A Customized Data Recovery Tool

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Abstract. Data recovery is the process of salvaging deleted, formatted, corrupted, damaged or inaccessible data from the storage media as it cannot be accessed through normal way. There are two types of data recovery which is physical recovery and logical recovery. Physical recovery needs special equipment to repair the damaged parts of storage device like scratched plates, stalled spindle, fried chip, etc. and this process need to be undertaken in clean and controlled environment to extract data from storage device. Logical recovery is a software-based solution that recovers data from storage device which faced logical error in operating system or accidental user deletion. This paper will discuss on logical recovery and it is divided into few sections which is public awareness on data recovery, literature review on existing data recovery tool, analysis on user requirements for data recovery tool, proposed data recovery tool functionality and proposed data recovery tool framework.

Index Terms— Data Recovery, Forensic Computing, Methods, Techniques, Tool

1. Public Awareness on Data Recovery
In this technology world, data loss or data breach tends to occur at least once a year which can cause serious implications for business of all sizes. Data loss or data breach can happen due to cyber attacks like ransomware, phishing, malware, etc or user errors like accidental deletion, unauthorized access, etc. Besides that, hackers like to target small and medium business enterprises with less than 1000 employees and most of this business enterprise don’t even have Disaster Recovery Plan (DRP) to encounter this problem. According to Small Business Trends, 43% of cyber attacks were targeted at small business enterprises as shown in figure 1 which have minimal security infrastructure that causes hackers to make easy attempts every day and it is expected to be increase by 18% in a few years [10].
However, 39% of small and medium sized business enterprises don’t have DRP to respond to data breaches and cyber attacks based on study conducted by Ponemon Institute’s 2019 Global State of Cybersecurity in Small and Medium-Sized Businesses. Hence, 60% of confidential data experienced on loss or theft [9]. Without DRP, business enterprises are unaware of data recovery procedure which able to recover lost data and prevent productivity loss of an enterprise.

In order to recover data, most of the business enterprise scare to send their storage media which contains lost data to data recovery service company due to several reasons like the data recovery company might steal the data, sell the database to a rival group, charge at very high price, fail to recover and damage it further and more [15]. Hence, purchasing a data recovery tool could benefits the business enterprise in recovering lost or damaged data. According to Disk Drill, there are top five best data recovery software of 2020 which is Disk Drill, PhotoRec, TestDisk, Recuva and EaseUS Data Recovery Wizard [7].

There are chances to recover loss data back but at the same time there are some influencing factor that lowers the success rate of data recovery. The most crucial factor is overwritten data where user continue to use the storage media to store data even though data loss occurred and they ignored it which could lead to permanent data loss. Besides this, file types and sizes also could affect the data recovery process where usually data of large file size like graphic or multimedia files will spread across the sectors in storage media that would take more time to scan damaged sector and recover it [14].

2. Literature Review on Existing System
The functionality of three data recovery tool that is selected out of five best data recovery tools mentioned above will be discussed below. The three tools are Recuva, Disk Drill and EaseUS Data Recovery Wizard.

2.1. Recuva
Recuva is a cross functional tool for file recovery that is supports on Windows and Mac operating system. There are two version of this tool which is free and professional that sell for $19.95. It is superior file recovery tool where it can recover images, music, documents, videos, emails and compressed files. The tool able to recover files from any rewriteable media and damages disks as well and it support file system of FAT families, NTFS, ext2, ext3 and HFS+ [1]. Besides this, the tool can perform deep scan for buried files and find traces of deleted files. Other than this, the tool has great feature of secure overwrite where it able to securely delete files using industry and military standard.
deletion techniques. The free version of Recuva able to perform advance file recovery only and can recover up to 1 GB only while Recuva Professional able to perform advance file recovery and the recovery size is limitless, support virtual hard drive recovery and update the tool automatically [3].

The advantages of this tool are able to filter scan results, find erased partitions, search for deleted files using specified parameters, scan and recover in high speed and the tool available in portable version [1] while the disadvantages of this tool are able to preview document file only, the tool will try to download other third party applications and downloading the tool itself will overwrite data in the system and it will be hard to recover [5].

2.2. EaseUs
EaseUS is all-in-one free data recovery software that is quick and complete file recovery for different data loss situations which can support in Windows and Mac desktop operating system and Android and IOS mobile operating system. The tool has four versions which is Free version, Pro version that sells for $69.95 per month, $99.95 per year and $149.95 for one-time purchase, Pro + Bootable Media version that sells for $99.90 and Technician that sells for $299.00 for one year, $399.00 for two year and $499.00 for one-time purchase. The tool able to perform recovery for lost data, recovery for lost, deleted, RAW and inaccessible partition, recovery for accidental formatted files and partition, recovery for damages, corrupted or inaccessible of all kind of storage media and recovery for emergency data that occurred due to disaster like virus attack, unexpected system crash, severe boot failure, etc. The tool able to recover more than 1000 types of file type of documents, graphics, video, audio, emails and other files. Besides this, the tool able to repair corrupted JPEG/JPG photos and damaged MP4/MOV videos. The free version of this tool able to recover files up to 2 GB, preview before recovery and recover data from deleted, hidden, lost or RAW partition. The Pro version of this tool able to recover unlimited data, preview before recovery, recover data from deleted, hidden, lost or RAW partition and EaseUS specialist provide free and high quality remote consultation and assistance for necessary cases while Pro and Bootable media version has additional feature of boot with downloadable WinPE when the system fails to start or crashes [8].

The advantages of this tool are able to recover while scanning, filter a specific file type, tag located files accurately, to pause and resume scanning process and the tool has advanced scan algorithm while the disadvantages of this tool are able to preview graphics and document files only, the tool cannot scan for individual folders and the tool requires quick scan before proceeding to deep scanning [2].

2.3. DiskDrill
Disk Drill is a powerful tool that able to scan, recover and protect data on virtually on any storage media which can support on Windows and Mac operating system. The tool has three versions which is Basic version, Pro version that sell for $89.00 and Enterprise version that sell for $499.00 [6]. The tool able to recover over 400 file formats of images, documents, audio, video and archives from any disk-based device with supported file system like HFS, HFS+, FAT16, FAT32, exFAT, NTFS, ext3 and ext4. Besides this, the tool able to protect data from any damage using three unique features which is recovery vault, guaranteed recovery and S.M.A.R.T monitor. Recovery Vault able to track every file removed from the computer and remember its location and filename. Guaranteed Recovery can make a copy of every file deleted from recycle bin and give “Undelete” option even though the user empties the recycle bin. Lastly, S.M.A.R.T monitor feature checks the storage media health and warns the user if there is any failing option. Other than that, the tool packed with free disk tool for basic and pro versions which includes cleaning software, creating backups and monitor disk’s health [4]. The basic version of this tool able to recover files up to 500 MB, has Recovery Vault data protection, create byte-to-byte backups of failing disks and preview before recovery. The Pro version of this tool able to recover unlimited data, has the feature of quick and deep scan, smart FAT and NTFS algorithm, lost partition search, etc., recovery for all kind of storage media and file types and license for one user but up to three activation only. The enterprise version of this tool able to recover unlimited data, has full-
featured commercial data recovery package, has priority support and license for 10 users and unlimited activations [6].

The advantages of this tool are able to save scan and resume recovery, preview for all files, the tool has multiple scan options and premium data protection while the disadvantages of this tool are the file preview is not effective, the tool has no portable version and the tool is difficult to start-up and sometimes it will crash [11].

| Tools / Features | File Recovery | Partition Recovery | Save scanning & resume recovery | High speed scanning & recovery | Available in portable version | Filter scanned files | Find erased partition | All types of file preview | Deep Scanning | Quick start up time | Data Protection | Recovering while scanning |
|------------------|---------------|---------------------|---------------------------------|--------------------------------|-------------------------------|----------------------|-----------------------|-------------------------|---------------|-----------------------|----------------|--------------------------|
| Recuva           | √             |                     |                                |                                |                               | √                    | √                     |                         |               |                       |               |                          |
| EaseUS           | √             | √                   | √                               |                               | √                             | √                   | √                     | √                       |               |                       |               |                          |
| Disk Drill       | √             | √                   | √                               |                               |                               | √                   | √                     | √                       |               |                       |               |                          |

Table 1 shows the comparison of features for all tools discussed in this paper.

Table 1. Comparison features of tools

3. Analysis on User Requirements

A survey of questionnaire has been conducted to collect user information related to data recovery and the response collected from the questionnaire has been analyzed. There are total 20 respondents involved in this questionnaire which is the students, lecturers from Asia Pacific University and public who working on industries. The overall analysis from the questionnaire will be discussed below.

The response gathered from the questionnaire is that user from the field of computing aware about data recovery while from other field like business, medical and others do not aware about data recovery. The most popular data recovery tool used among the users as shown in figure 2 below are Recuva, followed by EaseUS Data Recovery Wizard, PhotoRec, Disk Drill and other tools like Encase, Word Recovery.

![Figure 2: Analysis of tools used](image)

From the analysis shown in figure 3, 47% of users choose full recovery method, followed by 13% of users choose partial recovery method and 40% of users choose both methods to recover their files.
Figure 3: Analysis of recovery method

The file types that majority of users did recover is images (43%), followed by documents (29%), videos (21%), audio (7%) and other file types respectively for those who choose partial recovery method as shown in figure 4.

Figure 4: Analysis of file types recovered

Based on analysis shown in figure 5, 67% of users able to recover their file successfully while 33% of users did not able to recover their files.

Figure 5: Analysis of success rate of recovery

The majority of users used hard disk drive (HDD), followed by USB and solid state drive (SSD) respectively as shown in figure 6 to recover their damaged or lost files.

Figure 6: Analysis of storage media used

Majority of users used the size range of 2 - 8 GB (53%), followed by 16 - 64 GB (21%), 1 TB and above (16%) and 128 - 500 GB (11%) of storage media respectively as shown in figure 7 to recover their files.

Figure 7: Analysis of storage media size range
Based on analysis shown in figure 8, it took either less than one hour (40%) or more than one hour (40%) respectively, followed by more than one day (13%) and other options (7%) to recover their files.

> Figure 8: Analysis of time taken to recover

Lastly, 40% of users wants to improve feature of user-friendly interface, followed by 18.5% on file recovery based on file type feature and 18.5% on file recovery based on selected range of dates feature and 23% on successful recovery feature respectively as shown in figure 9.

> Figure 9: Analysis of features needed for tool

4. **Proposed System functionality**

A customize data recovery tool will be developed based on user requirement analysis but the tool will have certain limitation which is it only support for Windows operating system and file system for Windows and external storage media like FAT 12, FAT16, FAT 32, exFAT, ext2, ext3, ext4, NTFS and ReFS. Based on analysis from questionnaire response, most of the users would like to recover files using both methods which is full recovery and partial recovery. Hence, this customize will be focused on partial recovery method as most of the tool available for full recovery. There will be two types of techniques will be used to recover files which is recover files based on file types and recover files based on selected range of date. This recovery techniques will be useful for the users like students or employees who working on their projects or assignments for months. However, they faced some data loss disaster of their storage media where they used to save all their works before the due date of submission. Hence, they can use this data recovery tool that consists of these two techniques which able to recover their last-minute projects or assignments.

4.1. **File recovery based on file types**
This technique is works by analyzing the data stored in disk sector and search for file signature according to the file type. File signature is a unique pattern owned by every file type that signify the beginning and end of file [13]. For example, the file signature of jpeg or jpg file type will begin with file header of “FF D8” and end with file trailer of “FF D9”. Thus, the tool will use the file signature to identify the data stored in storage media that belongs to certain file type and can be recovered. The user can use this technique to recover any files that related to their projects or assignments.

4.2. File recovery based on selected range of dates
This technique is work by analyzing the file system of storage media and search for metadata of the files. Metadata is a structural information about files and folders like name and path of parent folder, date and time stamp, author and access right and location and size stored in storage media that is maintained by a file system [12]. Hence, when the user select range of dates the tool will search for metadata of the file system in storage media while scanning the storage media and identify files that belongs to selected range of dates and recover it. The user can use this technique to recover important files like final documentation of the assignment or project that need to submit.

5. Data Recovery System Framework
As shown in figure 10, once the user launches the data recovery tool, user has to select desired storage media that need to be recover. Then, the tool will create forensic image of the storage media to prevent data tampering of original file and preserve integrity of files. Next, user has to recovery method of partial recovery which is either file recovery based on file types or file recovery based on selected range of dates.

If user select on file recovery based on file types method then they have to choose file types like images, documents, audio, video, etc. that they wish to recover. After selecting the options, the tool will start scanning the forensic image of the storage media and analyses every byte of disk sector. Then, the tool will search for file signatures for selected file types and display the results folder and files.

If the user selects on file recovery based on selected range of dates then they have to input the range of dates that they wish to recover. Hence, the tool will start scanning of the forensic image of storage media and analyses the metadata of file system of storage media. Then, the tool will search for range of dates selected by the user and recognize the files that belongs to the dates. After that, the tool will display the results of files and folders of selected range of dates.

When the tool start scanning the image of storage media, it will start read and process the first copy of storage media service data and information at the beginning of partition. If the 1st copy is damaged then the tool will read and process 2nd copy of storage media service data and information. This is because file system usually makes backup of information of files and folders [13]. After displaying the results files and folders based on chosen file recovery method then user able to recover those files successfully.

6. Conclusions
Most of the data recovery tool available on internet provide full file recovery service and some data recovery provide partial file recovery service which is based on selected file types. Thus, it took longer time to scan and analyze files and folders in storage media as it has to search for every byte of sector. At the same time, the tool will take longer time to recover whole storage media or files selected by the user. This is because the size of storage media used by user to recover the files. The bigger the size of storage, the longer time it will take to recover the files. But this customize tool able to provide results very fast even though the size of storage media is large. This is because this tool able to scan and analyze the metadata that contain selected range of dates and search for files related to selected date. Hence, the scanning process will be faster and display the results quicker than other tools. At the same time, it will be short time to recover the files as it only recovers files based on selected range of dates. Last but not least, backup is very important to prevent losing of essential files and data because it can help to retrieve files easily and it is time saving too and user don’t have to waste time perform file recovery.

References
[1] Brown, V., 2019. Recuva - cross functional tool for data recovery on Windows 10. [Online] Available at: https://howtorecover.me/recuva-recover-deleted-files-windows-10 [Accessed 09 March 2020].
[2] Burchill, A., 2017. EaseUS Data Recovery Wizard Professional Review. [Online] Available at: https://computer-fixperts.com/hard-drive-data-recovery/easeus-review/ [Accessed 09 March 2020].
[3] CCleaner, 2020. Recuva. [Online] Available at: https://www.ccleaner.com/recuva [Accessed 09 March 2020].
[4] Cleverfiles, 2020. What is Disk Drill?. [Online] Available at: https://www.cleverfiles.com/help/what-is-disk-drill/ [Accessed 09 March 2020].
[5] Cook, J., 2019. Recuva Review: Is Recuva Safe?. [Online] Available at: https://www.any-data-recovery.com/alternative/recuva-review.html
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