NORTH SOUTH UNIVERSITY

Department of Electrical and Computer Engineering

Project Topic: Counterfeit Detection of Bangladesh Banknotes

Course Name: Junior Design

Course Code: CSE299

Section: 19

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Date of submission: 24th September, 2024

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Abstract:

Counterfeit notes are a big problem for the economy. The increase in counterfeit notes leads to economic losses, such as inflation, instability, and personal financial losses in the country's economy, which threaten a country's economy. Due to the problem of fake notes, our Bangladeshi economy is facing many losses. The project's main objective is to develop a web-based application that uses machine learning and deep learning technology to detect fake Bangladeshi notes easily. The application is built on a Convolutional Neural Network (CNN) model, trained on a dataset of real and fake banknote images. This results in a user-friendly web interface where users can upload pictures for banknote verification so that the system is efficient and accurate in detecting counterfeit notes, thereby further helping to reduce economic corruption and protect the vulnerable population of Bangladesh.

Keywords—Machine Learning, Deep Learning, Banknotes Detection, Image Classification,

Introduction:

We have always heard about zero tolerance against corruption or zero tolerance against drugs from Bangladesh's government officials, but never about zero tolerance against fake notes. Note that counterfeiting is a big problem in our society as well as all over the world. The economy can suffer from counterfeit money, especially when it comes to inflation. The money supply rises when fake notes are used, which causes an imbalance between the actual values of goods and money. This excess of money has the potential to destabilize the economy, raise prices, and reduce purchasing power.

As long as there has been coinage on Earth, there has been currency counterfeiting. Counterfeiters focus their efforts on paper currencies. In every country's currency, there are some security features of paper currencies. These features are made from chemical or physical properties. The appearance and security features of real banknotes are copied by counterfeiters, making it difficult for the general public to tell the difference between real and fake money. In many cases, fake note-detection machines, pens, torch lights, etc are used. These technologies are unavailable, have high costs, have poor accuracy, and need more user-friendliness.

To solve this problem, our AI project will efficiently detect fake currencies. In this project, we will use OpenCV for image processing. Pytorch will be used to develop a neural network model. Our programming language will be Python. Many things will be used to make our project efficient, which will help the general public to identify fake notes without any cost and with reasonable accuracy.

Literature review:

The authors of [1] have developed a three-layered Deep Convolutional Neural Network model that effectively identifies counterfeit Indian rupee notes. This model comprises the following main steps: image acquisition, image processing, image transformation, edge detection, image segmentation, feature extraction, pattern matching, and printing the result. These steps go in order, as written here. The study examined 306 photos that had undergone augmentation; 80% were used for training, and the remaining 20% for validation. The learning rate was found to be 0.001. The work's two main accomplishments are the ability to accurately identify counterfeit money, which is 96.6 with a success rate of 80%, and the development of mobile and web-based applications to do so.

[2] The authors consider three different architectures in the implementation of "Fake Banknote Recognition Using Deep Learning," where they develop a method to identify the best thresholds of the model by transfer learning, namely sequential, residual, and inception. The authors also implement a custom model where transfer is achieved by learning faster estimation in the embedded system. Then, the authors compare the accuracy of the custom model with that of transfer learning. Finally, the authors achieve the accuracy of different models for fake banknote recognition using deep learning 100% and 99.52% in the case of a custom network. Moreover, Using the transfer learning model achieved 99.52% accuracy for VGG16, 99.52% for VGG19, 99.52% for ResNet50, and 99.52% for InceptionV3. Using the custom network and transfer learning models achieved similar accuracy results, with ResNet18 achieving the highest accuracy of 100%. Therefore, the authors believe that custom networks capable of fast estimating fake banknote recognition are most suitable for real-time applications.

[3] The authors work on a convolutional neural network (CNN) classifier for counterfeit detection that can classify banknote images as genuine or counterfeit using visible light, IR reflectance, and IR transmission images of banknotes as input data. They mainly work with counterfeit notes from four national currencies (EURO, USD, Korean, and Jordan) datasets. They used a model in which they trained a convolutional neural network classifier using preprocessing images of banknotes to detect counterfeit banknotes. They also evaluated the classifier's performance using accuracy, precision, and

recall metrics. The authors achieved an average accuracy of 97.11% for note recognition in banknote datasets from four countries with their convolutional neural network model. Also, the authors worked more in-depth on using smartphones to detect fake notes and succeeded in developing this method. As a result, the smartphone camera achieves a high accuracy rate in terms of convenience and acceptability.

[4] The journal is about identifying other countries' currencies and fake Indian currencies. In this process, they used MATLAB software for the computational and image processing. The system must be uploaded via a file folder in MATLAB to identify the currency name of the country to which the input image belongs. Calculating parameters like PSNR, mean square error, and the similarity index is essential to this currency recognition system. In cases of fake note detection, an image of a currency note is selected and converted from color (RGB) to grayscale. Edge detection is applied to the entire grayscale image, and then specific features of the note are cropped and segmented. These features are analyzed, and their intensity is measured. Based on this analysis, the note is classified as real or fake. However, their currency recognition system works for some country's currencies.

[5] "Image Processing Based Feature Extraction of Bangladeshi Banknotes" investigates using sophisticated image processing methods to identify counterfeit money. Because of the advances in counterfeiting technologies, traditional methods of detecting counterfeit goods, like chemical and physical property-based techniques, as Bangladeshi bank notes following features, are becoming less and less effective. As a result, researchers are concentrating on feature-based techniques that examine security features, including watermarks, optically variable ink, and microprinting incorporated into currency (OVI). Ahmed [1] suggests a software-based solution that uses characteristics like ultraviolet lines, security threads, micro-letters, and others specific to Bangladeshi banknotes. Optical Character Recognition (OCR), Speeded Robust Features (SURF), Principal Component Analysis (PCA), and contour analysis are among the well-known image processing techniques they use. These are all implemented within the OpenCV library.

Motivation:

Throughout history, currency issuers have faced one common threat: the threat of counterfeiting. Despite the introduction of electronic currency, banknotes remain in abundance. The amount of counterfeit currency in circulation at any moment threatens the confidence in the currency. Counterfeit currency threatens economies worldwide, particularly in developing nations like Bangladesh. A fake currency detection system varies depending on the specific features of a country's bank notes. For Bangladeshi bank notes, the following features are considered: Microprinting, watermark, optically variable ink, iridescent ink, security thread, ultraviolet lines, and many detection systems. However, counterfeiting has been heavily reduced by using those features. Therefore, existing detection systems are either too costly, limited in availability, or insufficiently accurate. So, this project seeks to address these challenges by creating an affordable solution that anyone can use for personal or commercial work, and that is easy to use by phone—a website-based, user-friendly solution.
By leveraging modern image processing techniques, this project aims to provide a counterfeit detection tool that is accurate and accessible to a broader audience, ultimately mitigating the economic and social damages caused by counterfeit currency circulation.

Aim:

This project aims to develop a robust, cost-effective, web-based system that is reliable and effective in detecting counterfeit Bangladeshi bank notes using Image processing techniques.
This project will focus on identifying unique and distinguishing features. Bangladeshi Bank notes have special features like Microprinting, watermarks, optically variable ink, iridescent ink, security thread, and ultraviolet lines. This web-based project detects fake currency by extracting existing features of banknotes, such as micro-printing and optical variables.
Ink (OVI), watermark, iridescent ink, security thread, and ultraviolet lines using OCR (Optical Character Recognition). Analysis, Face Recognition, Speeded UP Robust Features (SURF) And Canny Edge & Hough transformation for watermark and security thread verification.

Therefore, the goal is to provide a reliable solution that can be widely adopted across various sectors and ensure high accuracy, speed, and affordability in the counterfeit detection process, providing a scalable and user-friendly solution suitable for use in Banks, retail stores, and commercial sectors. Personal use for individuals concerned about counterfeit currency.

Application:

The counterfeit detection method in Bangladesh banknotes is crucial for our country's economy. As a result, it is possible to reduce fraud in Bangladesh's financial sector and increase economic security. Detecting fake notes can reduce economic corruption and protect our vulnerable communities in Bangladesh from monetary losses. It is a web-based application that allows ordinary people to easily detect counterfeit notes. This application can have a significant impact on Bangladesh's economy and society.

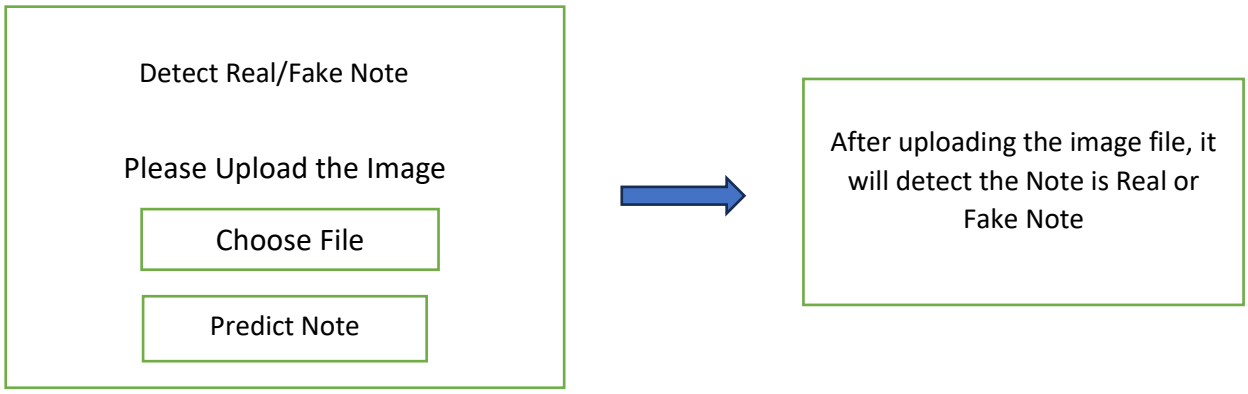


Fig: Web- Application Block Diagram

Tools needed and short description:

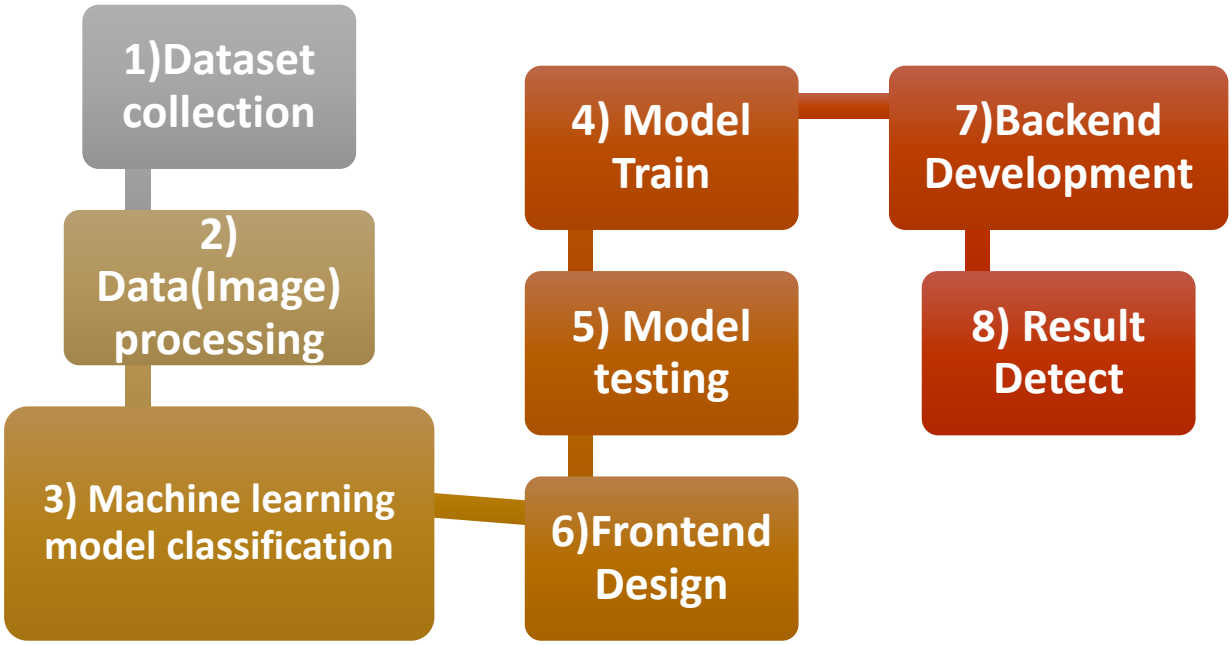
As we build a web application implementing machine learning, we can divide our project into Frontend, Backend, and (Machine learning and Deep learning models).

Frontend	Backend	Machine Learning Model
Tools: Language: HTML, CSS, JavaScript Framework: Bootstrap	Tools: Language: PHP	Tools: Language: Python Framework/library: NumPy, Pandas, Matplotlib, Scikit-learn, PyTorch, OpenCV
We will use HTML for the skeleton structure and CSS for the basic design. And bootstrap for responsive design	Our web application will contain PHP as the backend.	We will use Python as a programming language to build a machine-learning model. We will use PyTorch to develop the neural network Model.

We will also use version control, GitHub, and Figma for the design prototype. We will use Google Collab/ Jupyter Notebook to build a machine-learning model.

Project Plan:

Our project aims to create a system using software to identify fake Bangladesh banknotes during detection. Users can utilize the system via a web platform to submit a banknote image to verify and detect counterfeit banknotes. We will complete our project in several steps. For this, we will complete our project by planning a good project.



First, we must collect a dataset for Counterfeit Detection on the Bangladesh Banknote project. Next, we need to do image processing on that data. Then, the meshing learning model classifies that model. After training, the model should be tested. Then, we connect the trained model with the backend of our web application, and we can achieve our results.

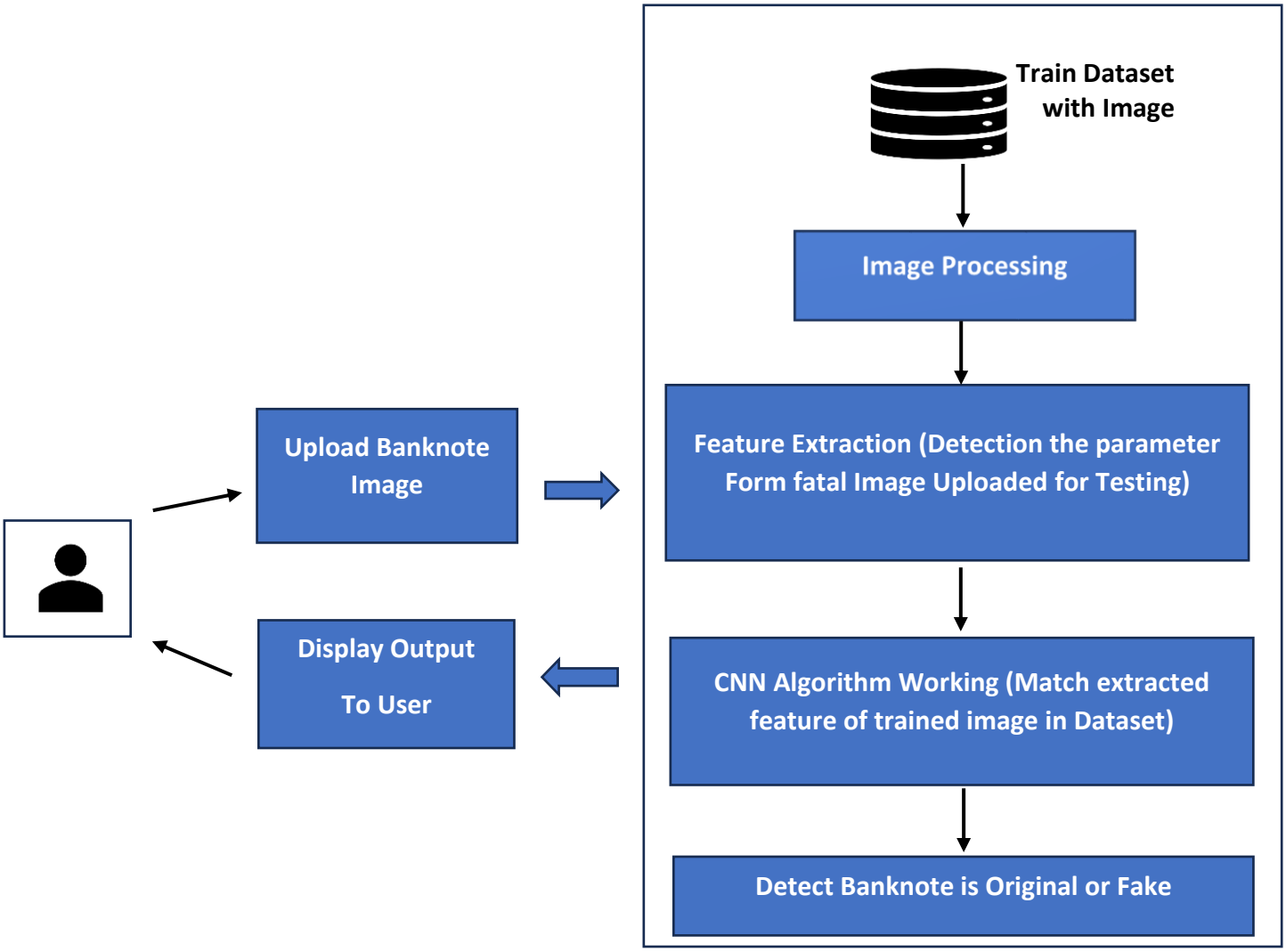


Fig: System Architecture Block Diagram

Projected Timeline:

Work	Approximate time
1) Image Processing	Two Week
2) Frontend Development	One week
3) Machine Learning Model Development	Three weeks
4) Machine Learning Model Testing	One week
5) Backend Development (Connect ML Model)	Two weeks
6) Report writing	One week

Projected Cost:

Since we are developing a web application-based project, "Counterfeit Detection on Bangladesh banknote," and no hardware equipment is required, we don't have any project costs. However, for training the deep learning model, we require GPU.

Conclusion:

The emergence of fake currency is increasing day by day, which is negatively affecting our economy and the rate of inflation. It has made life for low-income people difficult. Our counterfeit note detection using AI is essential to addressing this crisis. Just click on the image of the note and then upload it to our web application to detect whether the note is fake or not. The general public also has a vital role to play. People should report counterfeit money suspicions by detecting this web app to assist law enforcement. By creating this project, we can help strengthen the economy, lower inflation, and keep the financial system running smoothly.

Contribution:

1) **Asifur Rahman**
   - Data collection
   - Image Processing
   - Model Classification
   - Model Train & Testing
   - Backend Development
   - Report Writing

2) **Mohammad Hossain**
   - Data collection
   - Image Processing
   - Model Classification
   - Model Train & Testing
   - Frontend Development
   - Backend Development
   - Report Writing

3. Khandakar Anjuman Parvez

   - Data collection
   - Image Processing
   - Model Classification
   - Report Writing

References:

[1] S Naresh Kumar; Gaurav Singal; Shwetha Sirikonda; R. Nethravathi; "A Novel Approach for Detection of Counterfeit Indian Currency Notes Using Deep Convolutional," in *IOP Conference Series: Materials Science and Engineering*, Warangal, India, 2020.

[2] César G. Pachón; Dora M. Ballesteros; Diego Renza; "Fake Banknote Recognition Using Deep Learning," *Applied Sciences*, vol. 11, no. 3, pp. 1-20, 2021.

[3] Tuyen Danh Pham; Chanhum Park; Dat Tien Nguyen; Ganbayar Batchuluun; Kang Ryoung Park; "Deep Learning-Based Fake-Banknote Detection for the Visually Impaired People Using Visible-Light Images Captured by Smartphone Cameras," *IEEE Access*, vol. 8, pp. 63144 - 63161, 2020.

[4] P. Ashok Babu; P. Sridhar; Rajeev Ratna Vallabhuni; "Fake Currency Recognition System Using Edge Detection," in *2022 Interdisciplinary Research in Technology and Management (IRTM)*, Kolkata, India, 2022.

[5] Zahid Ahmed; Sabina Yasmin; Md Nahidul Islam; Raihan Uddin Ahmed; "Image processing based Feature extraction of Bangladeshi banknotes," in *The 8th International Conference on Software, Knowledge, Information Management and Applications (SKIMA 2014)*, Dhaka, Bangladesh, 2014.