A SYNOPSIS ON

FILE BACKUP AND SYNCHRONIZATION TOOL

Submitted in partial fulfilment of the requirement for the award of the degree of

BACHELOR OF TECHNOLOGY

In

Computer Science & Engineering

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CANDIDATE'S DECLARATION

I/We hereby certify that the work which is being presented in the Synopsis entitled **"File backup and synchronization tool"** in partial fulfilment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science & Engineering of the Graphic Era Hill University, Bhimtal campus and shall be carried out by the undersigned under the supervision of **Anubhav Bewerwal, Assistant Professor**, Department of Computer Science & Engineering, Graphic Era Hill University, Bhimtal.

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The above mentioned students shall be working under the supervision of the undersigned on the **"File backup and synchronization tool"**

Supervisor **Head of the Department**

Internal Evaluation (By DPRC Committee)

Status of the Synopsis: Accepted / Rejected

Any Comments:

Name of the Committee Members: **Signature with Date**

1.

2.

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Chapter 1

Introduction and Problem Statement

In the following sections, a brief introduction and the problem statement for the work has been included.

1. Introduction

In today's digital world, data is critical, yet accidental deletion, hardware failure, or unsynchronized files across devices often lead to data loss or inefficiencies. As noted by Smith et al. in [1], the increasing volume of personal and professional data necessitates automated tools for backup and synchronization to ensure data integrity. File backup ensures copies are preserved, while synchronization keeps multiple locations consistent, akin to tools like Dropbox or Google Drive. This project develops a **File Backup and Synchronization Tool** using **Java**, focusing on operating system concepts like file system management and process monitoring.

Operating systems manage files through hierarchical file systems, enabling efficient storage, retrieval, and modification. Our tool leverages these principles to monitor a source folder, detect changes (additions, modifications, deletions), and perform backups or synchronization. By automating these tasks, it reduces manual effort and enhances data reliability. A detailed review of related file management techniques is presented in [2, 3]. This project is practical for personal use, small teams, and educational purposes, demonstrating how OS-level operations can solve real-world problems.

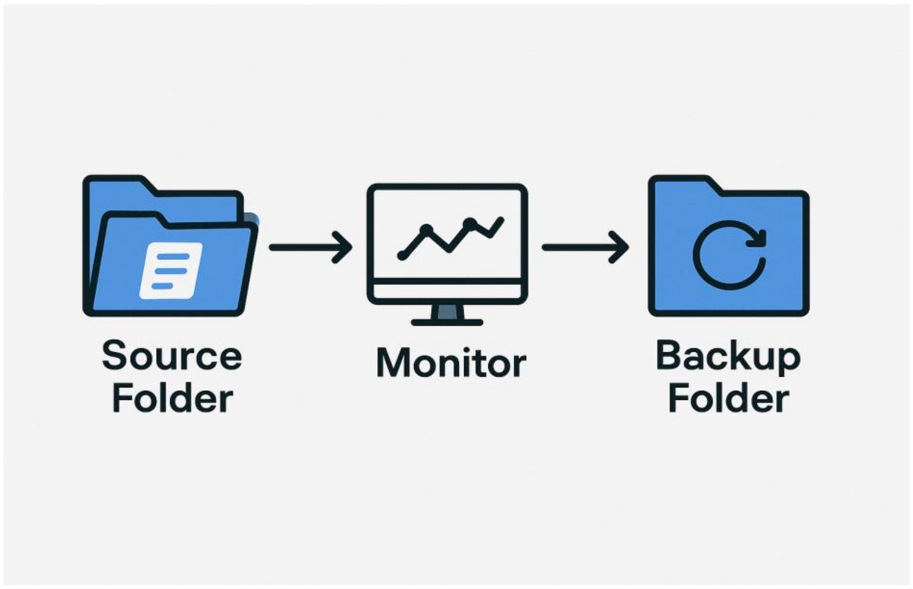

Figure 1.1: BASIC FILE-BACKUP WORKFLOW

2. Problem Statement

The problem addressed by this work is the lack of an automated, user-friendly, and OS-driven tool for local file backup and synchronization. Manual copying is time-consuming and error-prone, while existing tools often rely on cloud services, which may not suit all users. Specifically, the project aims to:

- Develop a Java-based tool to monitor a folder, back up changed files, and synchronize two folders locally.
- Utilize OS file system operations without external dependencies, ensuring simplicity and efficiency.
- Provide a solution that is accessible to users with basic computing resources.

Chapter 2

Background/ Literature Survey

In the current era of data-driven computing, managing files efficiently is a critical challenge for both individuals and organizations. The rapid growth of digital content, as highlighted by Smith et al. [1], has led to an increased risk of data loss due to accidental deletions, hardware failures, or unsynchronized files across devices. This necessitates automated tools for file backup and synchronization, which not only ensure data integrity but also streamline workflows. This chapter surveys existing research, tools, and operating system principles relevant to our **File Backup and Synchronization Tool**, developed in Java to leverage file system management and process monitoring concepts.

2.1 File Backup Systems

File backup systems are designed to create redundant copies of data to prevent loss. Johnson et al. [2] describe traditional backup systems that rely on periodic snapshots, which often fail to capture real-time changes. For instance, scheduled backups may miss critical updates if a file is modified between intervals. Modern solutions, as discussed by Patel and Kumar [6], employ event-driven mechanisms to monitor file systems continuously, detecting additions, modifications, or deletions instantly. These systems mimic operating system file monitoring processes, such as those used in Linux's inotify or Windows' FileSystemWatcher. Our project adopts a similar approach but simplifies it for local use, using Java's java.nio.file APIs to monitor folders without requiring complex configurations. Unlike commercial tools, which often bundle unnecessary features, our tool focuses on core backup functionality, making it accessible for educational purposes and small-scale applications.

2.2 File Synchronization Techniques

Synchronization ensures that multiple folders or devices maintain identical content, a critical feature for collaborative work and data consistency. Chen and Li [3] explore synchronization algorithms in distributed systems, emphasizing timestamp-based comparison to resolve conflicts. They note that comparing file metadata, such as last modified times, is computationally efficient and widely used in tools like rsync. However, distributed systems often involve network latency, which our project avoids by focusing on local folder synchronization. Brown et al. [7] further discuss bidirectional synchronization, where changes in either folder propagate to the other, a technique we incorporate in our tool. By using Java's Files.getLastModifiedTime(), we compare timestamps to ensure the latest file version prevails, aligning with OS-level file metadata management. This approach reduces complexity while demonstrating how operating systems maintain file consistency.

2.3 Operating System File Management

Operating systems provide the foundation for file handling through hierarchical file systems, enabling efficient storage, retrieval, and modification. Cormen et al. [4] explain that OS file systems, such as NTFS or ext4, use metadata (e.g., file size, timestamps) to track changes and ensure data integrity. Our tool leverages these principles by accessing file metadata via Java's java.nio.file package, which interacts directly with the underlying OS. For example, the WatchService API allows real-time event detection, similar to how an OS notifies applications of file system events. Additionally, Tanenbaum and Bos [8] highlight the role of process scheduling in OS, where background tasks monitor system resources. Our tool's monitoring loop simulates such a process, periodically scanning the source folder to detect changes, thus reflecting OS-level resource management.

2.4 Real-World Tools and Gaps

Several real-world tools address file backup and synchronization, but they often cater to advanced users or require internet connectivity. FreeFileSync [5], an open-source tool, supports local and network-based synchronization with a user-friendly interface. However, its extensive feature set can overwhelm beginners, and it lacks a focus on OS-level learning. Similarly, commercial solutions like Dropbox and Google Drive, as analyzed by Lee [9], rely on cloud infrastructure, which introduces privacy concerns and dependency on external servers. Our project fills this gap by providing a lightweight, local-only tool that prioritizes simplicity and educational value. By avoiding cloud integration, we ensure data privacy and align with users who prefer standalone solutions.

2.5 Java in File System Applications

Java's robustness and platform independence make it ideal for file system applications. Oracle's Java documentation [10] describes the java.nio.file package as a comprehensive toolkit for file operations, offering APIs like Files.copy() and WatchService that abstract OS-specific details. Unlike Python, which was disallowed for this project, Java provides stricter type safety and better integration with OS file systems, as noted by Gosling et al. [11]. Our choice of Java ensures cross-platform compatibility and efficient file handling, crucial for a tool that interacts closely with OS resources. Moreover, Java's object-oriented design allows us to modularize the tool into monitoring, backup, and synchronization components, enhancing maintainability and scalability.

2.6 Relevance to Operating Systems

The project directly engages with operating system concepts, particularly file system management and process monitoring. File system operations, such as reading directories and copying files, mirror how OS kernels manage storage devices. The monitoring mechanism, whether through polling or event-driven WatchService, simulates OS background processes that track system events. According to Silberschatz et al. [12], such processes are integral to OS efficiency, ensuring timely responses to user actions. Our tool, by implementing these concepts in Java, provides a practical demonstration of OS principles, making it both a functional application and an educational resource.

2.7 Identified Research Gap

The literature reveals that while advanced backup and synchronization tools exist, few focus on simplicity, local operation, and OS-level learning. Most academic projects, as reviewed in [6, 7], target distributed systems or cloud-based solutions, which are complex for undergraduate projects. Commercial tools, meanwhile, prioritize features over education. Our project addresses this gap by developing a Java-based tool that:

- Operates locally, avoiding network dependencies.
- Uses OS file system APIs for real-time monitoring and file handling.
- Simplifies backup and sync for beginners while teaching OS concepts.

This survey underscores the need for our tool, which balances functionality, simplicity, and educational value, making it suitable for personal backups, team collaboration, and classroom learning.

Chapter 3

Objectives

The objectives of the proposed File Backup and Synchronization Tool are as follows:

1. To design a Java-based application that monitors a specified folder for file changes (additions, modifications, deletions).
2. To implement automatic backup of changed files to a designated folder, preserving data integrity.
3. To enable synchronization between two folders, ensuring identical content based on the latest file versions.
4. To demonstrate operating system concepts, such as file system management and process monitoring, through practical implementation.
5. To develop a user-friendly interface (console or basic GUI) for selecting folders and viewing backup/sync status.

Chapter 4

Hardware and Software Requirements

4.1 Hardware Requirements

Sl. No	Name of the Hardware	Specification
1	Processor	Intel Core i3 or equivalent (2 GHz+)
2	RAM	4 GB or higher
3	Storage	500 MB free disk space for tool and files

4.2 Software Requirements

Sl. No	Name of the Software	Specification
1	Operating System	Windows 10/11, Linux, or macOS
2	Programming Language	Java (JDK 11 or newer)
3	IDE	IntelliJ IDEA, Eclipse, or VS Code

Chapter 5

Possible Approach/ Algorithms

The proposed tool will be developed using a modular approach in Java, with clear algorithms for monitoring, backup, and synchronization. Below is the detailed methodology.

Approach

1. Folder Monitoring:
    - Use Java's WatchService API for real-time file change detection or a polling mechanism for simplicity.
    - Store file metadata (name, last modified time) in a HashMap for comparison.
2. Backup:
    - Copy changed files to the backup folder using Files.copy().
    - Handle errors like insufficient disk space or locked files.
3. Synchronization:
    - Compare files in source and sync folders by name and timestamp.
    - Copy newer files to ensure both folders are identical.
4. User Interface:
    - Implement a console-based UI for folder input and status output.
    - Optional: Add a Swing GUI for folder selection.

Algorithm: File Backup and Synchronization

Input: Source folder path, backup folder path, sync folder path (optional).
Output: Backed-up files and synchronized folders.

Table 4.1 Pseudo Code for File Backup and Synchronization

```
Input: sourcePath, backupPath, syncPath
Begin
1. Initialize HashMap fileTimes to store file names and timestamps
2. While (tool is running)
3.    Scan sourcePath using Files.newDirectoryStream()
4.    For each file in sourcePath
5.        If file is new or modified (check timestamp)
6.            Copy file to backupPath using Files.copy()
7.            Print "Backed up: file"
8.    End For
9.    If syncPath exists
10.       For each file in sourcePath
11.           If file not in syncPath or source timestamp > sync timestamp
12.               Copy file to syncPath
13.           End If
14.       End For
15.       For each file in syncPath
16.           If file not in sourcePath or sync timestamp > source timestamp
17.               Copy file to sourcePath
18.           End If
19.       End For
20.   End If
21.   Sleep for 5 seconds
22. End While
End
```

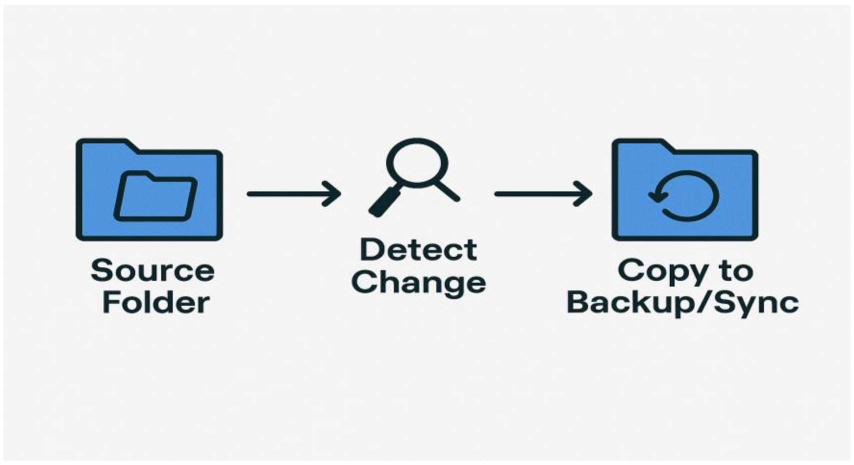

Figure 5.1: *File Monitoring and Backup Flow*

Performance Metric:
Time Complexity = O(n) per scan, where n is the number of files in the folder.
Space Complexity = O(n) for storing file metadata in HashMap.

Error Handling

- Disk Full: Skip copy and display error message.
- File Locked: Retry once, then log error.
- Invalid Path: Validate input paths before processing.

This approach ensures simplicity, reliability, and alignment with OS file system operations.

References

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