CURRENCY IDENTIFICATION AND FRAUDULENCE DETECTION SYSTEM

BY

MARJUK AHMED SIDDIKI
ID: 171-15-8959
AND

KHADIJA AKHTER
ID: 171-15-8587

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

Supervised By

Md. Riazur Rahman
Assistant Professor
Department of CSE
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

DHAKA, BANGLADESH

MAY 2021

APPROVAL

This Project titled "**Currency Identification and Fraudulence Detection System**", submitted by Marjuk Ahmed Siddiki, ID No: 171-15-8959 and Khadija Akhter, ID No: 171-15-8587 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 31 May, 2021.

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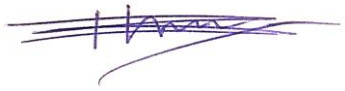


Dr. Touhid Bhuiyan
Professor and Head
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Internal Examiner

Gazi Zahirul Islam
Assistant Professor
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Internal Examiner

Raja Tariqul Hasan Tusher
Senior Lecturer
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

External Examiner

Dr. Dewan Md. Farid
Associate Professor
Department of Computer Science and Engineering
United International University

DECLARATION

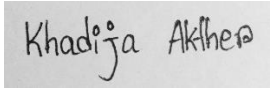
We hereby declare that, this project has been done by us under the supervision of **Md. Riazur Rahman, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

Md. Riazur Rahman
Assistant Professor
Department of CSE
Daffodil International University

Submitted by:

Marjuk Ahmed Siddiki
ID: 171-15-8959
Department of CSE
Daffodil International University



Khadija Akhter
ID: 171-15-8587
Department of CSE
Daffodil International University

ACKNOWLEDGEMENT

First, we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year research project successfully.

We really grateful and wish our profound our indebtedness to **Md. Riazur Rahman**, **Assistant Professor**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Deep learning and Image processing*" to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to **Professor Dr. Touhid Bhuiyan**, Professor, and Head**,** Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

Counterfeit currency is often rumored around the world. Growing up in tandem with technology, there is a huge cycle of making counterfeit notes. Just as it has become easier to make counterfeit currency day by day, it has become harder to detect counterfeit currency. The only way to stop fraud is to use a wide range of counterfeit detection tools or software that are easy to use. There are still many people who cannot afford a fake detection tool or software. So, these tools or software should be free, reliable and effective in terms of accuracy. This report describes a powerful counterfeit currency detection software system for Bangladeshi banknotes. And that which ordinary people can use for free. The main function of this software is to identify the currency and find out whether the currency is genuine or counterfeit. To make this whole process work, deep learning algorithm like Convolutional Neural Network (CNN) has been used to identify the currency and FLANN-based Matcher with the Scale-Invariant Feature Transform (SIFT) algorithm has been used to identify whether the currency is genuine or counterfeit. An input is observed with the help of many training images. It then recognizes the currency with high confidence by analyzing the results of their match. And through this process counterfeit currency can be detected in a very short time. We've put the system into a mobile and web application so everyone can use it quickly and easily.

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CHAPTER 1

Introduction

1.1 Introduction

The race for modernity is going on all over the world, everyone is running with modernity. Modernity means the advent of new technology, and with the help of this technology, everyone has made their life much easier. But on the other hand, some people continue to use this technology for bad purposes. Making counterfeit notes with the help of technology seems to have become a lucrative business. There are a total of 180 currencies in circulation all over the world [1]. Each note has certain security features and also differs in size [2], through which it is possible to recognize or understand which currency is the currency of which country or how much. Nowadays, counterfeiting of notes has become a problem in all countries, and the number of counterfeit notes is increasing day by day. The task of detecting counterfeit notes around the world has become very challenging. Because counterfeit notes and real notes look the same.

Like other countries, Bangladesh also has a lot of counterfeit notes. Original notes have some features that can be considered whether the note is genuine or counterfeit. But in this method, it is not always possible to say whether the note is counterfeit or not. So ordinary people are easily fooled and get involved in fraud because of these fake notes. Many times, their names also appear in the criminal record for carrying fake notes without realizing it.

There are currently many types of machines or devices for detecting counterfeit notes. These devices are a bit large in size, which makes it a little difficult to move from one place to another. But out of a population of 7.8 billion in the world today [3], 3.8 billion people use smartphones [4]. And the number of smartphone users in Bangladesh is 31 million of the total population [4]. So, if this counterfeit note detection system is inside our smartphone, then we can easily detect counterfeit notes anywhere or in any situation. So, our goal is to make the counterfeit note detection system accessible to all people through smartphones.

1.2 Motivation

Counterfeit notes have an impact all over the world. And it has also had a huge impact in Bangladesh. It is often seen in the media that crores of counterfeit money have been seized from different parts of the country [5][6][7][8][18]. Some people are making fake notes just as they are benefiting while others are losing their assets. There are some security features that can be used to identify real notes or counterfeit notes [2]. But not everyone is aware of these security features and is constantly facing problems with counterfeit notes.

The motivation behind this study is that the public is suffering because of some unscrupulous people. In this paper, we are offering a software system for detecting counterfeit notes through deep learning and image processing. Which can be used at any time or in any situation and see if the note they are using is genuine or counterfeit. Hopefully, with the help of this software system, the suffering of people with counterfeit notes can be easily overcome.

1.3 The rationale of the study

Most importantly, counterfeit note detection machines or devices are not available to everyone. Because not everyone can afford to buy it. If everyone had access to counterfeit note detection machines or devices, many would be able to protect themselves from counterfeit notes. But if the counterfeit note detection system could be digitized through deep learning or image processing and used on smartphones, then everyone could use this system. You can capture an image from your smartphone to see if the note is real or fake. It goes without saying that such work has not been done especially with counterfeit notes in Bangladesh. Below we will look at some of the information through which we can understand why this is the rationale of the study.

- ✓ **In less time:** The most precious thing in our lives is time. By taking pictures from the smartphone, you can identify the note in a very short time whether it is real or fake.
- ✓ **Usability:** Nowadays almost all of us have smartphones. So now the counterfeit money detection system is inside your smartphone. So, you can see at any time or in any situation whether your note is genuine or counterfeit.

1.4 Research Questions

There are various types of counterfeit note detection systems available in the market today. So, when we go to discuss or research counterfeit note detection systems, many questions come to our minds. And we have learned a lot of new things by solving these questions. There were some important questions, the counterfeit money detection system was created to solve those questions.

- ✓ Can we build a counterfeit currency detection system in a mobile or web application?
- ✓ Will the system take longer or less time to detect counterfeit notes?
- ✓ Can the security features of the notes be detected through image processing?
- ✓ There are different types of notes in Bangladesh. Can we recognize all kinds of notes?
- ✓ Will the counterfeit note detection system work even on a low-resolution phone's camera?

1.5 Expected Outcomes

We are always very busy with our work. And if you have to detect counterfeit money at any time during this busy time, then the best option is to use your smartphone or web

application. And our counterfeit note detection system will work on both platforms. Below is a process on how the counterfeit note detection system will display results:

- ✓ Recognize the number of notes in Bangladesh.
- ✓ With the help of note security features, the system will detect whether the note is genuine or counterfeit.
- ✓ Results can be seen in just 30 seconds.

1.6 Layout of the Report

- ✓ Chapter 2 presents the background study, related works, research summary, scope of the problem and challenges.
- ✓ In Chapter 3, we'll briefly discuss our research methodology, research subject and instrumentation, data collection and banknote database setup, statistical analysis and implementation requirements.
- ✓ Experimental setup, experimental results and analysis will be discussed in Chapter 4.
- ✓ In chapter 5, there is impact on society and we also discussed about the ethical aspects.
- ✓ In chapter 6, there is summary, conclusion and implication for future research future work has been discussed there also.

CHAPTER 2

Background Study

2.1 Introduction

In Bangladesh as well as in many developed countries, the public is facing a lot of problems for counterfeit notes. We need to create the fastest way to detect counterfeit notes. Developed countries have developed a variety of counterfeit note detection systems. And in Bangladesh too, various types of counterfeit note identification have been done.

In this chapter, we have discussed what researchers have done and what methods they have used to detect counterfeit notes. One thing that researchers have done in all of them is to detect counterfeit notes, but each note has a different size or security feature. In this chapter, we will look at what researchers have done or how they have detected counterfeit notes.

2.2 Related Works

Many researchers have done a lot of research to identify counterfeit currencies through a variety of methods. In [9], a system is proposed to identify fake currency based on distinctive features that can be extricated for comparison. Different strategies are utilized at distinctive stages of histogram equalization, using feature vectors to put away extricated features, etc. The features that were utilized for currency detection were security thread, RBI micro-print, and serial number detection.

This paper presents [10] a Fake currency detection using picture preparing and other standard strategies by using different methods like watermarking, optically variable ink, fluorescence, security thread, intaglio printing, latent picture, micro lettering, and recognizable proof check. By combining two different components of two images then, the variation will be decreased.

For the detection of Bangladeshi currency, Jahangir and Raja [11] utilized a neural organize approach and prepared it through the Back Propagation calculation. Pictures of banknotes

are filtered with less costly sensors. In a pre-processing step, the axis-symmetric veil is utilized due to which the proper recognition is performed indeed the note is in flipped condition.

Y. Neeraja, B. Divija, and M. Nithish Kumar [12] portray a fake currency detection using K-nn method. In this technique, the feature extraction handle by K-nn technology could be a robust and versatile classifier that's regularly utilized as a benchmark for more complex classifiers such as back vector machines (SVM).

K. Sawant and C. More [13], present an approach to distinguish fake notes utilizing the least distance classifier procedure. In this paper, the extract an ID mark and latent image and compute the Euclidean separate between the test and prepare the test. The Fourier descriptor is utilized the describe the note boundary. The test setup is done on rupees 20, 50, 100, 500, and 1000. The normal success rate accomplished is 90.0%.

For banknote detection, a modern point extraction and recognition calculation proposed by Lee and Kims [14]. In arrange to specific point extraction, arrange information extraction strategy utilized for banknotes with a comparative color. Five neural systems prepared for acknowledgment purposes.

There are many methods discussed above that can be used to detect counterfeit currency. Each method is very effective and gives very good accuracy. But the goal of our work is to make it accessible or easy for everyone to use.

2.3 Comparative Analysis and Summary

In our background study, we have learned about many different methods of detecting counterfeit notes. And more learned which algorithm gives better accuracy. In this report, we have identified two counterfeit notes in two steps:

- ✓ **Deep Learning:** One of the most common algorithms of deep learning for image recognition is the Convolutional Neural Network (CNN) [15]. This algorithm is being used to identify the currency. Within the Convolutional Neural Network (CNN), the system is able to recognize currency in a very short time.
- ✓ **Image Processing:** The SIFT algorithm is used to detect keypoints and the FLANN Matcher is used for feature matching. Which helped in detecting counterfeit notes. And the SIFT algorithm is included in the Non-free module in OpenCV [16].

2.4 Scope of the Problem

We had to worry about some problems when we went to do the project. We had to suffer a little while collecting data. But when it comes to the algorithm for identifying genuine notes and counterfeit notes, we have had a lot of trouble. Yet we managed to do everything right. Overcoming all obstacles, we have been able to create a counterfeit note detection system. And it gives higher accuracy in a short time.

2.5 Challenges

We have faced many challenges in building a counterfeit note detection system. Here are some of our challenges:

- ✓ **Data Collection:** We have to face some challenges while collecting data in Bangladeshi currency. Every few years, the currency notes of Bangladesh are redesigned [17]. It has been quite difficult to find recently updated notes. At first, we thought we would take updated pictures of Bangladeshi currency from an online

website. But we could not find updated pictures of Bangladeshi currency anywhere on any website. Since we are developing a counterfeit note detection system with only Bangladeshi notes, we will only need pictures of Bangladeshi currency. So, all the updated pictures of Bangladeshi currency have been collected from different people. And we also had to go to the bank and collect Bangladeshi currency notes. And later those images were used to detect counterfeit notes in our system.

- ✓ **Model Selection/Detection Algorithm:** Model selection was another important task. Because the right dataset and the right model can give a system good accuracy. There are many types of deep learning models that can be used to identify a currency. But not all models have good accuracy. All our collected data is pictorial. So, after a lot of observation, we have checked that our system will use Convolutional Neural Network (CNN) [15]. And this model has given 87% accuracy to our system. It is expected to give better accuracy in the future.

- ✓ **Keypoints Algorithm and Feature Matching:** There are many algorithms to detect counterfeit notes. Almost all algorithms that detect image keypoints have been tested in many ways. And almost in time, our plan was failing. After a lot of observation, we got good accuracy through SIFT algorithm [16]. And we decided to use the SIFT algorithm in the counterfeit note detection system. And at the same time, another challenge was to match the features of the pictures. We have used FLANN-based Matcher for feature matching.

- ✓ **Smartphone Usability:** In Bangladesh, 31 million people use smartphones [4]. Another important challenge for us was to install the system on the smartphone. This means creating an Android software that can easily detect counterfeit notes anywhere and in any situation. We were working on algorithms for deep learning and image processing, so developing android software was a little difficult for us.

- ✓ **Time Complexity:** Our focus was on being able to give good accuracy in the shortest time. And we have tried all the functions of our counterfeit note detection system to give good results in a very short time. That is just 15-30 seconds.

- ✓ **Lower Camera:** Working with low-quality camera resolution was another big challenge for detecting counterfeit notes. Because most smartphones have low-quality cameras. And it has been well noticed that this low-quality camera's picture can give good accuracy to the system.

CHAPTER 3

Research Methodology

3.1 Introduction

Counterfeit notes have originated in different countries of the world including Bangladesh. It is sometimes seen that the currency of one country is being smuggled from another country by making counterfeit notes [19][20][21]. And many people are constantly being harmed by this. The only way to solve this problem is to have a counterfeit note detection system with everyone. So, our goal is to create a software system that everyone can use with a smart phone and identify counterfeit notes.

This chapter will discuss the full implementation of the counterfeit note detection system. It has already been reported that our system is being developed in two steps. The first step will be to detect Bangladeshi currency notes and the second step will be to identify whether the currency is genuine or counterfeit. One by one the two methods will be discussed and we will know how our counterfeit note identification system works.

3.2 Research Subject and Instrumentation

The subject of our research is "CURRENCY IDENTIFICATION AND FRAUDULENCE DETECTION SYSTEM" and our goal is for every ordinary person to have a counterfeit note identification system. We have made this whole system software-based. Such as web applications and Android applications. Our main focus was to create an Android application for detecting counterfeit notes.

We have taken the help of the Deep Learning Algorithm Convolutional Neural Network (CNN) to recognize Bangladeshi currency notes. The only thing that can be recognized in a very short time is the amount of money in the currency notes of Bangladesh. And FLANN-based Matcher with the Scale-Invariant Feature Transform (SIFT) algorithm has been used to identify whether the currency is genuine or counterfeit.

3.3 Data Collection Procedure

The most important thing for any project is data collection. If the data is good then the accuracy will be quite good. The type of our data is the image. So, we had to manage all the data by taking pictures with the help of smartphone. Every few years, the currency notes of Bangladesh are redesigned [17]. It has been quite difficult to find recently updated notes. Pictures of updated currency notes of Bangladesh have been collected by visiting many people and visiting many banks. After collecting the images of the currency notes of Bangladesh, it has been divided into two parts. Training dataset and testing dataset.

Figure 3.1: Train Dataset

Figure 3.2: Testing Dataset

3.4 Statistical Analysis

We will now discuss how many images from our collected images have been used in our counterfeit note identification system. Our entire system will work in 2 steps. So here we have also divided the data into 2 parts:

- ✓ **Recognize Currency:** We used a total of 1041 images to identify the currency. And we have used the Convolutional Neural Network (CNN) algorithm to identify the currency. For this algorithm, the images are divided into 2 parts. And we have used a total of 10 types of Bangladeshi currency.

TABLE 3.1: TRAIN IMAGE DATA AMOUNT

Currency Notes	Amount
1 Taka	101
2 Taka	87
5 Taka	73
10 Taka	102
20 Taka	78
50 Taka	81
100 Taka	99
200 Taka	56
500 Taka	66
1000 Taka	121

TABLE 3.2: TEST IMAGE DATA AMOUNT

Currency Notes	Amount
1 Taka	46
2 Taka	32
5 Taka	24

Currency Notes	Amount
10 Taka	12
20 Taka	10
50 Taka	11
100 Taka	10
200 Taka	11
500 Taka	10
1000 Taka	11

- ✓ **Detect Counterfeit:** We have used 7 types of currency to identify counterfeit currency. These are 10 Taka, 20 Taka, 50 Taka, 100 Taka, 200 Taka, 500 Taka, and 1000 Taka notes. And a total of 75 Bangladeshi currency notes have been used.

3.5 Proposed Methodology

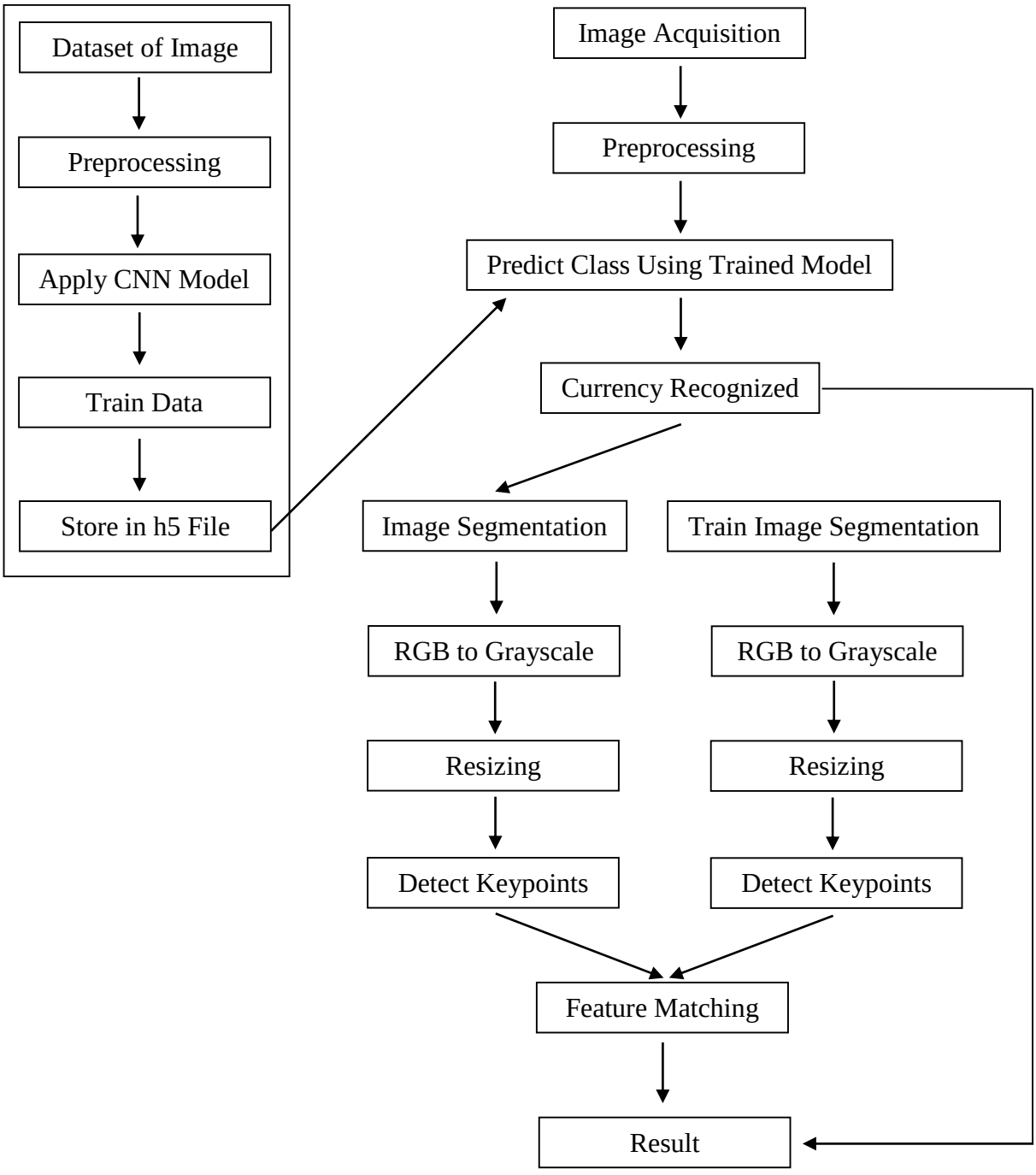

Figure 3.3: Overview of the main processing stages

The whole process of identifying counterfeit notes has been divided into two parts. First the work of recognizing the note will be done and later the note will be checked whether it is genuine or fake. Now the type of operation of this fake note identification system is briefly described below:

Currency Identification:

- ✓ **Dataset of Image:** The data for the counterfeit note detection system is the currency image. After collecting the images of the currency notes of Bangladesh, it has been divided into two parts. Training dataset and testing dataset. And by collecting the images of all the notes, they have been well leveled.

- ✓ **Preprocessing:** The format and size of the notes we have collected are not the same. So, the format and size of all the images have been made the same so that we get better accuracy. The image has been resized to (250 * 120) pixels and the image has been formatted (.jpg). And the pixel value of the image is normalized, as shown in Figure 3.5.

- ✓ **Apply CNN Model:** In this project we have used Convolutional Neural Network (CNN) model which includes deep learning algorithm. And we have used Convolutional Neural Network (CNN) to identify Bangladeshi notes. We used here TensorFlow and Keras in the backend to implement the model and Adam optimizer. We also used the Pooling layer, Con2d and activation layers for creating CNN layers. And we got 87% accuracy which is enough to recognize the note.

- ✓ **Store Trained Model:** After the model train, we have saved the model in h5 format [22]. And using this model later, our system will be able to recognize the currencies of Bangladesh in a very short time.

Figure 3.4: Saved model

Counterfeit Currency Detection:

- ✓ **Image Preprocessing:** Whenever an image is given in the system, the image size will be changed to a fixed size (250 * 120) pixel. And convert the image to an array. Because the h5 model that we have saved will take array input. And the array has been normalized so that the pixel value of the image is within (0-255).

Before After

Figure 3.5: Converting image to array

- ✓ **Predict Currency:** The Bangladeshi taka note that is given will predict from the model and will tell how much taka note is given in the system. With the help of the model, we have created through the Convolutional Neural Network (CNN), we can easily find out how many taka's notes we have.

- ✓ **Image Segmentation:** Image segmentation is the process which is divided into a digital image into multiple segments, a set of pixels. Through image segmentation, a digital image can be divided into different parts much faster. We will divide the image into different parts and detect the key points of each part separately. So that we can get a better accuracy.

Figure 3.6: Segmented Images

- ✓ **Grayscale Conversion:** The images of the currency of Bangladesh that we have collected are all RGB or color images. On the other hand, the notes given for checking in the system are color images. So now we need to convert this color or RGB image to grayscale. If you convert to grayscale, the color of each pixel of the image will now be limited to 1 color. RGB or color images carry 3 colors and gray images carry 1 color. An RGB image has three channels: red, green, and blue [23]. A grayscale image has just one channel: Black and White [23].

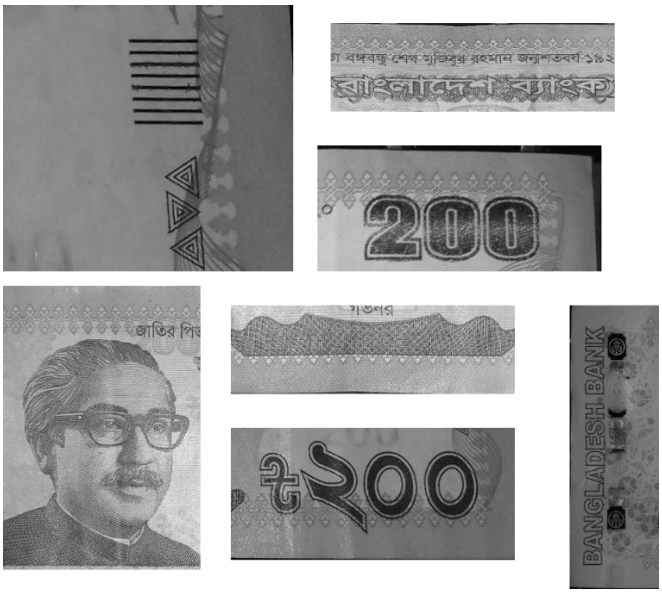

Figure 3.7: RGB to Grayscale

138	142	135	139	139	142	142	
149	153	146	150	150	151	152	
136	139	133	138	138	141	141	
134	137	140	130	128	135	138	
145	148	151	140	139	146	149	
131	134	137	126	125	132	134	
140	146	155	127	140	141	137	
151	156	166	138	151	153	149	
137	142	152	124	137	139	134	
136	156	167	141	135	140	134	
147	166	178	152	146	151	145	

Figure 3.8: RGB color coding per pixel

34	165	164	175	144	146	196	158	150	147	153	141	156	161
47	186	162	170	191	162	140	148	161	159	144	146	143	159
53	158	145	146	196	146	209	146	144	145	146	150	150	171
50	141	161	146	156	170	152	139	160	138	133	134	144	163
57	154	155	151	149	153	180	153	143	187	157	159	174	158
48	146	141	153	165	207	150	159	173	141	175	143	167	150
52	145	145	194	140	149	150	158	147	145	143	155	143	157

Figure 3.9: Grayscale color coding per pixel

- ✓ **Resize Image:** The size of each of the coins of Bangladesh is different from one to the other. And the features are completely different from one to the other. So, we have changed the sizes of the notes to the correct size so that the counterfeit note identification system can give better accuracy.

- ✓ **Keypoints Detection:** After preprocessing, we detect the keypoints of the input image for future recognition using SIFT (Scale-Invariant Feature Transform) Keypoints Detection. The SIFT algorithm can detect the fastest keypoints in a counterfeit note detection system. Keypoints basically work by detecting some points in interesting points according to the pixels of an image. Scale-invariant means that no matter how you scale the image, you should still be able to find those points. The keypoints that can be detected through SIFT are enough to identify counterfeit notes.

- ✓ **Feature Matching:** Keypoints matching or feature matching is the issue that comes up after detecting keypoints. The FLANN based Matcher algorithm is one of the fastest feature matching algorithms. FLANN stands for Fast Library for Approximate Nearest Neighbors. It contains a collection of optimized algorithms for fast nearest neighbor search in large datasets and for high dimensional features. Through this, we can understand how many keypoints are being matched between the two images.

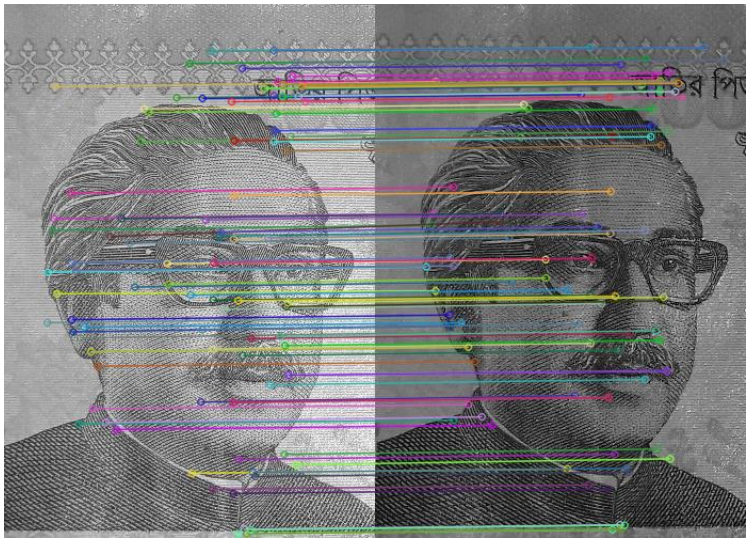

Figure 3.10: Feature matching of Bangabandhu Sheikh Mujibur Rahman's image

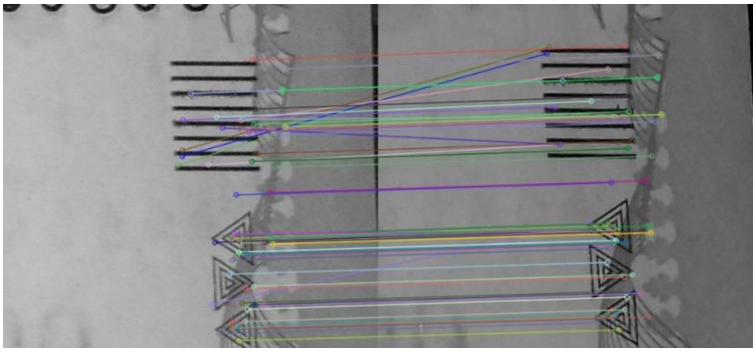

Figure 3.11: Matching feature of intaglio ink uneven print

3.6 Implementation Requirements

3.6.1 Computer Configuration

All tests were performed on a computer carrying the configuration as follows:

CPU: Intel i5-7200U 3.1GHz

GPU: Intel HD Graphics 620 and

AMD ATI Radeon HD 8670A/8670M/8690M

RAM: 8 GB DDR4

Operating System: KDE neon

3.6.2 Implemented Our System

- ✓ **Algorithm:** The algorithms used in our system have been implemented in two steps. Below is the software that has been used to implement the algorithms.
  Web Application: Google Colab
  Desktop Application: Spyder

- ✓ **Web and Android Application:** Our web and Android applications are designed to make this counterfeit currency recognition system accessible to the public. Below are some of the desktop applications we've used to create web and Android applications:
  - Visual Studio Code
  - Android Studio

3.6.3 To Use Our System

Our counterfeit note identification system is designed for the general public. And now one of the easiest to use is the software system. And our system will work with image input. Our full counterfeit note detection system has been implemented in web and Android applications. If you want to use it in web applications, you can use the fake note

identification system by using any web browser. And if you want to use our system in Android applications, you must have Android version 6.0.0 equal to or higher and API level 23 equal to or higher.

CHAPTER 4

Experimental Results and Discussion

4.1 Experimental Setup

Some aspects of setting up a counterfeit note detection system have been very well noted. Below is a description of how to set up this whole system or how to set up this system for an experiment:

- ✓ First, we have to collect all the data. Since the data is an image, it has been collected from different places with the help of smartphone camera.

- ✓ The next thing that comes up is training the data. Deep learning model training requires a lot of good machines later. Such as processors, graphics cards, RAM and hard disks. If all these equipment are highly configured then deep learning models can be trained very quickly and well. And if there is a shortage then it takes a lot of time to work. So, we decided to use Google Colab for model training. Because of the huge amount use of Google Colab and its popularity and easy, fast implementation. We used here Google Colab and google own GPU in runtime to make the best out of it.

- ✓ A very important step in our system was to determine whether the note was genuine or counterfeit using the FLANN based Matcher algorithm with the sift algorithm. And we have chosen Spyder IDE to implement this coding system. Spyder IDE is the most powerful IDE, especially for image processing. And we have been able to implement our entire system very well.

4.2 Experimental Results & Analysis

4.2.1 Model Summary

We have used the Convolutional Neural Network (CNN) to identify counterfeit notes, which is part of the Deep Learning Algorithm. In our project model we used Adam optimizer and a sequential model with layers of conv2d, maxPooling2 then finally a flatten layer. There are four CNN layers. Finally, we wrap these layers with a flatter layer and a dense layer. As a result, we get the accuracy with our model.

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 248, 118, 32)      896
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 124, 59, 32)       0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 122, 57, 64)       18496
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 61, 28, 64)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 59, 26, 128)       73856
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 29, 13, 128)       0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 27, 11, 256)       295168
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 13, 5, 256)        0
_________________________________________________________________
flatten (Flatten)            (None, 16640)             0
_________________________________________________________________
dense (Dense)                (None, 128)               2130048
_________________________________________________________________
dropout (Dropout)            (None, 128)               0
_________________________________________________________________
dense_1 (Dense)              (None, 256)               33024
_________________________________________________________________
dropout_1 (Dropout)          (None, 256)               0
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
dropout_2 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_3 (Dense)              (None, 64)                8256
_________________________________________________________________
dropout_3 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_4 (Dense)              (None, 10)                650
=================================================================
Total params: 2,593,290
Trainable params: 2,593,290
Non-trainable params: 0
```

Figure 4.1: The CNN model used our project

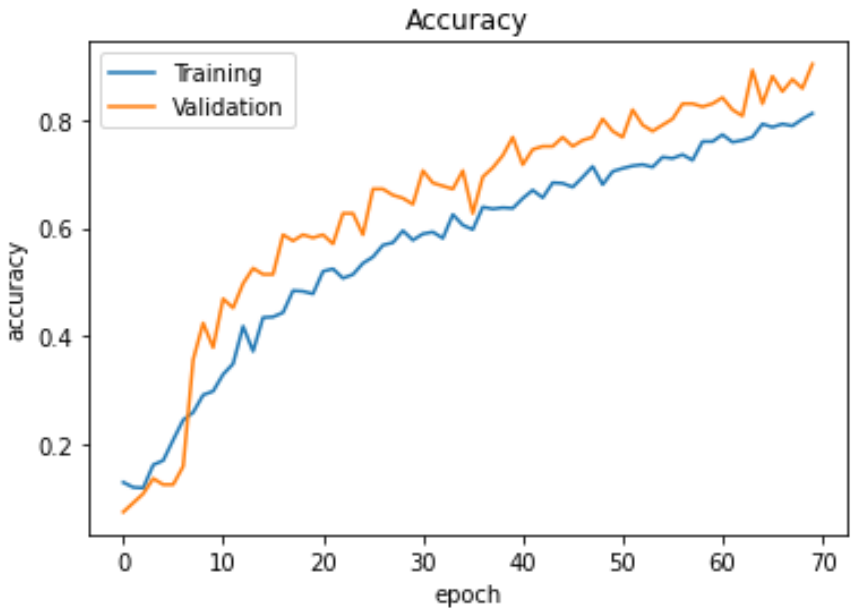

Figure 4.2: Training vs Validation accuracy

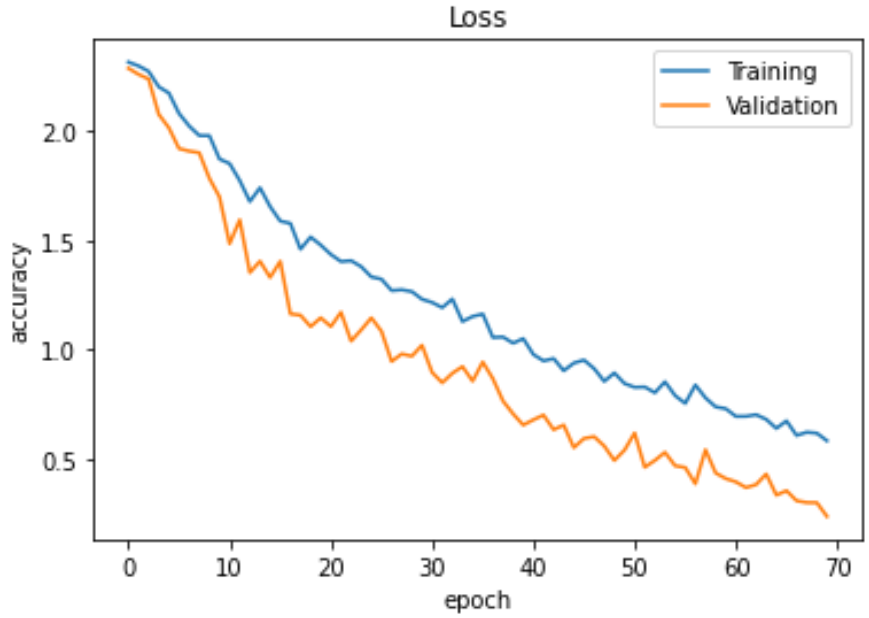

Figure 4.3: Training vs Validation loss

4.2.2 Control Flow

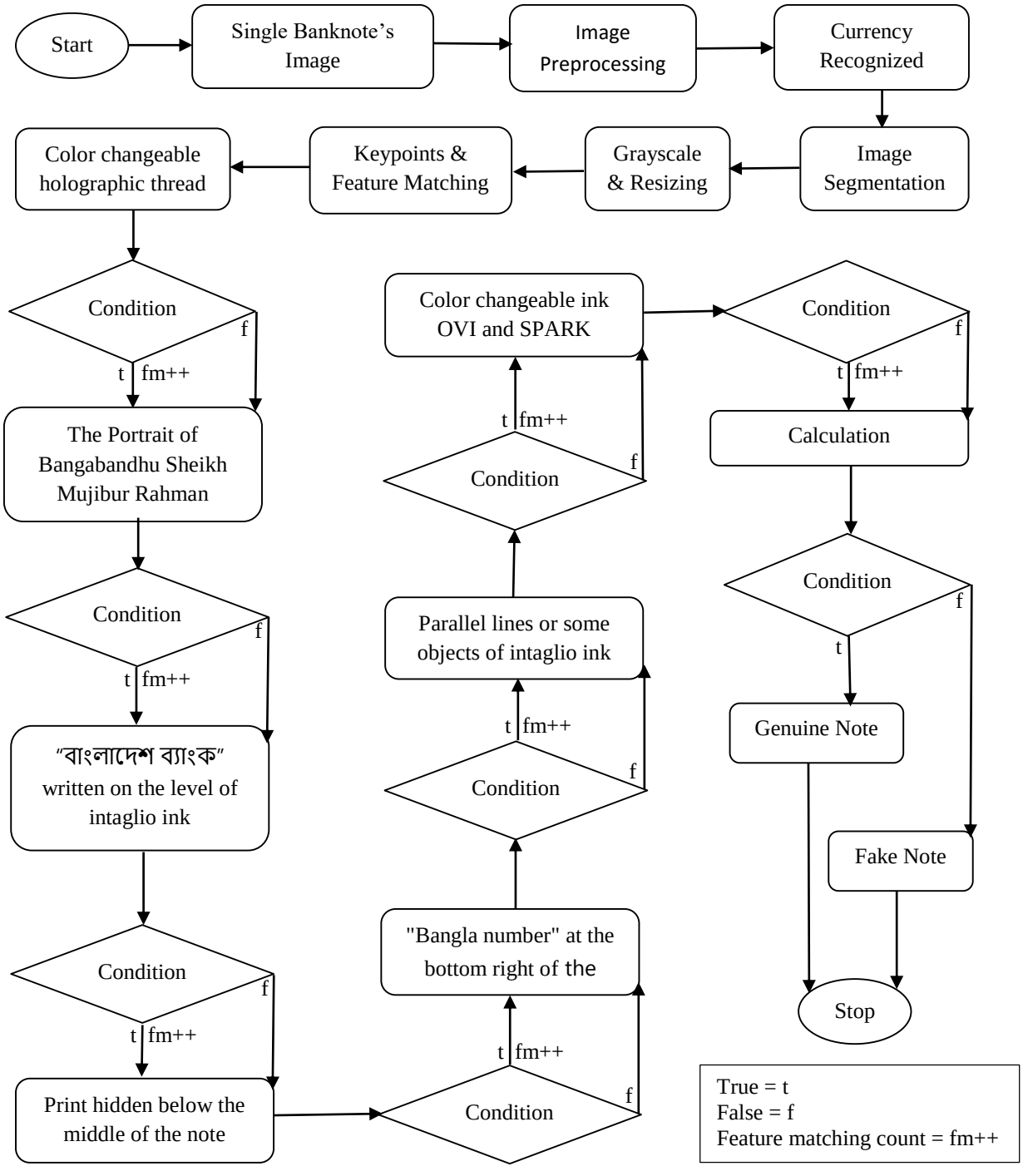

Figure 4.4: Control Flow Diagram

Figure 3.3 shows how our counterfeit note identification system works. From this part we will be clearer how our system detects counterfeit notes. In Figure 4.4 we can see a control flow diagram. From this diagram we can easily understand how the counterfeit note detection system detects counterfeit notes.

Every note in Bangladesh has some security features, with the help of these security features it is possible to understand or catch which is real or fake note. Our system also checks those security features and can detect counterfeit notes. Our system checks a total of 7 security features of a note.

- ✓ Color changeable holographic thread
- ✓ The Portrait of Bangabandhu Sheikh Mujibur Rahman
- ✓ "বাংলাদেশ ব্যাংক" written on the level of intaglio ink
- ✓ Print hidden below the middle of the note
- ✓ "Bangla number" at the bottom right of the note
- ✓ Parallel lines or some objects of intaglio ink
- ✓ Color changeable ink OVI and SPARK

Our system checks every security feature of the above 7. When each security feature is true or correct, the system will detect the original note. And if any security feature fails or is not correct then the system will detect the note as fake note. And by checking all these security features of the note, the result will show in a very short time.

4.2.3 Performance evaluation of the Proposed technique

The counterfeit note identification system has been tested 50 times with different notes of Bangladesh. And we are satisfied with the average result we have received from the counterfeit note identification system. The performance of the proposed technique is evaluated in terms of accuracy rate which is shown in Table 4.1. This table shows the experimental correct and incorrect results of 50 input images. We have found that 41 images have been detected correctly and 9 images have been incorrectly detected. We think it got better accuracy from our counterfeit note identification system. Therefore, accuracy rate of the proposed method is as:

Accuracy rate = (No. of Correct readings/Total No. of readings) * 100

= (41/50) * 100

= 82%

TABLE 4.1: TABLE OF EXPERIMENTED RESULTS

Test Denomination	Test Result	Test Denomination	Test Result
1	Correct	26	Correct
2	Correct	27	Correct
3	Correct	28	Correct
4	Correct	29	Correct
5	Incorrect	30	Incorrect
6	Correct	31	Incorrect
7	Correct	32	Correct
8	Incorrect	33	Correct
9	Correct	34	Correct
10	Correct	35	Correct
11	Correct	36	Correct
12	Incorrect	37	Correct
13	Correct	38	Correct
14	Correct	39	Incorrect
15	Correct	40	Correct
16	Correct	41	Correct
17	Correct	42	Correct
18	Incorrect	43	Correct
19	Correct	44	Correct
20	Correct	45	Correct
21	Correct	46	Incorrect
22	Incorrect	47	Correct
23	Correct	48	Correct
24	Correct	49	Correct
25	Correct	50	Correct

4.2.4 Pictures of some experiments with web and android applications

The counterfeit note detection system can be used as a web and Android application. So here are some experimental results for web and Android applications:

- ✓ **Web Application:**

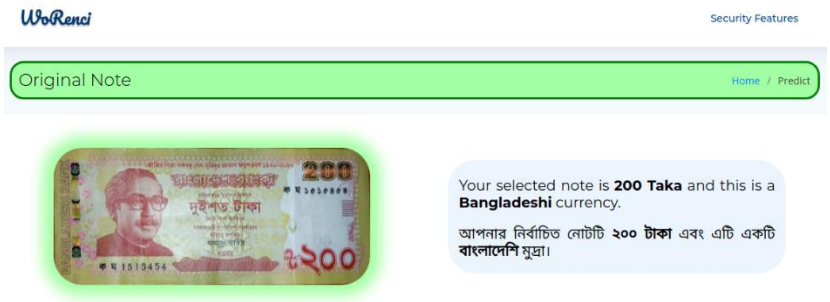

Figure 4.5: Original Note and 200 Taka

Figure 4.6: Fake Note and 200 Taka

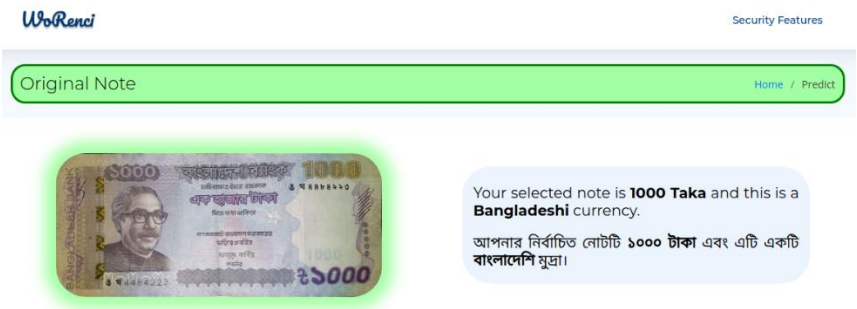

Figure 4.7: Original Note and 1000 Taka

Figure 4.8: Fake Note and 500 Taka

Figure 4.9: Original Note and 100 Taka

Figure 4.10: Original Note and 50 Taka

✓ **Android Application:**

Figure 4.11: Original Note and 200 Taka

Figure 4.12: Fake Note and 50 Taka

Figure 4.13: Original Note and 100 Taka

Figure 4.14: Original Note and 1000 Taka

Figure 4.15: Fake Note and 500 Taka

4.3 Discussion

Our counterfeit note detection system has been developed using two methods. Images of 1000+ Bangladeshi currency notes have been used in the system. And Deep Learning's Convolutional Neural Network (CNN) algorithm has been used to create models for note classification. And from this model we get 87% accuracy.

The next step after classification of notes is to check whether the note is genuine or counterfeit. And in this step, we have used FLANN based Matcher algorithm with the sift algorithm to monitor whether the note is genuine or counterfeit. And here we get 82% accuracy. Hopefully in the future our counterfeit note identification system will bring more accuracy.

CHAPTER 5

Impact on Society, Environment and Sustainability

5.1 Impact on Society

There are many bad people in the society who are making fake notes and pushing people towards harm. The main purpose of our system is to protect people from harm by identifying counterfeit notes. It will be good influence on our society, if it is used properly. Our life will be easier by this. We can use this system as a web and Android application. So, we are hopeful that the counterfeit note detection system is a very good thing for every person in our society. So, it will have a good impact on society.

5.2 Impact on Environment

Our project is a software that can be used as a web or Android application. This will be very beneficial for the environment. Because, if there is a barrier to making counterfeit notes, then both paper and ink can be used to improve the environment. It is to be hoped that our counterfeit note identification system will detect counterfeit notes from the environment or from our society and apply restrictions on the creation of counterfeit notes. It will not be harmful for nature and our environment because it is just a software.

5.3 Ethical Aspects

Wherever we live our lives or whatever we do, we seek ethics everywhere. We have created the counterfeit note identification system considering the ethical aspects of society and people. This system will basically help everyone to identify counterfeit notes without harming anyone morally. No cheat or harmful are done by it. For making people's life style easier, it is helping to produce more services.

CHAPTER 6

Summary, Conclusion, Recommendation and Implication for Future Research

6.1 Summary of the Study

This research project's main goal is to detect counterfeit notes. To digitize the current world, we need to give understanding to the machines. We have created a counterfeit note identification system using some algorithms of deep learning and image processing. And at the end of it all we got a very good accuracy which is very effective in detecting counterfeit notes.

6.2 Conclusion

Counterfeit notes have an impact all over the world. And it has also had a huge impact in Bangladesh. Some people are making fake notes just as they are benefiting while others are losing their assets. So, we have created a system that allows us to easily identify our notes and see if the note is genuine or counterfeit. We hope this will be of great benefit to the public.

6.3 Implication for Further Study

We have to think about a better version of any existing things. Same as we have a plan of future work with this project.

- ✓ We will give more data to get better accuracy of our dataset.
- ✓ We will work with the currencies of different countries including Bangladesh.
- ✓ We will make sure that everyone can identify counterfeit notes faster and with better accuracy.

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