DATA RECOVERY BOOK V1.0

FOREWORD

The core of information age is the information technology, while the core of the information technology consists in the information process and storage. Along with the rapid development of the information and the popularization of the personal computer, people find information more and more useful and need it ever more than the past. Owning to the massive data, there is a huge challenge to the data storage technology. So how to save so many documents and how to visit document as fast as possible become the key point. We know we need storage devices to save data, while there are so many kinds of storage devices and modes to save data. What's more, when saving the data and information, it is more important to ensure the storage security as well as the accuracy, usability, reliability of data. Often, what is invaluable is that invisible data.

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Elementary

Ⅰ.Elementary knowledge of data recovery

1.Connotation of data

Connotation of data is comprehensive, it includes not only multi-media files such as data documents, images, voices that stored in file system or data base, but also hardware information, network addresses and network services, which are used to deposit and manage those information.

2.The essence of data recovery

Data recovery means retrieving lost, deleted, unusable or inaccessible data that lost for various reasons.

Data recovery not only restores lost files but also recovers corrupted data.
On the basis of different lost reason, we can adopt different data recovery methods. There are software and hardware reasons that cause data loss, while we can recover data by software and hardware ways.

Being different from prevention and backup, data recovery is the remedial measure. The best way to insure the security of your data is prevention and backup regularly. To operate and use your data according to the normative steps, you can reduce the danger of data loss to the lowest.

3.The scope of data recovery

There are so many forms and phenomenon on data problem, we can divide the objects or scope of data recovery according to different symptoms.

System problem
The main symptom is that you cannot enter the system or the system is abnormal or computer closes down. There are complex reasons for this, thus we need adopt different processing methods. Reasons for this symptom may be the key file of system is lost or corrupted, there is some bad track on hard disk, the hard disk is damaged, MBR or DBR is lost, or the CMOS setting is incorrect and so on.

Bad track of hard disk
There are logic and physical bad track. Logic bad track is mainly caused by incorrect operation, and it can be restored by software. While physical bad track is caused by physical damage, which is real damage, we can restore it by changing the partition or sector. When there is physical bad track, you'd better backup your data for fear that the data can not be used any more because of the bad track.

Partition problem

If partition can not be identified and accessed, or partition is identified as unformatted, partition recovery tools such as Partition Table Doctor can be used to recover data.

Files loss

If files are lost because of deletion, format or Ghost clone error, files restoring tools such as Data Recovery Wizard can be used to recover data.

Password loss

If files, system password, database or account is lost, some special decryption tools that correspond to certain data form such as Word, Winzip can be used.

Files repair

For some reasons, some files can not be accessed or used, or the contents are full of troubled characters, the contents are changed so as they can not be read. In this condition, some special files restoring tools can be tried to restore the files.

4.The principle of data recovery

Data recovery is a process of finding and recovering data, in which there may be some risk, for no all situations can be anticipated or prearranged. It means maybe there will be some unexpected things happen. So you need reduce the danger in data recovery to the lowest:

Backup all the data in your hard disk
Prevent the equipment from being damaged again
Don't write anything to the device on which you want to recover data
Try to get detailed information on how the data lost and the losing process
Backup the data recovered in time.

Ⅱ.Data loss

Actually, there are various reasons that cause data loss; software, hardware, factitious, natural, intended, unintended, all may cause data loss or damage on storage devices.

Generally, There are two main reasons for data problem: software and hardware whose corresponding reasons are software reason and hardware reason.

1.Software reason

Virus, format, mis-partition, mis-clone, mis-operation, network deletion, power-cut during operation all may be the software reasons. The symptoms are usually mis-operation, read error, can not find or open file, report no partition, not formatted, password lost and troubled characters.

A: Computer Viruses: some malicious virus programs will destroy data, overwrite, or erase the data contents.

B: Mis-format: fast or completely format partition, thus changing the file system form (NTFS, FAT32) of partition.

C: Mis-Clone: when backing up the hard disk, mis-clone or overlay the original data on hard disk.

For these, we can use software tools to recover it. So called soft recovery means data can be recovered by software, not referring to hardware fixing operation for its fault is not because of hardware failure.

The following are prompts that system can not start up normally:

Invalid Partition Table: Invalid partition table information.

Missing Operating System: “55AA” mark in DOS boot sector lost or DBR corrupted.
Disk Boot Failure: System file read failure.

Bad or missing command interpreter: Can not find command.com file or ‘COMMAND.COM’ file corrupted.

Invalid system disk: DOS boot record corrupted.

Type the name of the command, Interpreter: DOS partition mark in partition table error or ‘COMMAND.COM’ file lost, corrupted.

Error Loading Operating System: Main boot startup program read boot sector unsuccessfully.
Not found any active partition in HDD: Active partition mark in partition table changed as inactive partition mark.

2.Hardware reason
Sometimes data loss is because of hardware, such as bad sector in hard disk, power cut, head damage, circuit panel problem, etc.

When your hardware has some problems, you probably will find: the speed of hardware become slow, you cannot operate successfully; you cannot read data, etc, which are most often physical bad track failures.

Correspondingly, data recovery in hardware fix is considered as hard recovery, such as memory medium damage, track damage, hard disk scrape, head damage, electric machinery damage, chip burnout and so on..

The most distinct feature or difference between soft recovery and hard recovery is whether the memory medium itself can be normally accessed by fixing or replacing parts.

Ⅲ.Data Protecting Technologies

Data security and fault freedom of storage are paid more and more attention. People are attaching more and more importance to developing new technologies to protect data.

1.SMART Technology

SMART, also called Self-Monitoring Analysis and Report Technology, mainly protects HD from losing data when there is some problems on the HD. SMART drive can reduce the risk of data loss, it alarms to predict and remind thus enhancing the data security.

2.SPS

Shake Protecting System, can prevent the head from shaking thus enhancing the anti-knock characteristics of HD, avoiding damages caused by shake.

3.DFT

DFT, a kind of IBM data protecting technology, can check hard disk via using DFT program to access the DFT micro codes in hard disk. By DFT, users can conveniently check the HD operation.

4.Floppy disk array technology

Originally 'Redundant Arrays of Inexpensive Disks'. A project at the computer science department of the University of California at Berkeley, under the direction of Professor Katz, in conjunction with Professor John Ousterhout and Professor David Patterson.

The project is reaching its culmination with the implementation of a prototype disk array file server with a capacity of 40 GBytes and a sustained bandwidth of 80 MBytes/second. The server is being interfaced to a 1 Gb/s local area network. A new initiative, which is part of the Sequoia 2000 Project, seeks to construct a geographically distributed storage system spanning disk arrays and automated libraries of optical disks and tapes. The project will extend the interleaved storage techniques so successfully applied to disks to tertiary storage devices. A key element of the research will be to develop techniques for managing latency in the I/O and network paths.

The original ('Inexpensive') term referred to the 3.5 and 5.25 inch disks used for the first RAID system but no longer applies.

The following standard RAID specifications exist:

RAID 0 Non-redundant striped array

RAID 1 Mirrored arrays

RAID 2 Parallel array with ECC

RAID 3 Parallel array with parity

RAID 4 Striped array with parity
RAID 5 Striped array with rotating parity
The basic idea of RAID (Redundant Array of Independent Disks) is to combine multiple inexpensive disk drives into an array of disk drives to obtain performance, capacity and reliability that exceeds that of a single large drive. The array of drives appears to the host computer as a single logical drive. The Mean Time Between Failure (MTBF) of the array is equal to the MTBF of an individual drive, divided by the number of drives in the array. Because of this, the MTBF of a non-redundant array (RAID 0) is too low for mission-critical systems. However, disk arrays can be made fault-tolerant by redundantly storing information in various ways.

5.SAN

SAN, called Storage Area Network or Network behind servers, is specialized, high speed network attaching servers and storage devices. A SAN allows "any to any" connection across the network, using interconnect elements such as routers, gateways, hubs and swithes. It eliminates the traditional dedicated connection between a server and storage, and concept that the server effectively "owns and manages" the storage devices. It also eliminates any restriction to amount of data that a server can access, currently limited by the number of storage devices, which can be attached to the individual server. Instead, a SAN introduces the flexibility of networking to enable one server or many heterogeneous servers to share a common storage "utility", which may comprise many storage devices, including disk, tape, and optical storage. And, the storage utility may be located far from the servers which use it.

6.NAS

NAS is Network Attached Storage. It can store the quick-increased information
.Backup means to prepare a spare copy of a file, file system, or other resource for use in the event of failure or loss of the original. This essential precaution is neglected by most new computer users until the first time they experience a disk crash or accidentally delete the only copy of the file they have been working on for the last six months. Ideally the backup copies should be kept at a different site or in a fire safe since, though your hardware may be insured against fire, the data on it is almost certainly neither insured nor easily replaced.

7.Backup

Backup in time may reduce the danger and disaster to the lowest, thus data security can be most ensured. In different situations, there are different ways. Both backing up important data of system with hardware and backing up key information with cloning mirror data to different storage device can work well.

Ⅳ.Elementary knowledge of hard disk

1.History of hard disk development

The hard disk drive has short and fascinating history. In 24 years it evolved from a monstrosity with fifty two-foot diameter disks holding five MBytes (5,000,000 bytes) of data to today's drives measuring 3 /12 inches wide and an inch high (and smaller) holding 400 GBytes (400,000,000,000 bytes/characters). Here, then, is the short history of this marvelous device.

Before the disk drive there were drums... In 1950 Engineering Research Associates of Minneapolis built the first commercial magnetic drum storage unit for the U.S. Navy, the ERA 110. It could store one million bits of data and retrieve a word in 5 thousandths of a second..

In 1956 IBM invented the first computer disk storage system, the 305 RAMAC (Random Access Method of Accounting and Control). This system could store five MBytes. It had fifty, 24-inch diameter disks!

By 1961 IBM had invented the first disk drive with air bearing heads and in 1963 they introduced the removable disk pack drive.

In 1970 the eight inch floppy disk drive was introduced by IBM. My first floppy drives were made by Shugart who was one of the "dirty dozen" who left IBM to start their own companies. In 1981 two Shugart 8 inch floppy drives with enclosure and power supply cost me about $350.00. They were for my second computer. My first computer had no drives at all.

In 1973 IBM shipped the model 3340 Winchester sealed hard disk drive, the predecessor of all current hard disk drives. The 3340 had two spindles each with a capacity of 30 MBytes, and the term "30/30 Winchester" was thus coined.

In 1980, Seagate Technology introduced the first hard disk drive for microcomputers, the ST506. It was a full height (twice as high as most current 5 1/4" drives) 5 1/4" drive, with a stepper motor, and held 5 Mbytes. My first hard disk drive was an ST506. I cannot remember exactly how much it cost, but it plus its enclosure, etc. was well over a thousand dollars. It took me three years to fill the drive. Also, in 1980 Phillips introduced the first optical laser drive. In the early 80's, the first 5 1/4" hard disks with voice coil actuators (more on this later) started shipping in volume, but stepper motor drives continued in production into the early 1990's. In 1981, Sony shipped the first 3 1/2" floppy drives.

In 1983 Rodime made the first 3.5 inch rigid disk drive. The first CD-ROM drives were shipped in 1984, and "Grolier's Electronic Encyclopedia," followed in 1985. The 3 1/2" IDE drive started its existence as a drive on a plug-in expansion board, or "hard card." The hard card included the drive on the controller which, in turn, evolved into Integrated Device Electronics (IDE) hard disk drive, where the controller became incorporated into the printed circuit on the bottom of the hard disk drive. Quantum made the first hard card in 1985.

In 1986 the first 3 /12" hard disks with voice coil actuators were introduced by Conner in volume,

but half (1.6") and full height 5 1/4" drives persisted for several years. In 1988 Conner introduced the first one inch high 3 1/2" hard disk drives. In the same year PrairieTek shipped the first 2 1/2" hard disks.

In 1997 Seagate introduced the first 7,200 RPM, Ultra ATA hard disk drive for desktop computers and in February of this year they introduced the first 15,000 RPM hard disk drive, the Cheetah X15. Milestones for IDE DMA, ATA/33, and ATA/66 drives follow:

1994 DMA, Mode 2 at 16.6 MB/s
1997 Ultra ATA/33 at 33.3 MB/s
1999 Ultra ATA/66 at 66.6 MB/s

6/20/00 IBM triples the capacity of the world's smallest hard disk drive. This drive holds one gigabyte on a disk which is the size of an American quarter. The world's first gigabyte-capacity disk drive, the IBM 3380, introduced in 1980, was the size of a refrigerator, weighed 550 pounds (about 250 kg), and had a price tag of $40,000.

2.Main technical specification and parameter of hard disk

Capacity
We can see the capacity in two aspects: the total capacity and the capacity of one disk. The whole capacity is made up of each disk capacity.
If we increase the disk capacity, we would not only improve the disk capacity, improve the speed of transmission, but also cut the cost down.

Rotate speed.
Rotate speed is the speed disk rotate. It is measured by RPM (Round Per Minute).The rotate speed of IDE hard disk are 5400RPM, 7200RPM etc.

Average Seek Time
The average seek time gives a good measure of the speed of the drive in a multi-user environment where successive read/write request are largely uncorrelated.
Ten ms is common for a hard disk and 200 ms for an eight-speed CD-ROM.

Average Latency
The hard disk platters are spinning around at high speed, and the spin speed is not synchronized to the process that moves the read/write heads to the correct cylinder on a random access on the hard disk. Therefore, at the time that the heads arrive at the correct cylinder, the actual sector that is needed may be anywhere. After the actuator assembly has completed its seek to the correct track, the drive must wait for the correct sector to come around to where the read/write heads are located. This time is called *latency*. Latency is directly related to the spindle speed of the drive and such is influenced solely by the drive's spindle characteristics. This operation page discussing spindle speeds also contains information relevant to latency.

Conceptually, latency is rather simple to understand; it is also easy to calculate. The faster the disk is spinning, the quicker the correct sector will rotate under the heads, and the lower latency will be. Sometimes the sector will be at just the right spot when the seek is completed, and the latency for that access will be close to zero. Sometimes the needed sector will have just passed the head and in this "worst case", a full rotation will be needed before the sector can be read. On average, latency will be half the time it takes for a full rotation of the disk.

Average Access Time

Access time is the metric that represents the composite of all the other specifications reflecting random performance positioning in the hard disk. As such, it is the best figure for assessing overall positioning performance, and you'd expect it to be the specification most used by hard disk manufacturers and enthusiasts alike. Depending on your level of cynicism then, you will either be very surprised or not surprised much at all, to learn that it is rarely even discussed. Ironically, in the world of CD-ROMs and other optical storage it is the figure that is universally used for comparing positioning speed. I am really not sure why this discrepancy exists.

Perhaps the problem is that access time is really a derived figure, comprised of the other positioning performance specifications. The most common definition is:

Access Time = Command Overhead Time + Seek Time + Settle Time + Latency

The speed with which data can be transmitted from one device to another. Data rates are often measured in megabits (million bits) or megabytes (million bytes) per second. These are usually abbreviated as Mbps and MBps, respectively.

Buffer Size（Cache）

A small fast memory holding recently accessed data, designed to speed up subsequent access to the same data. Most often applied to processor-memory access but also used for a local copy of data accessible over a network etc.

When data is read from, or written to, main memory a copy is also saved in the cache, along with the associated main memory address. The cache monitors addresses of subsequent reads to see if the required data is already in the cache. If it is (a cache hit) then it is returned immediately and the main memory read is aborted (or not started). If the data is not cached (a cache miss) then it is fetched from main memory and also saved in the cache.

The cache is built from faster memory chips than main memory so a cache hit takes much less time to complete than a normal memory access. The cache may be located on the same integrated circuit as the CPU, in order to further reduce the access time. In this case it is often known as primary cache since there may be a larger, slower secondary cache outside the CPU chip.

The most important characteristic of a cache is its hit rate - the fraction of all memory accesses which are satisfied from the cache. This in turn depends on the cache design but mostly on its size relative to the main memory. The size is limited by the cost of fast memory chips.

The hit rate also depends on the access pattern of the particular program being run (the sequence of addresses being read and written). Caches rely on two properties of the access patterns of most programs: temporal locality - if something is accessed once, it is likely to be accessed again soon, and spatial locality - if one memory location is accessed then nearby memory locations are also likely to be accessed. In order to exploit spatial locality, caches often operate on several words at a time, a "cache line" or "cache block". Main memory reads and writes are whole cache lines.

When the processor wants to write to main memory, the data is first written to the cache on the assumption that the processor will probably read it again soon. Various different policies are used. In a write-through cache, data is written to main memory at the same time as it is cached. In a write-back cache it is only written to main memory when it is forced out of the cache.

If all accesses were writes then, with a write-through policy, every write to the cache would necessitate a main memory write, thus slowing the system down to main memory speed. However, statistically, most accesses are reads and most of these will be satisfied from the cache. Write-through is simpler than write-back because an entry that is to be replaced can just be overwritten in the cache as it will already have been copied to main memory whereas write-back requires the cache to initiate a main memory write of the flushed entry followed (for a processor read) by a main memory read. However, write-back is more efficient because an entry may be written many times in the cache without a main memory access.

When the cache is full and it is desired to cache another line of data then a cache entry is selected to be written back to main memory or "flushed". The new line is then put in its place. Which entry is chosen to be flushed is determined by a "replacement algorithm".

Some processors have separate instruction and data caches. Both can be active at the same time, allowing an instruction fetch to overlap with a data read or write. This separation also avoids the possibility of bad cache conflict between say the instructions in a loop and some data in an array which is accessed by that loop.

Noise & Temperature

It comes from motor. So motor is the key to reduce the noise and temperature. If you can keep the temperature of hard disk down, then you can keep your hard disk effective.

3.Physical structure of hard disk

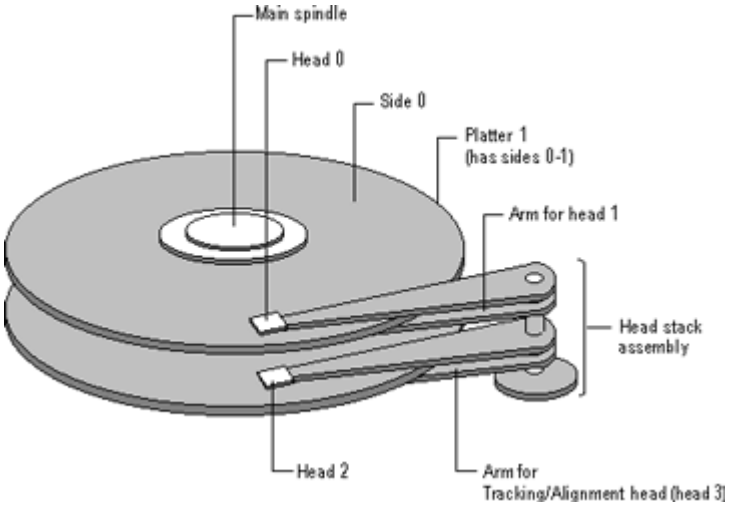
HD consists of platter, control circuit board and interface parts.

A hard disk is a sealed unit containing a number of platters in a stack. Hard disks may be mounted in a horizontal or a vertical position. In this description, the hard drive is mounted horizontally. Electromagnetic read/write heads are positioned above and below each platter. As the platters spin, the drive heads move in toward the center surface and out toward the edge. In this way, the drive heads can reach the entire surface of each platter.

Making Tracks

On a hard disk, data is stored in thin, concentric bands. A drive head, while in one position can read or write a circular ring, or band called a track. There can be more than a thousand tracks on a 3.5-inch hard disk. Sections within each track are called sectors. A sector is the smallest physical storage unit on a disk, and is almost always 512 bytes (0.5 kB) in size.
The figure below shows a hard disk with two platters.

Figure 3-1 Parts of a Hard Drive



The structure of older hard drives (i.e. prior to Windows 95) will refer to a cylinder/ head/ sector notation. A cylinder is formed while all drive heads are in the same position on the disk. The tracks, stacked on top of each other form a cylinder. This scheme is slowly being eliminated with modern hard drives. All new disks use a translation factor to make their actual hardware layout appear continuous, as this is the way that operating systems from Windows 95 onward like to work..

To the operating system of a computer, tracks are logical rather than physical in structure, and are established when the disk is low-level formatted. Tracks are numbered, starting at 0 (the outermost edge of the disk), and going up to the highest numbered track, typically 1023, (close to the center). Similarly, there are 1,024 cylinders (numbered from 0 to 1023) on a hard disk.

The stack of platters rotate at a constant speed. The drive head, while positioned close to the center of the disk reads from a surface that is passing by more slowly than the surface at the outer edges of the disk. To compensate for this physical difference, tracks near the outside of the disk are less-densely populated with data than the tracks near the center of the disk. The result of the different data density is that the same amount of data can be read over the same period of time, from any drive head position.

The disk space is filled with data according to a standard plan. One side of one platter contains space reserved for hardware track-positioning information and is not available to the operating system. Thus, a disk assembly containing two platters has three sides available for data.

Track-positioning data is written to the disk during assembly at the factory. The system disk controller reads this data to place the drive heads in the correct sector position.

4.Logical organization of hard disk

Sectors and Clusters

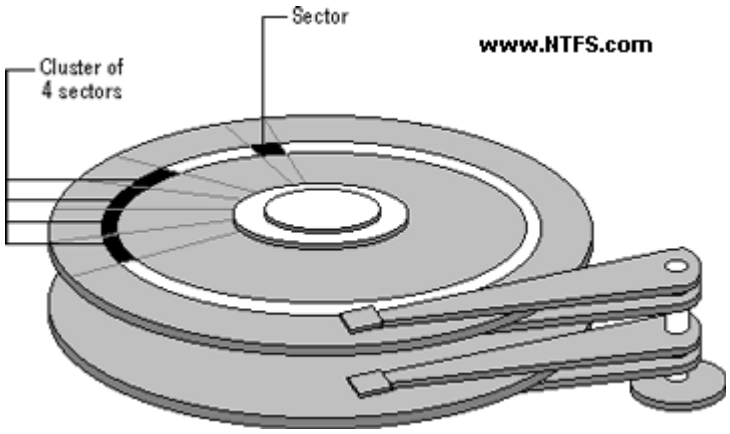
A sector, being the smallest physical storage unit on the disk, is almost always 512 bytes in size because 512 is a power of 2 (2 to the power of 9). The number 2 is used because there are two states in the most basic of computer languages - on and off.

Each disk sector is labelled using the factory track-positioning data. Sector identification data is written to the area immediately before the contents of the sector and identifies the starting address of the sector.

The optimal method of storing a file on a disk is in a contiguous series, i.e. all data in a stream stored end-to-end in a single line. As many files are larger than 512 bytes, it is up to the file system to allocate sectors to store the file's data. For example, if the file size is 800 bytes, two 512 k sectors are allocated for the file. A cluster is typically the same size as a sector. These two sectors with 800 bytes of data are called two clusters.

They are called clusters because the space is reserved for the data contents. This process protects the stored data from being over-written. Later, if data is appended to the file and its size grows to 1600 bytes, another two clusters are allocated, storing the entire file within four clusters.

Figure 3-2 Sectors and Clusters



If contiguous clusters are not available (clusters that are adjacent to each other on the disk), the second two clusters may be written elsewhere on the same disk or within the same cylinder or on a different cylinder - wherever the file system finds two sectors available. A file stored in this non-contiguous manner is considered to be fragmented. Fragmentation can slow down system performance if the file system must direct the drive heads to several different addresses to find all the data in the file you want to read. The extra time for the heads to travel to a number of addresses causes a delay before the entire file is retrieved.

Cluster size can be changed to optimize file storage. A larger cluster size reduces the potential for fragmentation, but increases the likelihood that clusters will have unused space. Using clusters larger than one sector reduces fragmentation, and reduces the amount of disk space needed to store the information about the used and unused areas on the disk.

Most disks used in personal computers today rotate at a constant angular velocity. The tracks near the outside of the disk are less densely populated with data than the tracks near the center of the disk. Thus, a fixed amount of data can be read in a constant period of time, even though the speed of the disk surface is faster on the tracks located further away from the center of the disk..

Modern disks reserve one side of one platter for track positioning information, which is written to the disk at the factory during disk assembly. It is not available to the operating system. The disk controller uses this information to fine tune the head locations when the heads move to another location on the disk. When a side contains the track position information, that side cannot be used for data. Thus, a disk assembly containing two platters has three sides that are available for data.

Hard disk interfaces

Hard disks also come in several flavors such as IDE (actually ATA), SCSI and SATA, as do optical drives. ATA is the most common interface used today. SCSI disks can usually be found on servers.

IDE

Integrated Drive Electronics, more commonly called by its acronym IDE, is an interface for hard drives. IDE is a marketing term; the real standard is called ATA.
EIDE (Enhanced IDE) or ATA-2 was later developed and increased transfer speed, added 32-bit transactions and DMA support.

ATA

ATA stands for Advanced Technology Attachment. The ATA -term is commonly used interchangeably with IDE. The older and more common paraller ATA (P-ATA) is currently being replaced by serial ATA (SATA).

Most PCs have two IDE controllers on the motherboard. One IDE controller can support two devices, so four storage devices is usually the maximum. Paraller ATA interface uses ribbon cables with 40 -pin connectors to connect the hard drives to the motherboard. The cable has usually three connectors. Of these one is connected to the motherboard and the rest two are left for hard drives. If two hard drives are connected to the same controller, one must be defined as master and the other one as slave. This is done with jumpers.

ATA-2 is the real standard for what is widely known as EIDE. ATA-2 introduced higher speed data transfer modes: PIO Modes 3 and 4 plus Multiword DMA Mode 1 and 2. These modes allow the ATA interface to run data transfers up to about 16MB/second.

SATA

Serial ATA, also known as SATA or S-ATA, is a bus used to communicate between the CPU and internal storage devices such as hard drives and optical drives. It is designed to eventually replace the ATA (also known as IDE) bus. Traditional ATA is beginning to be referred to as Parrellel ATA, P-ATA, or PATA to avoid confusion.

The main difference between SATA and PATA is in the cabling. SATA does away with the master/slave relationship of PATA (hence the difference in names), as well as PATA's ungainly ribbon cables. Instead, SATA has much slimmer and easier to manage cables, which will enable better airflow through cases. The connectors are keyed, preventing connectors from being plugged upside down. Truly native SATA drives will have different power connectors also.

A third advantage of SATA is hotplugging.
Currently, SATA has a transfer rate of 150 MB/s, which is only 17 MB/s more than standard PATA. However, with the introduction of SATA II, this is expected to go up to 300 MB/s, with 600 MB/s being released sometime around 2007. The faster bus isn't expected to affect performance in the short term, since hard drive performance is usually bottlenecked by the moving parts of the drive.
During the transitional period before true native SATA drives are released, most SATA drives actually have onboard PATA controllers, which connect to SATA by a bridge. This generally causes a 30-50% performance drop. Also, PATA power connectors are still being used.

DMA
DMA (Direct Memory Access) is a function of the memory bus in the computer that lets connected devices like hard disks transfer data to the memory without the intervention of the CPU, thus speeding up the transfer. This is superior to the way PIO works.

There are two distinct types of direct memory access, DMA and bus mastering DMA. The plain DMA relies on the DMA controller on the motherboard to grab the system bus and transfer the data. In bus mastering DMA all this is done by the logic on the interface card itself. Bus mastering allows the hard disk and memory to work without relying on the old DMA controller built into the system, or needing any support from the CPU.

USB
USB (Universal Serial Bus) is a hardware bus using a serial protocol used by many different hardware devices and supported in most computers/mainboards. Originally developed by Compaq, Intel, NEC and Microsoft. It allows many devices to be connected to the bus at the same time, the theoretical maxmium is 127 devices. The maximum data transfer bandwidth is about 12Mbit/s (USB2.0 supports 480 Mbit/sec).

Firewire is a less known alternative to USB that (at its time) was better then USB for media related tasks. As of USB2 there have been significant increases, specifically more bandwidth.

SCSI
SCSI - Small Computer System Interface. Pronounced "scuzzy". It's a specification for a hardware interface for connecting devices such as hard disks and scanners to a computer.

Most PCs have an ATA(IDE) bus instead of SCSI for connecting internal hard disks. SCSI is seen more often in servers, as it tends to be faster and more reliable (though more expensive). Another advantage of SCSI controller is that it requires only one IRQ and can hadle usually at least 7 devices whereas ATA can handle only 2.

Typically, you put a SCSI card in your computer, and then connect internal hard disks with a ribbon cable to some connector on the card. Also, the card will have an external connector which you might also be using simultaneously.

5.Connection synopsis of hard disk

Fiber Channel
Fibre Channel Hard Disk Drive
The Enterprise Virtual Array supports any combination of five different Fibre Channel Hard Disk Drives (HDD) with multiple capacity points and two different rotational speeds. Three drive capacity points are supported at 36 GB, 72 GB, and 146 GB. Two rotational speeds are supported at 10,000 RPM and 15,000 RPM.

The following individual drive capacity/rotational speed combinations are available:
146GB 10,000 RPM Fibre Channel HDD
72GB 15,000 RPM Fibre Channel HDD
72GB 10,000 RPM Fibre Channel HDD
36GB 15,000 RPM Fibre Channel HDD
36GB 10,000 RPM Fibre Channel HDD

Five different Fibre Channel HDDs for the Enterprise Virtual Array provides tremendous flexibility to the target customer base by allowing mixing and matching of capacity and performance to application needs. Application areas seen as potential markets include OLTP, ERP, and any other applications requiring large amounts of online storage.

IEEE
Also called Firewire. it is a less known alternative to USB that (at its time) was better then USB for media related tasks. As of USB2 there have been significant increases, specifically more bandwidth.

Intermediate

Ⅴ.Hard disk data organization

1.Primary formatting of hard disk

Before restoring data, hard disk usually needs low-level format, partition, high-level format to be used. The function is establishing certain data logical structure on physical hard disk. Usually hard disk is divided into 5 regions: MBR, DBR, DIR, FAT and DATA (Here we do not introduce FAT

and NTFS file system), which altogether store and manage data.

Low level format

After setting parameter of hard disk in CMOS Setting, why the hard disk is still unusable? That's about Cylinder, Header and Sector. When hard disk is firstly made in the factory, it usually is "blank". Only after partitioning tracks and sectors, we can save data on hard disk (Now, before leaving the factory, many disks have been low-level formatted. So you may need not do the operation, but it is not unnecessary.)

Main functions of low level format

Low level format can also be called physical format, whose functions are to detect the magnetic media, to partition tracks, to partition sectors for each track, and to arrange the order of partitions in track according to the interleave the customer choose. Its main functions are as following:

- Test the hard disk media
- Partition tracks for hard disk
- Arrange sectors for each track according to the specified interleave
- Set the sector ID to each track and finish setting sectors
- Test the hard disk surface, mark "bad" to the damaged track and sector
- Write a certain ASCⅡ to each sector of hard disk

Hard disk is an important storage resource in computer system. Do not low-level format the hard disk unless it is the only thing possible. For hard disk being used, you need back up important data before low level format; even if back up is unnecessary, it may take much time to partition, high-level format, and install system and application programs. Usually, low level format can be used in the following cases:

1 When you have bought a new hard disk or hard disk adapter, you'd better low level format it again, which is for the better matching of hard disk and hard disk adapter.

2 "Bad" sectors, which result from long-time operation, often cause "sector not found" error in DOS. This is because of the loss of sector ID. Sector ID is used to distinguish the sectors. It is marked onto disk as the magnetization map, which however, may dribble away for long-time storage or use. Low level format is the only way for computer users to refresh sector ID in disk. This assignment cannot be done by high level format.

3 Appropriate set of interleave can fasten data transfer. In most conditions, low level format is the only way to change the interleave.

4 When there are always inexplicable problems, you can take low level format into consideration.

Ways to low-level format

There are many ways to low-level format. In early time, it can be completed in CMOS or by some special disk tools, or by writing some short programs in Debug. Nowadays, people usually use special tools provided free by hard disk manufacturers.

2.Advanced formatting of hard disk

High-level format

After partitioning the hard disk, some “independent” logical drivers are founded. If now we start system from the floppy drive, enter DOS, then you can see the drive letters of DOS partition, which is on behalf of logical driver, for instance “C:”, “D:” and so on. The system commonly arranges letters according to alphabet. Now let’s try to enter “C:” or “D:” after that we can see the system prompt that “DISK MEDIA ERROR”. Why? These logical disks are empty; to use them, we need create file system. The whole process is high-level format of logic disk. The high-level format certainly aims at the logic disk, neither physical disk nor certain directory. For file system is corresponding to logic disk, we can say that high-level format aims at file system. In this article, logical disk means logical drive.

Format partition

High-level format of DOS logic disk can be completed by **“format”** command. Main functions of high-level format are as following:

Assign logical serial numbers for sectors (serial numbers in partition) from cylinder that assigned by each logical drive

Establish DBR in basic partition, and load 3 system files of DOS if there is “/S” parameter in the command.

Establish file allocation table (FAT) in each logical disk.

Establish File Directory Table (FDT) that is corresponding to root directory and data area.

If you carry out high-level format by “Format” command, please pay attention to following 4 items.

1. To already activated basic DOS partition (generally it is disk C), you need the following command:

```
Format C:/s
```

By this command, you may install DOS system files after high-level format, to make this logical disk to become the boot disk. Certainly, you may also use “SYS” command to send system files after high-level format, that is complete the boot disk and file transmission by the following two commands:

```
Format C：
SYS C：
```

Continuously using these two commands equals to “Format C:/S” command.

2. For other logical disk, we only need to carry out the following commands:

```
Format ［ d: ］
```

“d” is the logical disk drive.

3. Before format, on the screen it may appear the following prompt information:

```
WARNING: ALL DATA ON THE DISK
DRIVE C: WILL BE LOST!
Proceed with Format (Y/N) ? _
```

This information is warning user: The format will cause all data lose! Then, if user choose “Y”, then the high-level format officially carries on, if user choose “N”, then nothing will happened and exit.

4. For the using disk without adjusting the partition, also may carry on the fast format, the command is:

```
Format C: /Q
```

The full command of “Format” in Windows 2000 is as following shows:

```
FORMAT volume [/FS:file-system] [/V:label] [/Q] [/A:size] [/C] [/X]
FORMAT volume [/V:label] [/Q] [/F:size]
FORMAT volume [/V:label] [/Q] [/T:tracks /N:sectors]
FORMAT volume [/V:label] [/Q] [/1] [/4]
FORMAT volume [/Q] [/1] [/4] [/8]
```

Format hard disk partition in Windows

In explore of Windows, everything is displayed by graphics, and different forms (partition) are expressed by different colors. Click the right key in the corresponding partition, and choose “format”, you may also choose fast format, complete format and so on.

Format hard disk partition by Partition Magic

In Partition Magic, everything is displayed by graphics, and different forms (partition) are expressed by different colors. Click the right key in the corresponding partition, and choose “format”. In the dialogue box, there will be a prompt indicating this operation may destroy your own data, and in the box you may also choose different format.

Format hard disk by various hard disks special-purpose tool in hard disk factory

Low level format tool provided by various hard disks factory can help hard disk breakthrough

hard disk capacity limit, as well as complete low level format, the high-level format and make partitions. After partitions are done, you can choose corresponding options step by step.

Attention: To partitions with data, backup the data before format.

High-level format establish the file system, after format, it may carry on write in and read out operations with file as unit.

3.Data storage region of hard disk

In command to know hard disk better, we must have a simple understanding of hard disk construction. (NTFS uses different file management technology with FAT16 and the FAT32 file system, here we only introduce FAT16 and FAT32) The hard disk data may divide into 5 parts approximately according to its different characteristics and functions: MBR area, DBR area, FAT area, DIR area and DATA area. Among them, MBR is founded by the partition software, while DBR area, FAT area, DIR area and DATA area are founded by high-level format procedure. When file system writes in data, it just rewrites corresponding FAT area, DIR area and DATA area. Also it is the result which these 5 regions affect together. Only by this way, hard disk can be managed methodically. Here are some introductions to the 5 regions.

MBR:

The first physical sector (cylinder 0, head 0, sector 1) of the first hard drive in the system (the first hard drive with the BIOS device number 0x80); each hard drive contains an MBR, but not every BIOS can start the corresponding operation system from every hard drive. When booting from the hard drive, the BIOS or a special Firmware loads the contents of the MBR to a fixed address in the memory and allows it to take control. This code then loads either the operation system from a bootable hard drive partition, or from a complex boot loader, such as LILO.

Short for DOS Boot Record, it is the sector at cylinder 0, column 1, and sector 1 of a hard disk. DBR is the first sector that the operation system visits. It contains a boot program and a BPB (BIOS Parameter Block). The main task of the boot program is to determine whether the first two files in root directory of this partition are the boot files of operation system, when MBR hands over the system mastery to it. Take an example of DOS, i.e. IO.SYS and MSDOS.SYS. DOS of low edition requests that these two files are the first two files, and located at the section start of the root directory, covering the first two directory items (the high edition does not have this requirement.). Moreover, Windows and DOS are families; therefore, Windows follows the same management manner, except for the filenames. If it does exist, then reads IO.SYS in the memory, and hands over mastery to IO.SYS. BPB parameter block records the start sector, ending sector, file storage form, descriptor of hard disk media, size of root directory, number of FAT and size of allocated cell.

File Allocation Table (FAT) is a file system that was developed for MS-DOS and is the primary file system for consumer versions of Microsoft Windows up to and including Windows ME. The FAT file system is considered relatively uncomplicated, and because of that, it is a popular format for floppy disks; moreover, it is supported by virtually all existing operation systems for personal

computers, and because of that, it is often used to share data between several operation systems booting on the same computer (a multi-boot environment). It is also used on solid-state memory cards and other similar devices. It has a serious drawback in that when files are deleted and new files written to the media, the files can become scattered over the entire media making reading and writing a slow process. De-fragmentation is one solution to this, but is often a lengthy process in itself and has to be repeated regularly to keep the FAT file system clean.

FAT is also called 12-bit FAT, the file allocation table (FAT) for a floppy disk. The location of files on a floppy disk are listed in a one-column table in the FAT. Because the width of each entry in a floppy disk column is 12 bits, the FAT is called FAT12. As a file system for floppy disks, it had a number of limitations: no support for hierarchical directories, cluster addresses were “only” 12-bits long (which made the code manipulating the FAT a bit tricky) and the disk size was stored as a 16-bit count of sectors, which limited the size to 32MB.

The FAT file system, as is the case with most file systems, does not utilize individual sectors, and there are several performance reasons for this. By using individual sectors, the process of managing disks becomes overly cumbersome since files are being broken into 512-byte pieces. If you were to take a 20 GB disk volume set up with 512 byte sectors and manage them individually, the disk would have over 40 million individual sectors. Just keeping track of this many pieces of information is both time, as well as resource, consuming. While some operation systems do allocate specific sector storage, they also require some advanced intelligence to do so. Bear in mind how old the FAT file system is, as it was designed many years ago as merely a simple file system, without the capability to managed individual sectors.

In order for FAT to manage files with some form of efficiency is to group sectors into larger blocks referred to as clusters, or allocation units. Cluster size, however, is not a predetermined size, but rather is determined by the size of the disk volume itself, with small volumes (disk sizes) resulting in smaller clusters, and larger volumes (disk sizes) using larger cluster sizes. For the most part, a cluster ranges in size from 4 sectors or 2,048 bytes to 64 sectors or 32,768 bytes. You should be aware that you may, on some occasions, find 128-sector clusters in use at 65,536 bytes per cluster, as well as some floppy disks with smaller clusters that is usual at just 1 sector per cluster. In all cases, the sectors in a cluster are continuous, therefore each cluster is a continuous block of space on the disk.

Cluster sizing, and therefore partition or volume size, as they are directly related, have an important impact on performance and disk utilization. In all cases, cluster size is determined at the time a disk volume is partitioned. Certain third-party partitioning utilities such as Partition Magic by PowerQuest can alter the cluster size of an existing partition within specific parameters. However, this aside, once the partition size is selected, so are the cluster sizes fixed.

FAT 16 means that file allocation table that uses 16 bits for addressing clusters. It is commonly used with DOS and Windows 95 systems. A 16-bit DOS and Windows file system (see FAT) that varies cluster sizes based on hard drive size. Cluster sizes range from 4K (for drives up to 127MB), to 4K (255MB drives), 8K (511MB drives), 16K (1GB drives). and 32K (for drives up to 2GB). The ultimate capacity of a FAT16 partition is 2GB.

FAT 32 is a disk file allocation system from Microsoft that uses 32-bit values for FAT entries instead of 16-bit values used by the original FAT system, enabling partition sizes up to 2TB (terabytes). FAT32 first appeared in Windows 95B and is also found in Windows 98 and Windows NT 5.0.

In order to overcome the volume size limit of FAT16 while still allowing memory-constrained DOS real-mode code to handle the format, Microsoft decided to implement a newer generation of FAT, known as FAT32, with 32-bit cluster numbers, of which 28 bits are currently used.

In theory, this should support a total of approximately 268,435,438 ($< 2^{28}$) clusters, allowing for drive sizes in the range of 2 terabytes. However, due to limitations in Microsoft's scandisk utility, the FAT is not allowed to grow beyond 4,177,920 ($< 2^{24}$) clusters, placing the volume limit at 124.55 gigabytes, unless “scandisk” is not needed. Windows 2000 and XP placed a limit on the size of FAT32 partitions they can create at 32 GB, Microsoft says this is by design but does not explain why, and those versions of Windows are quite capable of reading and writing larger FAT32 partitions created by other means. FAT32 was introduced with Windows 95 OSR2. The many changes it incorporated made it a major improvement.

The maximum possible file size for a FAT32 volume is 4 GB minus 1 byte (2^{32}-1 bytes). For most users, this has become the most nagging limit of FAT32 as of 2005, since video capture and editing applications can easily exceed this limit, as can the system swap file.

32-bit File Allocation Table File System Not the same as VFAT or FAT, which are both 16-bit file systems.

DIR

Means Directory, also called FDT，File Directory Table. DIR is the root sector, following after the second FAT (backup FAT). It records each start cell, files. Operation system can locate files according to the outset of FAT and FAT.

DATA

DATA area is the real place where data is stored. It is after DIR, covering the most space of hard disk.

The location of the 5 areas is as following:

Usually, MBR covers 63 sectors (actually it covers only one); DBR covers 32 sectors (actually it covers the first and the sixth sectors. The first sector works while the sixth is backup of the first); FAT1=FAT2. The length of FAT will change according to the size of partition and the number of sectors. DIR changes the most. In early time system, DIR has fixed length of 32 sectors while each file directory covers 32 bytes. As a result, there are at most 512 items under root directory. Floppy disk can only contain 112 items, or there would be no file or directory created under root directory.

Afterward, the limitation is broken. From then on, there will be no single root directory, which becomes part of DATA. Even, root directory files are not right after FAT. They can be in any position in DATA.

Ⅵ.Common Cases of Partition Recovery

1.MBR Recovery

On condition that there is no problem with hardware, the first step is MBR recovery. MBR recovery is simple because it is system data. Though it may be created by different software and the code might be different, the method is the same. Even if multi-system boot, it is not hard. You can backup the data to be recovered after the system boot turn to be normal, and then restore the multi system boot.

Recover MBR by fdisk

The simplest way to recover MBR is Fdisk, whose command is simple too; you can use "**Fdisk/MBR**". Please note that, the hard disk to be operated should be connected on mater IDE interface as the master hard disk. As to other connection way, we need appoint the interface location of IDE device in form of "**Fdisk/CMBR**".

The command syntax of Fdisk command line is "**Fdisk/parameter switch".** Besides that obtained by "**FDISK/**？", there are some hidden parameters information:

/ACTOK
Parameter Function: not to check bad sectors on disk surface
Details: It can speed up partition operation.
/CMBR
Parameter Function: to re-create MBR of appointed disk
Details: Equals to /MBR parameter, except that it can appoint certain disk
/EXT
Parameter Function: to create extend partition.
Details: Creates extend partition on the currency disk , which used to create logical partition.
/FPRMT
Parameter Function: to check the usage of FAT16 and FAT32 in interactive mode.
Details: When /FPRMT parameter is added, there will be no query of that whether supports high- capacity hard disk; while there will be a query that it uses FAT16 or FAT32 when creating a new partition.
/LO
Parameter Function: to rebuild logical partition.
Details: Used to create logical disk, /LOG and /EXT should work together.
/LOGO
Parameter Function: to create logical partition with FAT16
/MBR

Parameter Function: to re-create MBR of master disk

Details: to clear the system booting choice recorded in MBR after uninstalling Windows NT or Windows 2000

/PRI

Parameter Function: to create primary partition and activate it.

Details: e to create primary partition, and the partition will be set active automatically.

/PRIO

Parameter Function: to create primary partition of FAT16 and activate it.

/Q

Parameter Function: not to restart computer when ending Fdisk

Details: unnecessary to restart computer after changing the partition table.

/STATUS

Parameter Function: to display details of current partition

Details: When there is no logical partition in extend partition, the extend partition will not be displayed.

/X

Parameter Function: no LBA attribute

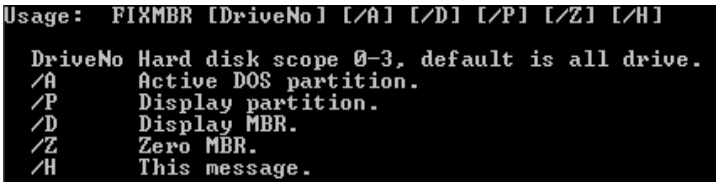
Details: there would be no partition with LBA attribute.

It makes handier to use Fdisk with these parameters. However, to hide the parameter will be more dangerous, which calls for more caution.

Uses Fixmbr to restore MBR

Provided by Microsoft, Fixmbr is a MBR recovery tool, which determines hard disk partition and re-construct MBR through overall search.

Only when using Windows 2000 recovery console that we can use Fixmbr. Windows 2000 recovery console can boot from Windows install CD. Fixmbr only revises MBR; it does not write other sectors, which is safe. You can get help information of Fixmbr as following when using Fixmbr/？.



The parameter “DriveNo” is to write a new MBR (driver). The device name can be obtained from output of the map command. For example, device name:

```
/Device/HardDisk0
```

The following command is to write a new MBR to the appointed device:

```
fixmar /Device/HardDisk0
```

Attention: If we do not assign DriverNo, the new MBR will be written in booting device, namely the driver that loads host system. If the system detects invalid or the non-standard partition mark, it will prompt that whether continue to execute this command or not. Only if there are some problems with the driver you visit; otherwise, please do not continue.

By default MBR structure will be checked. If it is abnormal, it will prompt that whether recover or not. If choose "Y", it will search partitions. When it has found the partition, it will also prompt that whether to revise MBR or not. If choose "Y", recovery will be finished. If the system is down now, please inactivate the anti-virus function in BIOS first and then continue.

By default, it will search all existing hard disk, and finish all mentioned operations above. If the result is not right, you may use "/Z" parameter to clear the result and restart; then it returns to the original condition.

2.Recovery of Partition

The partition recovery is generally the second step of the whole process. Because apart from some tools that directly reads and writes hard disk, most of tool software runs under operation system, working with the system calling. While operation system's visiting disk is on the basis of MBR and DBR; without MBR and DBR, operation system is unable to visit file system. Therefore, if the partition table is corrupted, we need rebuild partition table, which is usually fulfilled manually; in some special cases it can be done automatically by some working software.

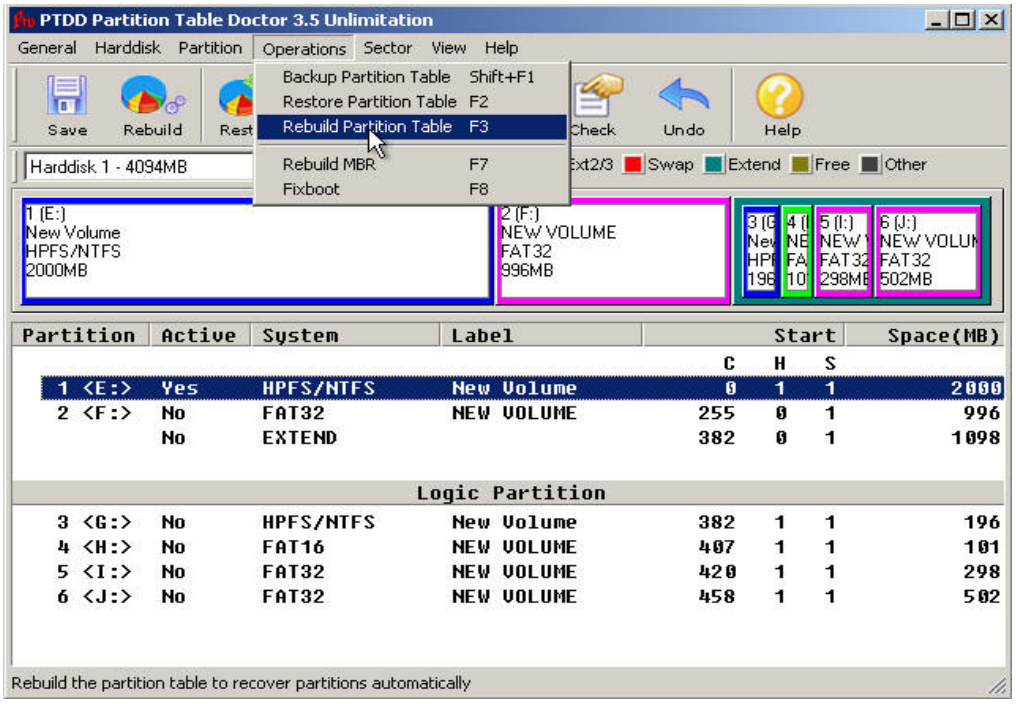
If partition table is corrupted, there are many tools to rebuild it automatically, if only the problem is not too serious. If it is too serious, or the partition table structure is too complex, it may possibly be out of the reach of their ability to rebuild. In this case, we need do it manually. Usually we use some tool software to recover the lost partition table, such as Norton Utilities 8.0, DiskMan, KV3000/Kavfix 和 PartitionMagic etc. Here we introduce **Partition Table Doctor**.

3.Partition Table Doctor

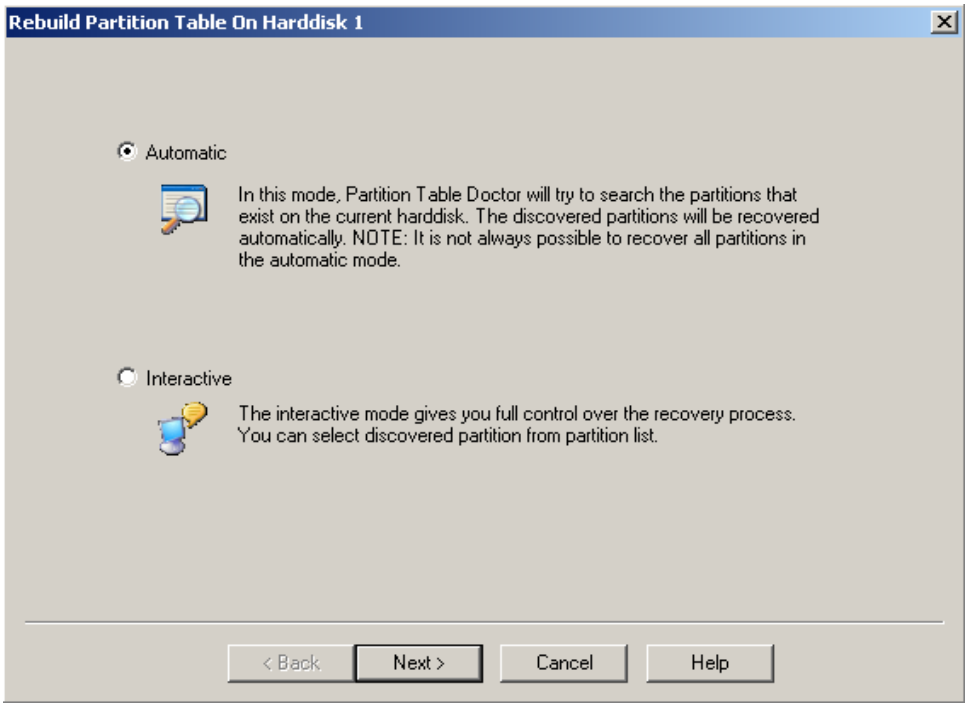
Partition Table Doctor is the only real software for hard disk partitions recovery. When you come up against a drive error (not hardware failure) this versatile tool would automatically check and repair the Master Boot Record, partition table, and the boot sector of the partition with an error, to recover the FAT16/FAT32/NTFS/NTFS5/EXT2/EXT3/SWAP partition on IDE/ATA/SATA/SCSI hard disk drives. It can create an emergency floppy disk or a bootable CD to recover the bad partition even if your operation system fails to boot. Partition Table Doctor manages for MS-DOS, Freedos, Windows 95/98/Me, Windows NT 4.0, Windows 2000, Windows XP and Windows 2003. There are two modes for partition recovery: "auto mode" and "interactive mode".

Auto mode

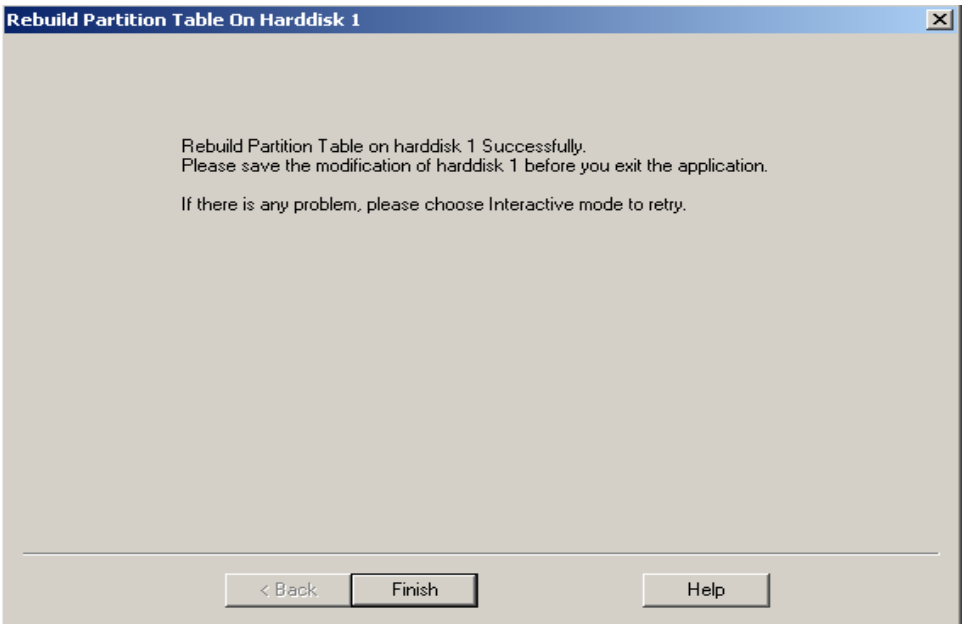
If you can enter operation system, you can install and run Partition Table Doctor and choose "Rebuild Partition Table"



In the procedure of rebuilding partition table, there are two ways to recover the lost partition:



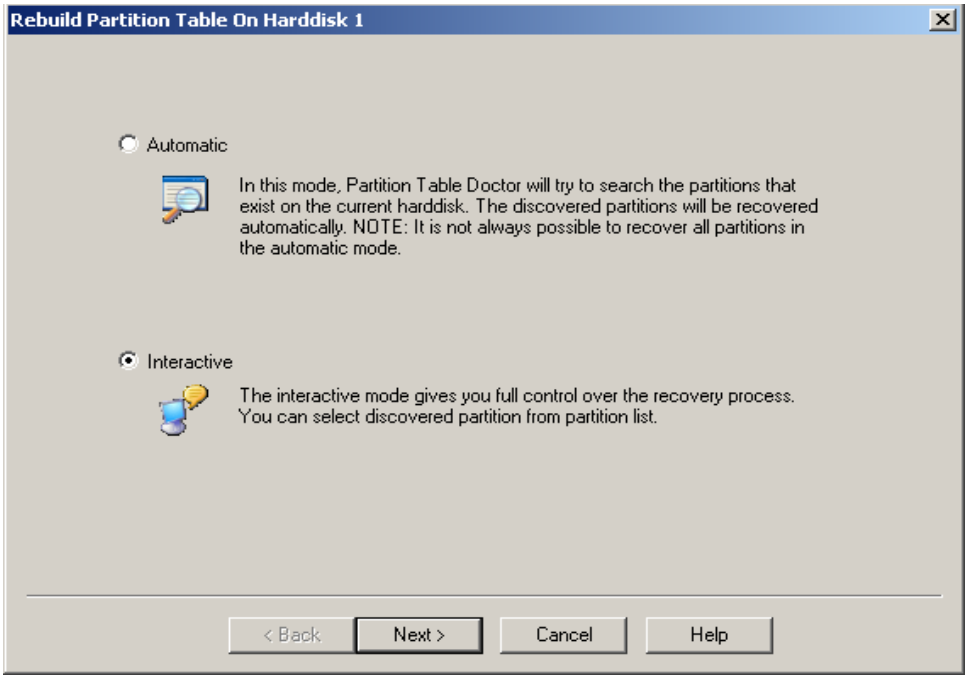
Here we mainly refer to "Automatic", so we choose "Automatic" (after this, in the whole process the users can not operate by themselves, the software will finish the work automatically.)



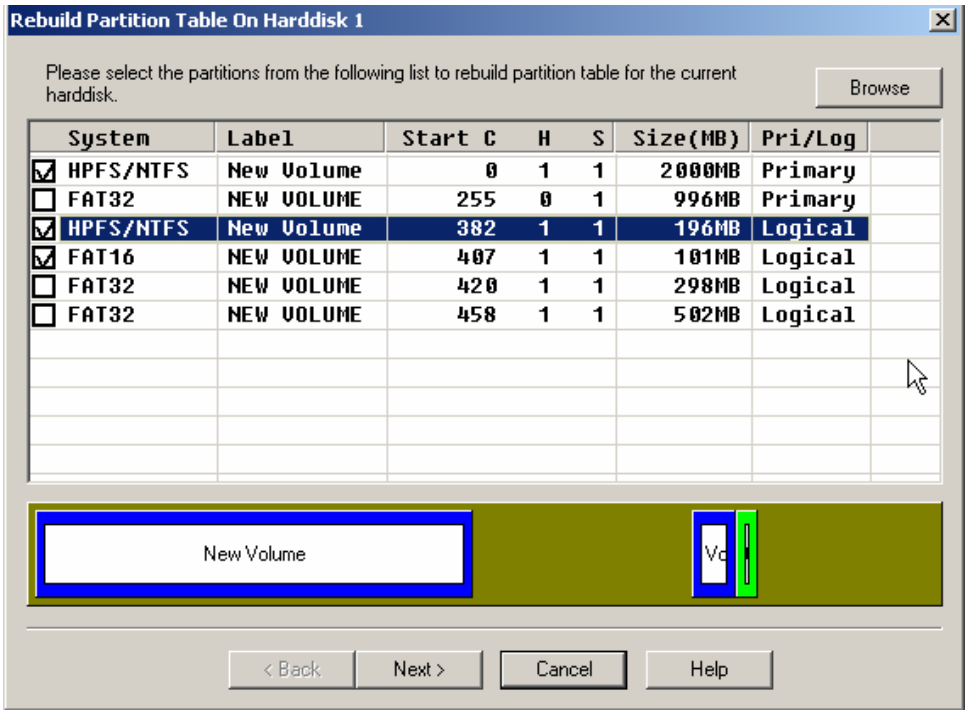
Automatic will automatically rebuild and recover partition according to your former partition information. Usually we suggest this mode if users do not know much about partition. Of course, if you are not satisfied with the result, you can choose “Interactive” mode.

Interactive

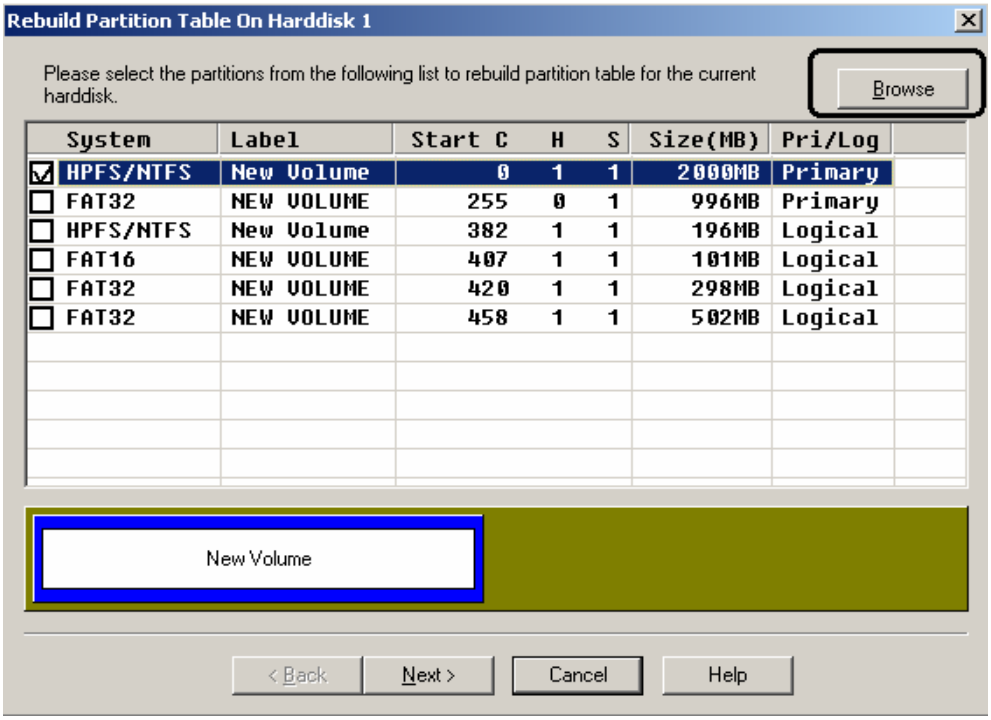
Run Partition Table Doctor and choose “Interactive” in “Rebuild Partition Table”.



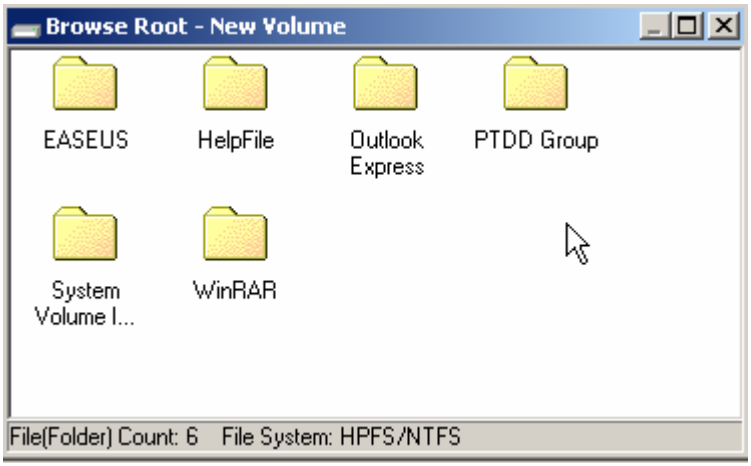
By this mode, Partition Table Doctor will display all the partition found, you can choose the partition you want to recover.



In the partition interface that Interactive mode has recovered, we can see clearly all the partition information that existed as well as information on file system, volume label, CHS, size and logics of the corresponding partition. With the information, user can locate the partition they want to recover. Also, to verify that whether the partition can be recovered normally and the recovered partition is the partition user want, the software provides a "**Browse**" function, with which we can choose the right partition:

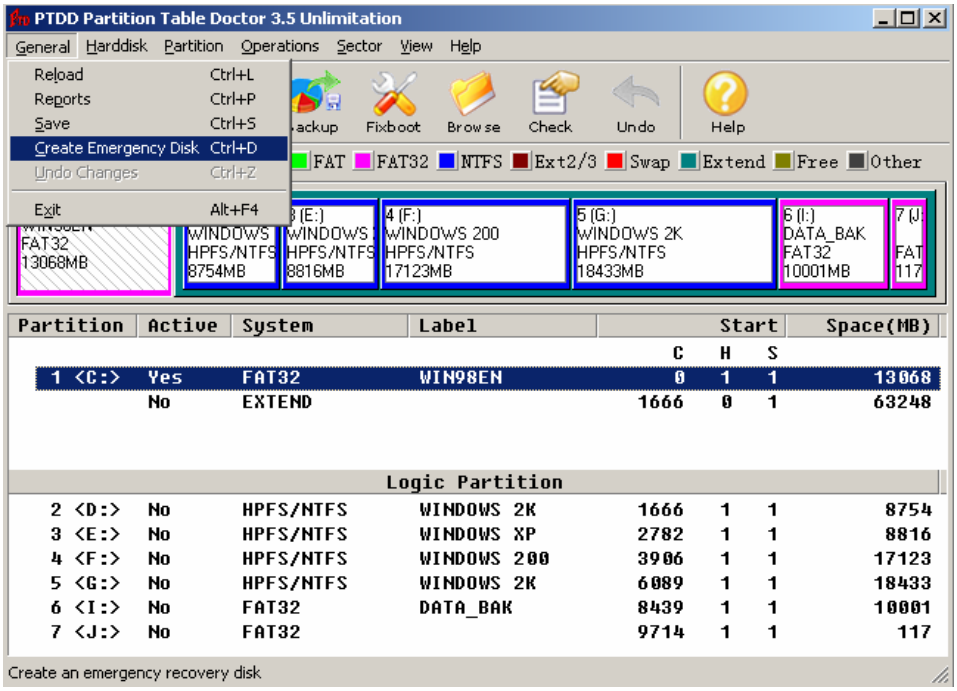


Click "Browse" and we can get file information of partition under root directory after recovery.

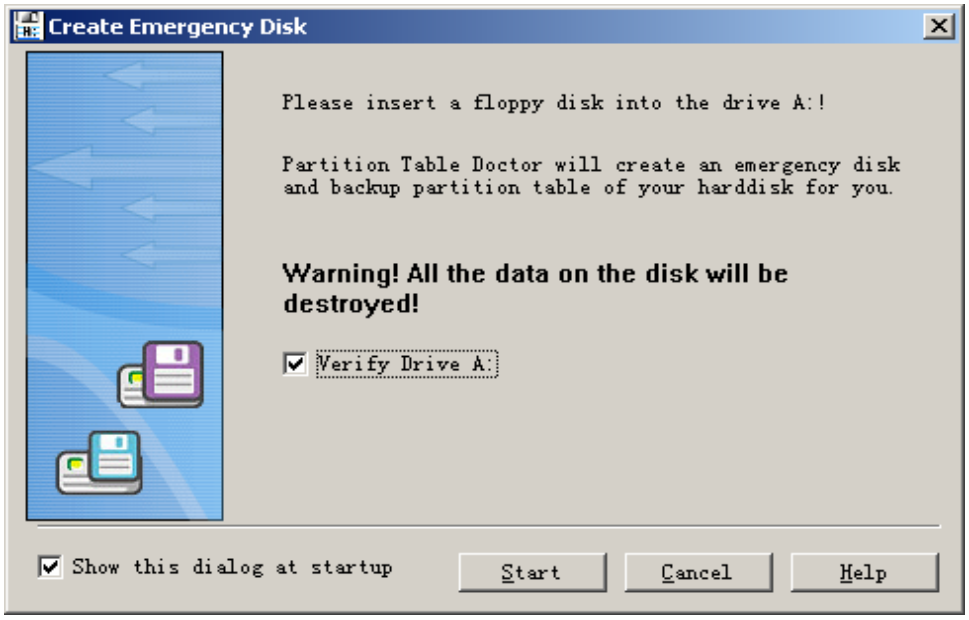


And then you can be surer about the accuracy and efficiency, thus know the final result.

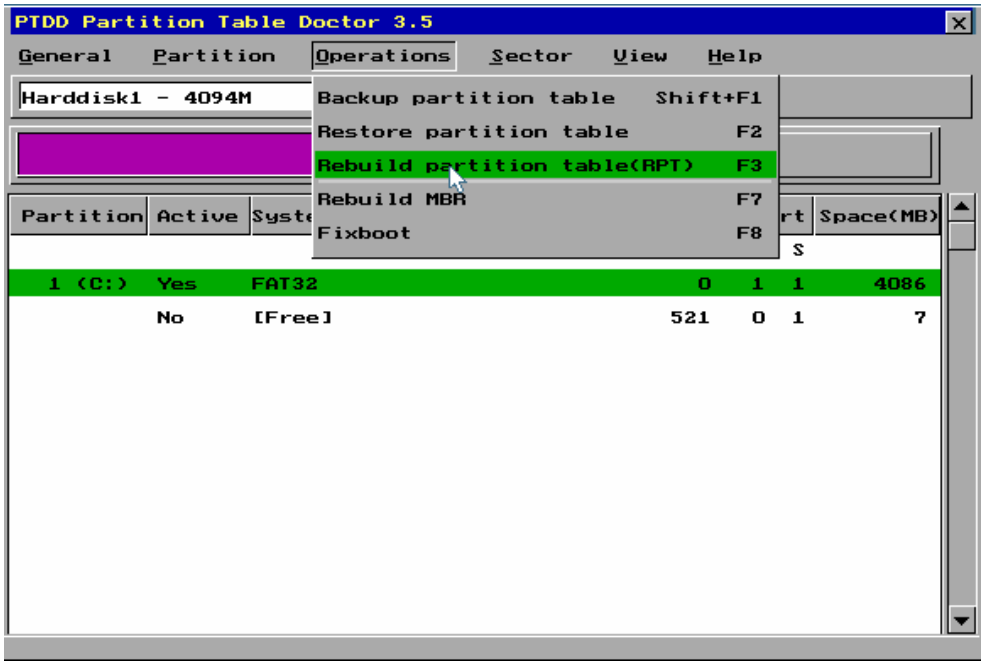
If the partition where your operation system locates is damaged and you cannot enter it, you can install Partition Table Doctor in another operation system,



By “Create Emergency Disk”, we can create an application under DOS to recover your partition:



Afterwards you can set your BIOS and then start from floppy disk, thus recover MBR by operation mode of Partition Table Doctor in DOS:



DBR recovery

MBR is for the whole hard disk, while DBR is for individual partition.

The first sector of each MBR is DBR. Just as MBR, DBR contains some information that the boot operation system need. If DBR is corrupted, you can neither visit the partition nor start up the operation system of the partition.

If boot sector is damaged, the possible symptoms are:

1. Invalid media type reading drive

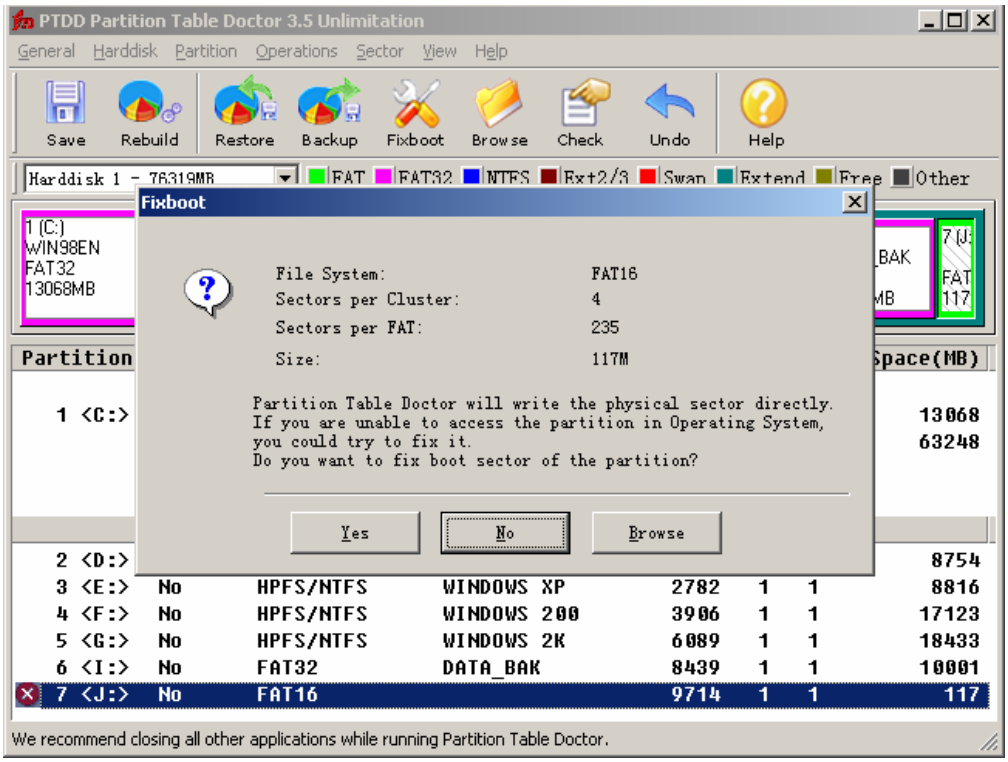
2. Abort Retry Fail?
3. File system is displayed as “RAW”
4. Windows may ask if you want to format the drive
5. File names contain “weird” characters
6.”Sector not found” messages
Etc.

Moreover, for partitions of NTFS, the functions of DBR are not all the same as that of FAT partition. For FAT partition, DBR locates FDT and FAT (correspondingly as well as DATA), but not verifying the correctness and reasonableness of FDT and FAT. For partition of NTFS, we need more units to load the file system, which is more complex than FAT.
What if when the DBR is destroyed? Usually, there are methods as following:

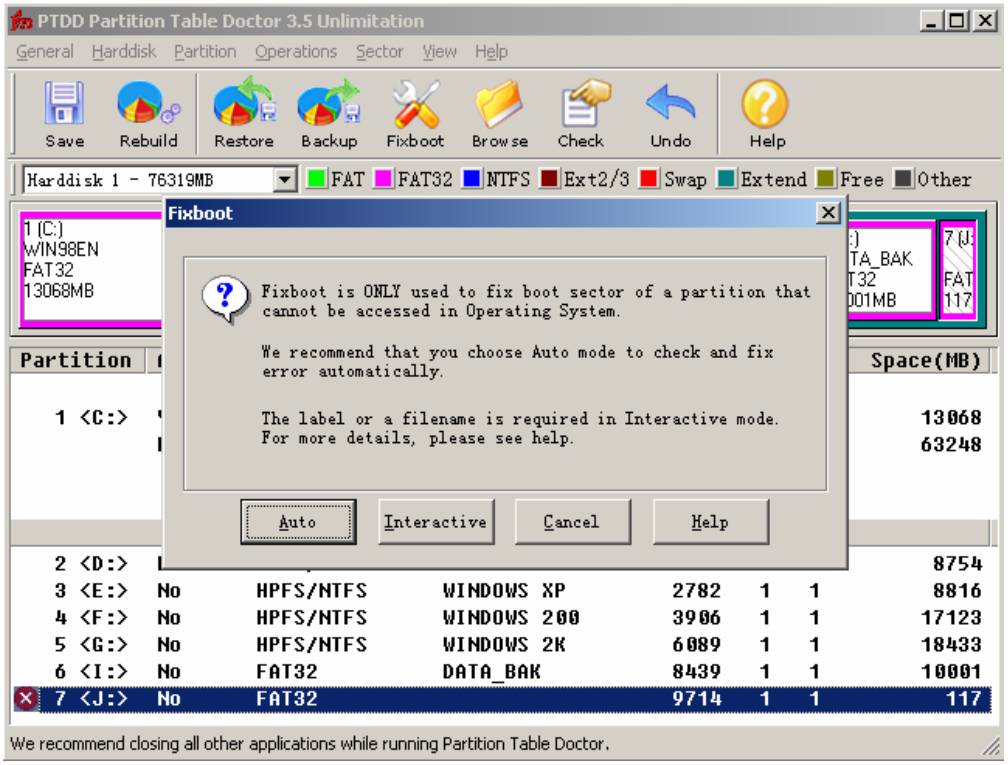
Recover DBR by Format
If there is no important data in this partition, or you have backed up the data, the best way to recover DBR is direct high-level format, fast format or complete format. If there is no limitation of partition form and capacity, there would be no difference between DOS format and Windows format except speed. Format is quite thorough, it can completely rearrange the data storage, even “reset” former file fragmentation.

Although this method is simple, it cannot recover data actually especially if you choose some different parameters. If you choose different system reserved sectors, or use clusters of different size, or change the size of FAT table etc, data recovery will be more difficult.

Data recovery by Fixboot of **Partition Table Doctor**
If the boot sector of a Fat16/Fat32/Ntfs partition was corrupted, it will be marked with **X** by Partition Table Doctor. If you cannot access a Fat16/Ntfs partition and the partition was marked with **X.** Right click the partition and choose Fixboot. Partition Table Doctor will automatically check and restore the boot sector of the partition.



If you cannot access the Fat32 partition and the partition was marked with **X** Right click the partition and choose Fixboot, there will be two choices:



'Auto' mode: Partition Table Doctor will automatically check and restore the boot sector of the partition. We recommend you choose this mode. If 'Auto' mode cannot help you, you can choose 'Interactive' mode. If so, you need input the volume label or a file name (under the root directory).

If you do not know what file name to input, follow the file name that is suggested:
Boot partition:

io.sys msdos.sys ntldr bootlog.txt
Other partitions: _restore recycled

Note:
For Fat16/Fat32 partition, fixboot can effectively restore damaged boot sector of partition.
For NTFS partition, even if boot sector is correct but MFT (Main File Table) is corrupted, symptoms are the same. We recommend you download the demo version of Partition Table Doctor to determine whether boot sector of partition was corrupted.
Mostly, scandisk that originally in operation system will destroy more than they retrieve. Please stop scandisk after logging on.

In addition, you may use WinHex to recover DBR
WinHex is powerful in disk editor. With backup DBR in WinHex to recover the DBR sector is convenient and fast. But for its strong specialization of WinHex we recommend that you choose easy-to-use software tool for integrity and correctness of the data.

4.The FAT table recovery

CIH destroys data backwards from partitions. In this case, system data in the former part may be destroyed and lost. If FAT2 is still intact, we may make FAT2 to cover FAT1. Usually we use DiskEdit and WinHex. Regarding to other forms of destruction such as format and so on, we usually make use of tool software to scan the whole disk, seldom manual recovery; because there are even dozens of trillions sectors a partition has several trillions. Depending on the manual analysis is impossible. For some extremely important data file, we can also recover manually.

Recover FAT by DiskEdit
After recovering DBR of FAT, if part of FAT1 is damaged while FAT2 remains intact (It is the most situation when destroyed by CIH), we may use FAT2 to cover FAT1. The specific method is to find the start sector of FAT2 and then start searching the start sector of DATA (if it is FAT16, search FDT). By this way, we can figure out the length of FAT table. According to length and the start sector of FAT2, we may know the start sector of FAT1. Copy FAT2 to the damaged FAT1, we can finally recover the whole partition.

Recover FAT by WinHex
Principle of recovering FAT by WinHex is the same as that by DiskEdit. After recovering DBR, we can make FAT2 to cover FAT1. After finding FAT2, we begin searching the start sector of DATA (if it is FAT16, search FDT). The division is distinct, because the conclusion part of FAT must be 0 regions, otherwise there is not any free space (even so, in ordinary circumstances, there is still a bit of space in FAT after scanning DATA area. So the end of the last sector must be 0 too.). While at the beginning of DATA region or FDT region it mustn’t be 0. No matter there is fixed

FDT, the system always begins from second cluster. If there is FDT, it follows closely FAT2, and its file registration must exist; if there is not, then begins from data area where some data must

exists. Thus we may figure out the length of the FAT table, and then the start sector of FAT1 according to the length and the start sector of FAT2. Copy FAT2 to the damaged FAT1 we can finally recover this partition.

Case Study

Ⅶ.Case Study

1. Introduction of Data Recovery Wizard 3.0

Data Recovery Wizard is an advanced data recovery software. In Windows, this software can recover data on different storage media and partitions.

General Functions of Data Recovery Wizard 3.0

Deletedrecovery: This module works only with deleted files and allows to “undelete” them (another popular term is “unerase”). Intact file system is important for this module. If you know that there is something wrong with your file system (for example, you did not delete some folder/files but you cannot access them) or if you see something strange with Windows, you should use “AdvancedRecovery” module.

Formattedrecovery: A common data recovery situation is accidentally reformatting a partition. The FormatRecovery tool will allow you to recover files from a partition, which has been accidentally formatted or reinstalled. This type of recovery will ignore the existing file system structures and search for structures associated with the previous file system. If you are not satisfied with the result, you should use “AdvancedRecovery” module

AdvancedRecovery:you can use this function to recover your damaged system, deleted partitions, misoperation of HD and deletion caused by virus.

RawRecovery:The RawRecovery tool allows you to scan severely corrupted partitions for files with a file signature search algorithm. This tool will help you recover files from a partition with damaged directory structures.

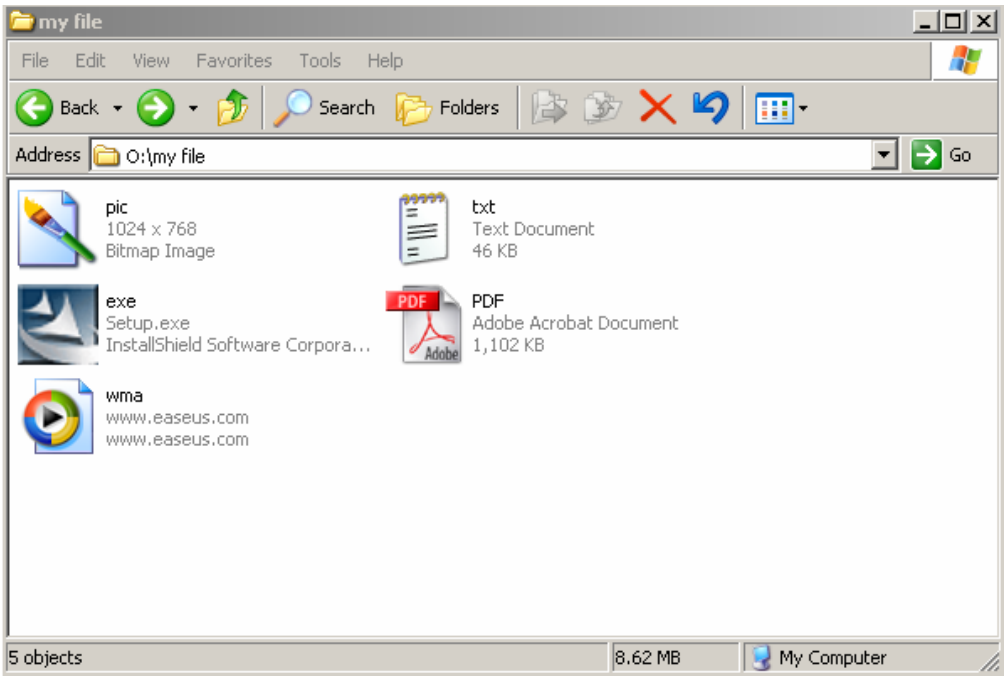
2. Matters needs attention before recovery

(1)Never operate on partition (such as write and create file) where the data lost.
(2)Please close any other application program when Data Recovery Wizard 3.0 is running.
(3)Make sure that there is no physical failure (such as physical bad track) on the disk you are operating. If there is any problem, please stop running Data Recovery Wizard 3.0, and send your disk to maintenace station.
(4)Do not save the recovered files to the original partition. You need make sure that there is enough free space to save the recovered data; also you can save your files to removable devices or network devices.

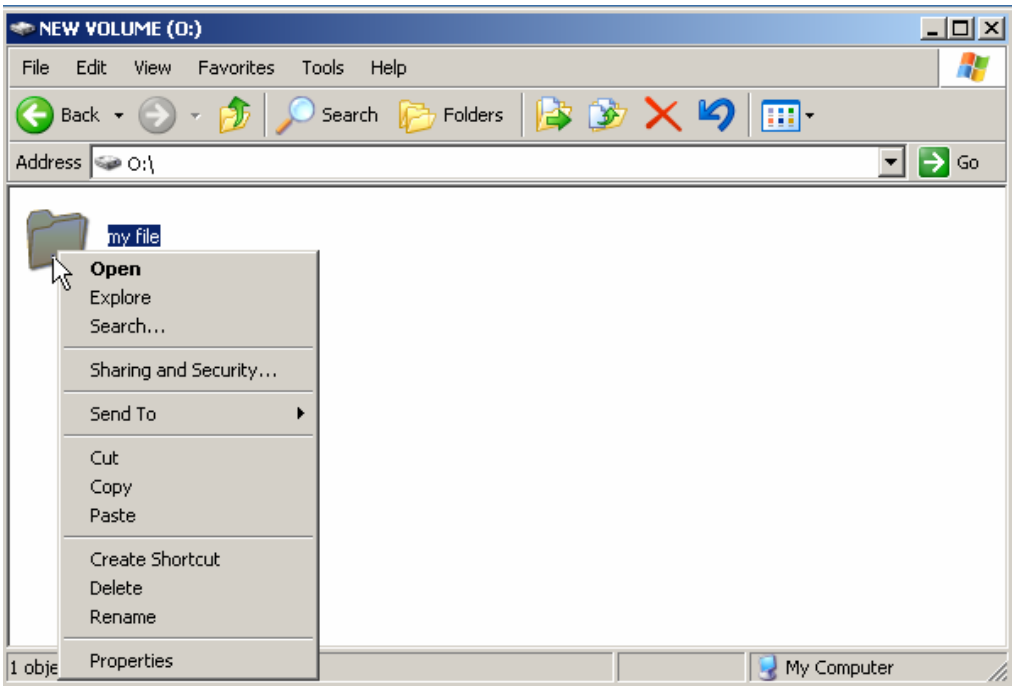
Here are some examples of using Data Recovery Wizard 3.0.

3. Deletedrecovery

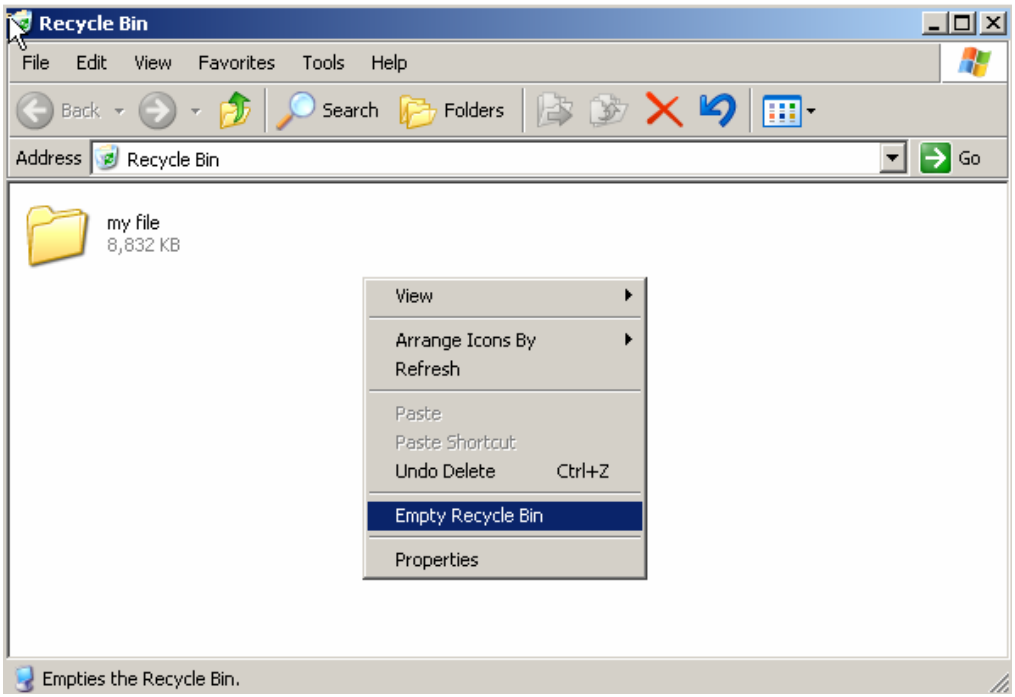
Eg: Here is a folder" my file", whose contents are as following:



Delete it:

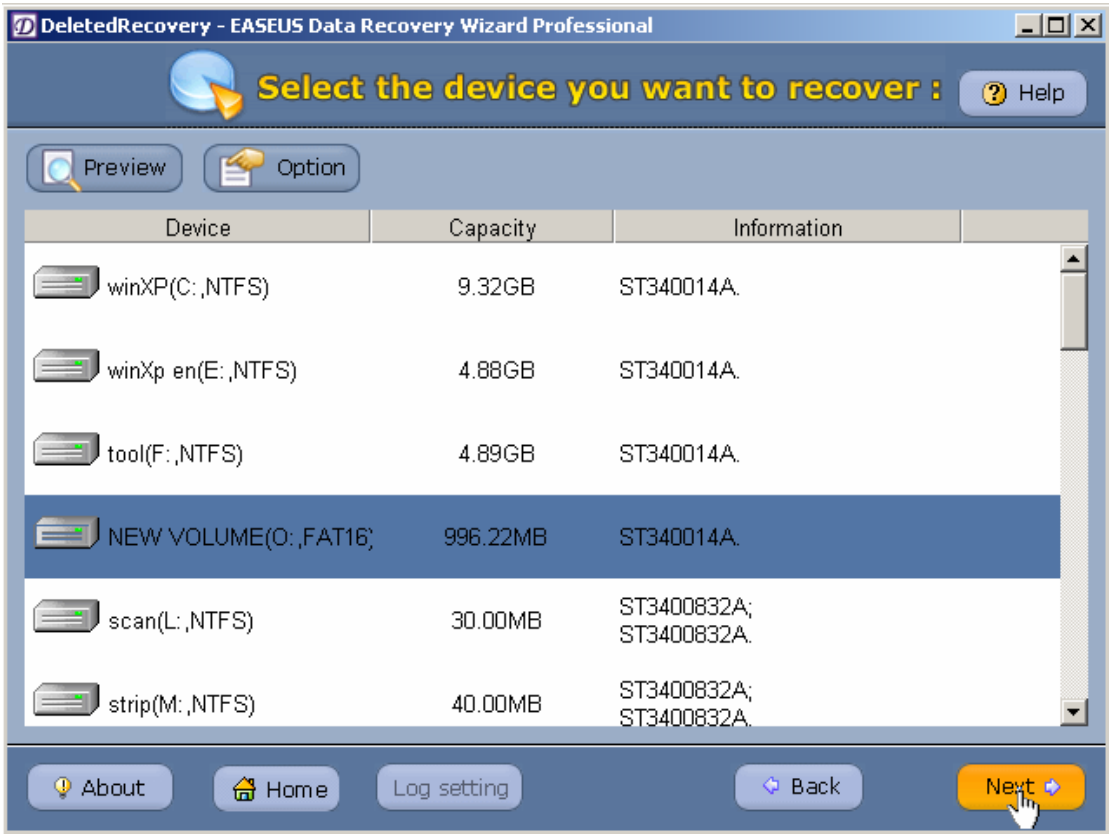


Empty your "recycle bin"

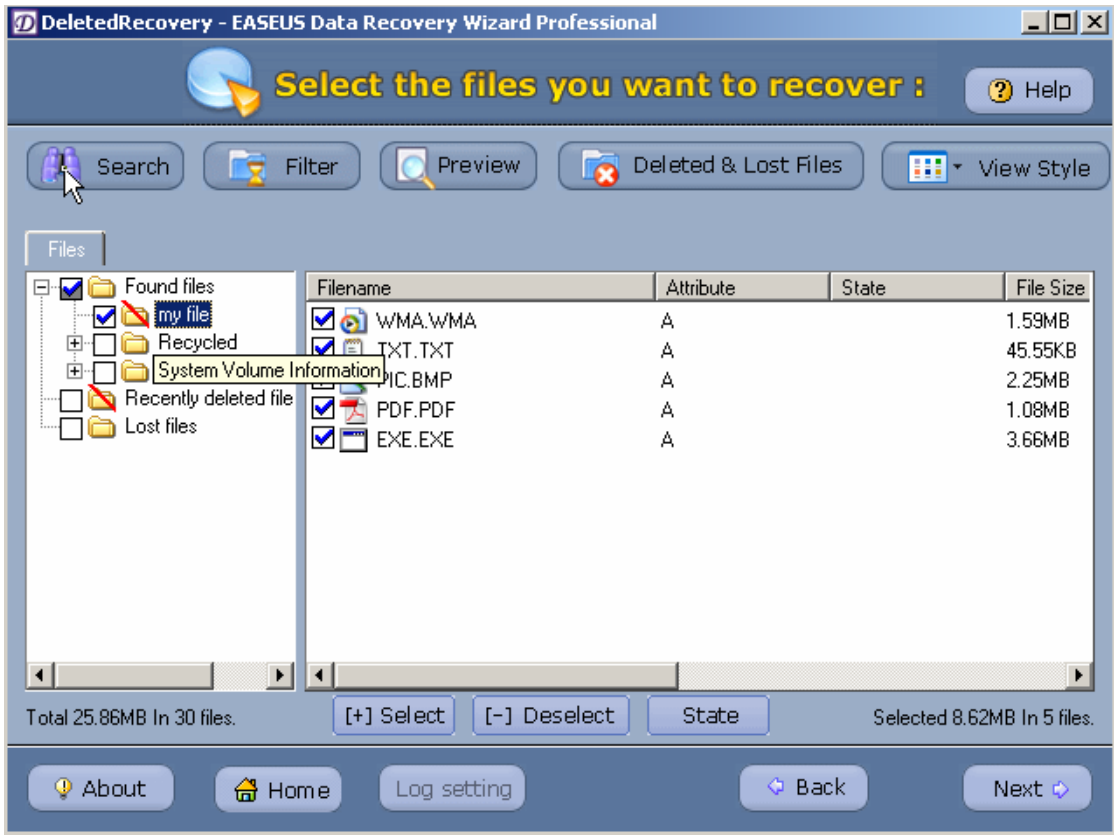


Run Data Recovery Wizard 3.0:

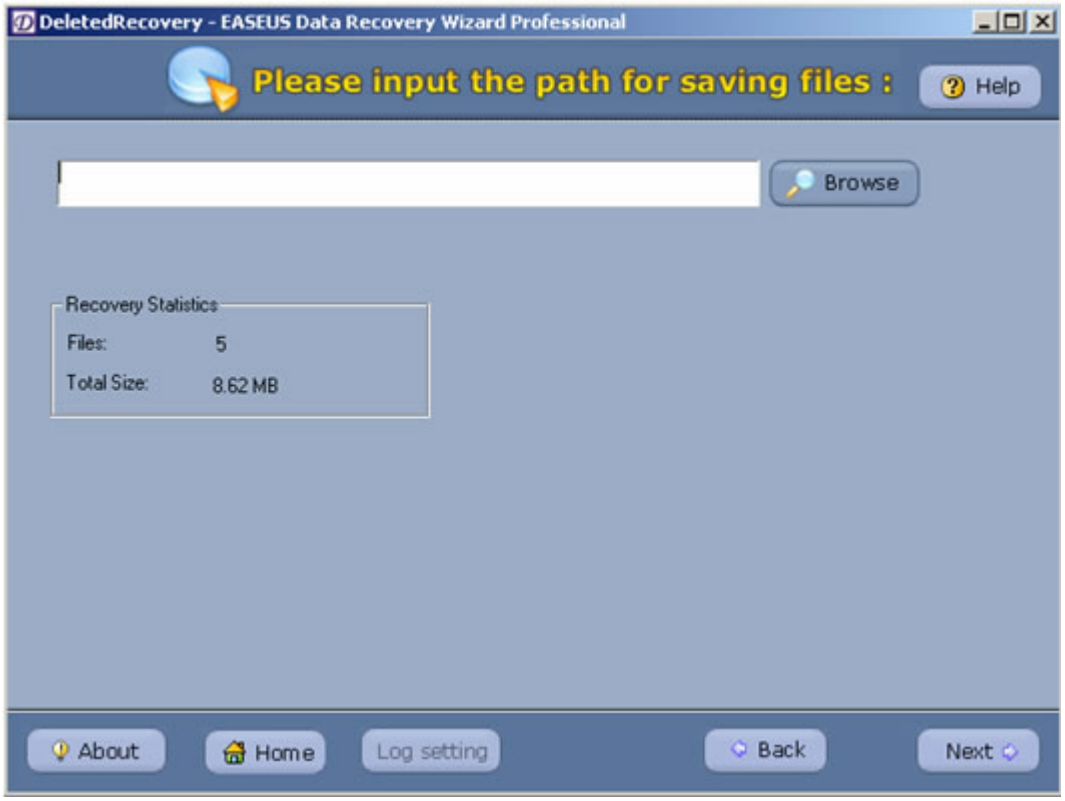
Select “deletedrecovery” then choose the partition that you want to recover.



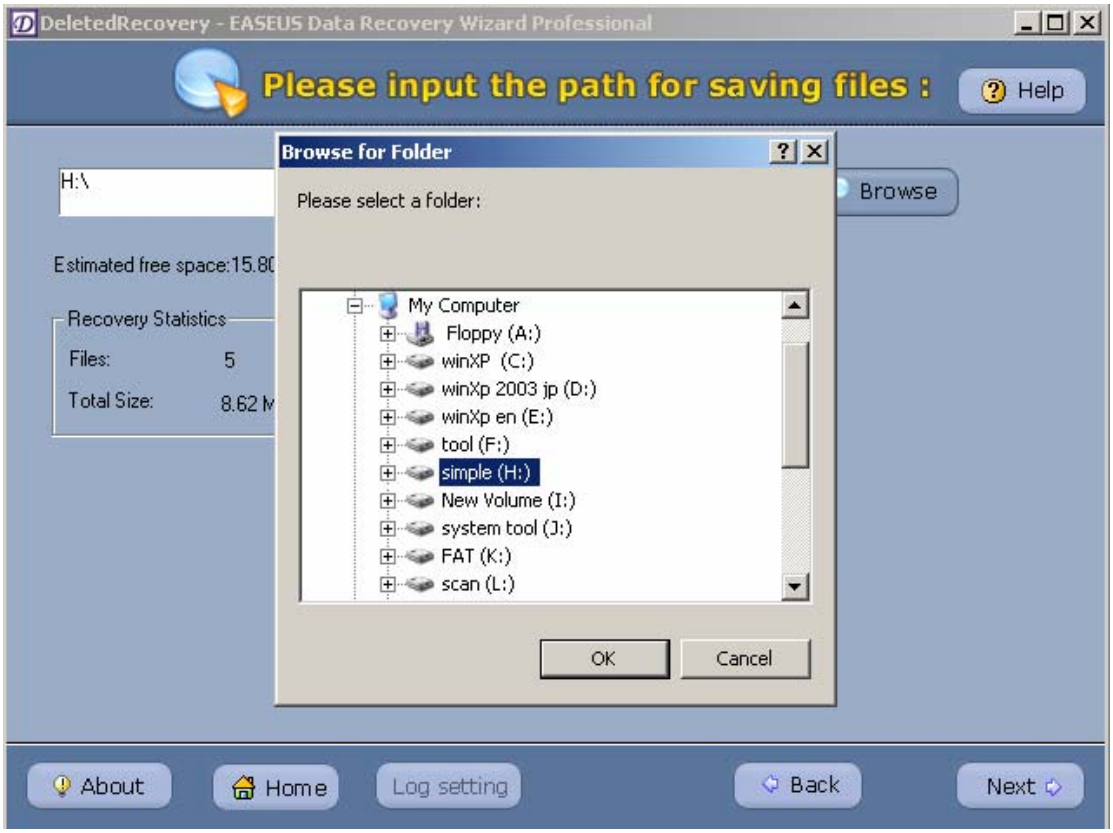
Click “Next” and scan the deleted files, choose the deleted folder” my file”

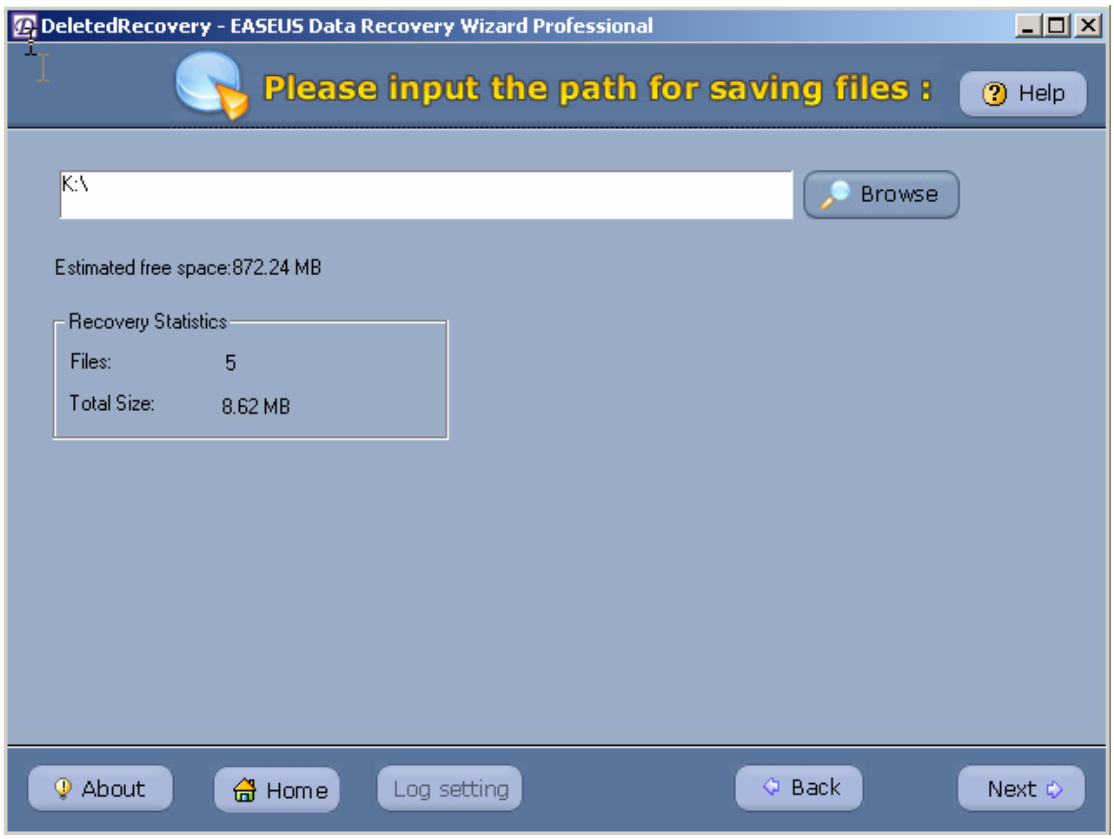


Tick it and click “Next” to enter the interface of choosing path for saving files.

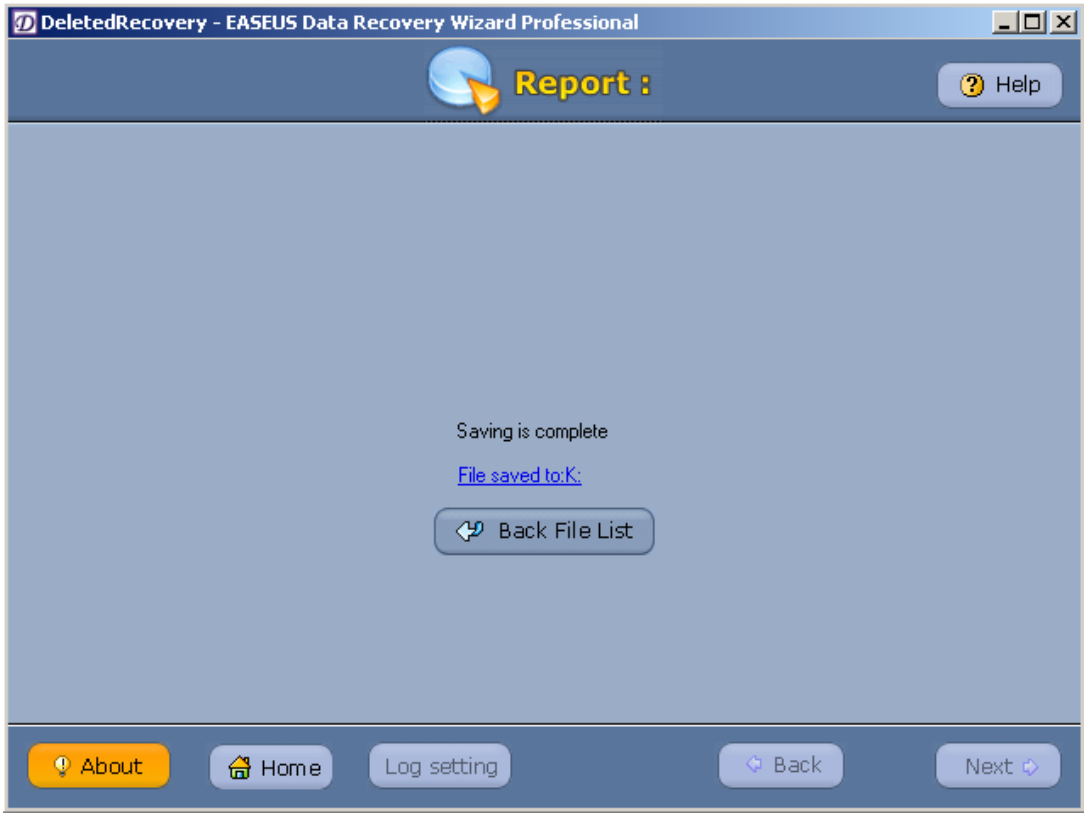


Choose a partition with large space to save the files

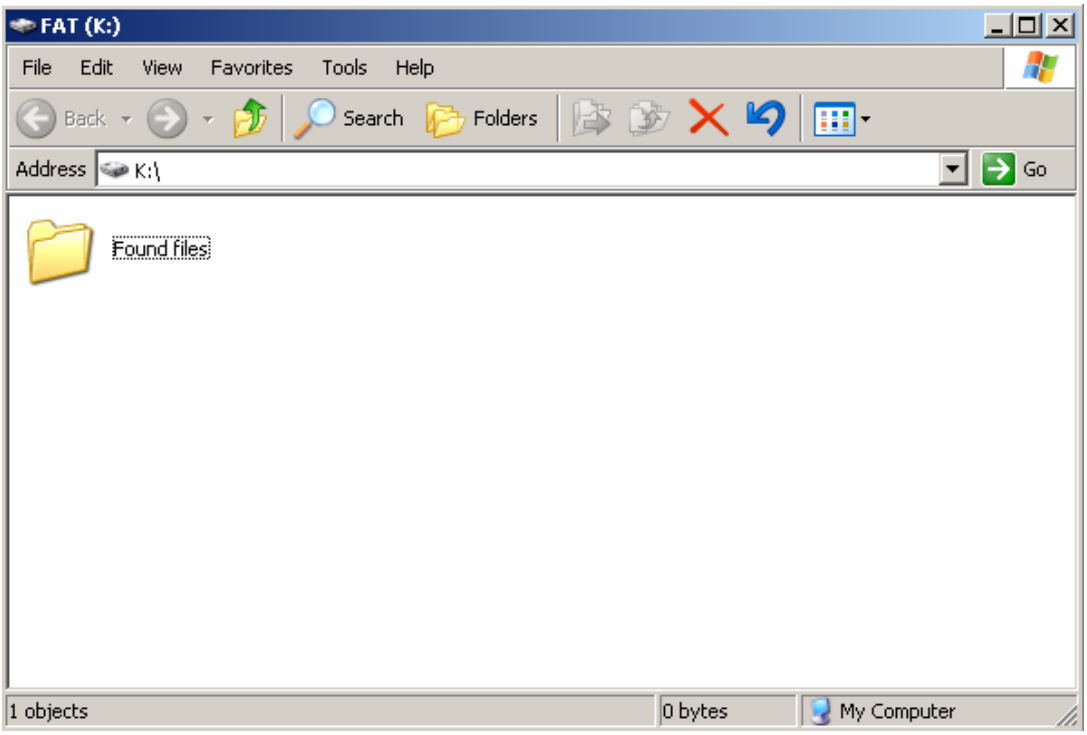




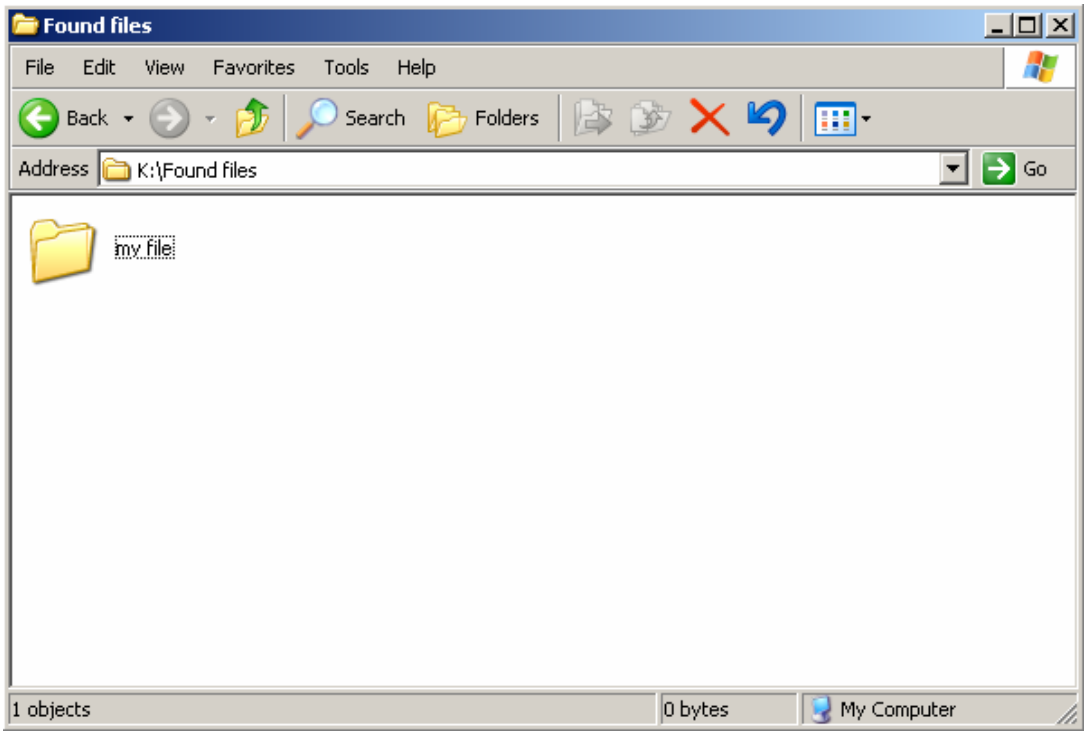
Click “Next”, after recovery, there will be a Report interface.

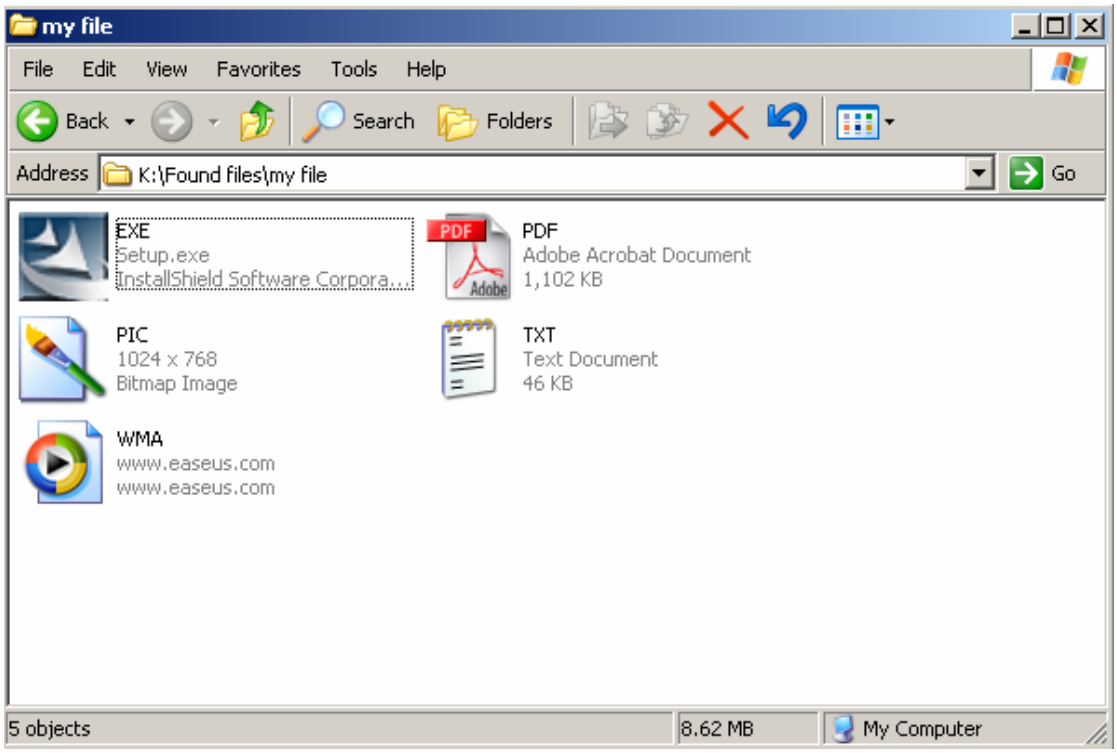


If you want to check the recovered files, please click “file saved to”.



Enter the folder “found files” created by Data Recovery Wizard 3.0 and you can see the recovered folder/file:

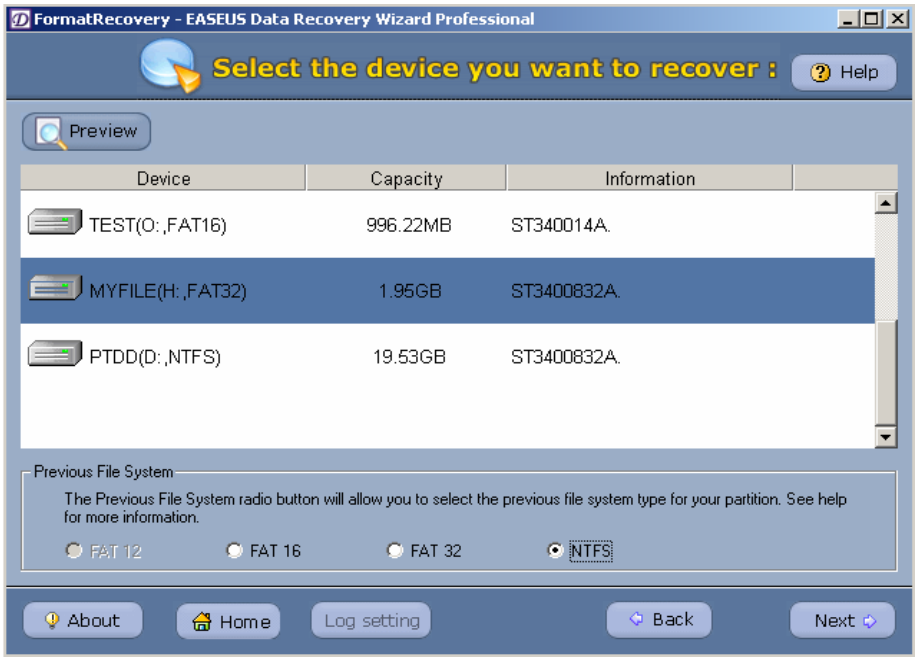




If you are not satisfied with the result, you can use “AdvancedRecovery” module, and repeat steps above.

4.FormatRecovery

Eg: Format a partition from NTFS to FAT32
Run and choose “FormatRecovery”, and then choose the formatted partition and tick the previous file system(here is “NTFS”)in “Previous File System”



Click “Next” to search files, the following steps are the same as previous methods.

Attention: if you are not satisfied with the result or you can not remember the previous file system on the partition or the program can not figure out the size of clusters on the partition, you can refer to the following steps:

Choose “AdvancedRecovery” and choose the partition

Click “Next”, the following steps please refer to previous methods.

5.Recover encrypt/compressed files in NTFS

Attention: if you want to recover encrypt/compressed file in NTFS, you need Data Recovery Wizard Professional 3.0, for Data Recovery Wizard 3.0 does not support encrypt/compressed file recovery.

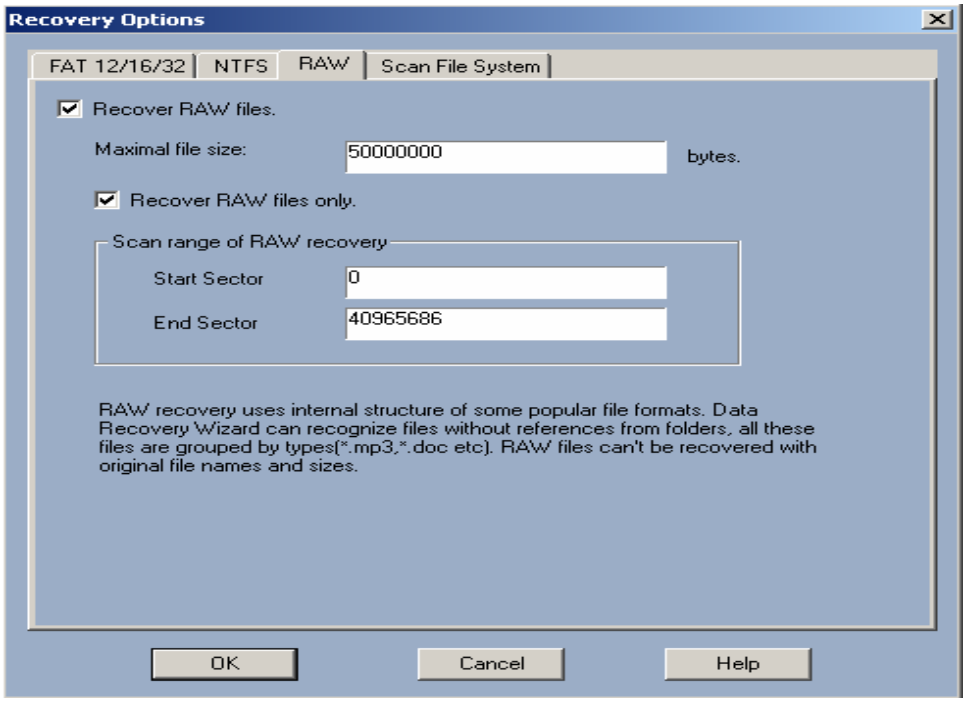
Encrypt/compressed file recovery and deletedrecovery are mostly the same. But more attention should be paid to that to rightly recover encrypt/compressed files , you need use the account that create encrypt/compressed files to log on Windows; moreover, the encrypt files must be recovered and saved to partition of other NTFS type not FAT partition, or the recovered encrypt files can not be opened correctly.

6.RAW RECOVERY

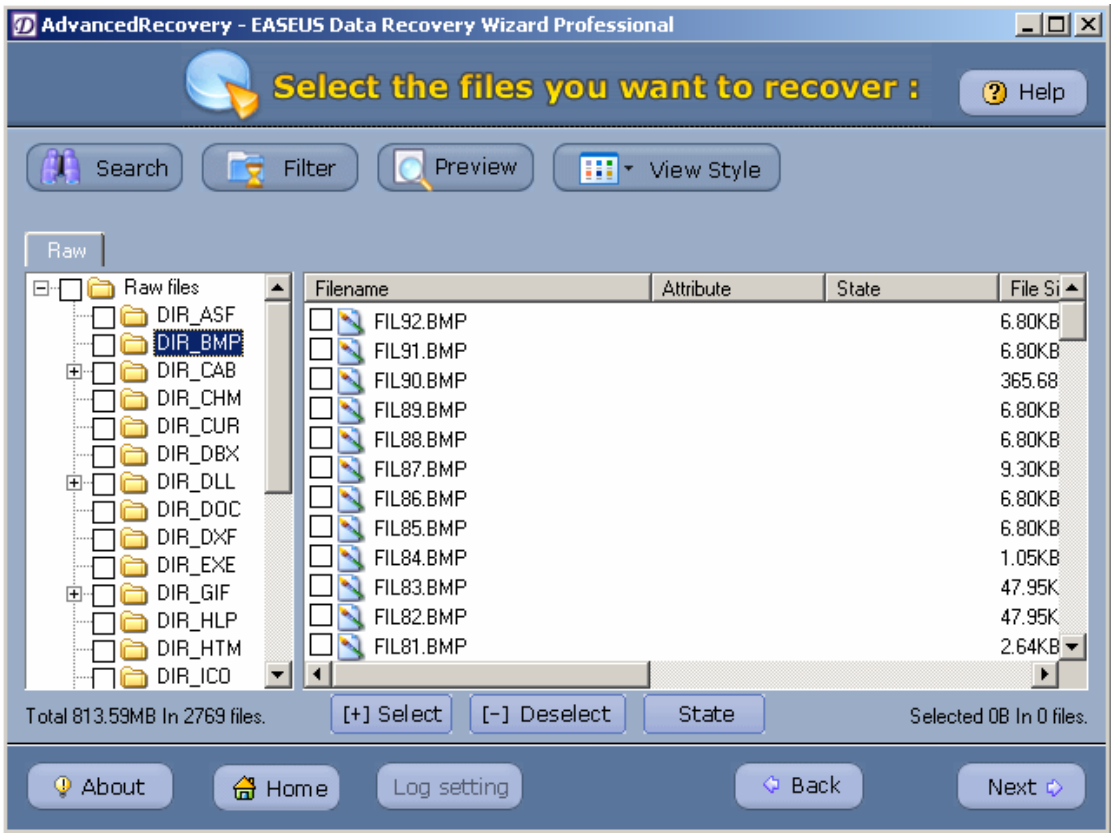
When the partition file system is completely destroyed or “AdvancedRecovery” cannot find data you want, you can try “RAWRECOVERY”.

Run the program and choose the partition you want to recover

Click “Option”, choose “RAW” and tick “Recover RAW files only.”:



Click “OK” and “Next” to finish the searching operation:

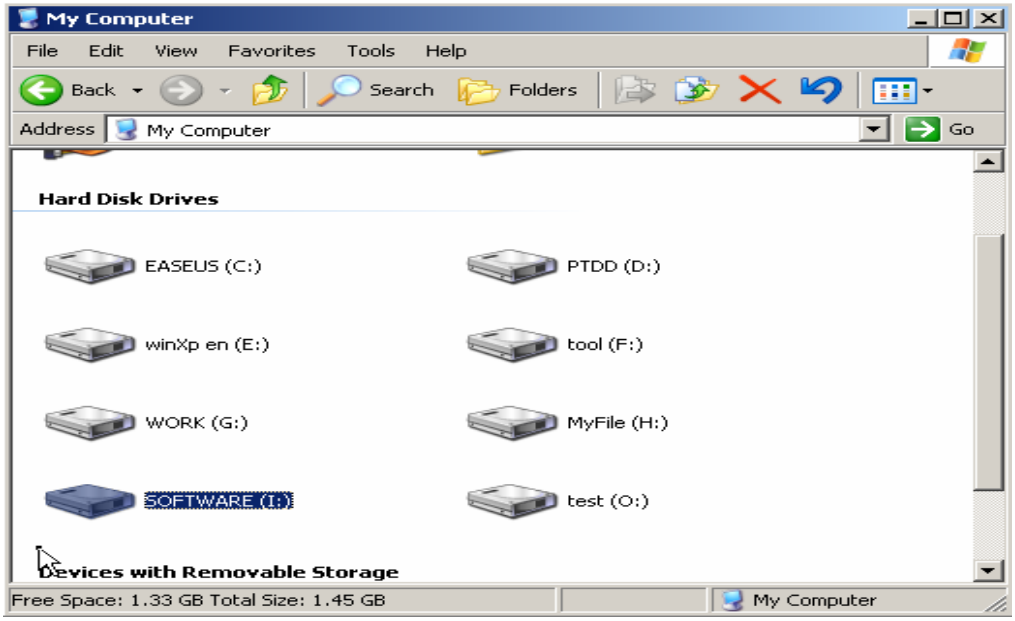


Attention: this recovery module does not scan files via file system, so the files found have no usual filename and path. The program will classify the files according to the file types.

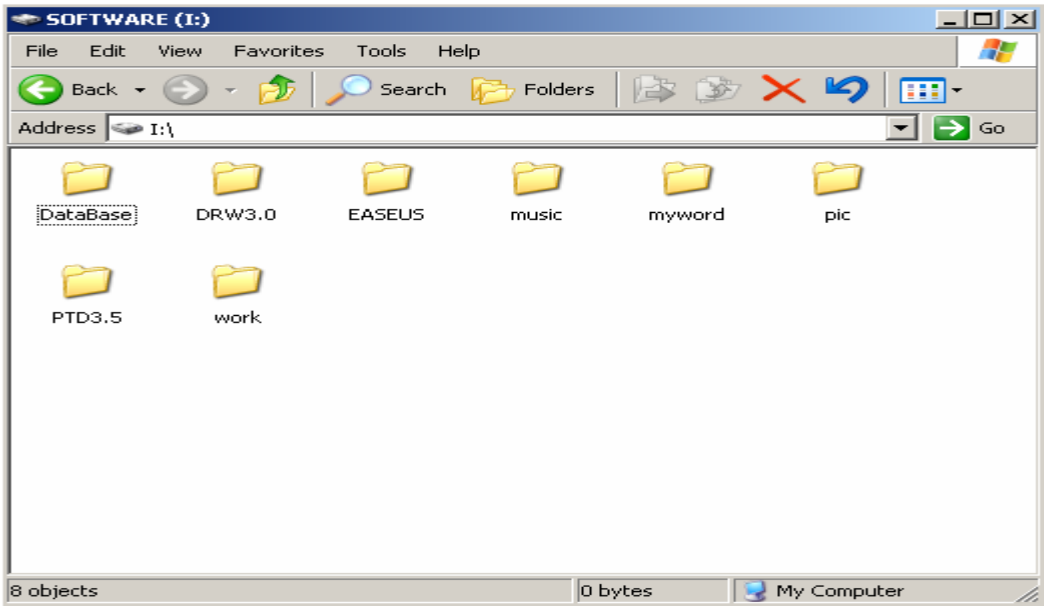
Click “Next”, the following steps are the same as the previous methods.

7. Recovery when parts of partitions are lost:

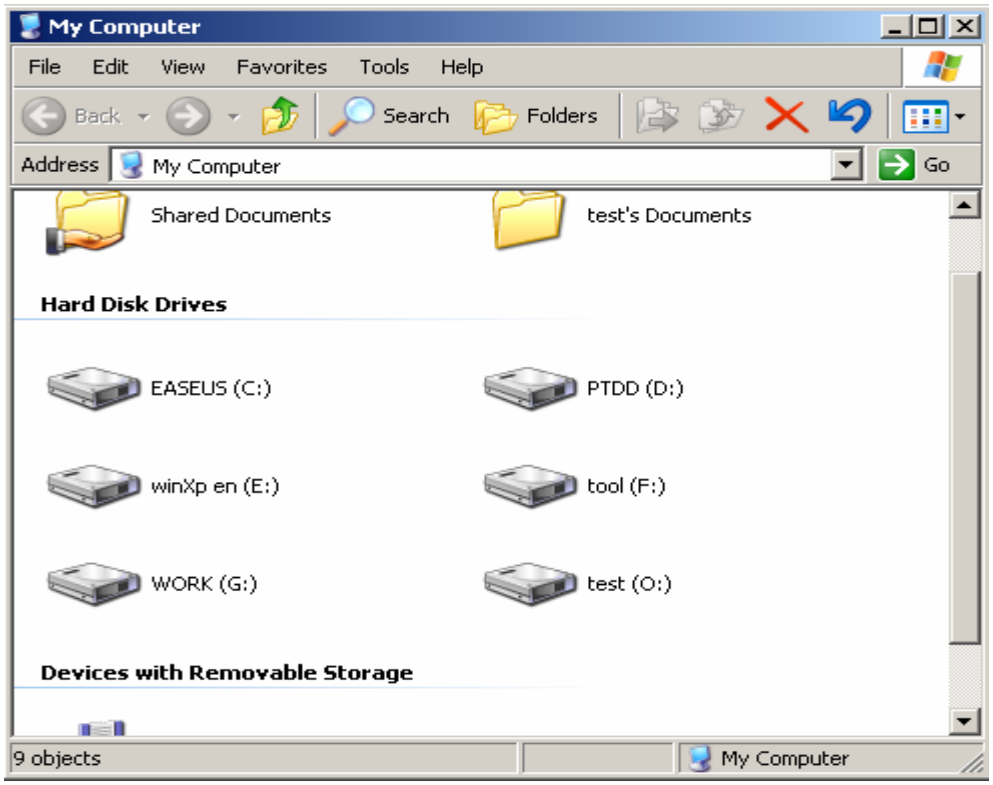
Here are the partitions before lost:



Files in the partition:



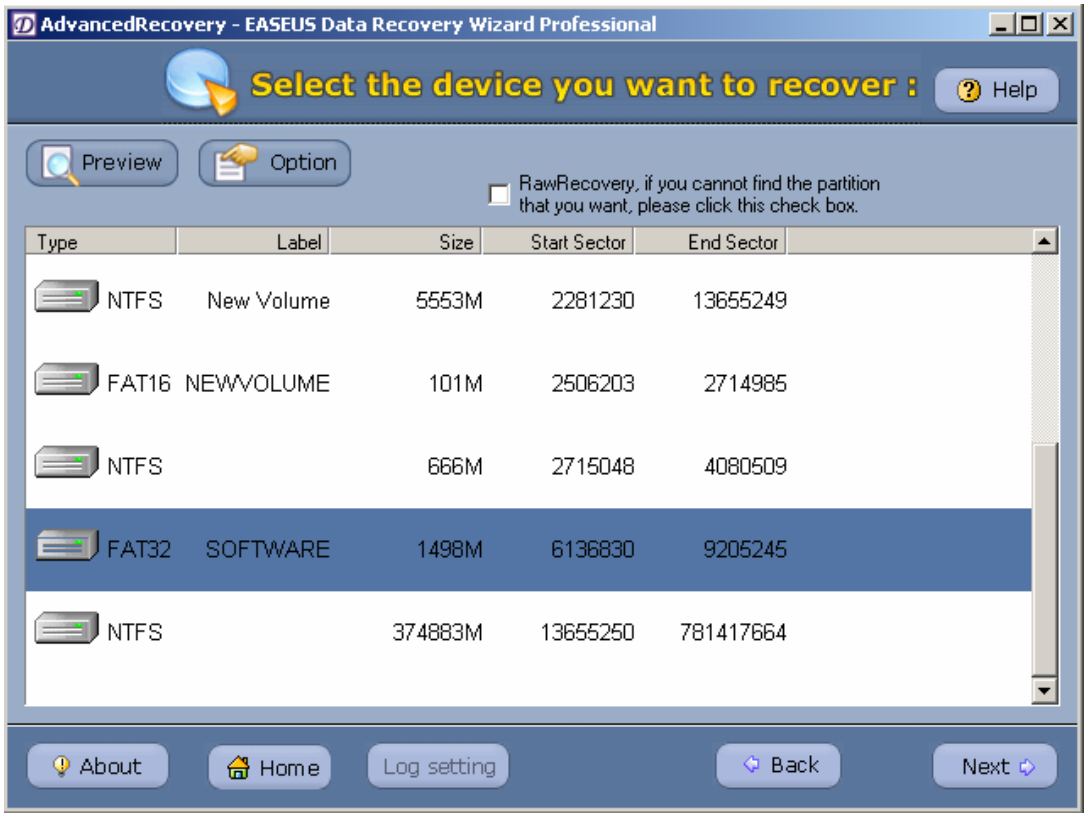
After deletion, we cannot see the partition in Windows explore:



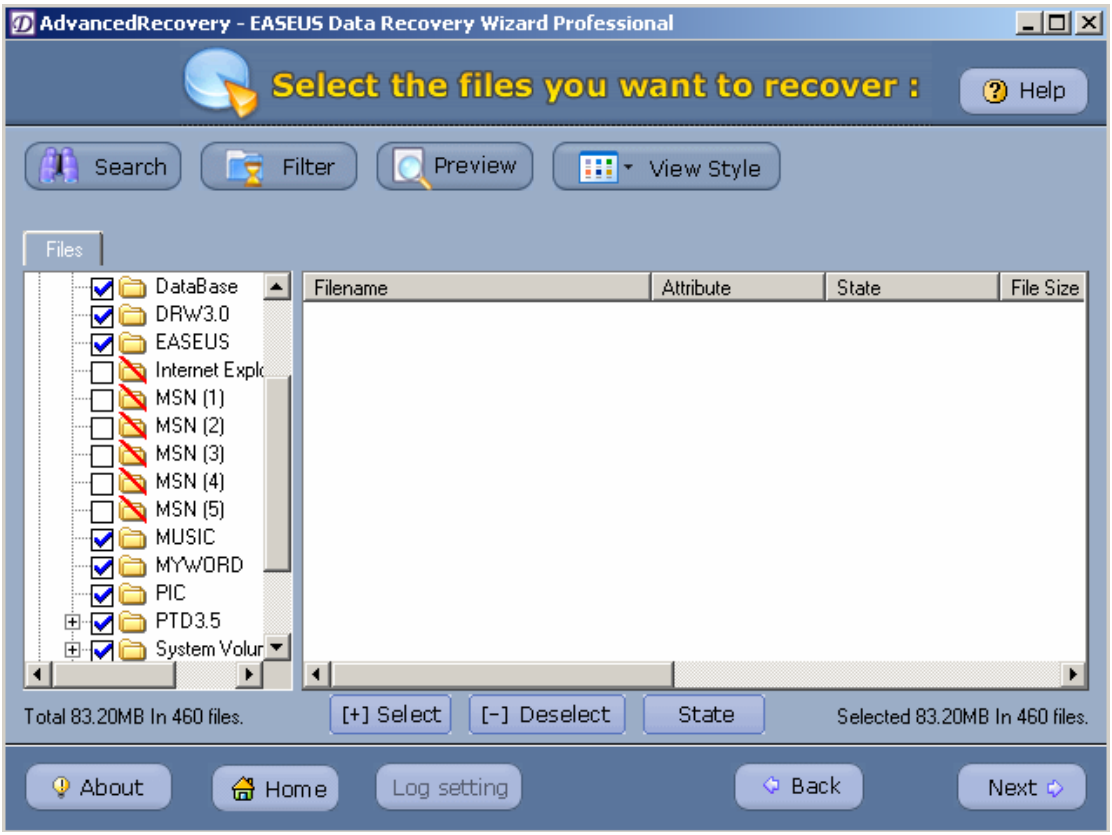
Run Data Recovery Wizard, enter “AdvancedRecovery”, and choose the disk where you lost your partition.

Click “Next”, search the lost partition.

After searching, find the lost partition on the list, choose it:



Click “Next”, the result of search is as following:



The rest steps are the same as the previous methods.

8. Data recovery in dynamic volume

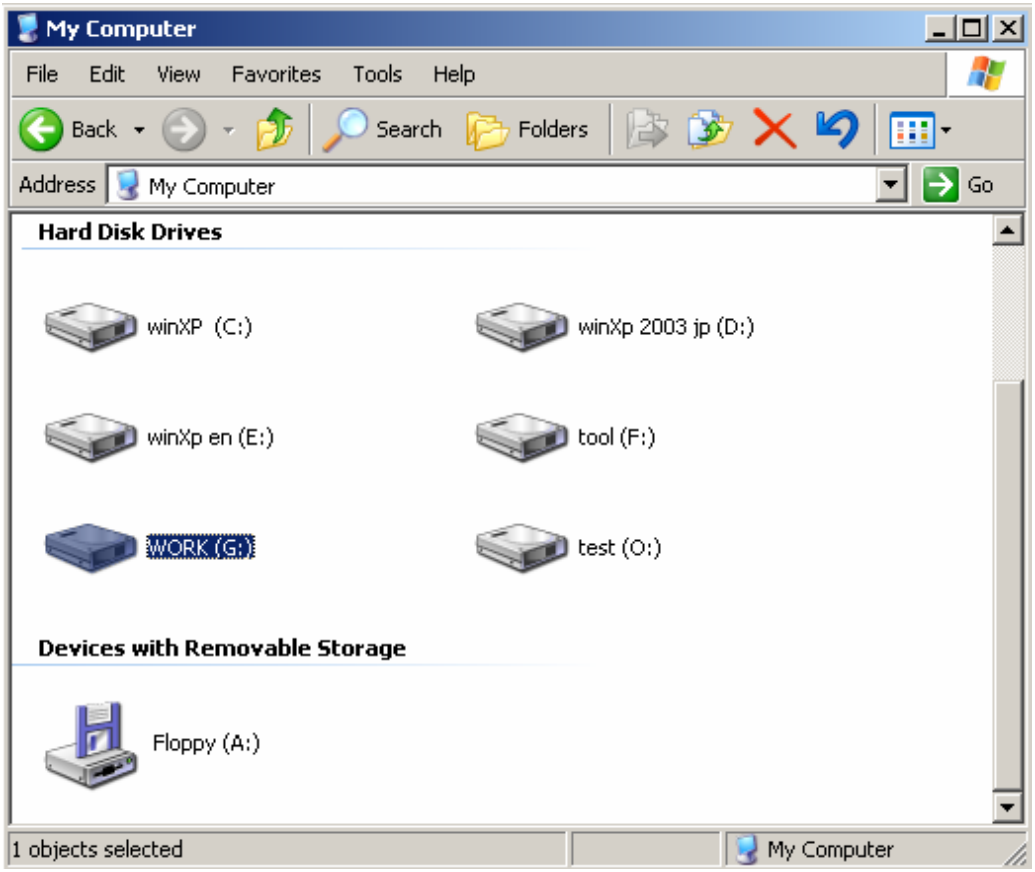
If you want to recover the data lost in a dynamic volume, you need Data Recovery Wizard Professional. Data Recovery Wizard does not support dynamic volume recovery.
Data Recovery Wizard professional supports simple volume, spanned volume, striped volume, mirrored volume and RAID5.

The method is the same as that of other types of partitions.

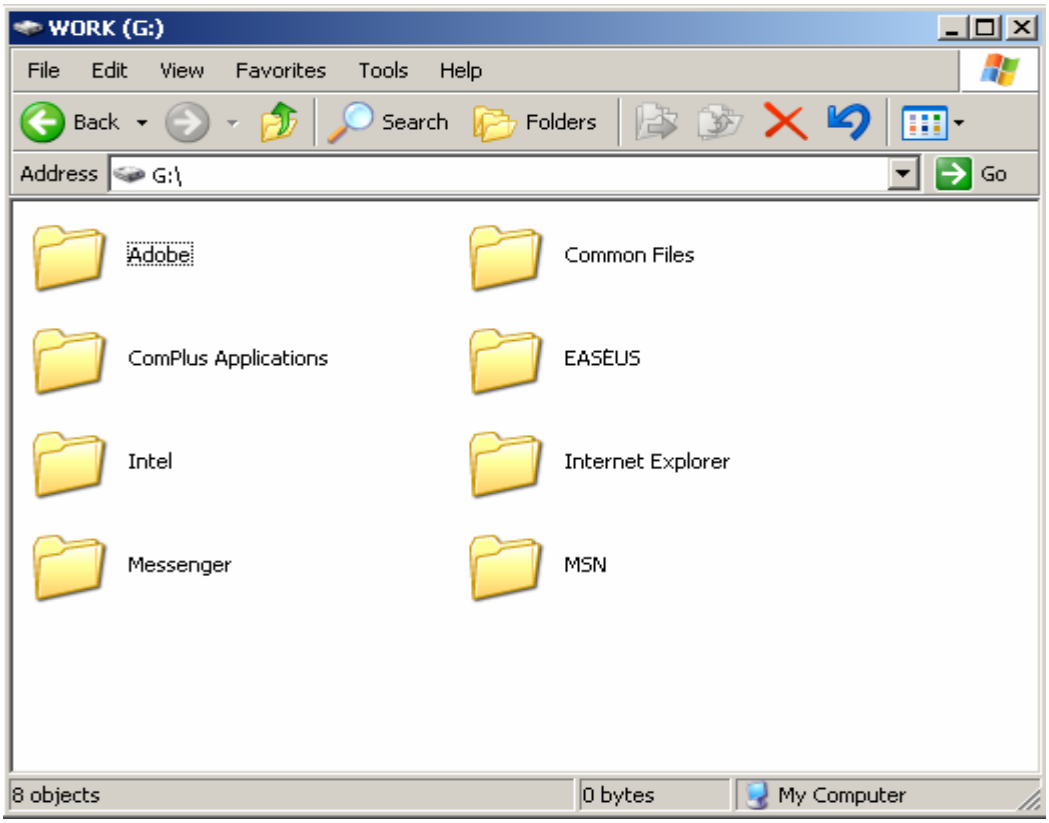
Attention: if you have lost the dynamic volume, Data Recovery Wizard professional can not recover your data except that on simple volume.

9. Data recovery on inaccessible partition.

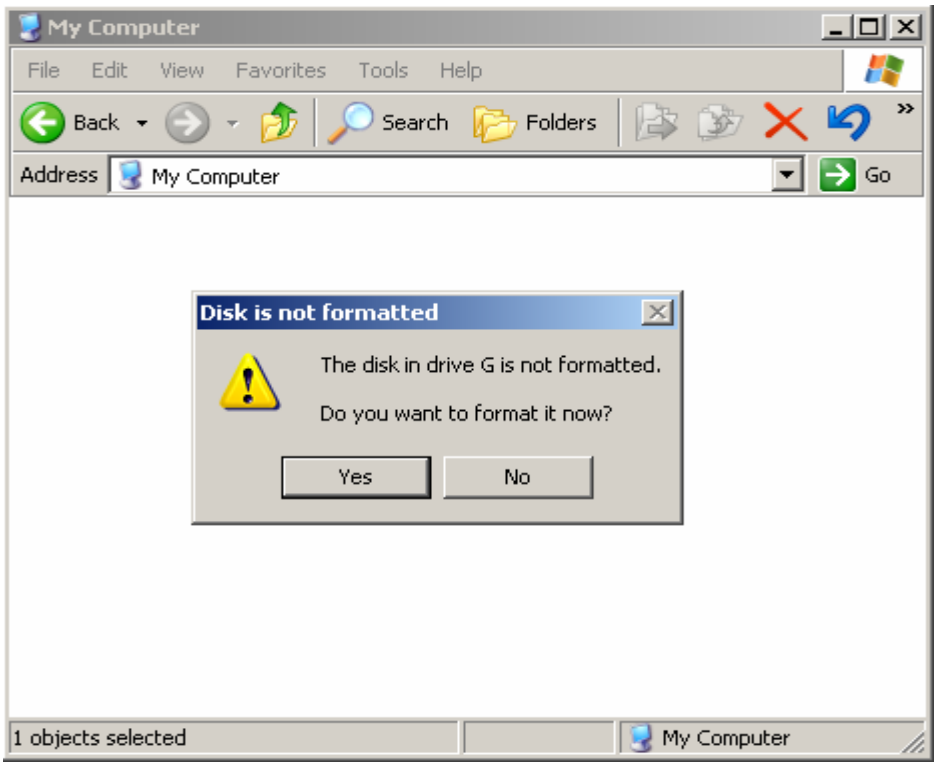
Before the partition was destroyed:



The files in partition are:



After the partition is destroyed, when enter the partition, it will prompts “The partition is not formatted.”



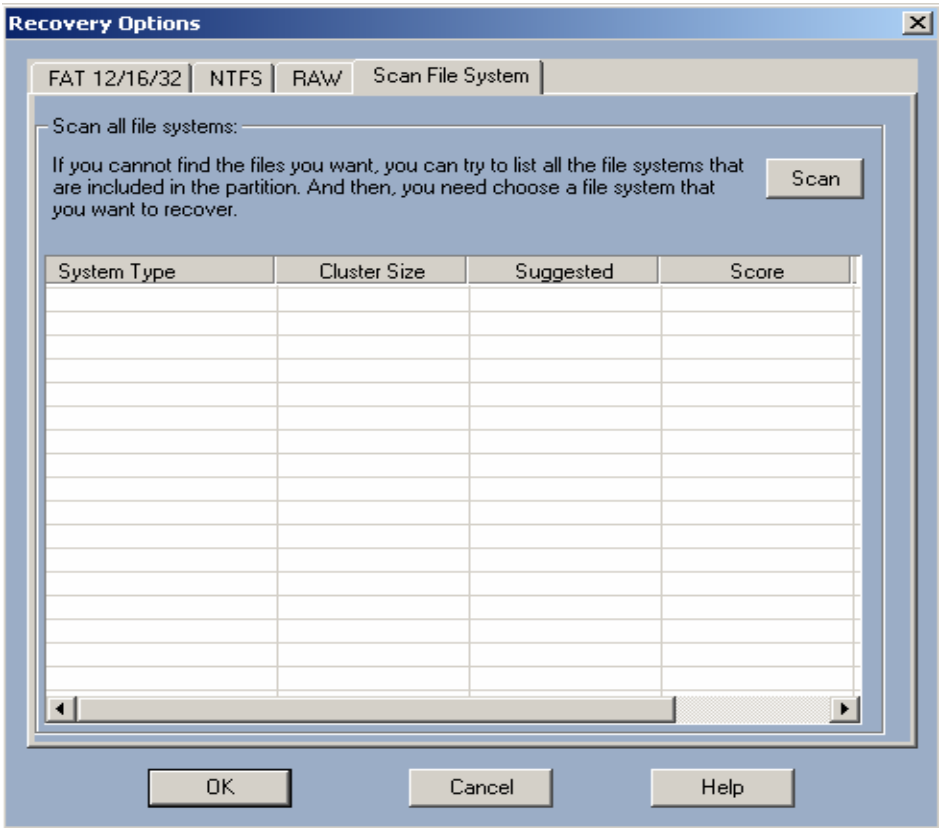
Run the program, choose AdvancedRecovery, and choose the partition.

Attention: the volume lable might have been destroyed, which may cause that the partition label cannot be shown on the partition list. In this case, you can choose partition according to the type and size of the partition.

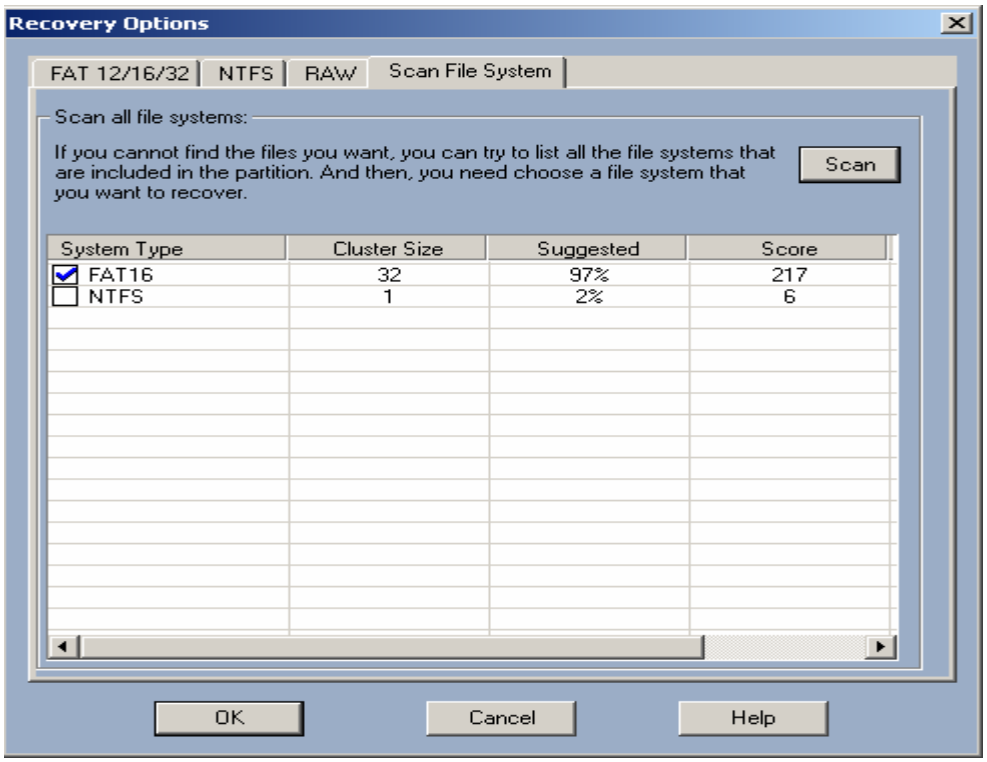
Click “Next”, the following steps are as the previous methods.

If the program cannot recover the files, there will be a prompt message:

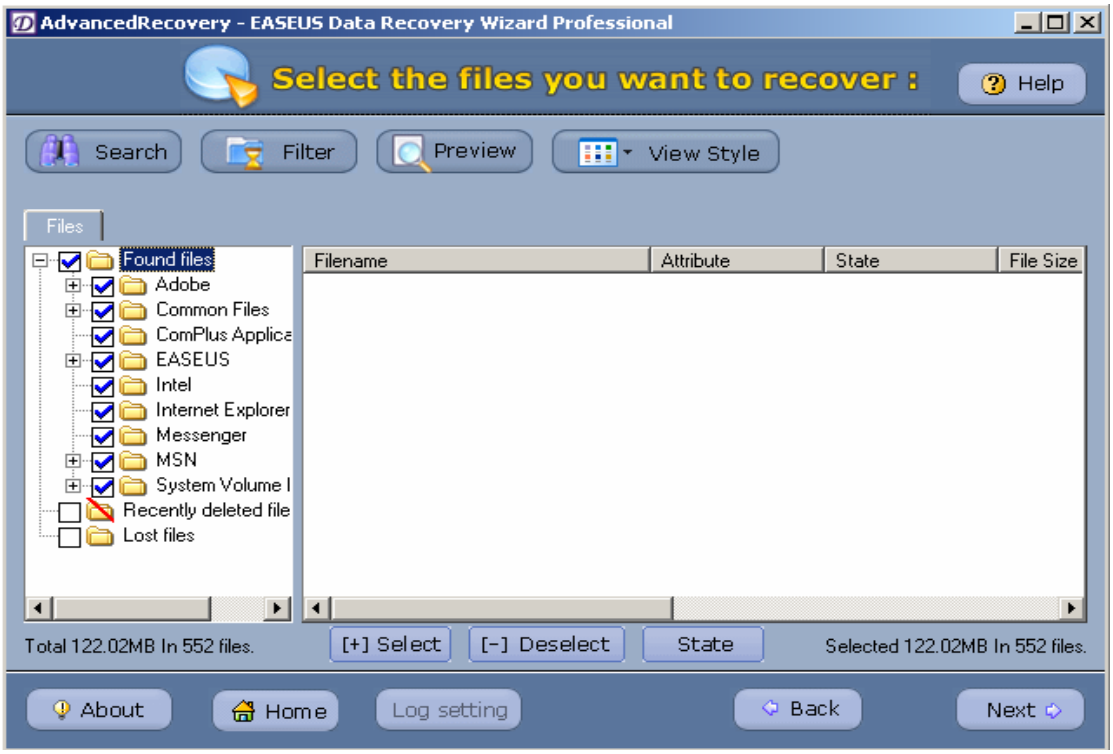
Choose the partition, click “Option”, and choose “Scan File System”:



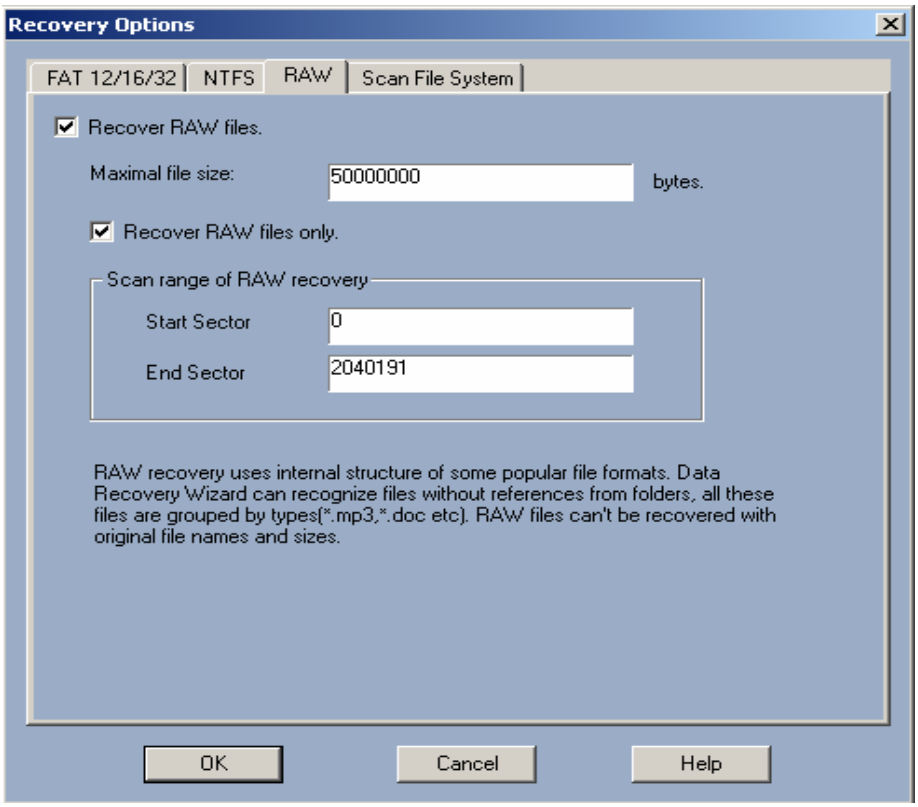
Click “Scan”, analyse the possibly existing file system information, and choose “System type” that gets the highest score:



Click” OK” to continue the recovery steps, the result of the searching is as following:



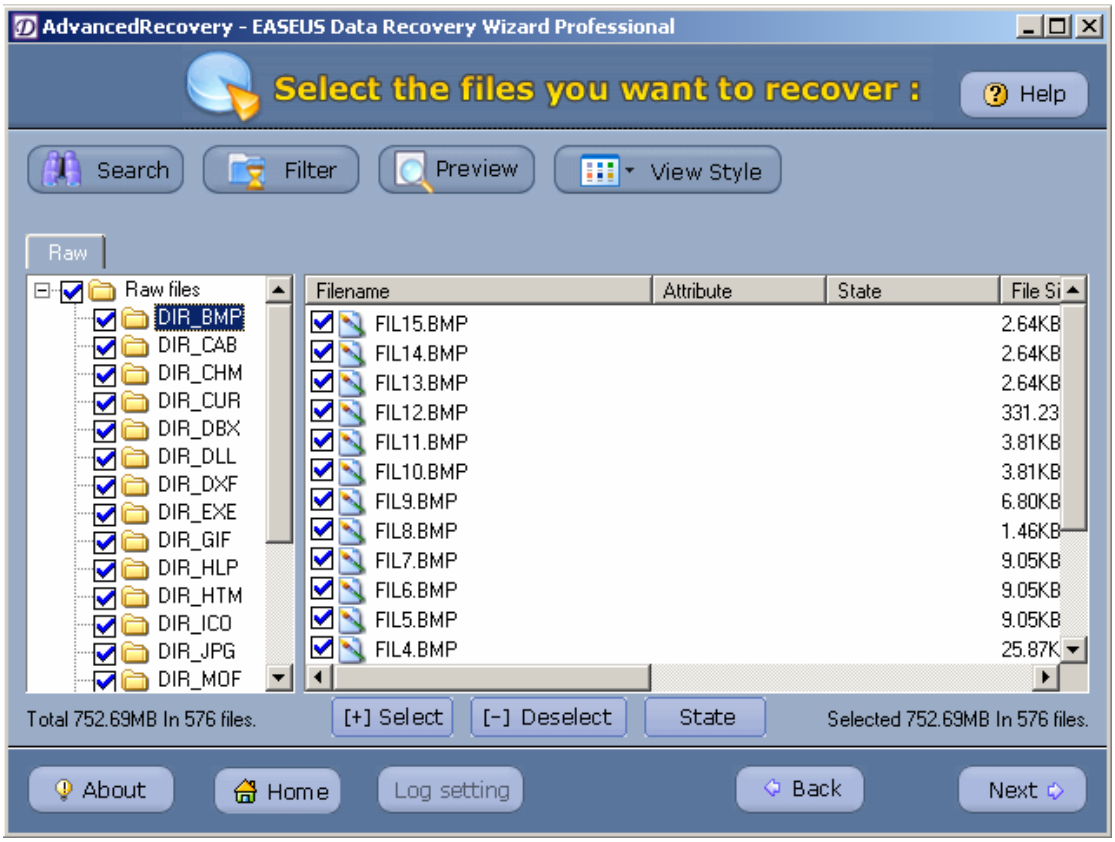
If you are not satisfied with the result, please Click “Option”, choose “RAW”, and tick “Recover Raw files only”



Keep the default, click “OK” and then click “Next”.

Attention: “RAW Function” does not scan files via file system, so the files found have no usual

filename and path. The system will classify the files according to their file types.



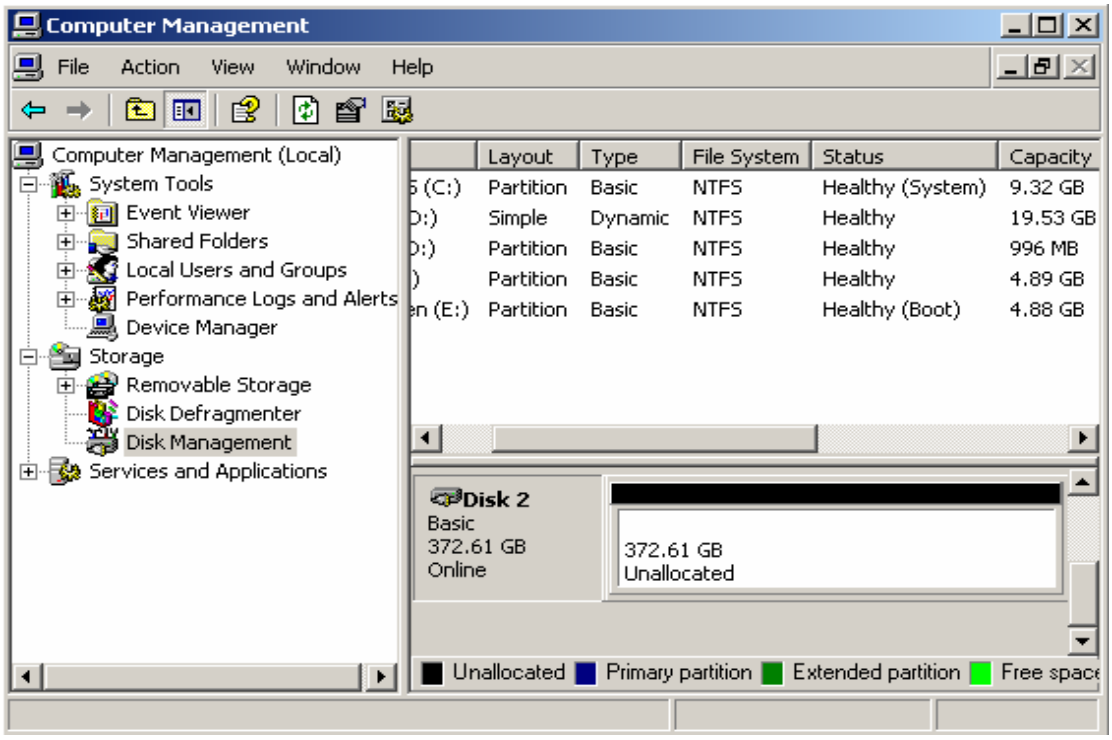
Click “Next”, the rest recovery steps refers to the previous methods.

10. File recovery on RAW partition

In this case, the methods are the same as that of “Data recovery on inaccessible partition.”

11. Data recovery when all the partitions are lost

When all the partitions are destroyed, you can not see any partition in disk management:



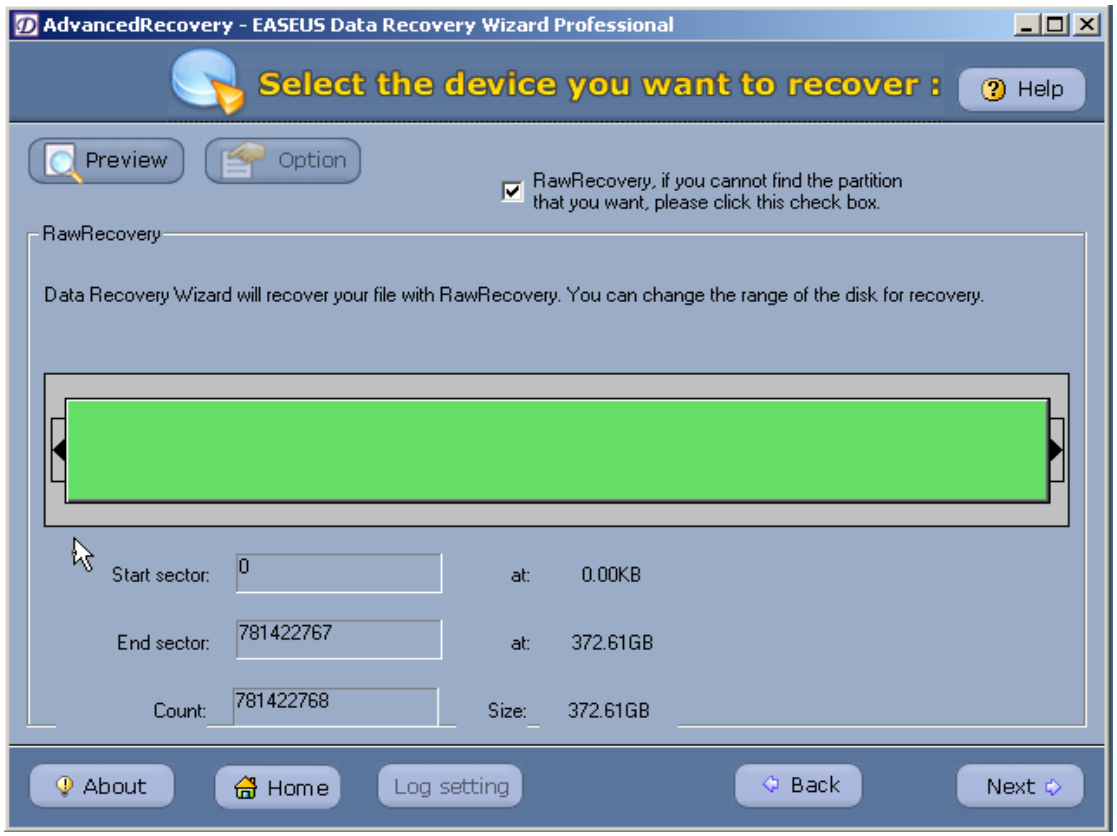
In this case, you can refer to the method of “Data recovery when parts of partitions are lost”.

If you cannot find the partition where you want to recover data when searching the partition, you can follow these steps:

Run the program, choose “AdvancedRecovery”, then choose the HD:

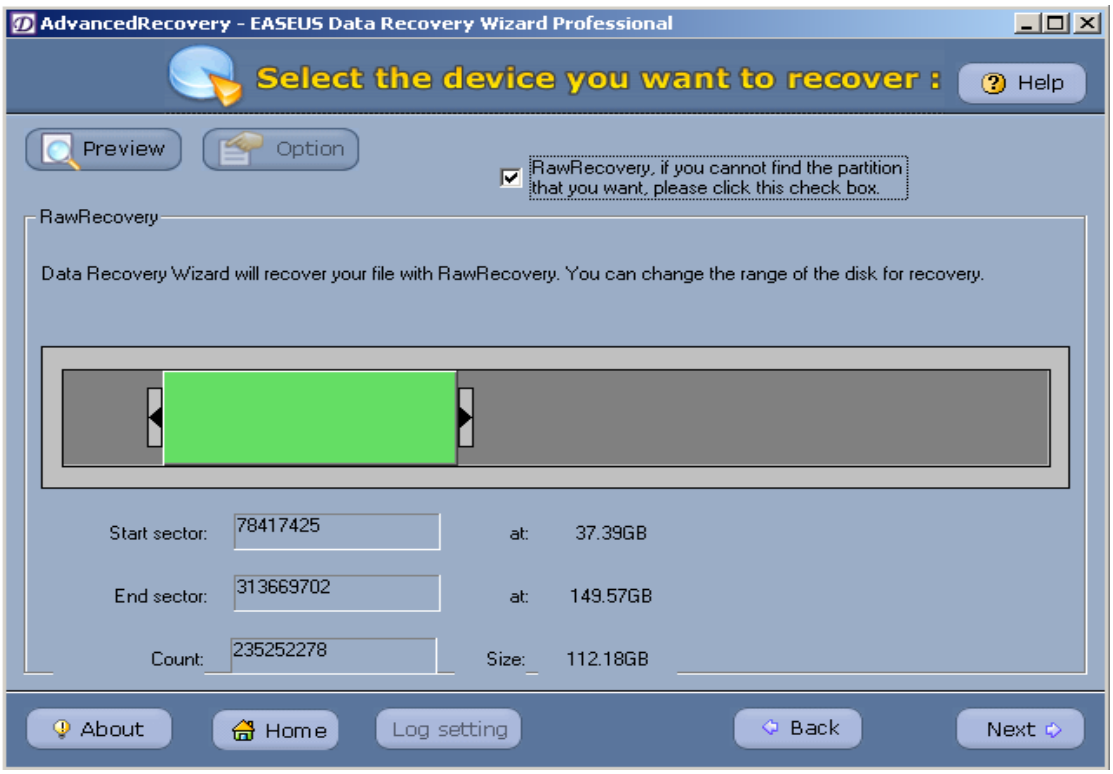
Click ”Next”, click ”Cancel” when searching the partition, then exit.

Tick “RawRecovery, if you cannot find the partition that you want, please click this check box”.

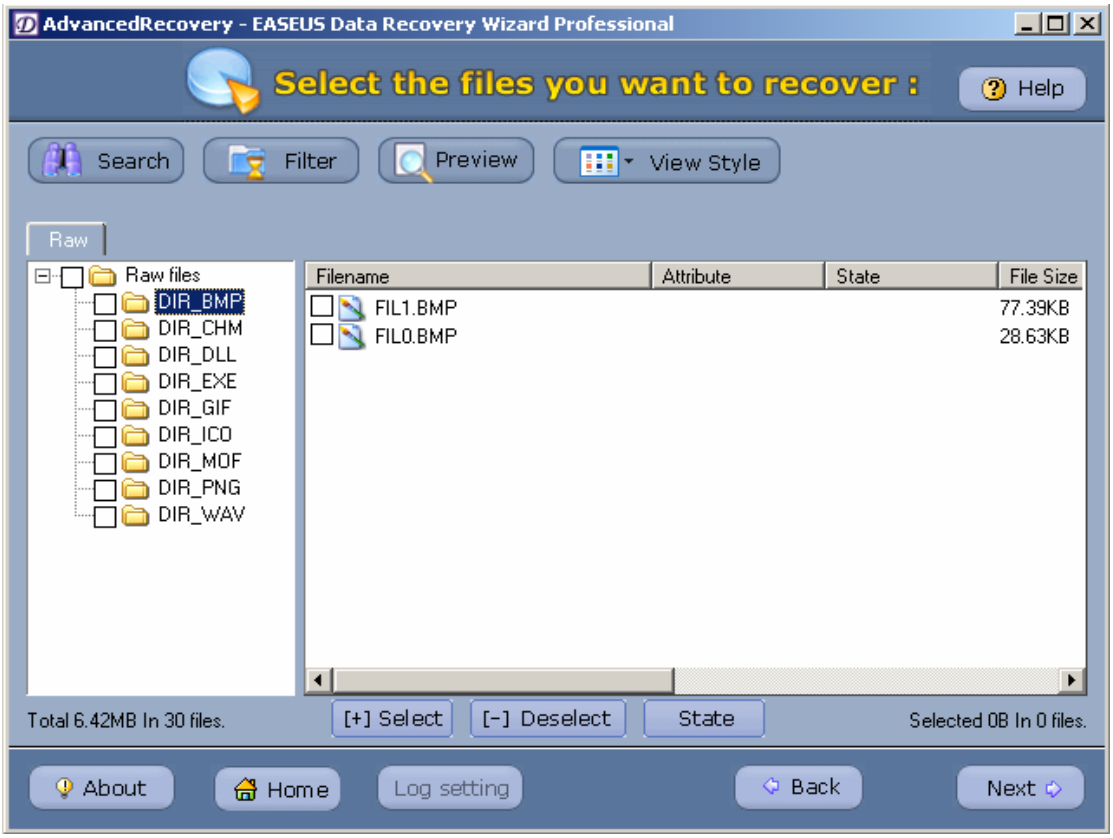


Roll the block to adjust the range of the sector you want to recover (you can set the range

according to the place and size of the partition):



Click “Next” to search files in specified sectors



The rest steps are the same as the previous methods.

12． Data recovery when GHOST Image restore failed.

In this case, there can be different recovery scenarios according to specific damage of the partition and file system:

Usually, after the failure of GHOST Image restore, partition table of the target disk would be in some damaged condition, you can search the partition where you want to recover data by “Searching for Partition “function in “AdvancedRecovery”.

If the partition is found, please refer to “Data recovery when parts of partitions are lost”.

If not, please refer to “data recovery when all the partitions are lost”.

13. After Partition Magic size revision/ combination/ division of partitions fails, how to recover the lost data?

In this occasion please refer to “Data recovery when GHOST Image restore failed”

14. When using Data Recovery Wizard 3.0 to recover files, there is some strange sound in HD. How to handle it?

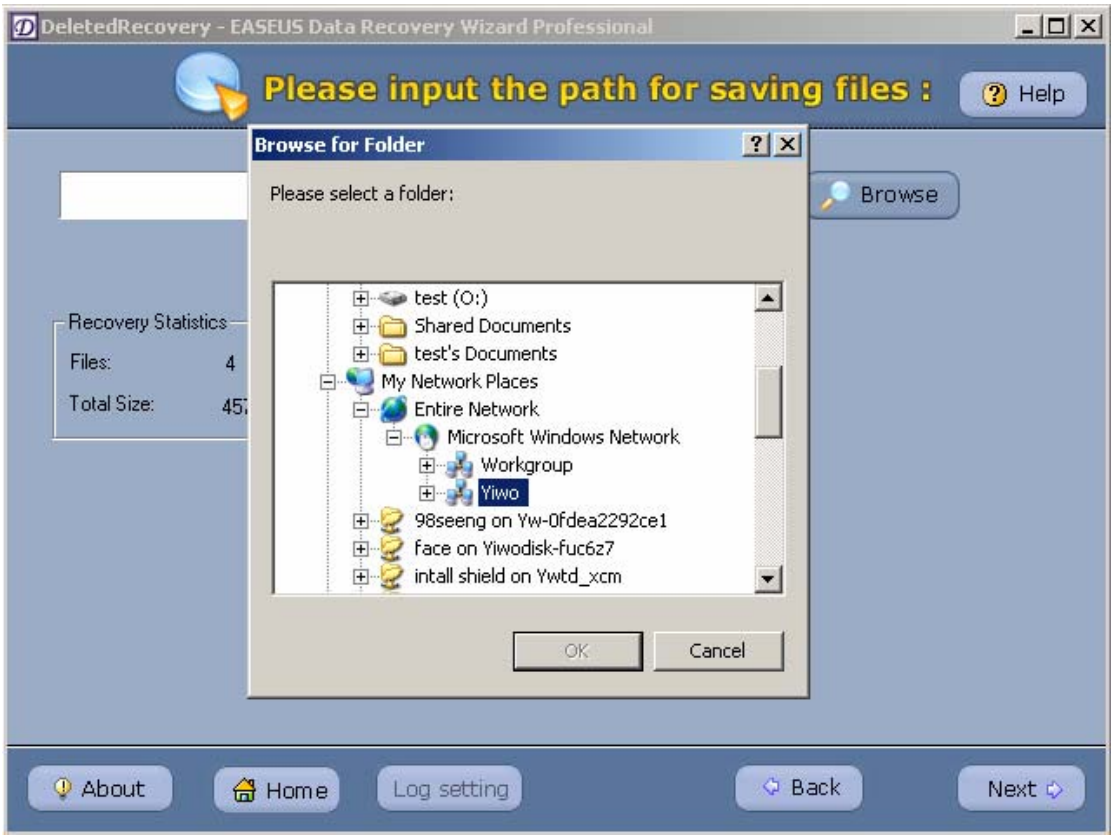
Your HD has some hardware problems. In this occasion, you need stop running Data Recovery Wizard 3.0 at once, and then send your HD to HD maintenance station.

15. HD cannot be detected in BIOS, how to recover data by Data Recovery Wizard 3.0

The precondition of data recovery by Data Recovery Wizard 3.0 is that the storage device has no hardware problem and runs normally; or Data Recovery Wizard 3.0 can not help you.

16. There is not enough space in hard disk to save the recovered files, nor there is removable storage device, how to handle it?

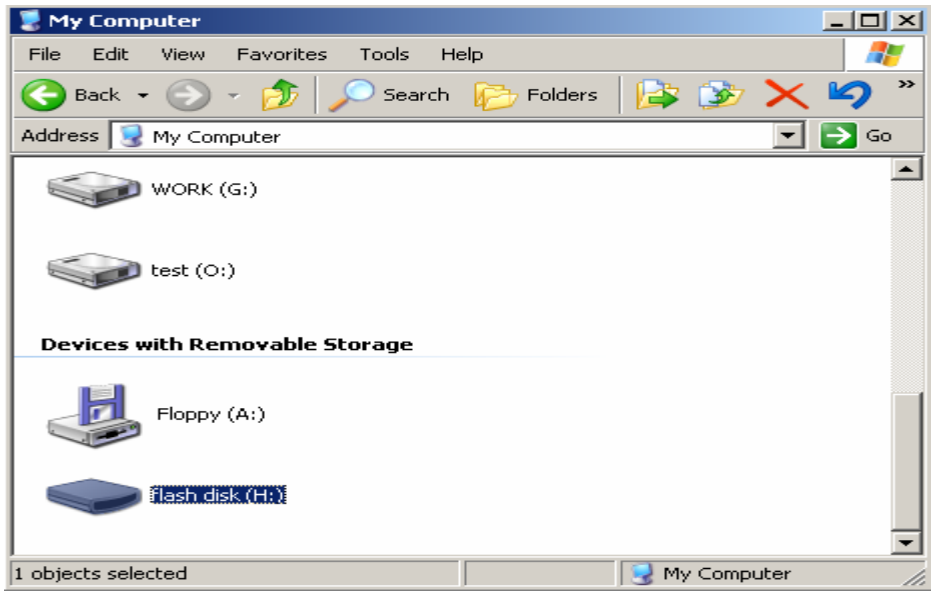
You can save you files to other host computers via network, please refer to steps as following:
Choose another host computer on network:



Choose the host computer where you want to save your files, the rest steps please refer to the previous methods.

17. How to recover data in other storage devices (eg: floppy disk, flash drive, removable disk etc)?

Attention: Date Recovery Wizard 3.0 supports storage devices both with MBR and without.
Eg: To recover data in flash drive
Connect flash drive with host computer:

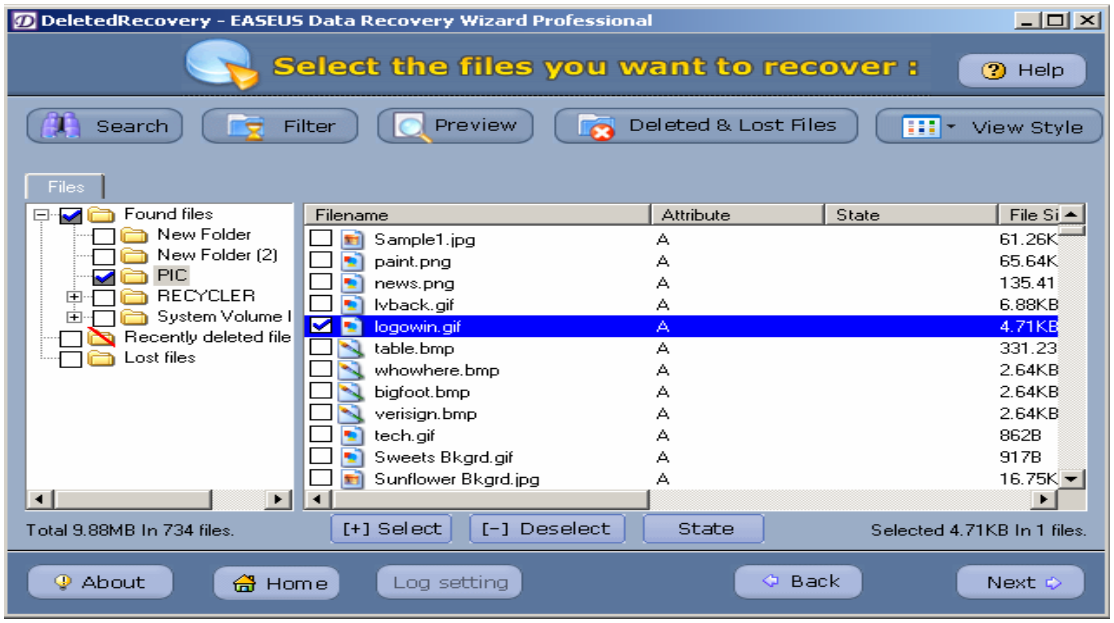


Choose different ways according to specific damage condition. Here we choose "AdvancedRecovery":

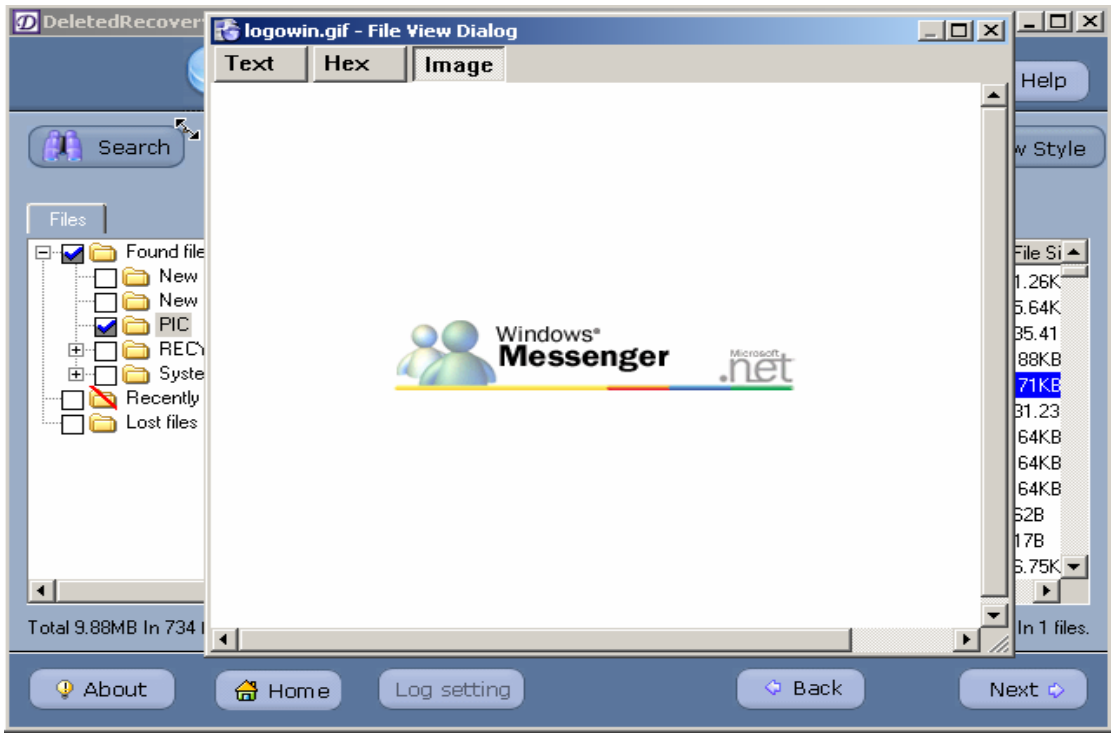
Click "Next", the rest steps please refer to the previous method.

18. To recover image file, how can I know it can really recover the data before I buy Data Recovery Wizard 3.0 ?

You can use “Preview” function to preview;
Run demo version to search the files, then choose an image file, click “Preview”



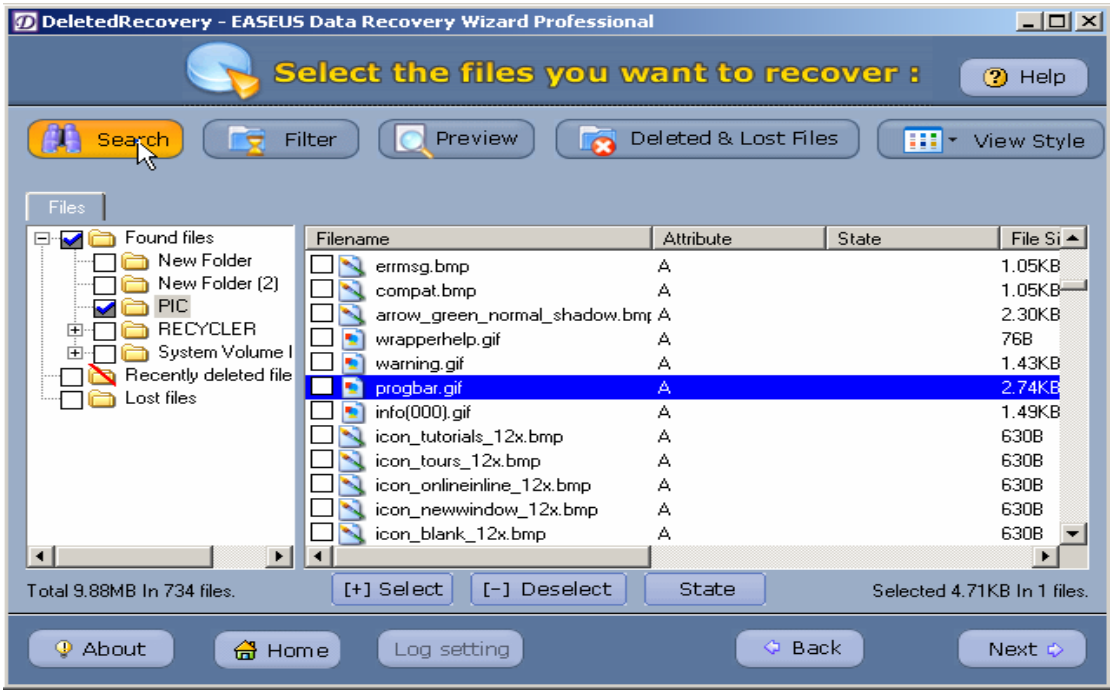
Preview result:



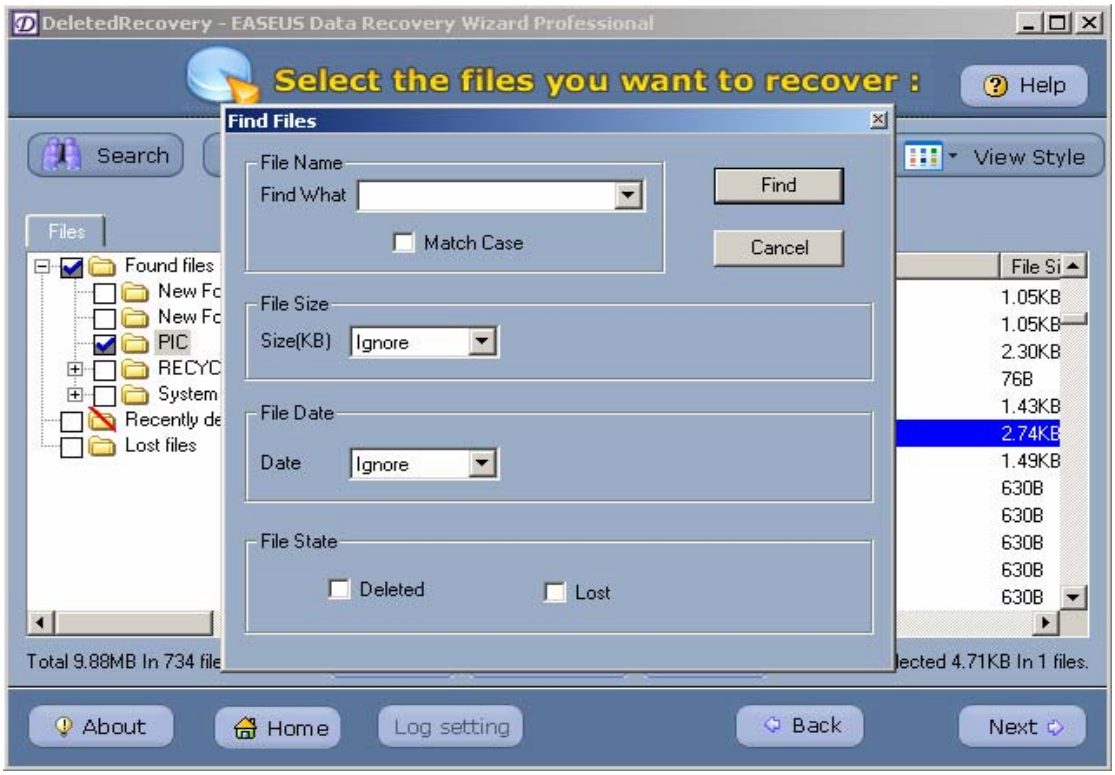
If the programmer can preview the image, Data Recovery Wizard 3.0 can rightly recover it.

19. There are so many files recovered, how can I find the files I want fast?

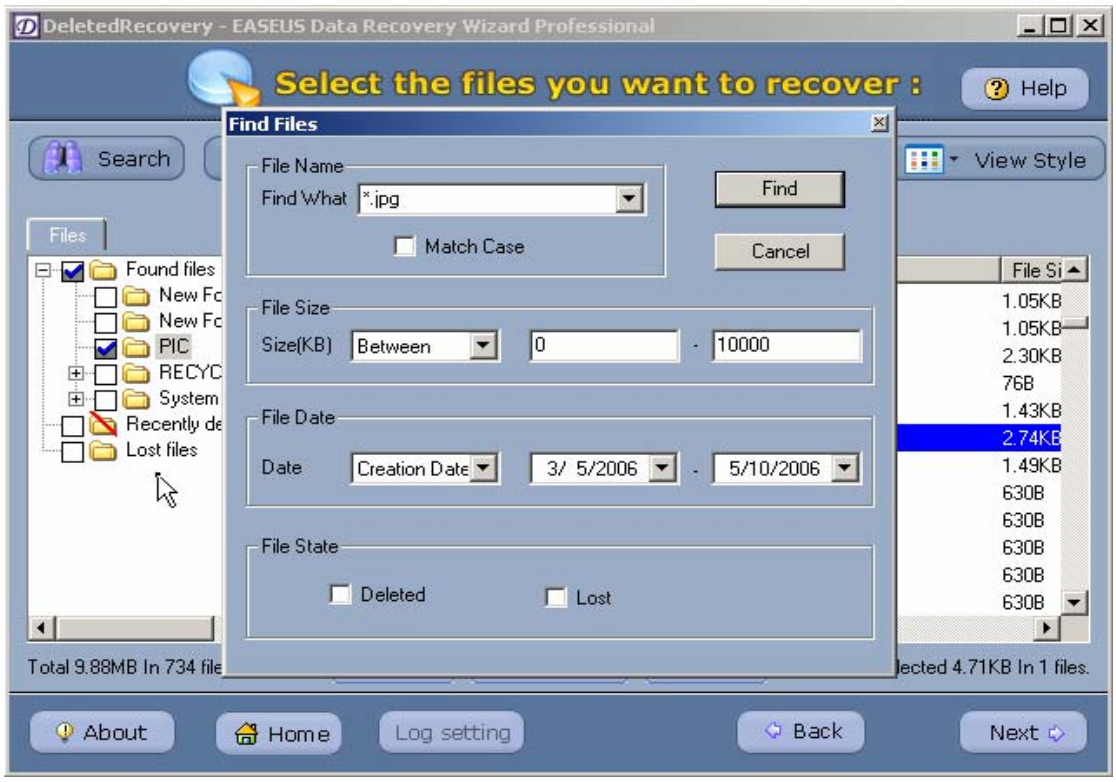
With “Search” and “Filter”, you can find files you want.
Eg for “Search”,
After searching:



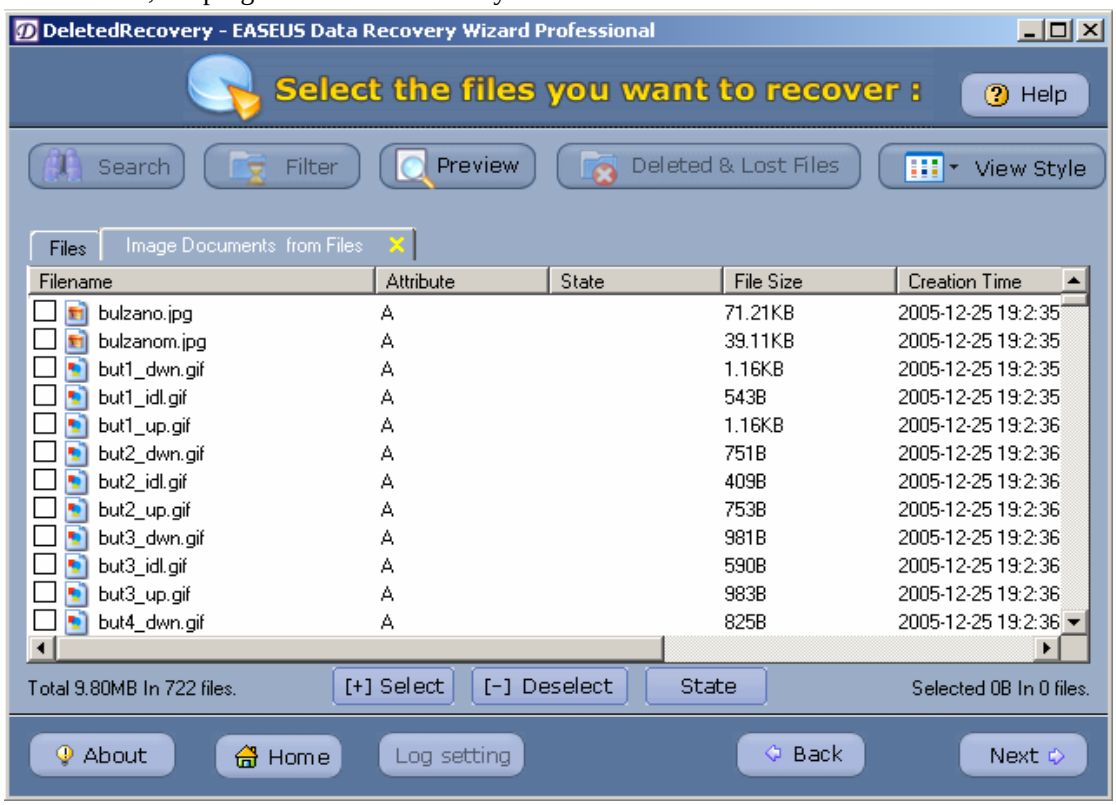
Click “Search”:



Enter the query information of your file:



Click “Find”, the program will list the files you want:



Click “Next”, the rest steps please refer to the previous methods.

20. I have recovered some files, but I cannot rightly open them.

In some cases, files recovered by using Data Recovery Wizard cannot be opened, which means the data has been badly destroyed.

You can try the following steps:

1. Send the badly destroyed files to our email (repair@easeus.com); we will try our best to recover for you.
2. Try to fix them with some file recovery tools

Attentions: Some documents that are badly damaged are irrecoverable.

21. In what occasion I cannot rightly recover data?

In occasions as following, you cannot rightly recover data:

1. Operations that cause the data are covered, such as: failure of GHOST image restore, virus attack, and mass write operation to the disk where you want to recover data etc.

2. There are some physical problems in storage devices.