National College of Ireland

Biometric based Fingerprint Verification System using Deep Learning for Secure Cloud Storage

MSc Cyber Security

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1 Introduction

This document intends to provide all the hardware and software required to carry on this research successfully. All the steps involved in accomplishing this research are mentioned logically to be repeated easily by anyone. This research uses three models, namely, Res-Net50, a pre-trained MobileNetV2 model and a hybrid CNN-RF model, to classify plant disease into three classes: Healthy, Powdery and Rust. All three models are compared to see which model performs well with a limited plant disease dataset.

2 System Cofiguration

This section focuses on the software and hardware required to execute this research successfully.

2.1 Hardware Cofiguration

The research can be conducted on a personal laptop with configuration as mentioned in the Table 1:

Table 1: Hardware Configuration

Hardware	Configuration
System	Dell
System Type	64 bit
RAM	8 GB
Graphics	None
SSD Memory	256 GB
Processor	11th Gen Intel(R) Core(TM) i5-1135G7 @ 2.40GHz 1.38 GHz

2.2 Software Configuration

All the requirements related to the software required for this research are mentioned in this section.

The details of the operating system required for the successful implementation of this research is mentioned in the

Table 2: Operating System

Specification	Value
Edition	Windows 11 Home
Version	23H2
OS Build	22631.3958

What is Jupyter Notebook?
Anaconda is the Ipython notebook is a web application that allows you to create documents inlcuding live computer code together with the text and graphics of a lecture including formulas, code, graphs and test. It mostly is used for data analysis and manipulation for both machine learning algorithms, scientific research and academic work.

Key Features
Interactive Code Execution:

Jupyter Notebook can operate on programming languages for data science and scientific computing, among them, Python, R, Julia, Scala, among others.
You are also able to test code snippets in respective cells and see the results at

the same time.
Rich Text and Visualizations:

Integrate code with narrative text, equations using Latex and with Figures eg; graphs, plots.
Because of this, it is suitable for building data stories, tutorials as well as reports.
Extensibility:

A number of extensions are available to be installed and used to add more functionality.
Notebooks can also be exported to other formats which are HTML, PDF and slide.
Collaboration:

It is also possible to share Jupyter Notebooks on GitHub or using email and any other medium one sees fit.
They can also be used in JupyterHub or in Google Colab or in any other collaborative notebook environment.
Integration with Other Tools:

Jupyter can work in conjunction with other tools such as TensorFlow, Pandas, Matplotlib among others, and other data science libraries.
It also supports other big data instrumentation such as Apache Spark.
Common Uses
Data Cleaning and Transformation: Jupyter Notebooks are really popular when it comes to data preprocessing.
Data Visualization: Another mathematical feature that is available is that plots and charts can be produced within the notebook.
Machine Learning: It is also a preferred place for constructing and experimenting new machine learning.
Educational Purposes: Specially suitable for programming, data analysis and mathematical courses.
The most fundamental structure of a Jupyter notebook is as follows:
Cells: The basic unit of a notebook, the purpose of which is, above all, to create a document in electronic form.
Code Cells: Computation, compilation and write the result of a program or the printed statement.
Markdown Cells: Applied for text, explanations or comments in Markdown or LaTeX.

Raw Cells: Fragment of unedited code; code meant for presentation

Thus, the following guide will provide an understanding of the first steps to using Jupyter Notebook including:

Installation:

Jupyter Notebook may be installed by pip (pip install notebook) or through the Anaconda package distribution.

Launching Jupyter Notebook:

Open up a terminal (or if you are in the Anaconda environment then type Anaconda Prompt) and just type jupyter notebook.

Doing so will open the notebook interface in your web browser with your account signed in.

Creating a New Notebook:

From the Jupyter interface it is possible to create a new notebook but first go to the dropdown menu labeled “New” on the upper right corner of the dashboard and select the programming language of your preference.

Running Code:

You are able to type an expression in a cell and then use Shift + Enter keys to evaluate the expression and then go to the subsequent cell.

Advantages and Limitations
Advantages:

It is very easy to use and it is also very versatile for the basic level user as well as the advance level user.
Very useful for explaining the code as well as posting the inputs, outputs, and visualizations all on a single note.
Permits integration and sharing of condence reliably.
Limitations:

Limited for use in production settings or by large-scale production or large

projects.
It can be worse in version control than traditional scripts depending on the format of the code.
Jupyter Notebook is now a popular among data scientists and academics because it provides the set of tools for a lot of tasks in a flexible and convenient way.

3. Project Implementation

3.1 Data Collection and Pe processing

Data Standardization:All fingerprint images are resized to a uniform dimension and resolution to ensure consistency during training and evaluation.

Real

Easy

Medium

Hard

Figure 2: Types of Fingerprint Images

Types of Fingerprint Images

1. Real: High quality, clear images obtained from controlled conditions. These serve as the baseline for assessing the SNN's performance under ideal circumstances.

2. Easy: Slightly degraded images with visible ridge and valley structures. These simulate minor wear or environmental variations, testing the SNN's ability to handle everyday changes.

3. Medium: Moderately degraded images with issues like smudging or partial occlusion. These challenge the SNN's robustness in lessthanideal conditions.

4. Hard: Severely degraded images simulating extreme conditions such as significant damage or extensive occlusion. This category assesses the SNN's reliability in highly compromised scenarios.

Data paring:In this project, a dataset of 6000 fingerprint images was utilized to train and evaluate the Siamese Neural Network (SNN) for biometricbased fingerprint verification. The dataset is divided into four types of fingerprint images: real, easy, medium, and hard, each representing varying levels of image quality and degradation.

What is Positive Pairs & Negative Pairs

Positive Pairs: These consist of two fingerprint images from the same finger of the same individual. For instance, two images from the index finger of the same person, even if taken under different conditions (e.g., real, easy, medium, hard).

Negative Pairs: These consist of fingerprint images from different fingers or different individuals. Examples include comparing an index finger image with a thumb image from the same person, or comparing images from different individuals.

Pairing Process

To train the SNN effectively, fingerprint images are organized into pairs:

Positive Pair Generation:Pairs are created from images of the same finger of the same individual. Ensure balance across all four image categories to provide a comprehensive learning experience for the model.

Negative Pair Generation: Pairs are formed from images of different fingers or different individuals. Balance the dataset by including diverse negative pairs to prevent training bias.

This structured approach to data pairing ensures that the SNN learns to accurately differentiate between matching and non-matching fingerprint images, improving its performance in realworld scenarios where fingerprints may be damaged or partially obscured.

Normalization:Pixel values of the images are normalized to a range of [0, 1] to

improve model training efficiency and performance.

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