other words, assessing how much of an impact the independent variable(s) has on a dependent variable. For example, if a soft drinks company is sponsoring a football match, they might want to determine if the ads being displayed during the match have accounted for any increase in sales.

Regression analysis can be broadly classified into two types: **Linear regression** and **logistic regression**.

In statistics, linear regression is usually used for predictive analysis. It essentially determines the extent to which there is a linear relationship between a dependent variable and one or more independent variables. In terms of output, linear regression will give you a trend line plotted amongst a set of data points. You might use linear regression if you wanted to predict the sales of a company based on the cost spent on online advertisements, or if you wanted to see how the change in the GDP might affect the stock price of a company.

The second type of regression analysis is logistic regression, and that's what we'll be focusing on in this post. Logistic regression is essentially used to calculate (or predict) the probability of a binary (yes/no) event occurring. We'll explain what exactly logistic regression is and how it's used in the next section.

4.4.3.RAMDOM FOREST

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process *of* combining multiple classifiers to solve a complex problem and to improve the performance of the model.

As the name suggests, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead

of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting.

The below diagram explains the working of the Random Forest algorithm:

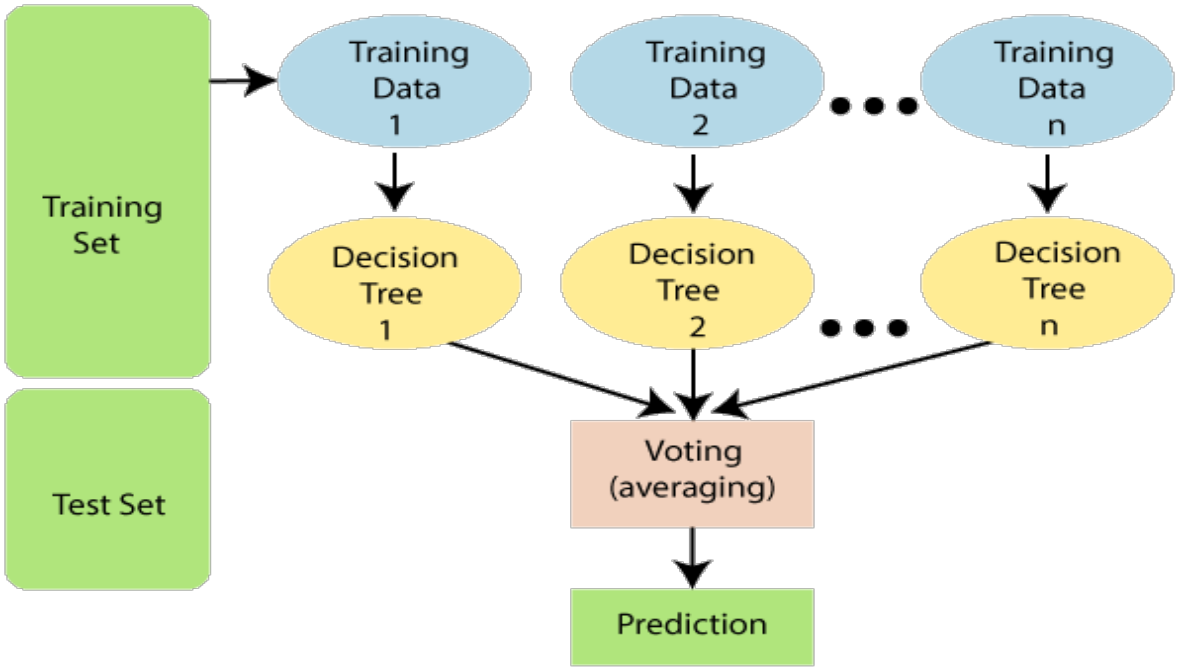


Fig. 9 Random Forest

Below are some points that explain why we should use the Random Forest algorithm:

- It takes less training time as compared to other algorithms.
- It predicts output with high accuracy, even for the large dataset it runs efficiently.
- It can also maintain accuracy when a large proportion of data is missing.

ALGORITHM

Random Forest works in two-phase first is to create the random forest by combining N decision tree, and second is to make predictions for each tree created in the first phase.

Step-1: Select random K data points from the training set.

Step-2: Build the decision trees associated with the selected data points (Subsets).

Step-3: Choose the number N for decision trees that you want to build.

Step-4: Repeat Step 1 & 2.

Step-5: For new data points, find the predictions of each decision tree, and assign the new data points to the category that wins the majority votes.

Random forest is a commonly-used machine learning algorithm trademarked by Leo Breiman and Adele Cutler, which combines the output of multiple decision trees to reach a single result. Its ease of use and flexibility have fueled its adoption, as it handles both classification and regression problems.

Decision trees

Since the random forest model is made up of multiple decision trees, it would be helpful to start by describing the decision tree algorithm briefly. Decision trees start with a basic question, such as, “Should I surf?” From there, you can ask a series of questions to determine an answer, such as, “Is it a long period swell?” or “Is the wind blowing offshore?”. These questions make up the decision nodes in the tree, acting as a means to split the data. Each question helps an individual to arrive at a final decision, which would be denoted by the leaf node. Observations that fit the criteria will follow the “Yes” branch and those that don’t will follow the alternate path. Decision trees seek to find the best split to subset the data, and they are typically trained through the Classification and Regression Tree (CART) algorithm. Metrics, such as Gini impurity, information gain, or mean square error (MSE), can be used to evaluate the quality of the split.

This decision tree is an example of a classification problem, where the class labels are "surf" and "don't surf."

While decision trees are common supervised learning algorithms, they can be prone to problems, such as bias and overfitting. However, when multiple decision trees form an ensemble in the random forest algorithm, they predict more accurate results, particularly when the individual trees are uncorrelated with each other.

Ensemble methods

Ensemble learning methods are made up of a set of classifiers—e.g. decision trees—and their predictions are aggregated to identify the most popular result. The most well-known ensemble methods are bagging, also known as bootstrap aggregation, and boosting. In 1996, Leo Breiman (link resides outside ibm.com) (PDF, 810 KB) introduced the bagging method; in this method, a random sample of data in a training set is selected with replacement—meaning that the individual data points can be chosen more than once. After several data samples are generated, these models are then trained independently, and depending on the type of task—i.e. regression or classification—the average or majority of those predictions yield a more accurate estimate. This approach is commonly used to reduce variance within a noisy dataset.

4.4.4 SUPPORT VECTOR MACHINE

A **support vector machine** is a supervised learning algorithm that sorts data into two categories. It is trained with a series of data already classified into two categories, building the model as it is initially trained. The task of an SVM algorithm is to determine which category a new data point belongs in. This makes SVM a kind of non-binary linear classifier.

An SVM algorithm should not only place objects into categories, but have the margins between them on a graph as wide as possible.

Some applications of SVM include:

- Text and hypertext classification
- Image classification
- Recognizing handwritten characters
- Biological sciences, including protein classification

It is a supervised machine learning problem where we try to find a hyperplane that best separates the two classes. **Note:** Don't get confused between SVM and logistic regression. Both the algorithms try to find the best hyperplane, but the main difference is logistic regression is a probabilistic approach whereas support vector machine is based on statistical approaches.

Now the question is which hyperplane does it select? There can be an infinite number of hyperplanes passing through a point and classifying the two classes perfectly. So, which one is the best?

Well, SVM does this by finding the maximum margin between the hyperplanes that means maximum distances between the two classes.

TYPES OF SUPPORT VECTOR MACHINE

Linear SVM

When the data is perfectly linearly separable only then we can use Linear SVM. Perfectly linearly separable means that the data points can be classified into 2 classes by using a single straight line(if 2D).

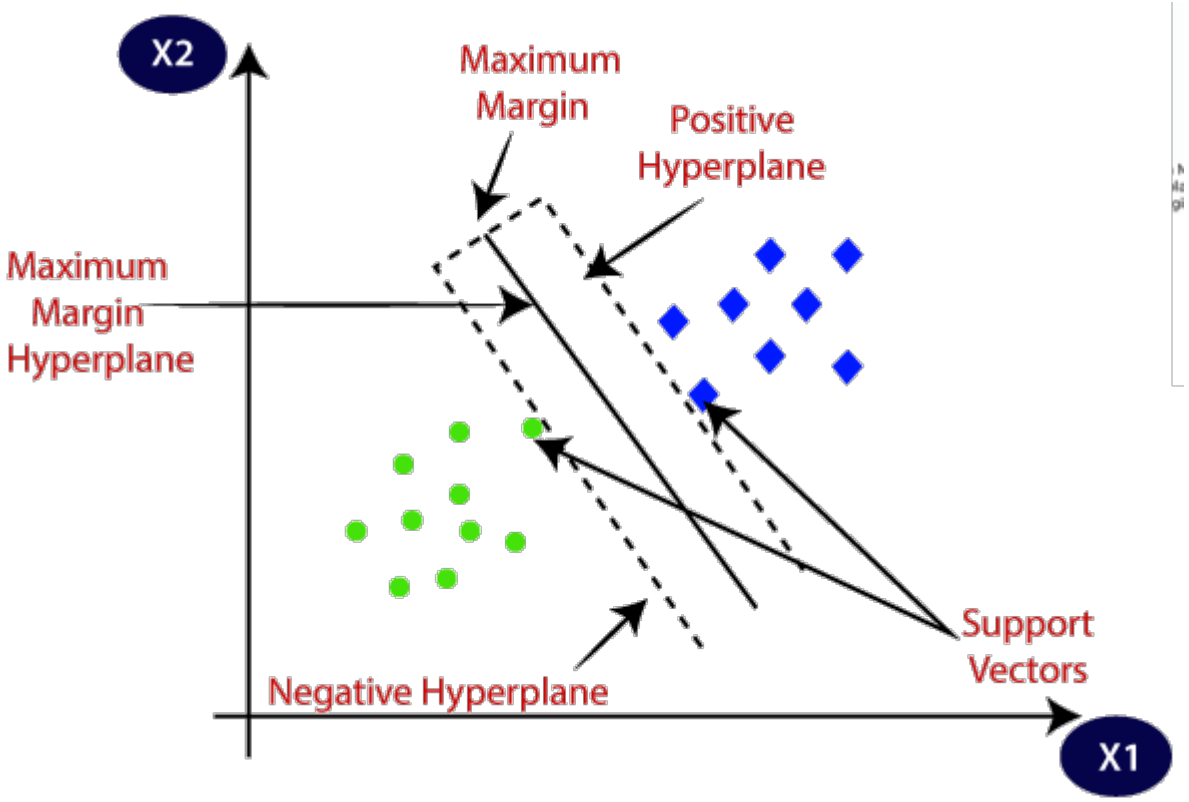
Non-Linear SVM

When the data is not linearly separable then we can use Non-Linear SVM, which means when the data points cannot be separated into 2 classes by using a straight line (if 2D) then we use some advanced techniques like kernel tricks to classify them. In most real-world applications we do not find linearly separable datapoints hence we use kernel trick to solve them.

Now let's define two main terms which will be repeated again and again in this article:

Support Vectors: These are the points that are closest to the hyperplane. A separating line will be defined with the help of these data points.

Margin: it is the distance between the hyperplane and the observations closest to the hyperplane (support vectors). In SVM large margin is considered a good margin. There are two types of margins **hard margin** and **soft margin.** I will talk more about these two in the later section.



4.5 DEEP LEARNING ALGORITHMS

Deep learning is a subset of machine learning that involves the use of artificial neural networks with multiple layers to model and learn from data. The key difference between deep learning and traditional machine learning is the use of multiple layers of non-linear processing units in deep learning algorithms, allowing them to learn complex and hierarchical representations of data.

Deep learning algorithms have been widely successful in a variety of domains, including computer vision, natural language processing, speech recognition, and robotics. They have been used to achieve state-of-the-art performance on a range of tasks such as image classification, object detection, speech recognition, machine translation, and game playing.

Some of the most popular deep learning architectures include Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Generative Adversarial Networks (GANs).

These architectures have been used to solve a range of problems, from image and speech recognition to natural language processing and autonomous driving.

One of the key advantages of deep learning is that it can automatically learn relevant features and representations from raw data, without the need for manual feature engineering. This makes it a powerful tool for processing large amounts of complex data, and has enabled breakthroughs in many fields.

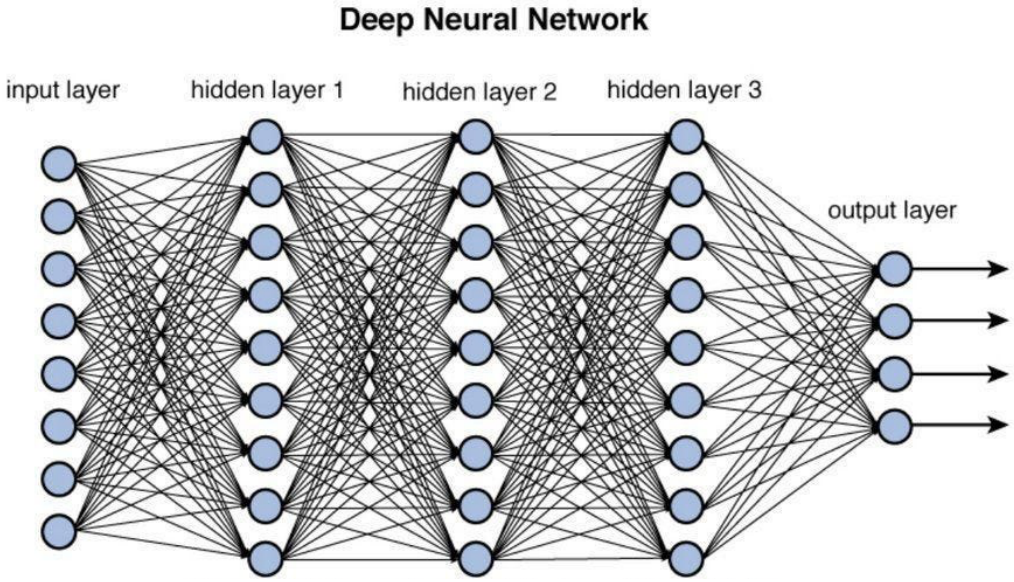


Fig. 10 Deep Neural Network

We have also use various algorithms in our project to train the model and they are following:

1) Convolutional neural network:
2) Recurrent neural network

4.5.1 Convolutional neural network:

Convolutional Neural Networks (CNNs) are a type of deep learning algorithm that are particularly well-suited for image and video processing tasks, but can also be used for other types of data such as audio and text. CNNs use a multi-layer architecture that is specifically designed to process and analyze visual data.

The key innovation of CNNs is the use of convolutional layers, which are specialized layers that learn to detect and extract local features from input images. These convolutional layers are followed by pooling layers, which aggregate and downsample the output of the convolutional layers, reducing the spatial size of the input and improving computational efficiency. The resulting feature maps are then flattened and fed into one or more fully

connected layers, which perform high-level feature extraction and classification.

CNNs have achieved state-of-the-art performance on a wide range of image and video processing tasks, including image classification, object detection, semantic segmentation, and image captioning. They have also been used for speech recognition, natural language processing, and other types of data analysis tasks.

Some popular CNN architectures include AlexNet, VGG, ResNet, and Inception, which have achieved groundbreaking results on various computer vision tasks.

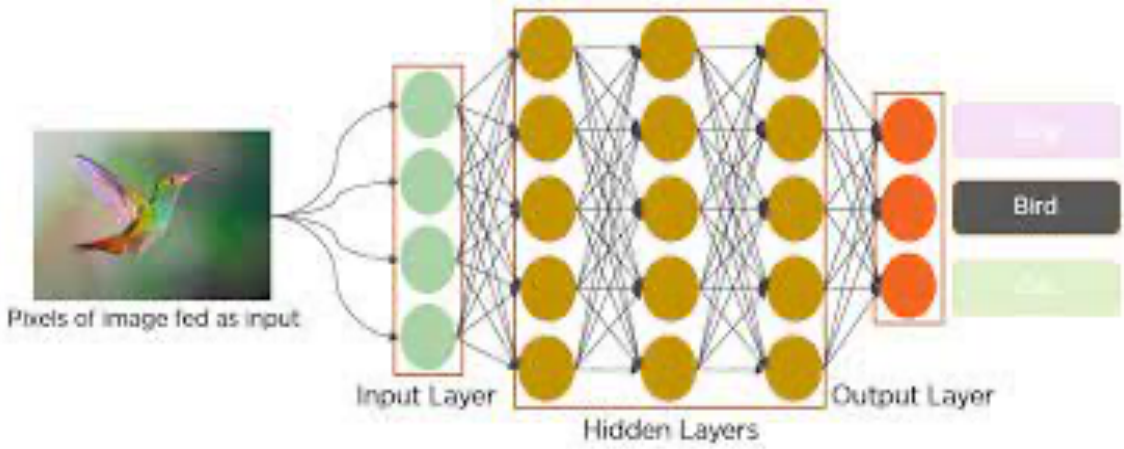


Fig. 11 Convolutional Neural Network

4.5.2 Recurrent neural network:

Recurrent Neural Networks (RNNs) are a type of neural network that are particularly well-suited for sequence data, such as text, speech, and time series data. RNNs are designed to process sequential inputs of variable length, and they are able to capture the temporal dependencies and context in the input data.

The key innovation of RNNs is the use of recurrent connections, which allow information to be passed from one time step to the next. This means that the hidden state of the network can encode the context and history of the input sequence, which makes RNNs well-suited for tasks such as language modeling, speech recognition, and machine translation.

One limitation of basic RNNs is that they can suffer from the vanishing gradient problem, which occurs when the gradients used to update the weights during training become too small to be useful. To address this issue, various RNN variants have been proposed, including Long Short-Term Memory (LSTM) and Gated Recurrent Units

(GRU), which use specialized gating mechanisms to control the flow of information through the network and avoid the vanishing gradient problem.

RNNs have achieved state-of-the-art performance on a wide range of sequence modeling tasks, including natural language processing, speech recognition, and time series forecasting. They are also used in combination with other types of neural networks, such as Convolutional Neural Networks (CNNs) and Transformers, to process complex inputs with multiple modalities.

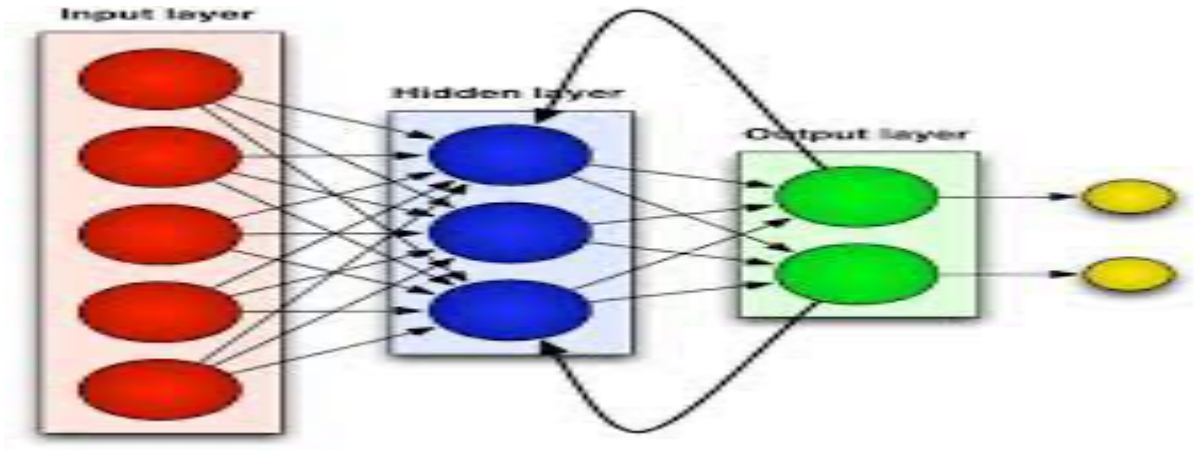


Fig. 11 Recurrent Neural Network

4.6 ALGORITHM

Working with TensorFlow:

TensorFlow is a powerful framework that works using a set of processing nodes, each representing a mathematical operation, the entire series of nodes called "graphs". TensorFlow is a software library for computing in graphics systems, where: The nodes in the graph represent mathematical operations. The edges in the diagram represent multidimensional data (called tensors) communicating between them.

TensorFlow is an open-source machine learning framework developed by Google. It was first released in 2015 and has since become one of the most popular deep learning frameworks in use today. TensorFlow is designed to allow developers to build and deploy machine learning models quickly and easily, using a wide range of high-level APIs and tools.

The core of TensorFlow is its computational graph engine, which allows users to define and execute complex mathematical operations on multi-dimensional arrays called tensors. The graph engine is highly optimized, and can efficiently distribute computations across multiple CPUs or GPUs for faster training and inference.

One of the key advantages of TensorFlow is its flexibility and scalability. TensorFlow can be used for a wide range of machine learning tasks, including deep learning, reinforcement learning, and probabilistic programming. It supports a variety of programming languages, including Python, C++, and Java, and can be used on a wide range of platforms, including desktop computers, mobile devices, and cloud servers.

TensorFlow also includes a number of high-level APIs and tools that make it easier to build and deploy machine learning models. These include:

Keras: a high-level API for building and training neural networks.
TensorFlow Hub: a repository of pre-trained machine learning models and modules that can be easily integrated into new projects.
TensorFlow Lite: a lightweight version of TensorFlow designed for mobile and embedded devices.
TensorFlow.js: a JavaScript library for building and deploying machine learning models in web browsers.

TensorFlow has been used to build a wide range of machine learning applications, including image and speech recognition, natural language processing, autonomous driving, and robotics. It has also been used in research to achieve state-of-the-art results on a number of benchmark tasks.

Algorithm Steps:

Step 1 - Collect the pictures.

A large number of images should be collected so that the comparison is easier, and the system becomes more precise. In the case of analyzing the results, several clusters of 5, 10, 20, 50, 100, 200, 500, and 2000 are captured at different angles in different lighting to get superior results. With these, dataset decision images should be created, and this dataset should be fast.

Step 2 - Train the model to learn from the images.

When enough images have been collected, the next step is to train the model. A Docker container can be used to get a TensorFlow installation. This process will take few minutes depending on the number of images available and the number of training steps specified.

Step 3 - Optimizing Model.

This model is now available. To use the training model on a mobile device, it must be optimized using a tool called inference optimization, removing all unnecessary nodes and other optimizations.

Step 4 - Import the model into the Android app.

The optimized model will now be included in the app. Once the Android app is ready, it can be effectively used to identify Indian currency notes.

Step 5 - Test the training model in the created application.

Install the build package (APK) on the user's mobile phone. Check out how it works on paper currency in different situations. This step is necessary as it helps measure usability. If problems are found with these steps, they should be corrected by reviewing or adding training materials for better results.

CHAPTER 5
ANALYSIS

5.1 SYSTEM CONFIGURATION

- Hardware requirements: Processer : Any Update Processer
- Ram : Min 4GB Hard Disk : Min 100GB
- Software requirements: Operating System
- Windows family Technology : Java
- IDE : Jupiter notebook

Sample Code:-

5.2 DATASET DETAILS

This Dataset contains 1050 images of 7 categories of Indian Currency Notes, this data is collected from Phone camera.

This Dataset looks forward, as a Image Classification Data, which contains 7 Distinct types of Indian Currency Notes, the images are not reduced to any single size, they may have different proportions.

These Distinct Types of Indian Currency can be Classified as:
1)Ten Rupee Notes
2)Twenty Rupee Notes
3)Fifty Rupee Notes
4)Hundred Rupee Notes
5)Two Hundred Rupee Notes
6)Five Hundred Rupee Notes, and,
7)Two Thousand Rupee Notes.

Figure: Dataset Attributes

Dataset Size	Time Required for Dataset Preprocessing (in seconds)	Time required for matching (in seconds)
20	0.61	3.02
40	1.13	5.27
60	1.72	7.02
80	2.10	9.21

Table 1. Time required for dataset preprocessing and currency matching.

Input dataset attributes :

- Denomination: This attribute would indicate the denomination of the currency note, such as 10, 20, 50, 100, 500, or 2000 rupees.
- Front Image: This attribute would provide the image of the front side of the currency note. This image could be used to recognize the denomination of the note.
- Back Image: This attribute would provide the image of the back side of the currency note. This image could be used to recognize the denomination of the note.
- Serial Number: This attribute would indicate the serial number of the currency note, which could be used for tracking and accounting purposes.
- Watermark: This attribute would indicate the presence and location of any watermarks on the currency note, which could be used to verify its authenticity.
- Security Thread: This attribute would indicate the presence and location of any security threads embedded in the currency note, which could be used to verify its authenticity.
- Microprint: This attribute would indicate the presence and location of any microprint on the currency note, which could be used to verify its authenticity.
- Dimension: This attribute would indicate the dimensions of the currency note, which could be used to differentiate it from other denominations.
- Color: This attribute would indicate the primary color of the currency note, which could also be used to differentiate it from other denominations.

- Background: This attribute would indicate the color and design of the background of the currency note, which could also be used to differentiate it from other denominations.

5.3PERFORMANCE ANALYSIS

In this project, various machine learning algorithms like SVM, Decision Tree, Random Forest, and K-Nearest Neighbors (KNN) were used to recognize currency notes from images. The dataset consisted of images of different Indian currency notes, and the algorithms were trained to recognize the denomination of each note.

The input dataset attributes for the currency recognition system included:

Image: The image of the currency note.
Denomination: The denomination of the currency note.
The accuracy for individual algorithms was measured, and the algorithm with the best accuracy was selected for currency recognition. For evaluating the experiment, various evaluation metrics like accuracy, confusion matrix, precision, recall, and f1-score were considered.

Accuracy: Accuracy is the ratio of the number of correct predictions to the total number of inputs in the dataset. It is expressed as:

Accuracy = (TP + TN) / (TP + FP + FN + TN)

Confusion Matrix: It gives us a matrix as output and gives the total performance of the system. The confusion matrix for the currency recognition system is as follows:

Predicted Positive	Predicted Negative	
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

Precision: Precision is the ratio of true positive predictions to the total number of positive predictions. It is expressed as:

Precision = TP / (TP + FP)

Recall: Recall is the ratio of true positive predictions to the total number of actual positive cases. It is expressed as:

Recall = TP / (TP + FN)

F1-Score: F1-score is the harmonic mean of precision and recall. It is expressed as:

F1-Score = 2 * ((Precision * Recall) / (Precision + Recall))

The evaluation metrics were calculated for each algorithm, and the algorithm with the highest accuracy was selected for currency recognition.

Chapter 6

DESIGN AND IMPLEMENTATION

Design goal:

Design is a meaningful engineering representation of something that is to be built. It can be traced to a customer's requirements and at the same time assessed for quality against a set of predefined criteria for ―good design. In the software engineering context, design focuses on four major areas of concern: data, architecture, interfaces, and components. The design process translate requirement into representation of software that can be accessed for a quality before core generation. Design is the process through which requirement are translated to blue print for constructing into software. Initially the blueprint depicts the holistic view of software. This is the design represented at the high level of abstraction. During various stages of system development and design following goals have been setup for a complete architecture.

- Analysis
- Design
- Development
- Testing
- Implementation

Design Strategy:

System design is the process of planning a new system or to replace the existing system. Simply, system design is like the blueprint for building, it specifies all the features that are to be in the finished product. System design phase follows system analysis phase. Design is concerned with identifying functions, data streams among those functions, maintaining a record of the design decisions and providing a blueprint for the implementation phase. Design is the bridge between system analysis and system implementation. Some of the essential fundamental concepts involved in the design of application software are:

ABSTRACTION

Abstraction is used to construct solutions to problems without having to take account of the intricate details of the various component sub problems. Abstraction allows system designers to make stepwise refinement, which at each stage of design may hide unnecessary details associated with representation or implementation from the surrounding environment.

MODULARITY

Modularity is concerned with decomposing the main module into well-defined manageable units with well-defined interfaces among the units. This enhances design clarity, which in turn eases implementation, Debugging, Testing, Documenting and Maintenance of the software product. Modularity viewed in this sense is a vital tool in the construction of large software projects.

VERIFICATION

Verification is a fundamental concept in software design. A design is verifiable if it can be demonstrated that the design will result in implementation that satisfies the customer's requirements. Verification is of two types namely.

Verification that the software requirements analysis satisfies the customer's needs.

Verification that the design satisfies the requirement analysis.

Some of the important factors of quality that are to be considered in the design of application software are:

Reliability:

The software should behave strictly according to the original specification and should function smoothly under normal conditions.

Extensibility:

The software should be capable of adapting easily to changes in the specification.

Reusability:

The software should be developed using a modular approach, which permits modules to be reused by other applications, if possible.

The System Design briefly describes the concept of system design and it contains four sections. The first section briefly describes the features that the system is going to provide to the user and the outputs that the proposed system is going to offer.

The second section namely Logical Design describes the Data Flow Diagrams, which show clearly the data movements, the processes and the data sources, and sinks, E-R diagrams which represent the overall logical design of the database, and high-level process structure of the system. The process of design involves "conceiving and planning out in the mind" and making a drawing pattern, or sketch of the system.

In software design there are two types of major activities, Conceptual Design and Detailed Design.

Conceptual or logical or external design of software involves conceiving, planning out, and specifying the externally observable characteristics of a software product. These characteristics include user displays, external data sources, functional characteristics and high-level process structure for the product

Details or internal design involves conceiving, planning out, and specifying the internal structure and processing details of the software product. The goal of internal design is to specify internal structure, processing details, blueprint of implementation, testing, and maintenance activities.

One of the important fundamental concepts of software design is modularity. A modularity system consists of interfaces among the units. Modularity enhances design clarity, which in turn eases implementation, debugging, testing, documentation, and maintenance of the software product.

The other fundamental concepts of software design include abstraction, structure, information hiding, concurrency and verification. The use of structuring permits decomposition of a large system into smaller, more manageable units with well-defined relationships to the other units. The system design is verifiable if it can be demonstrated that the design will result in an implementation that satisfies the customer's requirements.

Preliminary Design:

Preliminary design is basically concerned with deriving an overall picture of the system. Deriving the entire system into modules and sub-modules while keeping Cohesion and Coupling factors in mind. Tools, which assist in the preliminary design process, are Data Flow Diagrams.

Code design:

The purpose of code is to facilitate the identification and retrieval for items of information. A code is an ordered collection of symbols designed to provide unique identification of an entity or attribute. To achieve unique identification there must be only one place where the identified entity or the attribute can be entered in the code; conversely there must be a place in the code for everything that is to be identified. This mutually exclusive feature must be built into any coding system.

The codes for this system are designed with two features in mind. Optimum human

oriented use and machine efficiency. Length of the code range from length of one to length of five characteristics:

The code structure is unique; ensuring that only one value of the code with a single

meaning may be correctly applied to a given entity or attribute.

The code structure is extensible allowing for growth of its set of entities and attributes.

The code is concise and brief for recording, communication, and transmission and storage efficiencies.

They have a uniform size and format.

The codes are simple so that the user can easily understand it.

The codes are also versatile i.e., it is easy to modify to reflect necessary changes in condition, chart eristic and relationships of the encode entities.

The codes are also easily storable for producing reports in a predetermined order of format.

The codes are also stable and do not require being frequently updated thereby promoting user efficienct.

MODULE DIAGRAM

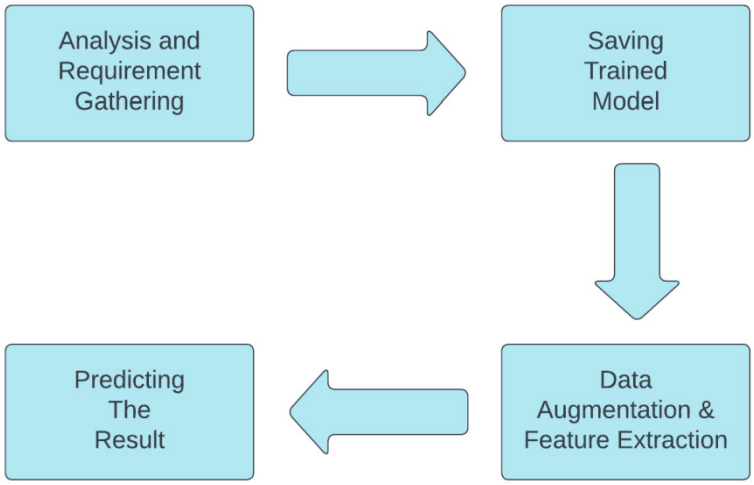


Figure 12: Module Diagram of System

STATE DIAGRAM

The name of the diagram itself clarifies the purpose of the diagram and other details. It describes different states of a component in a system. The states are specific to a component/object of a system. A State Chart diagram describes a state machine. State machine can be defined as a machine which defines different states of an object and these states are controlled by external or internal events. As State Chart diagram defines the states, it is used to model the lifetime of an object. State Chart diagrams are also used for forward and reverse engineering of a system. State Chart diagram is one of the five UML diagrams used to model the dynamic nature of a system. They define different states of an object during its lifetime and these states are changed by events. State Chart diagrams are useful to model the reactive systems. However, the main purpose is to model the reactive system. Following are the main purposes of using State Chart diagrams.

- To model the dynamic aspect of a system.
- To model the life time of a reactive system.
- To describe different states of an object during its life time.
- Define a state machine to model the states of an object.

State diagrams are used to give an abstract description of the behaviour of a system. This behaviour is analyzed and represented as a series of events that can occur in one or more possible states. State diagrams can be used to graphically represent finite state machines. Classic state diagrams require the creation of distinct nodes for every valid combination of parameters that define the state. This can lead to a very large number of nodes and transitions between nodes for all but the simplest of systems. This complexity reduces the readability of the state diagram.

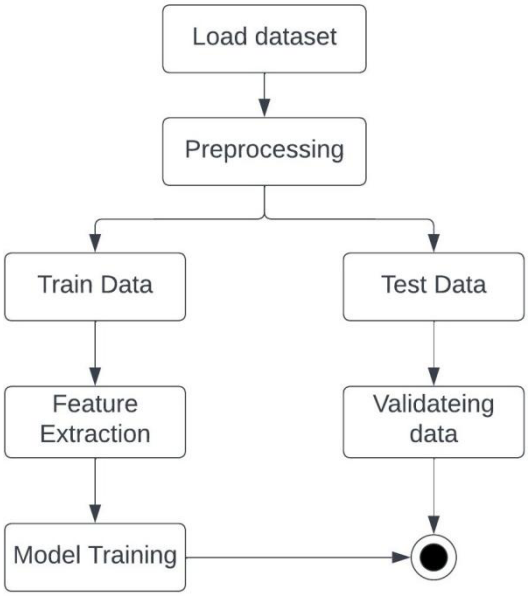


Figure 13 : State Diagram of System

Chapter 7

IMPLEMENTATION

7.1 Implementation Strategy:

Hardware Platform Used:

The hardware requirement may serve as the basis for a contract for the implementationof the system and should therefore be complete and consistent in specification.

The hardware used for the system is mentioned below.

- PROCESSOR: Intel CORE i5
- RAM: 8.00GB
- HARD DISK: 1 TB

It should be noted that better the hardware facilities available, higher would be responsetime of the system.

Libraries And Software Platform Used:

The software requirement document is the specification of the system. The softwarerequirement provides a basis for creating the software requirements specification.

OPERATING SYSTEM: Windows

SYSTEM TYPE: 64-bit , intel CORE i5

SOFTWARE: Anaconda

TECHNOLOGIES: Python

LIBRARIES: Flask, pandas, NumPy, pickle, sklearn

Python

Python is an interpreted, high-level, general purpose programming language created by Guido Van Rossum and first released in 1991, Python's design philosophy emphasizes code Readability with its notable use of significant White space. Its language constructs and object oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed and garbage collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming.

Sklearn

Scikit-learn (Sklearn) is the most useful and robust library for machine learning in Python. It provides a selection of efficient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction via a consistent interface in Python. This library, which is largely written in Python, is built upon NumPy, SciPy and Matplotlib.

Numpy

NumPy is a library for the python programming language, adding support for large, multi- dimensional arrays and matrices, along with a large collection of high level mathematical functions to operate on these arrays. The ancestor of NumPy, Numeric, was originally created by Jim with contributions from several other developers. In 2005, Travis created NumPy by incorporating features of the competing Numarray into Numeric, with extensive modifications. NumPy is open source software and has many contributors.

Librosa

Librosa is a Python package for music and audio analysis. Librosa is basically used when we work with audio data like in music generation(using LSTMs), Automatic Speech Recognition. It provides the building blocks necessary to create the music information retrieval systems. Librosa helps to visualize the audio signals and also do the feature extractions in it using different signal processing techniques.

Matplotlib :

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK. There is also a procedural "pylab" interface based on a statemachine (like OpenGL), designed to closely resemble that of MATLAB, though its use is discouraged.

Seaborn

Seaborn is a Python data visualization library based on matplotlib. It provides a highlevel interface for drawing attractive and informative statistical graphics. Seaborn is a library in Python predominantly used for making statistical graphics. Seaborn is a data visualization library built on top of matplotlib and closely integrated with pandas data structures in Python. Visualization is the central part of Seaborn which helps in exploration and understanding of data.

SciPy

SciPy contains modules for optimization, linearalgebra, integration, interpolation, special functions, FFT, signal and imageprocessing, ODE solvers and other tasks common in science and engineering. SciPy is also a family of conferences for users and developers of these tools: SciPy (in the United States), EuroSciPy (in Europe) and SciPy.in (in India). Enthought originated the SciPy conference in the United States and continues to sponsor many of the international conferences as well as host the SciPy website. SciPy is a scientific computation library that uses NumPy undserneath. It provides more utility functions for optimization, stats and signal processing.

Flask:

Flask is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries. It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself. Extensions exist for object-relational mappers, form validation, upload handling, various open authentication technologies and several common framework related tools.

7.2 Testing:

System testing is the stage before system implementation where the system is made error free and all the needed modifications are made. The system was tested with test data and necessary corrections to the system were carried out. All the reports were checked by the user and approved. The system was very user friendly with online help to assist the user wherever necessary.

Test Plan:

A test plan is a general document for the entire project, which defines the scope, approach to be taken, and schedule of testing, as well as identifying the test item for the entire testing process, and the personnel responsible for the different activities of

testing. This document describes the plan for testing, the knowledge management tool. A Test Plan is a detailed document that describes the test strategy, objectives, schedule, estimation, deliverables, and resources required to perform testing for a software product. Test Plan helps us determine the effort needed to validate the quality of the application under test. The test plan serves as a blueprint to conduct software testing activities as a defined process, which is minutely monitored and controlled by the test manager.

What is the Importance of Test Plan?
Making Test Plan document has multiple benefits:
Help people outside the test team such as developers, business managers, customers understand the details of testing.
Test Plan guides our thinking. It is like a rule book, which needs to be followed.
Major testing activities are:

- Test units
- Features to be tested
- Approach for testing

Test units:
Test Case specification is a major activity in the testing process. In this project, we have performed two levels of testing.
Unit testing
System testing
The basic units in Unit testing are:

- Validating the user request

- Validating the input given by the user
- Exception handling

The basic units in System testing are:

- Integration of all programs is correct or not
- Checking whether the entire system after integrating is working as expected.
- The system is tested as a whole after the unit testing.

Analyze the product:

How can you test a product without any information about it? The answer is Impossible.You must learn a product thoroughly before testing it.
The product under test is educational website/system. You should research clients andthe end users to know their needs and expectations from the application
Who will use the website/system?What is it used for?
How will it work?

What are software/ hardware the product uses?

Chapter 8

REFRENCE

[1]. Pratiksha Ganjave1, Rushikesh Markad2, Gaurav Rasal3, Yash Kalekar4 "Currency Detector for Visually Impaired (Study of The System Which Identifies Indian Currency for Blind People)" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV10IS110073 (This work is licensed under a Creative Commons Attribution 4.0 International License.) Vol. 10 Issue 11, November-2021.

[2]. Srushti Samant1, Sakshi Sonawane2, Rohini Thorat3, Parsika Shah Bera4, Dr. N. P. Kulkarni5 "CURRENCY RECOGNITION SYSTEM FOR VISUALLY IMPAIRED PEOPLE" international journal of advanced scientific research and engineering trend Volume 5 Issue 3 March 2020.

[3]. Shweta Yadav, Mr. Zulfikar Ali Ansari, Kaushiki Gautam Singh "CURRENCY DETECTION FOR VISUALLY IMPAIRED" 2020 JETIR May 2020, Volume 7, Issue 5.

[4]. Gerrit J. J. van den Burg, Christopher K. I. Williams - "An Evaluation of Change Point Detection Algorithms - May 2020".

[5]. Venkata Sai Teja. D1, *A Krishnamoorthy2, P Boominathan3 "INDIAN CURRENCY RECOGNITION AND SPEECH SYNTHESIS FOR THE VISUALLY IMPAIRED PERSONS" International Journal of Pure and Applied Mathematics Volume 119 No. 15 2018

[6]. Prof. Rajesh Babu, Ms. Monali Patil, Prof. Jayant Adhikari; Fake Currency Detection using Image Processing (2018).

[7]. Anil Kumar B, KRJ Srikanth; Design and Development of real-time paper Currency Recognition System of Demonetization new Indian notes by using Raspberry Pi for Visually Challenged (2018)

[8]. Snehal Saraf, VrushaliSindhikar, Ankita Sonawane,Shamali Thakare "Currency Recognition System for Visually Impaired" Vol-3 Issue-2 2017.

[9]. Vedasamhitha Abburu, Saumya Gupta, S. R. Rimitha, Manjunath Mulimani, Shashidhar G. Koolagudi;
Currency Recognition System using Image Processing (2017).

[10]. Yi C, Tian Y, Arditi A. Portable camera-based assistive text, and product labelreading from hand-held objects for blind persons. IEEE/ASME Transaction on Mechatronics.

Chapter 9

RESEARCH PAPER

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

Currency Detector Android Application for Visually Impaired People

Mr. Chandrashekhar Mankar[1], Anand Agrawal[2], Vinita Tiwari[3], Nikita Shrinath[4], Himanshu Jamwal[5], Priya Diwnale[6]
Assistant Professor, Department of Computer Science and Engineering[1]
Students, Department of Computer Science and Engineering[2,3,4,5,6]
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra, India

Abstract: *Not everyone in this world can see the colors or even the light from his/her eyes. These people are known as visually impaired people. Visually disabled people are partially sighted or completely blind. These types of people face many problems in their day-to-day life, including transactions through money. Every category of currency is different from the others, and the difference can be noticed through the naked eye. For visually challenged people, it is hard for them to differentiate between the notes. Higher organizations or institutions like Banks have expensive hardware machines that can easily determine the difference between original and fake notes. The technology used in those machines is not handy or cost-efficient. So, to overcome this issue, this project can help the visually disabled person recognize the currency notes using a mobile camera.The system will be developed as an Android application and will use high-performance image processing techniques.*

Keywords: Currency identification, visually disabled, TensorFlow, Android application, Image processing techniques.

I. INTRODUCTION

Of the 295 million visually disabled people in the world,70million are from India (about 18 million are completely blind). A petition by an NGO called the All-India Federation of the Blind said that visually impaired people were affected and recognized the new Rs 50, Rs 200, Rs 500, and Rs 2,000 banknotes [2]. They showed that the new currency is different in size. The plea said that this trouble can lead to difficulty in the transaction for the visually impaired. Identifying each note correctly is a challenge for anyone with visual impairment. Because they are disabled, they are repeatedly scammed with fake currency. Therefore, the need for a simple system to help in detecting notes is important. In August 2019, RBI also realized this problem and came up with the idea of providing an Android application for the visually impaired [2]. The concept of this Android application is that it will work on voice command, firstly the user will open the application through voice command and then the user will simply take out the note and place it behind the camera, within 2-3 seconds, a voice will be heard telling which note the user had held. Hence, our motivation is to help visually disabled people in India. This application will be easy to use and hence require less computation power.

Here are some of the goals of this project: -

- The main aim of the project is to help the visually impaired determine the currency.
- Another goal is to get precise results in different lighting conditions and follow the Android
- app using voice commands with a simple Graphical User Interface (GUI).
- Since the system will work entirely on commands, it is easy to use, practical, and economical for the visually impaired.

Many problems arise when we use this method to target blind people. The user does not know conditions such as lighting, contrast, saturation, or even whether the note is visible in the camera. The system requires changes to many of the images that will be taken by the user. Using the app should be easy for visually impaired people. It must have cameras that must be activated by voice command, and it must not have a single-user login. Therefore, the issue requires innovative ideas that can trust and validate invoices in various environments.

DOI: 10.48175/IJARSCT-9606

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

II. LITERATURE SURVEY

Many researchers have made distinct contributions to the advancement of currency recognition techniques. owing to the variations in characteristics among coins Researchers take a unique approach to the recognition issue for each of the bills (notes). In this part, we will review earlier research on currency recognition methods.

The research by Pratiksha Ganjaveet al.[1] focuses on various image processing algorithms(SIFT-Scale-Invariant Feature Transform, FAST- Features from Accelerated Segment Test, ORB- Oriented FAST and Rotated BRIEF and SURF- Speeded Up Robust Features) for an image-processing-based currency detection system. In feature extraction and matching, these methods are applied. This particular study concentrates on Indian currency notes. The algorithms have been studied, and it has been discovered that each algorithm has benefits and drawbacks.

To address the issue of visually challenged persons being able to recognize notes, Srushti Samant et al.[2] created a system wherein cash recognition is achievable by employing several image processing techniques.

To assist blind people in their daily lives, Snehal Sarafet al.[8] proposed a mobile appfor currency recognition that can recognize Indian currency form solving blind people's difficult problems. Regional audio is the output format for this project. The SIFT algorithm outperforms the current HOG in terms of performance and recall. Compared to other algorithms, the SIFT algorithm is reasonably efficient.

Shweta Yadav et al.[3] developed a solution to help blind people in their daily life, solve problems faced by blind users, and created a smart cash app for Indian rupee detection.YoloV3 has a superior recall value and performance.

Venkata Sai Teja et al.[5] proposed a system that would allow a visually impaired person to know the accuracy of the results shown when using the proof. When my MATLAB method is run on a Raspberry Pi using a scanner or camera, it captures currency notes and processes the images as defined in the project, highlighting its ability to identify true and false HSV values of the currency, which in front gives the ability to a person with disabilities to detect it.

III. METHODOLOGY

Mostly the methods of currency recognition are hardware methods, so to make it more feasible for people, having a software system will be beneficial. A software solution includes a camera that can be activated by voice command and does not require user input once activated.

Some constraints for image identification are Fluorescence, Intaglio, Serial number, and Reserve Bank of India logo.

The following figure depicts the proposed system:

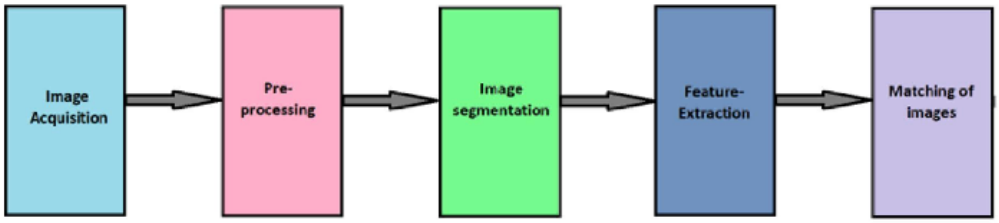


Figure 1.Conceptual Model Architecture Diagram

The process described in this document includes the following steps:

1) Image Acquisition
2) Preprocessing
3) Image segmentation
4) Feature Extraction
5) Matching of images

Image Acquisition:

It is a key step in the study as no action is taken before the image is taken. It involves storing images from a source (usually a hardware source).

Hardware sources include cameras and sensors. It is the most crucial step because an inaccurate image will render the entire workflow useless.

DOI: 10.48175/IJARSCT-9606

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

Pre-processing:
It is used to increase accuracy, as well as reduce complexity. There are many image preprocessing methods, such as resizing the image, converting the image to grayscale, and enhancing the image. It ensures that the data is consistent. Preprocessing allows us to remove unwanted corruption and enhance certain features that are important to the application we are working on. Images need to be preprocessed in order for the software to work properly and produce the desired results.

Image Segmentation:
In this process, we divide the image into different groups, called segments, to do the main processing instead of the full image, to reduce the complexity of the image, and to facilitate further processing or analysis of the image. The purpose of segmentation is to simplify or transform the representation of the image into something more useful and interpretable.

Feature Extraction:
Features are special properties that describe the image. Extract features to distinguish images. Images are made up of pixels. So, in feature extraction, we find which parts of the image are special, such as lines, corners, and special patches, which can uniquely identify the image. Feature extraction helps reduce the amount of redundant information in a dataset. The ORB (Oriented FAST and Rotated BRIEF) algorithm is a good example of feature detection.
Parameters to be considered forcurrency detection are:

- Currency value area
- Reserve Bank of India logo
- Security Thread
- Serial number
- Mahatma Gandhi logo
- Satyamev Jayate logo

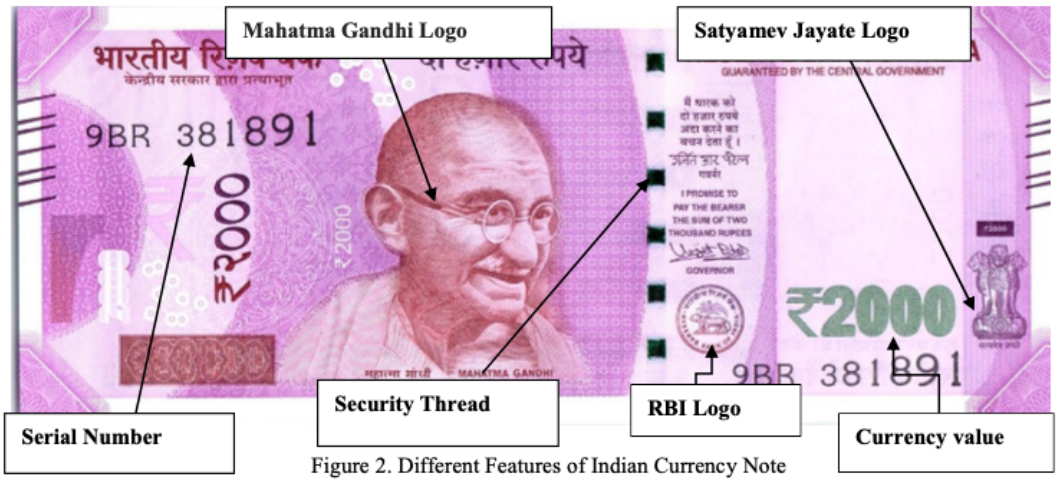


Figure 2. Different Features of Indian Currency Note

Matching of images:
During this matching, the best value that matches the data tells it to match the currency. It also provides audio informati on for visually impaired people.

DOI: 10.48175/IJARSCT-9606

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

IV. PROPOSED SYSTEM

The methods that can be used to detect currency notes are generally non-public hardware systems. The novelty of the system is that it is cheap and easy to use for blind people in India. For the visually impaired, the app should be easy to use. It will have a camera that will be activated by voice command and will not require user input when activated. In short, the challenge requires new cost-effective, robust, and efficient models in many areas. Newer systems with better GUIs may well meet these needs. It is extremely easy to use, as the proofing result is shown in Figure 3, open the Android app, tap the screen to open the camera. After turning on the phone camera, the user can tap anywhere on the screen to take a photo. The application system will be developed to identify different banknotes of 10, 20, 50, 100, 200, 500, and 2000 rupees. The application will provide an audio output of the results. The system will only show satisfactory results that match the original results and show immediate and accurate results.

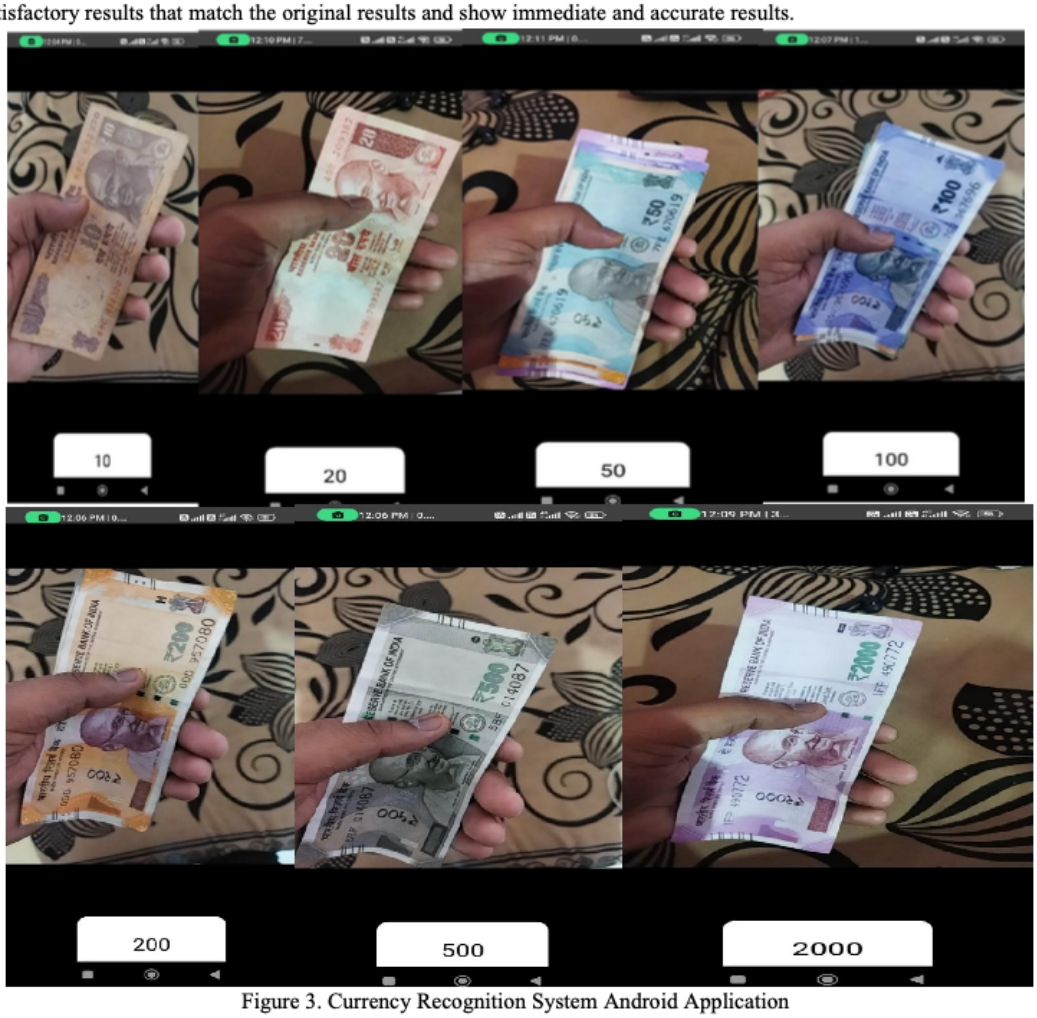


Figure 3. Currency Recognition System Android Application

4.1 System Flowchart

In the flowchart of the system, the first target user captures images. In this case, there are two major decisions that the system must make to work, the first is to check that the photos taken by the user are free of noise and that there are special features in the photo that describe the text. Otherwise, the user will receive an error message.

This flowchart is a physical tool that summarizes the activities to be performed in the currency recognition system.

DOI: 10.48175/IJARSCT-9606

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

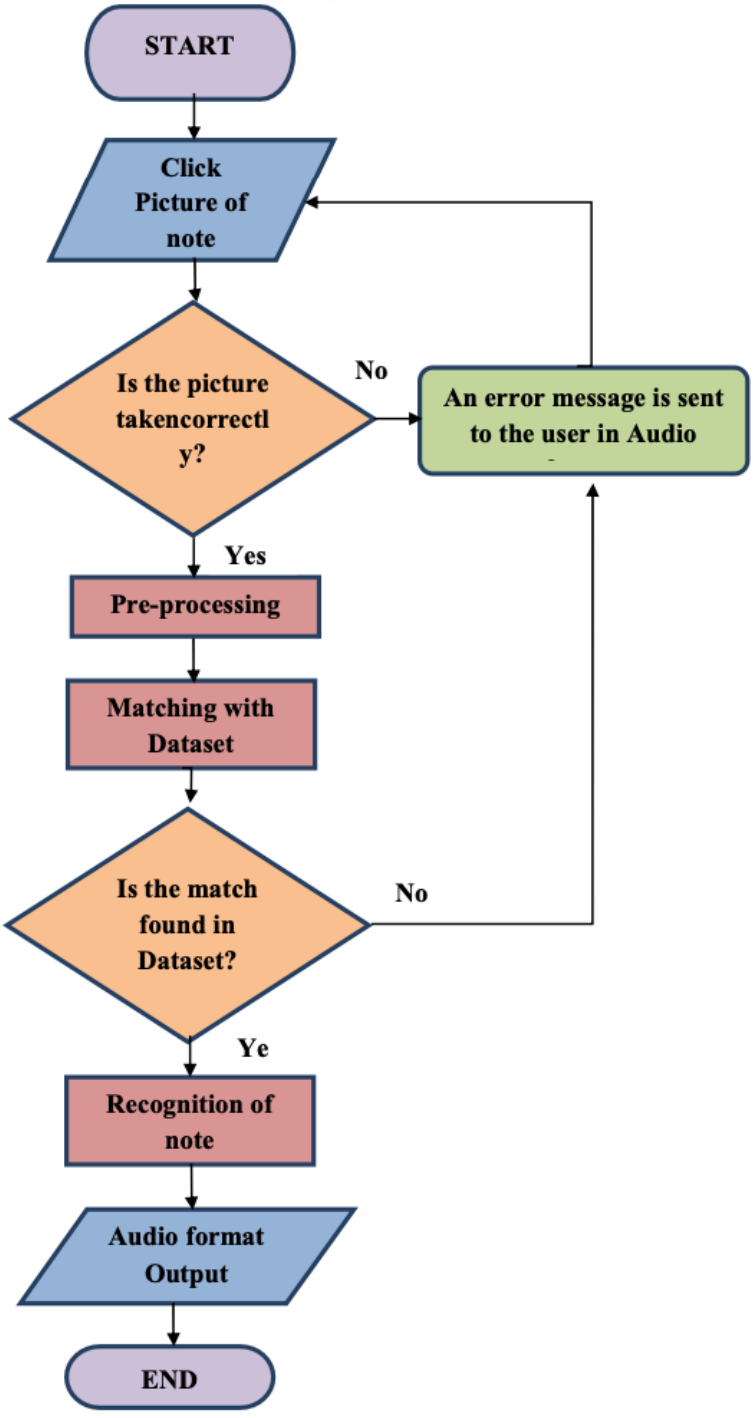


Figure 4. System Flowchart for currency recognition

DOI: 10.48175/IJARSCT-9606

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

4.2 Algorithm

Working with TensorFlow:

TensorFlow is a powerful framework that works using a set of processing nodes, each representing a mathematical operation, and an entire family of nodes called "graphs". TensorFlow is a software library for computing on graphs, where: The nodes in the graph represent mathematical operations. The edges in the diagram represent multidimensional data (called tensors) communicating between them.

Algorithm Steps:

Step 1 - Collect the pictures.

Theneed to save more images, so it iseasier, and the system is more accurate. If the results are analyzed, several groups of 5, 10, 20, 50, 100, 200, 500, and 2000 are captured at different angles in different lighting to get more useful results. With these, the image detection dataset should be created, and this dataset should be fast.

Step 2 - Teach the model to learn from pictures.

After collecting enough pictures, the next step is to train the model. Docker containers can be used to install TensorFlow. This process takes a few minutes, depending on the number of images available and the number of training steps specified.

Step 3 - Optimizing Model.

This model is now available. To use the training model on a mobile device, it must be optimized using a tool called inference optimization, removing all unnecessary nodes and other optimizations.

Step 4 - Import the model into the Android app.

The optimized model will now be included in the app. Once the Android app is ready, it can be effectively used to identify Indian currency notes.

Step 5 - Test the training model in the created application.

Install the Build pack (APK) on the user's phone. See how it works on paper currency in different situations. This step is necessary as it helps measure usability. If problems are found with these steps, they should be improved by reviewing or adding information.

Accuracy Graph:

The graph shows the accuracy of the system in different light conditions and pictures taken from varying distances.

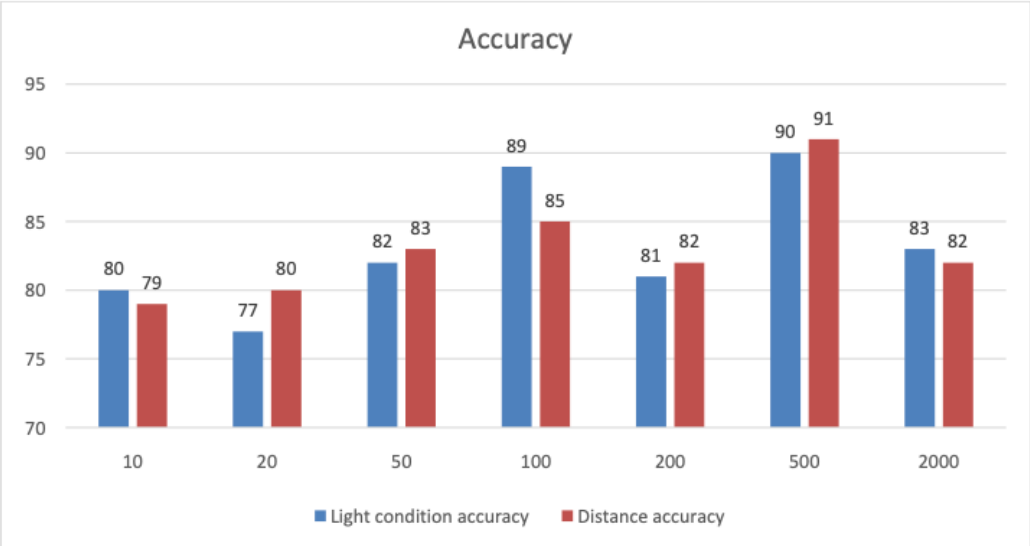


Chart 1.Showing the accuracy of the Android application in different light conditions and varying distances

DOI: 10.48175/IJARSCT-9606

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

V. EXPERIMENTAL RESULT

Build an Android-based system to check the currency notes. Image processing and matching using the TensorFlow framework. The system has been tested on Android 10.0 and above.

To create the dataset, eight images were taken for each currency: four for the front and four for the back. Here, we take the image from the mobile phone as the input image, as in Figure 5.

We have stored many image files in our dataset. Recognize images from stored data using TensorFlow algorithms. Sound will be produced after matching.

Picture taken by user.

Picture from Dataset

Figure 5: Image taken by user's mobile phone and image matching from the dataset.

5.1 Performance Evaluation

We tested our system in various dataset sizes for performance evaluation. The time required for processing is captured for dataset preprocessing and currency matching.

Dataset Size	Time Required for Dataset Preprocessing (in seconds)	Time required for matching (in seconds)
20	0.61	3.02
40	1.13	5.27
60	1.72	7.02
80	2.10	9.21

Table 1. Time required for dataset preprocessing and currency matching.

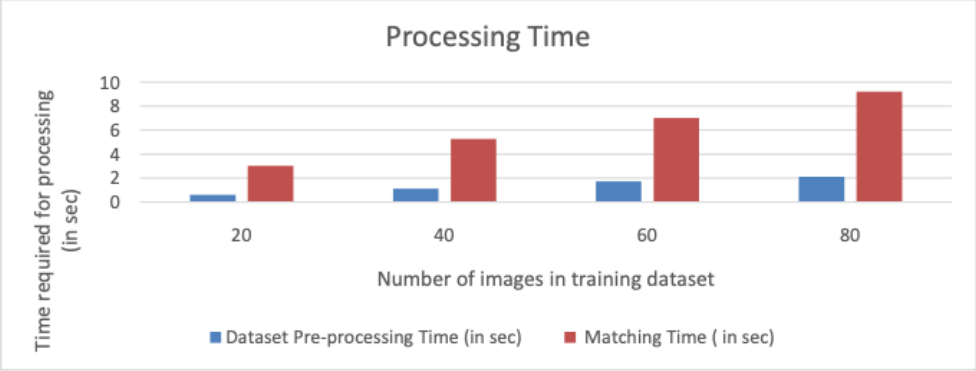


Chart 2. Graphical Representation of processing time.

DOI: 10.48175/IJARSCT-9606

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, April 2023

VI. CONCLUSION

The proposed system considers a solution that makes it possible to recognize currency by using various image processing methods to address the issue of visually impaired persons being able to recognize notes. The entire process applies to notes worth 10, 20, 50, 100, 500, and 2000. The technique is incredibly simple to use. It is highly adaptable to use this method in the actual world. The technology recognizes the monetary denomination and outputs the outcome as auditory data.

VII. FUTURE WORK

- Foreign currency recognition can be added in the future.
- The audio output can also be generated in regional languages.
- Accuracy of the project can be maximized.

REFERENCES

[1]. Pratiksha Ganjave1, Rushikesh Markad2, Gaurav Rasal3, Yash Kalekar4 "Currency Detector for Visually Impaired (Study of The System Which Identifies Indian Currency for Blind People)" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV10IS110073 (This work is licensed under a Creative Commons Attribution 4.0 International License.) Vol. 10 Issue 11, November-2021.

[2]. Srushti Samant1, Sakshi Sonawane2, Rohini Thorat3, Parsika Shah Bera4, Dr. N. P. Kulkarni5 "CURRENCY RECOGNITION SYSTEM FOR VISUALLY IMPAIRED PEOPLE" international journal of advanced scientific research and engineering trend Volume 5 Issue 3 March 2020.

[3]. Shweta Yadav, Mr. Zulfikar Ali Ansari, Kaushiki Gautam Singh "CURRENCY DETECTION FOR VISUALLY IMPAIRED" 2020 JETIR May 2020, Volume 7, Issue 5.

[4]. Gerrit J. J. van den Burg, Christopher K. I. Williams - "An Evaluation of Change Point Detection Algorithms - May 2020".

[5]. Venkata Sai Teja. D1, *A Krishnamoorthy2, P Boominathan3 "INDIAN CURRENCY RECOGNITION AND SPEECH SYNTHESIS FOR THE VISUALLY IMPAIRED PERSONS" International Journal of Pure and Applied Mathematics Volume 119 No. 15 2018

[6]. Prof. Rajesh Babu, Ms. Monali Patil, Prof. Jayant Adhikari; Fake Currency Detection using Image Processing (2018).

[7]. Anil Kumar B, KRJ Srikanth; Design and Development of real-time paper Currency Recognition System of Demonetization new Indian notes by using Raspberry Pi for Visually Challenged (2018)

[8]. Snehal Saraf, VrushaliSindhikar, Ankita Sonawane,Shamali Thakare "Currency Recognition System for Visually Impaired" Vol-3 Issue-2 2017.

[9]. Vedasamhitha Abburu, Saumya Gupta, S. R. Rimitha, Manjunath Mulimani, Shashidhar G. Koolagudi; Currency Recognition System using Image Processing (2017).

[10]. Yi C, Tian Y, Arditi A. Portable camera-based assistive text, and product labelreading from hand-held objects for blind persons. IEEE/ASME Transaction on Mechatronics.

DOI: 10.48175/IJARSCT-9606

Chapter 9

CERTIFICATE OF PUBLICATION


INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN SCIENCE, COMMUNICATION AND TECHNOLOGY
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
IJARSCT
CERTIFICATE OF PUBLICATION
INTERNATIONAL STANDARD SERIAL NUMBER ISSN NO: 2581-9429
THIS IS TO CERTIFY THAT
Vinita Tiwari
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra, India
HAS PUBLISHED A RESEARCH PAPER ENTITLED
Currency Detector Android Application for Visually Impaired People
IN IJARSCT, VOLUME 3, ISSUE 8, APRIL 2023
Certificate No: 042023-A2587
www.ijarsct.co.in
Crossref
DOI: 10.48175/IJARSCT-9606
www.doi.org
www.crossref.org
7.301
www.sjifactor.com
Editor-in-Chief


INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN SCIENCE, COMMUNICATION AND TECHNOLOGY
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
IJARSCT
CERTIFICATE OF PUBLICATION
INTERNATIONAL STANDARD SERIAL NUMBER ISSN NO: 2581-9429
THIS IS TO CERTIFY THAT
Anand Agrawal
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra, India
HAS PUBLISHED A RESEARCH PAPER ENTITLED
Currency Detector Android Application for Visually Impaired People
IN IJARSCT, VOLUME 3, ISSUE 8, APRIL 2023
Certificate No: 042023-A2586
www.ijarsct.co.in
Crossref
DOI: 10.48175/IJARSCT-9606
www.doi.org
www.crossref.org
7.301
www.sjifactor.com
Editor-in-Chief


INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN SCIENCE, COMMUNICATION AND TECHNOLOGY
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
IJARSCT
CERTIFICATE OF PUBLICATION
INTERNATIONAL STANDARD SERIAL NUMBER ISSN NO: 2581-9429
THIS IS TO CERTIFY THAT
Nikita Shrinath
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra, India
HAS PUBLISHED A RESEARCH PAPER ENTITLED
Currency Detector Android Application for Visually Impaired People
IN IJARSCT, VOLUME 3, ISSUE 8, APRIL 2023
Certificate No: 042023-A2588
www.ijarsct.co.in
Crossref
DOI: 10.48175/IJARSCT-9606
www.doi.org
www.crossref.org
7.301
Journal Impact Factor
www.sjifactor.com
Editor-in-Chief


INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN SCIENCE, COMMUNICATION AND TECHNOLOGY
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
IJARSCT
CERTIFICATE OF PUBLICATION
INTERNATIONAL STANDARD SERIAL NUMBER ISSN NO: 2581-9429
THIS IS TO CERTIFY THAT
Mr. Chandrashekhar Mankar
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra, India
HAS PUBLISHED A RESEARCH PAPER ENTITLED
Currency Detector Android Application for Visually Impaired People
IN IJARSCT, VOLUME 3, ISSUE 8, APRIL 2023
Certificate No: 042023-A2585
www.ijarsct.co.in
Crossref
DOI: 10.48175/IJARSCT-9606
www.doi.org
www.crossref.org
7.301
Journal Impact Factor
www.sjifactor.com
Editor-in-Chief