

GoPro Recovery



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GPR - GoPro Recovery

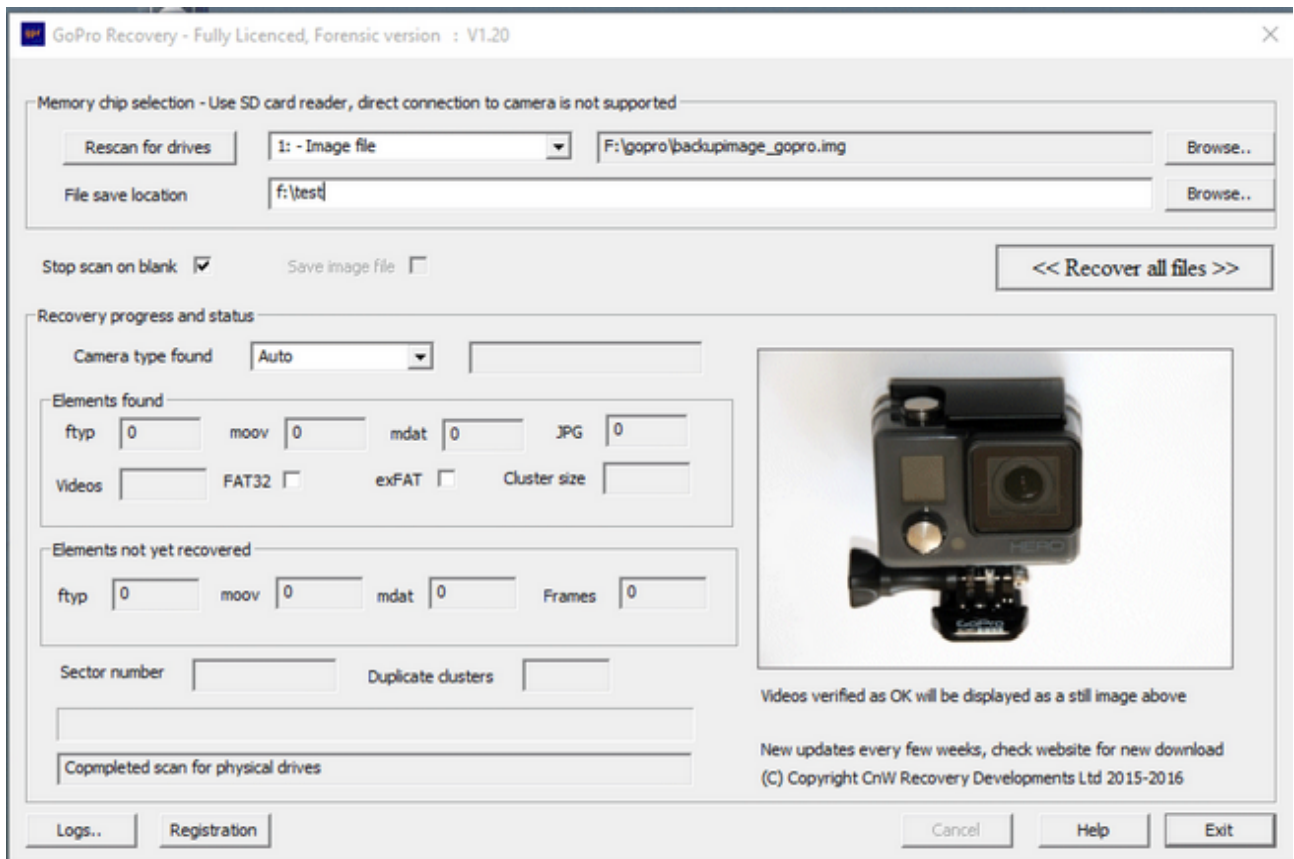
Introduction

GoPro Recovery is a program designed to just recover deleted, and corrupted videos from GoPro camera SD memory chips - and it works!

NB, the program will not read the camera directly, but only the memory chip.

GoPro cameras save the MP4 files in a way that means almost all other recovery programs fail. CnW Recovery have developed ways to recover that numerous fragments that make up a file and save them in the correct order. The process is simple, and automatic. This program is a concise subset of the CnW Recovery program and just works with GoPro cameras. There are two versions, standard and forensic. Both will perform the same basic recovery. The forensic version has enhanced logs and file hashing and will also (under development) recover unfinalised file and video extracts.

The software only processes memory chips, or an copy of a memory chip (DD file in Unix terms). The current maximum size of memory chip handled is 128GB, matching the current maximum size of GoPro SD memory chips. The program does have a mode to produce such DD image files.



Getting started

The process is very simple, select memory chip, and output location, and then select Recover all files.

Memory chip selection

The GoPro Recovery is designed to work just with memory chips. ie it is not designed to recover files that have been deleted from a hard drive. For this reason, the disk scan will only show drives with a capacity of 128GB or less. The program can also process image files of the memory chip. These should be straight sector by sector copies (Unix DD format).

Save Location

The save location can be any valid drive, local or networked on the PC. The program does ensure that you cannot select the memory chip as a save location. Nothing must ever be written to the memory chip until the full recovery has been completed (and then it best to wait a week to be sure).

Recover all files

When the Recover all files is selected the recovery process starts. There are two options related to this function, Stop scan on blank and Save image file. The Stop scan on blank will truncate the initial scan if the program finds a long area of blank sectors. Many cameras have 64GB chips, but maybe only 10GB is used. This option will speed the recovery process up. The second option is to create a disk image of the memory chip on the initial scan. This can be security, but may also speed up the second second stage of recovery slightly. Obviously, the hard disk drive must have enough space to save an image file, and the recovered videos

Five stages of recovery

- First stage is a scan of the complete memory chip. This will find all atom starts, eg ftyp, mdat and also all video frame starts and jpeg starts.
- The status box will display *'Stage 1 of 5 : Scanning the memory chip for video frames'*
- *This stage also saves the first 2GB of the memory chip, as an image file*
-
- Second stage is to recover all stand alone JPEGs.
- The status message is *'Stage 2 of 5 : Recover JPEGS'*
-
- Third stage is to match a moov atom with each ftyp atom. This will then give a frame work for all remaining data.
- The status message for this stage is *'Stage 3 of 5 : Extract ftyp and moov : <file name>'*
-
- Fourth stage is to make use of the earlier scan giving frame start locations to build up the video based on frame start values stored within the moov atom. The sequence here to recover low resolution videos. Each time a recovered video verifies as OK it will be added to the thumbnails being displayed. The final 24 videos will be displayed in sequence.
- The status message for this stage is *'Stage 4 of 5 : Reconstruct low res videos : <file name>'*
-
- Fifth and final stage is to make use of the earlier scan giving frame start locations to build up the video based on frame start values stored within the moov atom. The sequence here to recover high resolution videos, MP4. Each time a recovered video verifies as OK it will be added to the thumbnails being displayed. The final 24 videos will be displayed in sequence.
- The status message for this stage is *'Stage 4 of 5 : Reconstruct high resolution videos : <file name>'*

These stages are displayed as part of the status bar. The sector number should keep changing - it is displayed mainly to indicate that the program is processing data.

In many parts of the above sequence the progress bar will move, and also the sector

number change value. The sector number just shows the area of disk being worked on and it's main function is to indicate the the program is processing video data.

Status display values

While the program is processing data there are several status messages displayed. These are described below

Camera type

This displays the type of camera detected. If the version cannot be found from the meta data an unrecognised message may be displayed.

The camera type can be preset. This can be useful for some older camera models where the camera type is not stored in the meta data. It will also assist if a memory chip has been used in different types of camera. However, for normal use, Auto should be selected by default. The choices are

Hero, Hero 2 / Hero 3, Hero 4

Elements found

The elements found are detected on the initial chip scan. It will search for all ftyp, moov and mdat atom starts. The number of these atoms should be the same, though occasionally false mdat atoms may be detected. JPGs are also counted.

The video count is the number of videos recovered

Cluster size

The program will determine if the chip is FAT32 or exFat, and also the cluster size. The cluster size is very critical, and if incorrect, videos will not be recovered. Typical values are

FAT32	0x40
exFAT	0x100, 0x200, 0x400

Elements not yet recovered

At the end of the initial scan, elements found, and not yet recovered will be the same. As video recovery proceeds, the elements not yet recovered will reduce. With a perfect recovery all values should be zero at the end. If files have not been finalised, or otherwise corrupted, these atom and frame values may still be positive. The forensic version of the program will attempt to use these atoms to reconstruct playable videos.

Stop on blank

This can be a useful time saver when it is known that the memory chip is only partially used. NB, if doing a forensic investigation, this option must be used with caution in case there is video further down the chip. The routine will stop scanning after it has found a 'significant' length of blank sectors.

Save image file

This allows the program to create a complete image file of the memory chip. This could be for security, or to save in the case of a forensic investigation. It can also be used to send to CnW Recovery if there are problems encountered. The image file is a sector by sector copy.

Duplicate clusters

When the memory chip is being scanned the program checks to see if there are duplicate clusters. If multiple duplicate clusters are found it is very likely the chip is a fake memory chip. This will mean that much video might have been lost and there is no way to recover

the original data. The chip should not be used again, and should be returned to the vendor (with a request for compensation). It is possible for a chip to have duplicate clusters because of the way it was initialised, but this is rare.

Any problems

To help with any possible problems the program produces a 2GB file from the start of the memory chip image. This is saved in the output directory with the name 2gb_image.img. See section on [support](#) for more details

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Installation and system requirements

The GoPro recovery program is for any current Windows PC. It requires Windows 7, 8, 8.1 or Windows 10. Windows XP is not supported. Any PC that will run Windows 7 will be able to run GPR. The software does make use of multiple CPU cores, so performance may suffer on an older PC.

Requirements

Processor - Core 2 Duo, or better. Core i5 or Core i7 is preferred
Memory 4GB RAM
Hard drive 20MB on the C: drive
Working space - large enough to store the video from the memory chip, eg 64GB

Installation

The program is downloaded from the main website, www.goprorecovery.co.uk. The main program and the demo are identical, but are controlled by the registration number. The demo will not save any files.

The program downloaded is called `gpr_setup.exe`

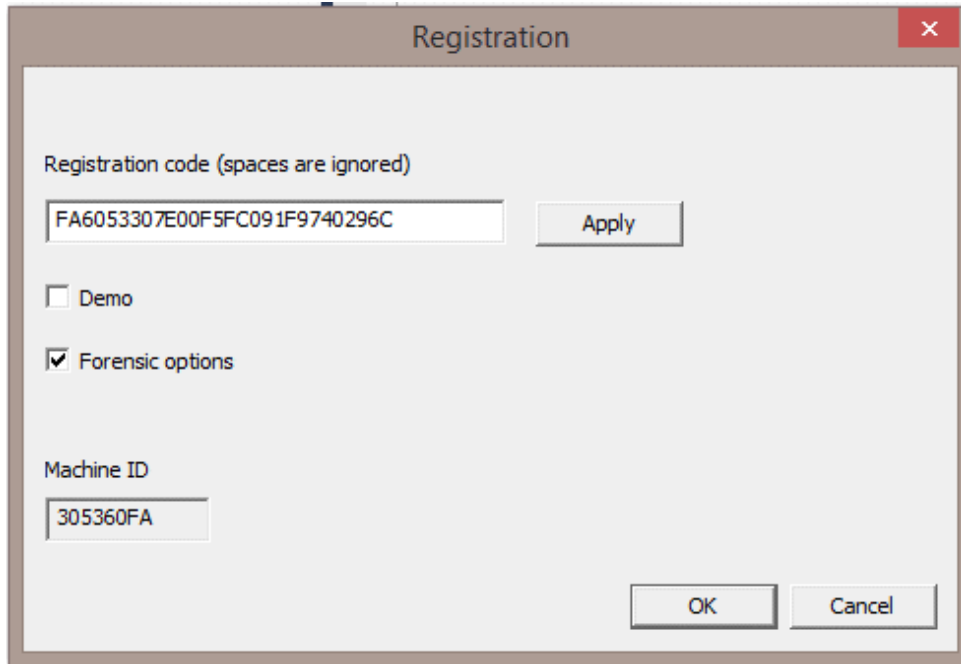
The program is digitally signed, both the installation and run program. The signature is 'CnW Recovery Developments Ltd'

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Registration

The registration screen gives details required for purchase and registration.

It displays the Machine ID - and 8 byte code unique to your PC or Laptop. This is the code that must be used when making a purchase.



The image shows a Windows-style dialog box titled "Registration". It contains the following elements:

- A label "Registration code (spaces are ignored)" above a text input field containing the alphanumeric string "FA6053307E00F5FC091F9740296C".
- An "Apply" button to the right of the registration code input field.
- Two checkboxes: "Demo" (unchecked) and "Forensic options" (checked).
- A label "Machine ID" above a text input field containing the alphanumeric string "305360FA".
- "OK" and "Cancel" buttons at the bottom right of the dialog.

Although the purchase is related to a single PC, it can always be transferred by an e-mail request to info@goprorcovery.co.uk

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Demo

The demo program mode is designed to show potential users that the program, will recover videos.

The demo will not save any working videos, but each time it verifies a video that will be recovered, it saves a Bitmap image in the output directory. As a second level of verification, the log will be filled in and Verify will be set to OK.

Not every video will be recoverable as some may have been overwritten or are not complete. However, on typical runs over 95% of potential will be found and recovered. This will display 'as new' with both sound and vision.

NB, Connect the PC to the memory chip, and not the camera!

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Logs

The main function of the log is to keep a record of files recovered. For the forensic option, it provides details of exactly how the data has been reconstructed which ensures that such evidence could be used in court.

For the demo, the log provides a very good indication of which files have been found, and will be recovered by the licenced version.

#	Status	File size	Full File Name	File Name	Ext	Verify	Horz	Vert	Fra...	Frags	Start Sector	Create
256	?	1441792	G:\test_demo2\recover_42.mp4	recover_42.mp4	mp4	OK	432	240	30	13	5452352	2014-07-12 15:32
257	?	58425344	G:\test_demo2\recover_43.mp4	recover_43.mp4	mp4	OK	1280	720	15	36	5580800	2014-07-12 15:36
258	?	2850816	G:\test_demo2\recover_44.mp4	recover_44.mp4	mp4	OK	432	240	30	24	5581120	2014-07-12 15:36
259	?	17891328	G:\test_demo2\recover_45.mp4	recover_45.mp4	mp4	OK	1280	720	15	87	5809024	2014-08-16 10:50
260	?	917504	G:\test_demo2\recover_46.mp4	recover_46.mp4	mp4	OK	432	240	30	11	5818560	2014-08-16 10:50
261	?	110395392	G:\test_demo2\recover_47.mp4	recover_47.mp4	mp4	OK	1280	720	15	70	5821696	2014-07-12 14:15
262	?	5373952	G:\test_demo2\recover_48.mp4	recover_48.mp4	mp4	OK	432	240	30	43	5822144	2014-07-12 14:15
263	?	53641216	G:\test_demo2\recover_49.mp4	recover_49.mp4	mp4	OK	1280	720	15	33	5939712	2014-07-12 14:17
264	?	2654208	G:\test_demo2\recover_50.mp4	recover_50.mp4	mp4	OK	432	240	30	22	5939904	2014-07-12 14:17
265	?	237010944	G:\test_demo2\recover_51.mp4	recover_51.mp4	mp4	OK	1280	720	15	101	6454656	2014-07-12 17:57
266	?	11501568	G:\test_demo2\recover_52.mp4	recover_52.mp4	mp4	OK	432	240	30	50	6455488	2014-07-12 17:57
267	?	458752	G:\test_demo2\recover_53.mp4	recover_53.mp4	mp4	OK	432	240	30	4	6933312	2014-08-16 11:03
268	?	131072	G:\test_demo2\recover_54.mp4	recover_54.mp4	mp4	OK	432	240	30	4	6989888	2014-08-16 11:04
269	?	276168704	G:\test_demo2\recover_55.mp4	recover_55.mp4	mp4	OK	1280	720	15	111	7053952	2014-07-12 18:02
270	?	13434880	G:\test_demo2\recover_56.mp4	recover_56.mp4	mp4	OK	432	240	30	57	7054912	2014-07-12 18:02
271	?	17891328	G:\test_demo2\recover_57.mp4	recover_57.mp4	mp4	OK	1280	720	15	9	7297280	2014-07-19 12:56
272	?	917504	G:\test_demo2\recover_58.mp4	recover_58.mp4	mp4	OK	432	240	30	8	7297600	2014-07-19 12:56
273	?	1008664...	G:\test_demo2\recover_59.mp4	recover_59.mp4	mp4	Fail	1280	720	15	319	9438144	
274	?	48988160	G:\test_demo2\recover_60.mp4	recover_60.mp4	mp4	Fail	432	240	30	319	9440192	
275	?	324042752	G:\test_demo2\recover_61.mp4	recover_61.mp4	mp4	OK	1280	720	15	122	10105280	2014-07-19 13:14
276	?	15728640	G:\test_demo2\recover_62.mp4	recover_62.mp4	mp4	OK	432	240	30	120	10105984	2014-07-19 13:14
277	?	100892672	G:\test_demo2\recover_63.mp4	recover_63.mp4	mp4	OK	1280	720	15	40	10314240	2014-07-19 13:25
278	?	4947968	G:\test_demo2\recover_64.mn4	recover_64.mn4	mn4	OK	432	240	30	39	10314674	2014-07-19 13:25

The log has many columns, and an entry for each file/video recovered

#	The number of the file recovered
Filesize	Bytes in the file
Full file name	The full name and path for the file
Filename	Just the file name
ext	Type of file, normally mp4, jpg etc
Verify	If OK, the file has been verified as valid
Horz	This is the horizontal resolution of the video
Vert	This is the vertical resolution of the video
Frames	This is the frame rate
Frags	This indicates the number of fragments the file is made up of. On the forensic version, if the number is clicked on, a full report of each data run is displayed
Start sector	The first sector of the file
Create date	The date the file was created

Modify date The date the file was modified

MD5 Hash On the forensic version, the MD5 hash value is saved.

Export

The displayed log can always be exported to a .CSV file. This can be useful for logging in a forensic case, or sometimes to send to CnW Recovery for analysis.

The forensic package will include the MD5 hash value and also the fragmentation information. The fragments are stored as pairs of fields following the main data. The first field is the sector number, and the second field is the run length, in sectors.

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Support

Support is a very important part of GoPro Recovery. It is intended that very recovery will work straight out of the box - however, theory and practice unfortunately often divide at that point.

Check for update

The first point of call will always be to check if there has been a software update, and if so download the new version. The website www.recovergopro.com will have a download link for the latest software (ie the demo)

Report problem

The second will be an e-mail to info@goprorecovery.co.uk. This should always be responded to within 24 hours. Being a world wide product one always has to allow for time zone differences.

Send image file

If a simple solution cannot be found, it may be necessary to send a partial, or complete chip image to CnW Recovery for development investigation.. To assist this, when a memory chip is scanned, a 'temp' 2GB image file is also saved to the hard drive (in the selected output directory). This file can be sent to CnW Recovery, and an easy way is with cloud sharing program. CnW Recovery have had a lot of success with www.wetransfer.com that is free upto 2GB in file size. The image file is created automatically in the selected output directory, and has the name 2gb_image.img

If the whole images needs to be sent, then CnW have an SFTP:// server, and an account can be created to allow for sending, and maybe receiving files.

Possible problems

Not all videos found

There can be several reasons why not all videos are found. A very useful guide to the number that may be found is by looking at the values for ftyp, moov and mdat. For each good file there should be one such value. At the same time it must be noted that there can be false positive matches for mdat, but these are less likely for ftyp and moov. If the number for ftyp is much less than expected, maybe try a scan again making sure that the 'Stop on blank' option has been turned off.

Fake Memory

Another very 'sad' reason for missing videos is of the memory chip is a fake device. This is a device (often sold cheaply on eBay) where a small chip, eg 8GB is modified to look like a large memory chip, eg 64GB. The result is that memory chip looks OK, even display a directory for the large size, but when data is written, maybe 75% of the data goes nowhere and is totally lost. Recovery of the lost data is impossible. The symptoms are that the early files can be read, but then the data is corrupted.

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Recovery of unfinalised GoPro videos

The GoPro range of cameras are designed for action. Sometimes things go wrong and there may be an accident, or maybe the camera just gets dropped. When this happens the video may not be completed or finalised. The result is that the video file may appear to be on the memory chip, but will not play.

The forensic version of the software (currently under final development, Jan 2016) will recover the videos into a playable format.

Issues with unfinalised videos

To understand the issue with unfinalized videos it is important to know how the camera records the video, and builds it up into the final version. There are two elements, the file system (FAT32, or exFAT) and the video file.

File system

The file system has three elements

- Directory entry
- File allocation table
- Data

Any writing to the memory chip takes time

The directory is fairly short and contains the file name, the length, and the start location. The when the data is being written, the length will occasionally be updated. It is therefore very likely that in the case of an accident, the saved length may not be up to date. The operating system will look at the saved length, and so may think the file is shorter than it is. 99% of the video file is a stream of video and audio frames. These frames are written continuously to the memory chip. The process is relatively slow and so writing will start very quickly. Also, the memory required to buffer the video data runs out very quickly. Thus the data is written very soon after recording, but the FAT and directory are easily buffered, and only updated occasionally.

With the GoPro camera, the files are not stored sequentially. The details of each cluster are stored in the File Allocation Table, (FAT). To save memory writes, this will only be updated occasionally - probably at the same time as the directory entry. Thus, as above, there may be more data on the memory chip than is reported.

If there is a camera failure - for any reason, it is there essential that nothing is changed on the memory chip, ie no test shots etc. If anything is written, even a short test video, the camera will think that the length indicated by the directory and FAT is correct, and so will write over any data that has not yet been registered by the directory or FAT. Overwritten data cannot be recovered and so is lost for ever.

GoPro Recovery does not use the file system to read the card, and so can access data not registered by the file system. This way extra video can sometimes be found. How much data - this is impossible to say, it might be a single frame, or a few seconds. The amount of extra data recovered depends on the timing of the malfunction in relation to the updating of the directory. If there is any thought that the video may be required for any type of investigation, the memory chip should be removed from the camera, and if possible write protected. No 'repair' routine should be run on the original data. An ideal approach is to create an image file of the original memory chip, a function the GoPro Recovery software can do.

Video file

As seen from above, the video data may be on the memory chip, but is totally unplayable. To make the video playable there are two main stages

- Extract the video data
- Create the moov atom

To extract the video data, the memory chip is examined and each cluster of data is analysed. The data blocks are then stored in sequence for each original video, allowing for the high and low resolution blocks that can be physically interleaved (or multiplexed)

The second stage involves analysing the video stream to isolate each video and audio frame. After this has been done a new MP4 compatible header is created and so the video may be played as an original video. In normal operation, the header will be built up in memory, and only written once the file is complete. Thus for an interrupted video, there may be no header information at all on the memory chip.

Recovery service

If problems are encountered CnW Recovery will always offer support, and if required a service to help recover data.

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GoPro video file structures

This section will give a brief overview of the way that each GoPro camera records the video data.

MP4 File elements

An MP4 file contains three main elements, referred to as atoms

- ftyp - a short header block
- mdat - contains all video and audio data
- moov - meta data and pointers to all the video and sound frames

There are two variations of MP4 files

- <ftyp> <moov> <mdat>
- <ftyp> <mdat> <moov>

Each camera does use the same basic MP4 structure with H-264 encoding and AAC sound. Each camera does have small variations (useful to help determine camera type) but there are significant differences on how the video file is physically recorded on the memory chip.

Memory chip ordering

There are two important aspects to understand with the GoPro camera, the logical file recording and the physical file recording. Due to buffering memory constraints the video meta data in the moov atom has to be saved to the memory chip last. If the logical order of the file is

- <ftyp> <moov> <mdat>

then obviously this is a problem, as the length of the moov meta data is variable. Also the length cannot be determined until the recording is complete. For this reason, the <mdat> is physically recorded first, and then the <ftyp><moov> atoms are added when the video is finalised. Thus the physical order on the disk is

- <mdat> <ftyp> <moov> -next video - <mdat> <ftyp> <moov>

Many data recovery programs see a sequence of <ftyp> <moov> <mdat> and think this is a logical file, but in fact it is associating the second file video, with the first file's <moov>. The result is a file that looks correct on the directory listing, but has zero chance of playing. GoPro Recovery both understands the ordering, but also has sophisticated routines to ensure that the correct video is linked to the correct header.

Camera variations

Each of the main three cameras has it's own variation of the above

Hero

- Physical <mdat><ftyp><moov> + embedded jpegs
- Logical <ftyp><moov><mdat>

Hero 2

- Physical <mdat><ftyp><moov>
- Logical <ftyp><moov><mdat>

Hero 3

Physical <mdat><mdat><ftyp><moov><ftyp><moov> High and low res interleaved

- Logical <ftyp><moov><mdat> <ftyp><moov><mdat>

Hero 4

Physical interleaved	<ftyp><mdat><ftyp><mdat><moov><moov>	High and low res
Logical	<ftyp><mdat><moov>	<ftyp><mdat><moov>

High and low resolution multiplexing

Hero3 and Hero 4 cameras can record both high and low resolution videos at the same time. Obviously they both need to be stored on the memory chip at the same time and so these end up being interleaved. Typically just the mdat atoms are interleaved but is is another reason that data carving will not recover these files. Being a complete data stream there are no nice headers at the start of each cluster. The recover function of GoPro recovery has to examine each cluster to see if it is a high or low resolution cluster and then save it in the correct recovered file. For a deleted file this process can make use of the moov atom. For an unfinalised file, the examination needs a different approach to separate the high and low resolution elements. Fortunately it is possible to determine the length of a raw video and audio frame which helps with creating a complete data stream.

We have not seen another camera type that records multiple streams of data this way, though 3D cameras might have a similar issue

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Repair or recovery

One often reads reports of someone attempting to recover a video file, but being told that it was probably corrupted, and so could not be recovered. Most of these reports we don't totally believe. If you read the previous section on [GoPro file structures](#) you will see that the video file is not stored sequentially, so that when the FAT is lost after file deletion, there is no simple way to recover the data, unless you use GoPro recovery software.

The repair route may take an unplayable file and reconstruct the meta data and make the video playable. However, the data may well be incomplete or corrupted. It is impossible to repair corrupted video, but only repair corrupted <moov> atoms.

Many video cameras have the same non sequential issue, but GoPro have a bigger problem with repair in that Hero3 and Hero 4 cameras typically record low and high resolution videos at the same time. We have seen 'repaired' videos where the video kept jumping between the two streams of video. Fixing this would be a very tedious manual job! The solution is to do a correct recovery in the first place. GoPro Recovery understands the interleaving of low and high resolution and can recover each one independently. The result are two playable video files, just recorded, ie an MP4 and LRV file.

When is repair necessary

There are times when repair is valid solution, and this is when a video has not been finalised. ie there is no <moov> atom. This is an option in the forensic version of GoPro Recovery, but unlike many programs, the low and high resolution streams are extracted first, and then reindexed. The GoPro Recovery program does not actually repair, but just reindexes.

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Useful Links

These links are included because we think they may be useful. CnW Recovery have no connection with the companies involved

Forums

GoPro UK	www.goprouk.org
GoPro User Forums	goprouser.freeforums.org
Video Help	www.videohelp.com

Technical data

Quicktime/MP4 Structure	developer.apple.com
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Development plans

All programs need to develop to keep upto date.

GoPro Recovery was launched August 2015 and so is still very new. The list below highlights some key points

With GoPro recovery, all updates are free.

Planned new features

- Reconstruct leftover fragments (forensic option only)
- Enhance documentation

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About GoPro Recovery

GoPro Recovery is a program developed by CnW Recovery Developments Ltd. The GoPro camera is a very popular model, but very complex to recover deleted data from. The idea of GPR.EXE is a simple, dedicated program to solve just this problem.

There are many programs being promoted on the internet that claim to recover GoPro videos. However, none seem to work with the original GoPro memory chip, and so it is possible that GoProRecovery is a truly unique product.

[CnW Recovery](#) was started in 2004 to recover data from many PC and Unix resources. It has built up a very good reputation for forensic level data recovery. The CnW program does contain routines for GoPro data recovery but as part of a more complex system. GoProRecovery (GPR) has just extracted the critical elements required, but will also add on processing of isolated fragments. The result is a simple, low cost but professional level recovery program.

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