Determining the Probability of Recovering Data from Damaged USB Flash Drive

Kalpana Shinde, Vini Kale, C.N.Kayte, Shobha Bawiskar

Abstract: Habit of storing digital data is becoming a common practice. To cope this need lots off secondary memory devices are commercially available in cheap prices. Important factor is significance of data, its dependability in human daily life. Hence looking at this scenario the cyber crime rates are at hike. Mostly after committing the crime intentionally or unintentionally criminals try to destroy the digital evidence by doing damage to e-device. Basic aim is to check whether damaged secondary can recover the data or not. For this purpose various damaged setup are done and by using software’s results are analyzed.

Keywords: Pen Drive (PD), Pen Drive Models, Data Recovery, Damaged PD

I. INTRODUCTION

Secondary storage media are widely used as it is portable, small/micro in size, light weighted and easily carried from one place to another. Consumes less power compared to other devices.[21] Universal USB, less expensive. . The USB which stands for Universal Serial Bus is already a customary in business for attaching peripheral devices to different types of computer [17, 18]. In this article A pen drive, or a USB flash drive is used for digital investigation. In market currently available pen drives with storage capacities ranging from 4GB and 32GB, 64 GB,… can be used to store multimedia content like graphics-heavy documents, photos, music files and video clips of various file formats. [19, 20] As of March 2016, flash drives with anywhere from 8 to 256 GB were frequently sold, while 512 GB and 1 TB units were less frequent [13,14]. As of 2018, 2TB flash drives were the largest available in terms of storage capacity.[15]. The extensive market for USB flash drives which is projected to exceed 555 million units by the year 2020 had shown the increasing importance of the technology in consumer applications [16].

II. PEN DRIVE

Design and implementation 1. USB standard male-A plug 2. USB mass storage control device. 3. Test points. 4. Flash memory chip. 5. Crystal oscillator 6. LED (optional). 7. Write protect switch (option). 8. Space for second flash memory[22,23]

I. PEN DRIVE MODELS:

Now a day’s storage devices, recording devices, spy camera are present in disguised manner. It’s just unbelievable that such devices exits can be used for or against any persons either to save or destroy human property.(may be tangible or intangible). Cyber Crime is technology based crime committed by technocrats.[12]
Determining the Probability of Recovering Data from Damaged USB Flash Drive

As this research article is focused on pen drives few disguised pen drive models are shown below.

Credit card style memory flash USB drive

High Quality Usb Flash Drive Real Capacity Pen Drive

China USB Flash Drive Cartoon Boy Toy Pen Drive Building Blocks Pendrive 4GB 8GB 16GB 32GB 64GB

Usb Bracelets

16gb car model usb 2.0 flash drive memory smart design storage u ...

8GB USB2.0 Memory Stick Creative Metal Wrench USB Flash

---

Retrieval Number: E10440785S319/2019©BEIESP
DOI: 10.35940/ijeat.E1044.0785S319

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

180
| URL | Image | Description |
|-----|-------|-------------|
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | 4-1 pen drive |
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | Diary pen drives |
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | Fancy Heart shape pen drive |
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | Wooden USB pen drive |
| [https://google.com/search?q=images+of+funny+pen+drive&gws_img_rsz=672x672&num=200&hl=en&safe=strict&tbm=isch] | ![Image](https://google.com/search?q=images+of+funny+pen+drive&gws_img_rsz=672x672&num=200&hl=en&safe=strict&tbm=isch) | IRT1 - funny picture #8035 - tags: usb tech |
| [https://google.com/search?q=images+of+funny+pen+drive&gws_img_rsz=672x672&num=200&hl=en&safe=strict&tbm=isch] | ![Image](https://google.com/search?q=images+of+funny+pen+drive&gws_img_rsz=672x672&num=200&hl=en&safe=strict&tbm=isch) | Funny And Cool USB Sticks |
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | Credit card style memory flash USB drive |
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | High Quality USB Flash Drive Real Capacity Pen Drive 16GB~128GB |
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | China USB Flash Drive Cartoon Boy Toy Pen Drive Building Blocks Pendrive 4GB 8GB 16GB 32GB 64GB |
| [https://subusb.com](https://subusb.com) | ![Image](https://subusb.com) | Usb Bracelets 16gb car model usb 2.0 flash drive memory smart design storage u ... |
| [https://google.com/search?q=images+of+funny+pen+drive&gws_img_rsz=672x672&num=200&hl=en&safe=strict&tbm=isch] | ![Image](https://google.com/search?q=images+of+funny+pen+drive&gws_img_rsz=672x672&num=200&hl=en&safe=strict&tbm=isch) | 8GB USB2.0 Memory Stick Creative Metal Wrench USB Flash |
Data loss, data deletion, device formatting or physical damage to PD may be accidentally or unintentionally happen. In this scenario role of data is important. Hence data recovery can be possible in above mentioned criteria’s. this article majorly deals with physically damaging PD and then check for data recovery possibilities.

A. Data Recovery

The information remaining on the storage can be recovered to a safe location. Recovery chances depend greatly on the specific data loss situation Data recovery software serves to get data back after its loss with the maximum result possible. Commonly, data recovery process is based on storage scan to find specific information (deleted files, lost file systems) and assemble structures of the damaged file system.

The process of retrieving and handling the data from damaged, failed, corrupted or inaccessible secondary storage device when it is unable to access it normally is known as file recovery process.[11]

B. Recovery data process is done in three steps:

1. Recovery Software first detects the device PD
2. Scan the device (select either 2.1 or 2.2)
3. for this article 2.2 is selected
   2.1 Quick Scan - Searches for deleted files and folders using a basic algorithm for fast results.
   2.2 Deep Scan - Scans the storage device sector by sector to ensure recovery results.
4. Recover the data can be F= Fully recovered, P=partially Recovered, NO=No Recovery...

IV. EXPERIMENT:-

A. Data Sample: Multimedia content of one GB (1-GB data) with Maximum types of file extensions are collected as data sample.

B. Device used: 25 SanDisk’s Cruzer Blade™ USB Flash Drive of 16 GB (PD).

| Sample No | Mud         | Time Factor | Detectable | Recovery possibility |
|-----------|-------------|-------------|------------|---------------------|
| Sample 1  | Dry         | 1hr         | yes        | yes                 |
| Sample 2  | Dry         | 1-day= 24hrs| yes        | yes                 |
| Sample 3  | Semi wet    | 1hr         | yes        | yes                 |
| Sample 4  | Semi Wet    | 5hrs        | yes        | yes                 |
| Sample 5  | Liquid muddy| 7-days=168 hrs| yes    | yes                 |
2.2 Method 2: Use of aqueous media like Water,

| Sample No | Water amount | Water Type       | Environment temperature min approximately | Time depth Factor | Detected | Recovery possibility |
|-----------|--------------|------------------|--------------------------------------------|-------------------|----------|----------------------|
| Sample 1  | 4 ltr in bucket | Normal Water     | 6-8                                        | 1 hr              | yes      | yes                  |
| Sample 2  | 4 ltr in bucket | Normal Water     | 8-11                                       | 12 hrs            | yes      | yes                  |
| Sample 3  | 500 ml in bottle | Drainage Water  | 8-14                                       | 12 hrs            | yes      | yes                  |
| Sample 4  | 500 ml in beaker | Hot 50 continuously boiled Water | 11-14 | 1 hr | yes | yes |
| Sample 5  | 500 ml in beaker | Hot 100 continuously boiled Water | 11-14 | 1 hr | No  | No |

2.3 Method 3: Heating Method

| Sample No | Heating equipment used | Temperature in Celsius | Time Factor | Detectable | Recovery possibility |
|-----------|------------------------|------------------------|-------------|------------|----------------------|
| Sample 1  | Hot Oven Method        | 50                     | 1 hr        | yes        | yes                  |
| Sample 2  | Hot Oven Method        | 80                     | 1 hr        | yes        | yes                  |
| Sample 3  | Hot Oven Method        | 160                    | 1 hr        | yes        | yes                  |
| Sample 4  | Bunsen Burner heated   | 05 sec                 | yes         | yes        | yes                  |
| Sample 5  | Bunsen Burner heated   | 60 min                 | Yes/no      | no         | no                   |

2.4 Method 4: Freezing Method

| Sample No | Freezer Temperature in degree Celsius | Time Factor | Detectable | Recovery possibility |
|-----------|---------------------------------------|-------------|------------|----------------------|
| Sample 1  | -20                                   | 1           | yes        | yes                  |
| Sample 2  | -20                                   | 24          | yes        | yes                  |
| Sample 3  | -20                                   | 48          | yes        | yes                  |
| Sample 4  | -20                                   | 72          | yes        | yes                  |
| Sample 5  | -20                                   | 96          | yes        | yes                  |
Determining the Probability of Recovering Data from Damaged USB Flash Drive

2.5 Method 5: Scratching Method

| Sample No | No of Scratches with I-pin | Detectable | Recovery possibility |
|-----------|-----------------------------|------------|----------------------|
| Sample 1  | 100                         | yes        | yes                  |
| Sample 2  | 150                         | yes        | yes                  |
| Sample 3  | 200                         | yes        | yes                  |
| Sample 4  | 250                         | yes        | yes                  |
| Sample 5  | 500                         | no         | no                   |

Observation

Method: Water Deep Method

| Recuva[1] | No of samples | Type s of files in | No. of files before recover | Scanning status | No files after recover | Noise And type of noise & Reason of noise | Data loss | Time required for deep scanning | Type of recovery F/P/NO recovery | Recovered Data |
|-----------|---------------|--------------------|-----------------------------|-----------------|-----------------------|------------------------------------------|-----------|-------------------------------|------------------|----------------|
| 1 HR in clean water | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 300 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | N | 2.40 HR | F | 33GB |
| 12 HR in clean water | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 300 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | N | 1.25HR | F | 33GB |
| 12 HR dirty water | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 300 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | N | 2.10HR | F | 33GB |
| 1.15 HR in water at 60 degree | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 299 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | N | 1.5 HR | F | 33GB |
| 1 HR boiling water | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 00 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | N | 0.00 | F | 1.70GB |
| 7data[2] | 1 HR in clean water | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 505 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | No | 2.15 HR | F | 1.70GB |
| 12 HR in clean water | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 505 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | No | 1.56 HR | F | 1.70GB |
| 12 HR dirty water | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 505 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | No | 2.16HR | F | 1.70GB |
| 1.15 HR in water at 60 degree | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 500 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | No | 2.45 HR | F | 1.70GB |
| 1 HR boiling water | 269 | Webp ,dll,exe,m4a ,mp3, jpg,png,pp tx,doc,s,pdf, mkv, mp4 | 269 | Successful | 00 | Types of noise: Wed,To,TED,OY, OUT,CESa,ITH,IO N,ING,ILE,I,I<, HFA,H<,H<,Fix, File,EAD,ATE,AT A,AND,AFL,%f",s "",SD Reason: due to damaged PD noise get added. | No | 0.00 | F | 997MB |

Photor: 1 HR in clean water | 269 | Successful | 274 | No | 1.67 HRS | F | 997MB |
### Table 1: Results of Data Recovery

| Method                  | No of samples | Types of files | No files before recover | Scanning status | No files after recover | Noise And type of noise & Reason of noise | Data loss | Time required for deep scanning | Type of recovery F/P/NO recovery | Recovered Data |
|-------------------------|---------------|----------------|-------------------------|-----------------|-----------------------|-------------------------------------------|-----------|-------------------------------|----------------------------------|----------------|
|                         |               |                |                         |                 |                       |                                           |           |                               |                                   |                |
| 12 HR in clean water    | 269           | Successful     | 274                     | NO noise        |                       |                                           | No        | 1.30 HRS                      | F                  | 997MB                       |
|                         |               |                |                         |                 |                       |                                           | No        | 1.55 HRS                      | F                  | 997MB                       |
|                         |               |                |                         |                 |                       |                                           | No        | 1.57 HRS                      | F                  | 997MB                       |
| 12 HR dirty water       | 269           | Successful     | 274                     | NO noise        |                       |                                           | No        | 1.30 HRS                      | F                  | 997MB                       |
|                         |               |                |                         |                 |                       |                                           | No        | 1.55 HRS                      | F                  | 997MB                       |
|                         |               |                |                         |                 |                       |                                           | No        | 1.57 HRS                      | F                  | 997MB                       |
| 1.15 HR in water at 60 degree | 269 | Successful     | 274                     | NO noise        |                       |                                           | No        | 1.30 HRS                      | F                  | 997MB                       |
|                         |               |                |                         |                 |                       |                                           | No        | 1.55 HRS                      | F                  | 997MB                       |
|                         |               |                |                         |                 |                       |                                           | No        | 1.57 HRS                      | F                  | 997MB                       |
| 1 HR boiling water      | 269           | NOT DETECTED   |                         |                 |                       |                                           | No        |                               | F                  | 00                         |
|                         |               |                |                         |                 |                       |                                           | No        |                               | F                  | 00                         |
| **Stellar** [4]         |               |                |                         |                 |                       |                                           | No        |                               | F                  | 00                         |
| 1 HR in clean water     | 269           | Successful     | 270                     | ---------------- |                       |                                           | No        | 2.58 hrs                      | F                  | 1GB                        |
|                         |               |                |                         |                 |                       |                                           | No        | 1.45 hrs                      | F                  | 1GB                        |
|                         |               |                |                         |                 |                       |                                           | No        | 3.15 hrs                      | F                  | 1GB                        |
| 12 HR in clean water    | 269           | Successful     | 270                     | NO noise        |                       |                                           | No        | 3.15 hrs                      | F                  | 1GB                        |
|                         |               |                |                         |                 |                       |                                           | No        | 1.45 hrs                      | F                  | 1GB                        |
| 12 HR dirty water       | 269           | Successful     | 270                     | NO noise        |                       |                                           | No        | 3.15 hrs                      | F                  | 1GB                        |
|                         |               |                |                         |                 |                       |                                           | No        | 1.45 hrs                      | F                  | 1GB                        |
| 1.15 HR in water at 60 degree | 269 | Successful     | 270                     | NO noise        |                       |                                           | No        | 3.15 hrs                      | F                  | 1GB                        |
|                         |               |                |                         |                 |                       |                                           | No        | 1.45 hrs                      | F                  | 1GB                        |
| 1 HR boiling water      | 269           | NOT DETECTED   |                         |                 |                       |                                           | No        |                               | F                  | 00                         |
|                         |               |                |                         |                 |                       |                                           | No        |                               | F                  | 00                         |
| **Method: Buried Method** |               |                |                         |                 |                       |                                           | No        |                               | F                  | 00                         |

### Table 2: Data Recovery Results

| recuva         | No of samples | Types of files | No files before recover | Scanning status | No files after recover | Noise And type of noise & Reason of noise | Data loss | Time required for deep scanning | Type of recovery F/P/NO recovery | Recovered Data |
|----------------|---------------|----------------|-------------------------|-----------------|-----------------------|-------------------------------------------|-----------|-------------------------------|----------------------------------|----------------|
| 1 HR Land      |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 303 | Types of noise: Wed,To,TED,OY,OUT,CESa,ITH,1ON,ING,ILE,IA,1 <,HFA,H,<E,H,<,Fix,File,EAD,AT,E,ATA,AND,AF L,%","","SD,Reason: due to damaged PD noise get added. | No   | 2.54hr                      | F                  | 33GB                       |
| 24 Land        |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 300 | Types of noise: Wed,To,TED,OY,OUT,CESa,ITH,1ON,ING,ILE,IA,1 <,HFA,H,<E,H,<,Fix,File,EAD,AT,E,ATA,AND,AF L,%","","SD,Reason: due to damaged PD noise get added. | No   | 1.45 hrs                    | F                  | 33GB                       |
| 1 HR Mud       |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 300 | Types of noise: Wed,To,TED,OY,OUT,CESa,ITH,1ON,ING,ILE,IA,1 <,HFA,H,<E,H,<,Fix,File,EAD,AT,E,ATA,AND,AF L,%","","SD,Reason: due to damaged PD noise get added. | No   | 1.43 hrs                    | F                  | 33GB                       |
| 5 HR mud       |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 300 | Types of noise: Wed,To,TED,OY,OUT,CESa,ITH,1ON,ING,ILE,IA,1 <,HFA,H,<E,H,<,Fix,File,EAD,AT,E,ATA,AND,AF L,%","","SD,Reason: due to damaged PD noise get added. | No   | 1.43 hrs                    | F                  | 33GB                       |
| 25 HR mud      |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 287 | Types of noise: Wed,To,TED,OY,OUT,CESa,ITH,1ON,ING,ILE,IA,1 <,HFA,H,<E,H,<,Fix,File,EAD,AT,E,ATA,AND,AF L,%","","SD,Reason: due to damaged PD noise get added. | No   | 1.45 hrs                    | F                  | 29.5GB                      |

| 7datarec       |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 505 | Repeated data get recovered. | No   | 2.10 hrs                      | F                  | 1.70GB                      |
| 24 Land        |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 505 | Repeated data get recovered. | No   | 1.56 hrs                      | F                  | 1.70GB                      |
| 1 HR Mud       |               | Webp,dll,exe,m4a,mp3,jpg,png,pp,doc,pdf, mkv, mp4 | 269 | Successful | 500 | Repeated data get recovered. | No   | 2.19 hrs                      | F                  | 1.70GB                      |
## Determining the Probability of Recovering Data from Damaged USB Flash Drive

| Method: Heating method | .No of samples | Types of files in | No files before recover | Scanning status | No files after recover | Noise And type of noise & Reason of noise | Data loss | Time required for deep scanning | Type of recovery F/P/NO recovery | Recovered Data |
|------------------------|----------------|------------------|-------------------------|----------------|-----------------------|------------------------------------------|-----------|-------------------------------|----------------------------------|----------------|
| recuva | At 80 degree in hot air oven | Webp, dlexl , m4a, mp3, j pg, png ,pptx, docs, pd f, mkv, mp4 | 269 | Successfu l | 288 | Types of noise: Wed,To,TED,OY,O UT,CE Sa,ITH,ION, IN G,ILE,IA,1<,HF A,H<(E,H<,Fix,File ,EAD,ATE,ATA,A ND,AFL,%"",SD | No | 3.56 hr | F | 29.5GB |
| | At 110 degree in hot air oven | Webp, dlexl , m4a, mp3, j pg, png ,pptx, docs, pd f, mkv, mp4 | 269 | Successfu l | 285 | Reason: due to damaged PD noise get added. | No | 3.45 hrs | F | 29.5GB |
| | At 160 degree in hot air oven | 269 | Not Detected | | | | | | |

##raw_text##

| Method: Heating method | .No of samples | Types of files in | No files before recover | Scanning status | No files after recover | Noise And type of noise & Reason of noise | Data loss | Time required for deep scanning | Type of recovery F/P/NO recovery | Recovered Data |
|------------------------|----------------|------------------|-------------------------|----------------|-----------------------|------------------------------------------|-----------|-------------------------------|----------------------------------|----------------|
| photorec | 1 HR Land | Webp, dlexl , m4a, mp3, j pg, png ,pptx, docs, pd f, mkv, mp4 | 269 | Successfu l | 274 | | No | 1.56 hrs | F | 997MB |
| | 24 Land | | | | | | | | | |
| | 1 HR Mud | | | | | | | | | |
| | 5 HR mud | | | | | | | | | |
| | 25 HR mud | | | | | | | | | |
| Stellar | 1 HR Land | Webp, dlexl , m4a, mp3, j pg, png ,pptx, docs, pd f, mkv, mp4 | 269 | Successfu l | 270 | | No | 2.16 hrs | F | 1.0 GB |
| | 24 Land | | | | | | | | | |
| | 1 HR Mud | | | | | | | | | |
| | 5 HR mud | | | | | | | | | |
| | 25 HR mud | | | | | | | | | |
| 7datarec | At 80 degree in hot air oven | Webp, dll, exe, .m4a, mp3, jpeg, png, pptx, docs, pd f, mkv, mp4 | 269 | Successful | 500 | Repeated data get recovered. | No | 2.10 hrs | F | 166GB |
|----------|-----------------------------|-------------------------------------------------|-----|----------------|----|-------------------------------|----|----------|----|-------|
|          | At 110 degree in hot air oven | Webp, dll, exe, .m4a, mp3, jpeg, png, pptx, docs, pd f, mkv, mp4 | 269 | Successful | 496 | Noise:#.OUT file | No | 1.56 hrs | F | 166GB |
|          | At 160 degree in hot air oven | Webp, dll, exe, .m4a, mp3, jpeg, png, pptx, docs, pd f, mkv, mp4 | 269 | Successful | 498 | Repeated data get recovered. | No | 2 hrs | F | 166GB |
|          | 5 sec. on flame | Webp, dll, exe, .m4a, mp3, jpeg, png, pptx, docs, pd f, mkv, mp4 | 269 | Successful | 278 | | No | 1.56 hrs | F | 921MB |
|          | 1min. on flame | Webp, dll, exe, .m4a, mp3, jpeg, png, pptx, docs, pd f, mkv, mp4 | 269 | Successful | 278 | | No | 1.50 hrs | F | 921MB |
|          | 5 sec. on flame | Webp, dll, exe, .m4a, mp3, jpeg, png, pptx, docs, pd f, mkv, mp4 | 269 | Successful | 278 | | No | 2.14 hrs | F | 921MB |
|          | 1min. on flame | Webp, dll, exe, .m4a, mp3, jpeg, png, pptx, docs, pd f, mkv, mp4 | 269 | Successful | 278 | | No | 2.16 hrs | F | 1.0GB |

No 1.13 hrs F 29.5GB

No 00

No 2.00

No 00

No 2.10 hrs F 166GB

No 1.56 hrs F 166GB

No 2 hrs F 166GB

No 1.56 hrs F 921MB

No 1.50 hrs F 921MB

No 00

No 2.14 hrs F 921MB

No 2.16 hrs F 1.0GB
Determining the Probability of Recovering Data from Damaged USB Flash Drive

| Method: Freezing Method |
|-------------------------|
| **No of samples** | **Types of files in** | **No of files before recover** | **Scanning status** | **No files after recover** | **Noise And type of noise & Reason of noise** | **Data loss** | **Time required for deep scanning** | **Type of recovery F/P/NO recovery** | **Recovered Data** |
| Webp, dll, exe, .mp3, jpg, png, .pptx, docs, pd f, mkv, mp4 | 269 | successful | 288 | Types of noise: Wed, To, TED, OY, OUT, CESa, ITH, ION, ING, ILE, IA, I <, HFA, H < (E, H <, Fix, File, EAD, AT, E, ATA, AND, AF L, %f", "s", SD | No | 1.56 hrs | F | 29.5GB |
| Yes | 1.50 hrs | P | 29.5GB |
| Yes | 1.57 hrs | P | 29.5GB |
| Yes | 2.14 hrs | P | 29.5GB |
| Yes | 1.45 hrs | P | 6.62GB |

**datarec**

| **No of samples** | **Types of files in** | **No of files before recover** | **Scanning status** | **No files after recover** | **Noise: #.OUT file** | **Data loss** | **Time required for deep scanning** | **Type of recovery F/P/NO recovery** | **Recovered Data** |
| Webp, dll, exe, .mp3, jpg, png, .pptx, docs, pd f, mkv, mp4 | 269 | successful | 501 | Repeat data get recovered. | No | 2.15 hrs | F | 1.67GB |
| No | 1.56 hrs | F | 1.67GB |
| No | 1.59 hrs | F | 1.67GB |
| No | 2.19hrs | F | 1.67GB |
| No | 2.10 hrs | F | 1.67GB |

**photorec**

| **No of samples** | **Types of files in** | **No of files before recover** | **Scanning status** | **No files after recover** | **Noise:** | **Data loss** | **Time required for deep scanning** | **Type of recovery F/P/NO recovery** | **Recovered Data** |
| Webp, dll, exe, .mp3, jpg, png, .pptx, docs, pd f, mkv, mp4 | 269 | successful | 278 | | No | 1.56 hrs | F | 921MB |
| No | 1.50 hrs | F | 921MB |
| No | 1.57 hrs | F | 921MB |
| No | 2.14 hrs | F | 921MB |
| Yes | 1.45 hrs | P | 921MB |
| Freeze Duration | Files Type          | No of Samples | Scanning Status | No of Files before | No of Files after | Noise And type of noise & Reason of noise | Data Loss | Time Required for Deep Scanning | Type of Recover & NO recovery | Recovered Data |
|-----------------|---------------------|---------------|----------------|-------------------|------------------|------------------------------------------|-----------|-------------------------------|---------------------------------|----------------|
| 1 HR Freeze     | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269           | Successful     | 269               | 271              | Types of noise: Wed, To, TED, OY, OUT, CESa, ITH, ION, ING, ILE, IA, <, HFA, H<, E, H<, Fx, File, EAD, AT, E, ATA, AND, AF, L, %f", s", SD | Yes       | 1.56 hrs                      | P                   | 6.63GB                      |
| 24 HR Freeze    | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269           | Successful     | 269               | 287              | No                                       | No        | 1.50 hrs                      | F                   | 29.5GB                      |
| 48 HR Freeze    | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269           | Successful     | 269               | 268              | Yes                                      | Yes       | 1.57 hrs                      | P                   | 6.62GB                      |
| 72 HR Freeze    | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269           | Not Detected   | 269               | No               | Repeated data get recovered. Noise: #.OUT file | No        | 2.15 hrs                      | F                   | 1.66GB                      |
| 96 HR Freeze    | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269           | Not Detected   | 269               | No               | No                                       | No        | 1.56 hrs                      | F                   | 1.65GB                      |
|                 |                     | 250           | Not Detected   | 269               | No               | No                                       | No        | 1.59 hrs                      | F                   | 1.65GB                      |
|                 |                     | 500           | Not Detected   | 269               | No               | 1.56 hrs                                | No        | 1.56 hrs                      | F                   | 921MB                       |
|                 |                     | 100           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269 | Successful | 279             | No                                      | 1.56 hrs | F                           | 921MB              |
|                 |                     | 150           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269 | Successful | 277             | No                                      | 1.56 hrs | F                           | 921MB              |
|                 |                     | 200           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269 | Successful | 277             | No                                      | 1.50 hrs | F                           | 921MB              |
|                 |                     | 250           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269 | Not Detected | 277            | No                                      | 1.50 hrs | F                           | 921MB              |
|                 |                     | 500           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269 | Not Detected | 277            | No                                      | 1.50 hrs | F                           | 921MB              |

Method: Scratch Method

| Method | No of Samples | Types of Files | No of Files before | Scanning Status | No of Files after | Noise And type of noise & Reason of noise | Data Loss | Time Required for Deep Scanning | Type of Recover & NO recovery | Recovered Data |
|--------|---------------|----------------|--------------------|-----------------|------------------|------------------------------------------|-----------|-------------------------------|---------------------------------|----------------|
| recuva | 100           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 271              | Types of noise: Wed, To, TED, OY, OUT, CESa, ITH, ION, ING, ILE, IA, <, HFA, H<, E, H<, Fx, File, EAD, AT, E, ATA, AND, AF, L, %f", s", SD | Yes       | 1.56 hrs                      | P                   | 6.63GB                      |
|        | 150           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 287              | No                                       | No        | 1.50 hrs                      | F                   | 29.5GB                      |
|        | 200           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 268              | Yes                                      | Yes       | 1.57 hrs                      | P                   | 6.62GB                      |
|        | 250           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Not Detected   | 271              | Repeated data get recovered. Noise: #.OUT file | No        | 2.15 hrs                      | F                   | 1.66GB                      |
|        | 500           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Not Detected   | 277              | No                                       | No        | 1.56 hrs                      | F                   | 1.65GB                      |
| 7datarec| 100           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 498              | Repeated data get recovered. Noise: #.OUT file | No        | 2.15 hrs                      | F                   | 1.66GB                      |
|        | 150           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 496              | No                                       | No        | 1.56 hrs                      | F                   | 1.65GB                      |
|        | 200           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 497              | No                                       | No        | 1.59 hrs                      | F                   | 1.65GB                      |
|        | 250           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Not Detected   | 498              | No                                       | No        | 2.15 hrs                      | F                   | 1.66GB                      |
|        | 500           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Not Detected   | 496              | No                                       | No        | 1.56 hrs                      | F                   | 1.65GB                      |
| Photorec | 100           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 279              | No                                      | No        | 1.56 hrs                      | F                   | 921MB                       |
|        | 150           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 277              | No                                      | No        | 1.56 hrs                      | F                   | 921MB                       |
|        | 200           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Successful     | 277              | No                                      | No        | 1.50 hrs                      | F                   | 921MB                       |
|        | 250           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Not Detected   | 277              | No                                      | No        | 1.50 hrs                      | F                   | 921MB                       |
|        | 500           | Webp, dll, exe, .m4a, mp3.j, pg, png, .pptx, d ocs, pd f, mkv, mp4 | 269    | Not Detected   | 277              | No                                      | No        | 1.50 hrs                      | F                   | 921MB                       |
Determining the Probability of Recovering Data from Damaged USB Flash Drive

| Stellar | 100 | Webp, dll.exe, .m4a, mp3, jpg, pg.png, .pptx, docs, pd, f.mkv, mp4 | 269 | successful | 267 | 1.45 hrs | F | 1.0GB |
|---------|-----|-----------------------------|-----|------------|-----|----------|---|------|
| 150     |     | 269 | successful | 265 | NO | 2.15 hrs | F | 0.99GB |
| 200     |     | 269 | successful | 267 | NO | 2.30 hrs | F | 0.99GB |
| 250     |     | 269 | Not Detected | NO | N | 0 | 0 | 0 |
| 500     |     | 269 | Not Detected | NO | N | 0 | 0 | 0 |

V. RESULT AND CONCLUSION:

Physical damage was done by applying Various Methods like Buried in soil, Deeping in aqueous media like water, Heating, Freezing Scratching to the PD with various criteria and conditions and then during recovery of data is recovered in successful recovery, Partially Successful Recovery and unsuccessful Recovery. Unsuccessful recovery was happened at very extreme conditions when applied. It is concluded that stellar phoenix as it was licensed software gives 100% result with little noise insertion. While other three software are observed maximum noise is inserted because of which file properties like file size changed, memory space changed. One disadvantage was that more memory size to store so many amounts of data is required

REFERENCES:

1. Recuva software https://recuva.en.softonic.com/downloadStellar Phoneix
2. Data Recovery Software https://datarecovery.com/#forwardPhotec data recovery
3. PhotoRec 7.0 Data Recovery - https://downloads.tomsguide.com/PhotoRec.0301-3287.html
4. Stellar Phonix - https://www.stellarinfo.com/
5. https://www.google.com/search?q=ICICBD_enIN764IN764&biw=1200&bih=616&tbm=isch&sa=1&ei=Z9eIXKuIGZa9rQHiEval:
7. https://www.google.com/search?q=ICICBD_enIN764IN764&biw=1200&bih=616&tbm=isch&sa=1&ei=Z9eIXKuIGZa9rQHiEval:
8. https://www.google.com/search?q=ICICBD_enIN764IN764&biw=1200&bih=616&tbm=isch&sa=1&ei=Z9eIXKuIGZa9rQHiEval:
9. https://www.google.com/search?q=ICICBD_enIN764IN764&biw=1200&bih=616&tbm=isch&sa=1&ei=Z9eIXKuIGZa9rQHiEval:
10. https://www.wantitall.co.za/pchardware/8gb-usb2.0-memory-stick-creative-metal-wrench-usb-flash-drive-kempnum-funny-gift-

11. Sneha Pandhare, Dr.Shebha Bawiskar, “Recovery Of Data From Damaged Disks” (“Online-Oral Presentation”, International Conference on “Innovations in Engineering, Technology and Sciences” - (ICETES2018) with callog “CFP18Q63-PRC.1978-1-3364-7321-8” held on September 21-22 2018, NIE Institute of Technology, Mysore, Karnataka, (Bangalore)India, will be published in IEEE Xplore Digital Library
12. Alpna, Dr. Sona Malhotra, “Cyber Crime-Its Types, Analysis and Prevention Techniques” International Journal of Advanced Research in Computer Science and Software Engineering

Research Volume 6, Issue 5, May 2016 ISSN: 2277 128X .jpeg no 145. Paper Available online at: www.jarcuse.com
13. Madison, Alex (2016-07-09), “Keychain Not Included: The Five Highest-Capacity USB Flash Drives For Your Digital Life”. Digital Trends. Retrieved 17 October 2016.
14. Jump up to a b Athow, Desire (2016-07-04). “The best USB flash drives 2016”. Tech Radar. Retrieved 17 October 2016.
15. “The Largest Flash Drives | Digital Trends”. Digital Trends. 2018-07-03. Retrieved 2018-10-09.
16. G. I. A., Incorporated, “USB Flash Drive Market Trends”. Global Industry Analyst Inc., 20 March 2017.[Online] Available:http://www.strategyiq.com/MarketResearch/USB_Flash_Drives_Markets_Trends.asp. [Accessed 20 March 2017]
17. Parthasarathy, M., & Parthasarathy, S. (2017). Performance Analysis of USB Flash Memory Devices on Linux vs. Windows XP.
18. JUANCHO D ESPINELI 2 JASMIN NIQUIDULA, “INFORMATION THEORY IN USB FLASH MEMORY DEVICE ANALYSIS” Proceedings of Academics World 63 rd International Conference, Manila, Philippines, 28th -29th April 2017, http://www.worldresearchlibrary.org/up_proc/pdfs/834-14997520531-6.pdf
19. International Journal of Engineering Research and Development. ISSN: 2278-067X. 2012; (1): 25-34.
20. B Naresh Kumar Reddy, N Venktram, Sreeeha, “An Efficient Data Transmission by using Modern USB Flash Drive” International Journal of Electrical and Computer Engineering (IJECE) Vol. 4, No. 5, October 2014, pp. 730–740 ISSN: 2088-8708
21. Oka Mahendra,Djohar Syamis,Adi Ramdan,Marcella Astrid,“Design and implementation of data storage system using USB flash drive in a microcontroller based data logger”, DOI 10.1109/ICACOMIT.2015.7440175,Electronic ISBN: 978-1-4673-7408-8 CD-ROM ISBN: 978-1-4673-7407-1, https://ieeexplore.ieee.org/abstract/document/7440175
22. PNY USB Flash Drive – CES 2006 – LetsGoDigital. Ceshow.com. Retrieved on 2011-05-18.
23. BlueTrek Bizz – an expandable USB and a Bluetooth headset in one Archived 2014-08-29 at the Wayback Machine. TechChee.com (2008-05-20). Retrieved on 2011-05-18.
AUTHORS PROFILE

I am Kalpana Dnyaneshwar Shinde Student of M.Sc (Forensic Science)-SY-IVth semester in Government Institute of Forensics Science Aurangabad in Department of Digital and Cyber Forensics. I had done my research work determine the possibilities of recovering the data from damaged USB Flash Drive. Other topics of are cyber investigation, Incidence response, network Forensics, Multimedia Forensics,etc… further wish to apply for Ph.D too.

Kale Vini Arun Completed M.Sc (Computer Science) in 2008 from University of Pune. Qualified UGC-NET in “Computer Science and Applications” held on 24th June 2012. work experience is of six plus years - includes as Lecturer in K.V.N.Naik’s Arts, Commerce and Science College, as Junior Consultant Yashwantrao Chavan Maharashtra Open University, Nashik, as Assistant Professor in MVP’s KSKW College, Nashik and Currently working as Assistant Professor in Government Institute of Forensic Science. Aurangabad. Topic of research interest includes Digital and Cyber forensic, Mobile Forensics, Network forensics, Nanotechnology, image processing, Internet Of Things.

Dr.Charansing Nathusing Kayte Bachelor of Science in PCM (BSc) from Yashwantrao Chavan College of Science Sillod, Aurangabad, affiliated to Dr.Babasaheb Ambedkar Marathwada University, Aurangabad Maharashtra, Master of Science in Information Technology (MSc) Dr.Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India, Ph.D in Computer Science Singhania University, Rajasthan,India. 13 plus years of teaching experience, have published 30 plus research articles in various national / international conferences, Journals, Seminars. Currently working as HOD of Digital and Cyber forensic in Government Institute of Forensic Science. Aurangabad. Topic of research interest includes Digital and Cyber forensic, Mobile Forensics, Network forensics, image processing, and Internet of Things Speech recognition.

Dr.Shobha Bawiskar has completed BCS degree and M.Sc Computer Science from College of IT & M , Vivekanand college of Arts , science and commerce respectively affiliated to Dr.Babasaheb Marathwada University, M.Phil from YCMOU from affiliated IMTR study centre in Aurangabad and received Ph.D in Computer Science from Dr.Babasaheb Marathwada University. 13 years of teaching experience. Have published twenty five plus research articles in various national / international conferences, Journals, Seminars. Currently working as Assistance Professor in Government Institute of Forensic Science. Aurangabad. Topic of research interest includes Digital and Cyber forensic, Mobile Forensics, Network forensics, Nanotechnology, image processing,Internet Of Things.