AN OVERVIEW ON HIDING AND DETECTING STEGO-DATA IN VIDEO STREAMS

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Agenda

Research Question

Background

Literature Study

Analysis

Conclusion

RESEARCH QUESTION

Research Question

Which methods are available for (real-time) steganalysis on a video-stream and how can these be prevented?

- Which are the steganography methods available for video-stream?
- Which are the steganalysis methods available for video-stream?
- How can steganography be prevented on a video-stream?

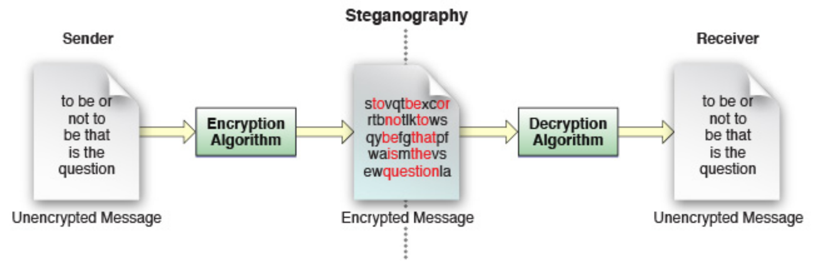
BACKGROUND

What is Steganography?

The art and science of hiding communication

Originates from the ancient Greek

- *steganos* (covered)
- *graphein* (writing)


Steganography
Sender
Receiver
to be or not to be that is the question
Encryption Algorithm
stovqtbexcor rtbnotlktows qybefgthatpf waismthevs ewquestionla
Decryption Algorithm
to be or not to be that is the question
Unencrypted Message
Encrypted Message
Unencrypted Message

Source: *https://developer.apple.com/*

What is Steganography? History

Earliest recordings from the Greek historian Herodotus (440 BC)

- Prisoners scalp tattooed to deliver secret messages
- Wooden tables carved before applying its wax surface

On the XV century Johannes Trithemius wrote about

- Invisible inks, Coding techniques for text, Hidden messages in music

Used to send hidden messages during World War II

- Null ciphers, Image substitution, Microdots

Steganography vs Watermarking

Similar to Steganography

- On Steganography the data embedded should be covert and undetectable
- On Watermarking it does not matter, however ...
- ... any attempt to remove it should result in significant degradation of the quality of the carrier file

Commonly used to help trace the origin of files

Steganography vs Cryptography

Different from Steganography

- Cryptography scrambles a message so it cannot be understood
- Steganography hides the message so it cannot be seen

Both are used to protect confidential information …

- … therefore often confused

What is Steganalysis?

Security of a steganographic system is defined by its strength to defeat detection

Practice of detecting the presence of messages that have been hidden using steganography

Ideally the content of the hidden message is also determined

What is Steganalysis? Types of Attacks

Steganalysis attacks can be active or passive

- On active attacks a steganalyst can manipulate the data
- On passive attack the steganalyst is only able to analyze the information without changing it

Attacks used by steganalysts to detect steganography on files can be:

- Visual Attacks
- Structural Attacks
- Statistical Attacks

Types of Attacks - Visual Attacks

The simplest form of attacking a steganographic system

Based on the visual analysis of the image

- Noticeable differences indicate that the image probably carries hidden information

If the carrier is not known this attacks becomes very hard

Types of Attacks - Structural Attacks

Analysis of known properties of the algorithms used to hide information

- Analysed further if found any properties of these algorithms

Outputs a lot of false positives

- Used to highlight images which show signs of possible embedding

Depends a lot on if the carrier file is known

Types of Attacks - Statistical Attacks

Statistical analysis done using mathematical formulas

- Much more effective than the Visual or Structural attacks

It is successful even without knowing the carrier file …

- … however it fails to determine the hidden data’s size

LITERATURE STUDY

Steganographic Techniques (1)

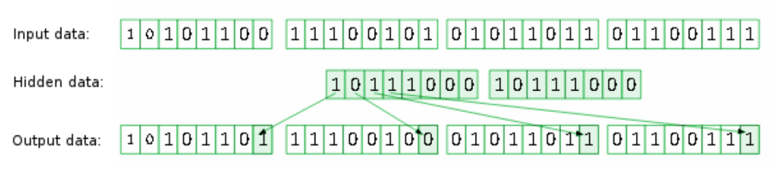
Big variety of techniques used to camouflage information:

- Injection
    - By far the simplest steganographic technique
    - Hides a message in parts of a file that are “ignored” by the application
- Substitution
    - Identify areas of a file of least relevance
    - Replace this data with the hidden information
    - Does not modify the size of the container file …
        - … therefore the steganographic capacity of the file is limited

Steganographic Techniques (2)

List Significant Bits Manipulation

- LSB Sequential Insertion
- LSB Pseudo Random Insertion
  - Pseudo Random Number Generator (PRNG) is used to randomly hide the secret bits of the message into the LSB of the carrier file



Input data: 1 0 1 0 1 1 0 0 | 1 1 1 0 0 1 0 1 | 0 1 0 1 1 0 1 1 | 0 1 1 0 0 1 1 1

Hidden data: 1 0 1 1 1 0 0 0 | 1 0 1 1 1 0 0 0

Output data: 1 0 1 0 1 1 0 1 | 1 1 1 0 0 1 0 0 | 0 1 0 1 1 0 1 1 | 0 1 1 0 0 1 1 1

Source: *http://lvee.org/uploads/abstract_file/file/111/2.png*

Transform Domain

Generally used on compressed container files, such as JPEG or MPEG

- Discrete Cosine Transform
  - Algorithm works by using quantization
    - Rounding values of least important parts (not noticeable by the human eye)
  - Image is split into smaller areas to be transformed via DCT
    - Quantization on the frequencies is then applied
    - This is the stage where the secret message is injected
  - Finally the image is compressed
    - No impact on the integrity of the secret message
- Discrete Wavelet Transform
  - Makes it possible to rise the level of robustness of the information being hidden
  - If the threshold is too high the stego-file has detectable differences

Compression

Regards reducing and removing redundant video data …

- … with no undesirable effects on the visual quality

Lossless Compression

- Every single bit of data that was originally in the file remains after the file is uncompressed

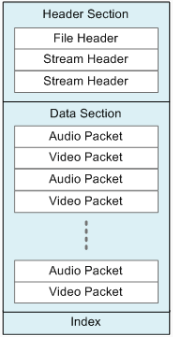
Lossy Compression

- Discards the points which are difficult to identify by the human eye
- Resulting image is similar to the original image
- Generally used on video and sound

Video Container Format

Contains the various components of a video

- Such as the stream of images or the sound



Source: *https://msdn.microsoft.com/*

ANALYSIS

Approach

Create some stego-videos

- *OppenPuff*

Perform known attacks

- Visual Attack
- Statistical Attack
- Structural Attack

OpenPuff (1)

Created by Cosimo Oliboni

The users to hide information in a wide range of carrier formats

- 3gp, Mp4, Mpeg II, etc.

Possible to hide data in more than a single carrier file

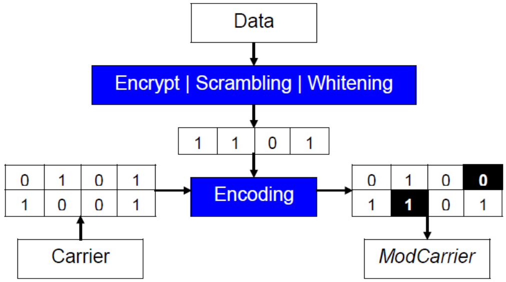
2 important factors were taken into consideration

- Embedding efficiency
- Embedding payload

OpenPuff (2)

Based on Niels Provos paper *Defending Against Statistical Steganalysis*

- which states ”steganalysis resistance and performance are incompatible trade-offs”

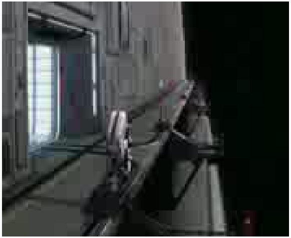


Source: *https://en.wikipedia.org/wiki/File:OpenPuff*

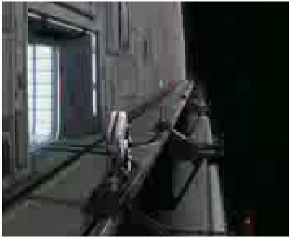
OpenPuff Stego-analyzed - Visual Attack

Performed by

- Reproducing both the original and stego videos
- Comparing and analysing individual frames from the original and from the stego-file



Original file frame



Stego-file frame

OpenPuff Stego-analyzed - Statistical Attack (1)

Program *ent* used to perform this attack

- Entropy - Information density of the contents of the file
- Chi-square Test
  - greater than 99% and less than 1% - almost surely not random
  - between 99% and 95% or between 1% and 5% - considered suspect
  - between 90% and 95% or between 5% and 10% - not sure to be suspect
- Arithmetic Mean - Result of the sum of all the bytes in the file divided by the its length
- Monte Carlo Value for Pi - If the sequence is close to random, the value will approach the correct value of π
- Serial Correlation Coefficient - Calculates how much each byte in the file depends on the previous byte

OpenPuff Stego-analyzed - Statistical Attack (2)

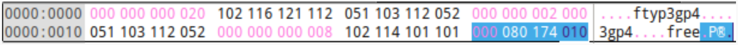
Values are very similar and do not raise any suspicious upon the stego-file

	Original	Stego	Expected
Entropy	1%	1%	0%
Chi-square Test	0.01%	0.01%	N/A
Arithmetic Mean	127.0006	126.5138	127.5
Monte Carlo Value for Pi	3.025822076	3.010476826	π
Serial Correlation Coefficient	0.147440	0.154106	0.0

OpenPuff Stego-analyzed - Structural Attack (1)

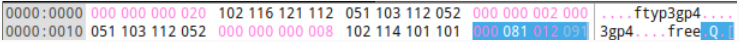
Based on the comparison of the original file and the stego-file

- hexdump of both files was analyzed



```
0000:0000 000 000 000 020  102 116 121 112  051 103 112 052  000 000 002 000 | ....ftyp3gp4....
0000:0010 051 103 112 052  000 000 000 008  102 114 101 101  000 080 174 010 | 3gp4....free.P®.
```

File type header hexdump from the original file



```
0000:0000 000 000 000 020  102 116 121 112  051 103 112 052  000 000 002 000 | ....ftyp3gp4....
0000:0010 051 103 112 052  000 000 000 008  102 114 101 101  000 081 012 091 | 3gp4....free.Q.[
```

File type header hexdump from the stego-file

OpenPuff Stego-analyzed - Structural Attack (2)

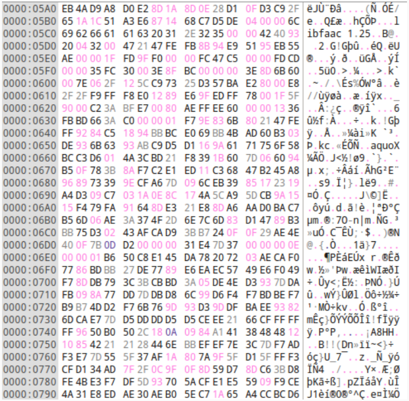
Last four bytes of the header are changed

- These bytes are an offset pointing to the beginning of the header that belongs to the MOOV box …
- … which defines the timescale, duration, display characteristics of the movie, as well as sub-boxes containing information for each track in the movie

hexdump of both files is different since some bytes were inserted outside this box

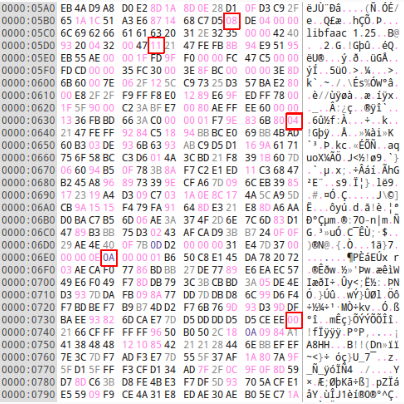
OpenPuff Stego-analyzed - Structural Attack (3)

Pattern followed through out the stego-file, outside the MOOV box



```
0000:05A0 EB 4A D9 A8  D0 E2 8D 1A  8D 0E 28 D1  0F D3 C9 2F  ëJÙ¨Ðâ....(Ñ.ÓÉ/
0000:05B0 65 1A 1C 51  A3 E6 87 14  68 C7 D5 DE  04 00 00 6C  e..Q£æ..hÇÕÞ...l
0000:05C0 69 62 66 61  61 63 20 31  2E 32 35 00  00 42 40 93  ibfaac 1.25..B@.
0000:05D0 20 04 32 00  47 21 47 FE  FB 8B 94 E9  51 95 EB 55   .2.G!Gþû..éQ.ëU
0000:05E0 AE 00 00 1F  FD 9F F0 00  00 FC 47 C5  00 00 FD CD  ®...ý.ð..üGÅ..ýÍ
0000:05F0 00 00 35 FC  30 00 3E 8F  BC 00 00 00  3E 8D 6B 60  ..5ü0.>.¼...>.k`
0000:0600 00 7E 06 2F  12 5C C9 73  25 D3 57 BA  E2 80 00 E8  .~./.\És%ÓWºâ..è
0000:0610 2F 2F F9 FF  F8 E0 12 89  E6 9F ED FF  78 00 1F 5F  //ùÿøà..æ.íÿx.._
0000:0620 90 00 C2 3A  BF E7 00 80  AE FF EE 60  00 00 13 36  ..Â:¿ç..®ÿî`...6
0000:0630 FB BD 66 3A  C0 00 00 01  F7 9E 83 6B  80 21 47 FE  û½f:À...÷..k.!Gþ
0000:0640 FF 92 84 C5  18 94 BB BC  E0 69 BB 4B  AD 60 B3 03  ÿ..Å..»¼ài»K `³.
0000:0650 DE 93 6B 63  93 AB C9 D5  D1 16 9A 61  71 75 6F 58  Þ.kc.«ÉÕÑ..aquoX
0000:0660 BC C3 D6 01  4A 3C BD 21  F8 39 1B 60  7D 06 60 94  ¼ÃÖ.J<½!ø9.`}.`.
0000:0670 B5 0F 78 3B  8A F7 C2 E1  ED 11 C3 68  47 B2 45 A8  µ.x;.÷Âáí.ÃhG²E¨
0000:0680 96 89 73 39  9E CF A6 7D  09 6C EB 39  85 17 23 19  ..s9.Ï¦}.lë9..#.
0000:0690 A4 D3 09 C7  03 1A 0E 8C  17 4A 5C A9  5D CB 9A 15  ¤Ó.Ç.....J\©]Ë..
0000:06A0 15 F4 79 FA  91 64 8D E3  21 E8 8D A6  AA D0 BA C7  .ôyú.d.ã!è.¦ªÐºÇ
0000:06B0 B5 6D 06 AE  3A 37 4F 2D  6E 7C 6D 83  D1 47 89 B3  µm.®:7O-n|m.ÑG.³
0000:06C0 BB 75 D3 02  43 AF CA D9  3B B7 24 0F  0F 29 AE 4E  »uÓ.C¯ÊÙ;·$..)®N
0000:06D0 40 0F 7B 0D  D2 00 00 00  31 E4 7D 37  00 00 00 0E  @.{.Ò...1ä}7....
0000:06E0 00 00 01 B6  50 C8 E1 45  DA 78 20 72  03 AE CA F0  ...¶PÈáEÚx r.®Êð
0000:06F0 77 86 BD BB  27 DE 77 89  E6 EA EC 57  49 E6 F0 49  w.½»'Þw.æêìWIæðI
0000:0700 F7 8D DB 79  3C 3B CB BD  3A 05 DE 4E  D3 93 7D DA  ÷.Ûy<;Ë½:.ÞNÓ.}Ú
0000:0710 FB 09 8A 77  DD 7D DB D8  6C 99 D6 F4  F7 BD BE F7  û..wÝ}ÛØl.Öô÷½¾÷
0000:0720 B9 B7 4D D2  F7 6B 76 9D  93 D3 9D DF  BA EE 93 82  ¹·MÒ÷kv..Ó.ßºî..
0000:0730 6D CA E7 7D  D5 DD DD D5  D5 CE EE 21  66 CF FF FF  mÊç}ÕÝÝÕÕÎî!fÏÿÿ
0000:0740 FF 96 50 B0  50 2C 18 0A  09 84 A1 41  38 48 48 12  ÿ.P°P,....¡A8HH.
0000:0750 10 85 42 21  21 28 44 6E  BB EF EF 7E  3C 7D F7 AD  ..B!!(Dn»ïï~<}÷
0000:0760 F3 E7 7D 55  5F 37 AF 1A  80 7A 9F 5F  D1 5F FF F3  óç}U_7¯..z._Ñ_ÿó
0000:0770 CF D1 34 AD  7F 2F 0C 9F  0F 8D 59 D7  8D C6 3B D8  ÏÑ4 ./....Y×.Æ;Ø
0000:0780 FE 4B E3 F7  DF 5D 93 70  5A CF E1 E5  59 09 F9 CE  þKã÷ß].pZÏáåY.ùÎ
0000:0790 4A 31 E8 ED  AE 30 AE B0  5E C7 1A 65  A4 CC BC D6  J1èí®0®°^Ç.e¤Ì¼Ö
```

Original file hexdump



```
0000:05A0 EB 4A D9 A8  D0 E2 8D 1A  8D 0E 28 D1  0F D3 C9 2F  ëJÙ¨Ðâ....(Ñ.ÓÉ/
0000:05B0 65 1A 1C 51  A3 E6 87 14  68 C7 D5 08  DE 04 00 00  e..Q£æ..hÇÕ.Þ...
0000:05C0 6C 69 62 66  61 61 63 20  31 2E 32 35  00 00 42 40  libfaac 1.25..B@
0000:05D0 93 20 04 32  00 47 11 21  47 FE FB 8B  94 E9 51 95  . .2.G.!Gþû..éQ.
0000:05E0 EB 55 AE 00  00 1F FD 9F  F0 00 00 FC  47 C5 00 00  ëU®...ý.ð..üGÅ..
0000:05F0 FD CD 00 00  35 FC 30 00  3E 8F BC 00  00 00 3E 8D  ýÍ..5ü0.>.¼...>.
0000:0600 6B 60 00 7E  06 2F 12 5C  C9 73 25 D3  57 BA E2 80  k`.~./.\És%ÓWºâ.
0000:0610 00 E8 2F 2F  F9 FF F8 E0  12 89 E6 9F  ED FF 78 00  .è//ùÿøà..æ.íÿx.
0000:0620 1F 5F 90 00  C2 3A BF E7  00 80 AE FF  EE 60 00 00  ._..Â:¿ç..®ÿî`..
0000:0630 13 36 FB BD  66 3A C0 00  00 01 F7 9E  83 6B 80 04  .6û½f:À...÷..k..
0000:0640 21 47 FE FF  92 84 C5 18  94 BB BC E0  69 BB 4B AD  !Gþÿ..Å..»¼ài»K
0000:0650 60 B3 03 DE  93 6B 63 93  AB C9 D5 D1  16 9A 61 71  `³.Þ.kc.«ÉÕÑ..aq
0000:0660 75 6F 58 BC  C3 D6 01 4A  3C BD 21 F8  39 1B 60 7D  uoX¼ÃÖ.J<½!ø9.`}
0000:0670 06 60 94 B5  0F 78 3B 8A  F7 C2 E1 ED  11 C3 68 47  .`.µ.x;.÷Âáí.ÃhG
0000:0680 B2 45 A8 96  89 73 39 9E  CF A6 7D 09  6C EB 39 85  ²E¨..s9.Ï¦}.lë9.
0000:0690 17 23 19 A4  D3 09 C7 03  1A 0E 8C 17  4A 5C A9 5D  .#.¤Ó.Ç.....J\©]
0000:06A0 CB 9A 15 15  F4 79 FA 91  64 8D E3 21  E8 8D A6 AA  Ë...ôyú.d.ã!è.¦ª
0000:06B0 D0 BA C7 B5  6D 06 AE 3A  37 4F 2D 6E  7C 6D 83 D1  ÐºÇµm.®:7O-n|m.Ñ
0000:06C0 47 89 B3 BB  75 D3 02 43  AF CA D9 3B  B7 24 0F 0F  G.³»uÓ.C¯ÊÙ;·$..
0000:06D0 29 AE 4E 40  0F 7B 0D D2  00 00 00 31  E4 7D 37 00  )®N@.{.Ò...1ä}7.
0000:06E0 00 00 0E 0A  00 00 01 B6  50 C8 E1 45  DA 78 20 72  .......¶PÈáEÚx r
0000:06F0 03 AE CA F0  77 86 BD BB  27 DE 77 89  E6 EA EC 57  .®Êðw.½»'Þw.æêìW
0000:0700 49 E6 F0 49  F7 8D DB 79  3C 3B CB BD  3A 05 DE 4E  IæðI÷.Ûy<;Ë½:.ÞN
0000:0710 D3 93 7D DA  FB 09 8A 77  DD 7D DB D8  6C 99 D6 F4  Ó.}Úû..wÝ}ÛØl.Öô
0000:0720 F7 BD BE F7  B9 B7 4D D2  F7 6B 76 9D  93 D3 9D DF  ÷½¾÷¹·MÒ÷kv..Ó.ß
0000:0730 BA EE 93 82  6D CA E7 7D  D5 DD DD D5  D5 CE EE 00  ºî..mÊç}ÕÝÝÕÕÎî.
0000:0740 21 66 CF FF  FF FF 96 50  B0 50 2C 18  0A 09 84 A1  !fÏÿÿÿ.P°P,....¡
0000:0750 41 38 48 48  12 10 85 42  21 21 28 44  6E BB EF EF  A8HH...B!!(Dn»ïï
0000:0760 7E 3C 7D F7  AD F3 E7 7D  55 5F 37 AF  1A 80 7A 9F  ~<}÷ óç}U_7¯..z.
0000:0770 5F D1 5F FF  F3 CF D1 34  AD 7F 2F 0C  9F 0F 8D 59  _Ñ_ÿóÏÑ4 ./....Y
0000:0780 D7 8D C6 3B  D8 FE 4B E3  F7 DF 5D 93  70 5A CF E1  ×.Æ;ØþKã÷ß].pZÏá
0000:0790 E5 59 09 F9  CE 4A 31 E8  ED AE 30 AE  B0 5E C7 1A  åY.ùÎJ1èí®0®°^Ç.
```

Stego-file hexdump

OpenPuff Stego-analyzed - Structural Attack (4)

Although it could not be proved ...

- ... these bytes might be related to the size of the file being hidden
- ... as well as the password(s) used to encrypt the message

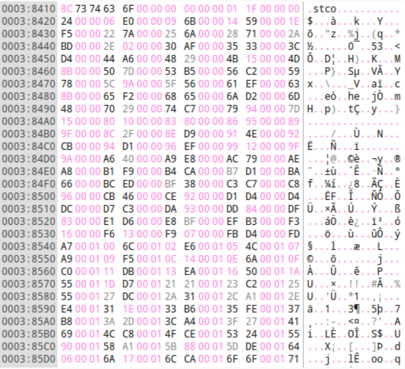
Assumption is made based on Niels Provos paper

- Stated that ”32 state bits are hidden, 16 bits for a seed and 16 bits for an integer containing the length of the message being hidden”

Important to notice that the video container format may change, therefore the optimal location of the moov box will be depend on this

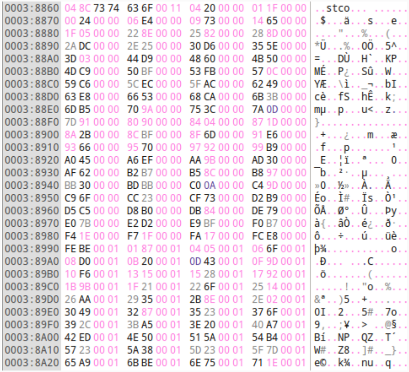
OpenPuff Stego-analyzed - Structural Attack (5)

While analysing in detail the MOOV box, it was noticed that the bytes were modified



```
0003:8410 8C 73 74 63 6F 00 00 00 00 00 00 01 1F 00 00 00 .stco...........
0003:8420 24 00 00 06 E0 00 00 09 6B 00 00 14 59 00 00 1E $...à...k...Y...
0003:8430 F5 00 00 22 7A 00 00 25 6A 00 00 28 71 00 00 2A õ.."z..%j..(q..*
0003:8440 BD 00 00 2E 02 00 00 30 AF 00 00 35 33 00 00 3C ½......0¯..53..<
0003:8450 D4 00 00 44 A6 00 00 48 29 00 00 4B 15 00 00 4D Ô..D¦..H)..K...M
0003:8460 8B 00 00 50 7D 00 00 53 B5 00 00 56 C2 00 00 59 ...P}..Sµ..VÂ..Y
0003:8470 78 00 00 5C 9A 00 00 5F 56 00 00 61 EF 00 00 63 x..\..._V..aï..c
0003:8480 8B 00 00 65 F2 00 00 68 65 00 00 6A D2 00 00 6D ...eò..he..jÒ..m
0003:8490 48 00 00 70 29 00 00 74 C7 00 00 79 94 00 00 7D H..p)..tÇ..y...}
0003:84A0 15 00 00 80 10 00 00 83 80 00 00 86 95 00 00 89 ................
0003:84B0 9F 00 00 8C 2F 00 00 8E D9 00 00 91 4E 00 00 92 ..../...Ù...N...
0003:84C0 CB 00 00 94 D1 00 00 96 EF 00 00 99 12 00 00 9F Ë...Ñ...ï.......
0003:84D0 9A 00 00 A6 40 00 00 A9 E8 00 00 AC 79 00 00 AE ...¦@..©è..¬y..®
0003:84E0 A8 00 00 B1 F9 00 00 B4 CA 00 00 B7 D1 00 00 BA ¨..±ù..´Ê..·Ñ..º
0003:84F0 66 00 00 BC ED 00 00 BF 38 00 00 C3 C7 00 00 C8 f..¼í..¿8..ÃÇ..È
0003:8500 96 00 00 CB 46 00 00 CE 92 00 00 D1 D4 00 00 D4 ...ËF..Î...ÑÔ..Ô
0003:8510 DC 00 00 D7 C3 00 00 DA 93 00 00 DD 84 00 00 DF Ü..×Ã..Ú...Ý...ß
0003:8520 83 00 00 E1 D6 00 00 E8 BF 00 00 EF B3 00 00 F3 ...áÖ..è¿..ï³..ó
0003:8530 16 00 00 F6 13 00 00 F9 07 00 00 FB D4 00 00 FD ...ö...ù...ûÔ..ý
0003:8540 A7 00 01 00 6C 00 01 02 E6 00 01 05 4C 00 01 07 §...l...æ...L...
0003:8550 A9 00 01 09 F5 00 01 0C 14 00 01 0E 6A 00 01 0F ©...õ.......j...
0003:8560 C0 00 01 11 DB 00 01 13 EA 00 01 16 50 00 01 1A À...Û...ê...P...
0003:8570 55 00 01 1D D7 00 01 21 21 00 01 23 C2 00 01 25 U...×..!!..#Â..%
0003:8580 55 00 01 27 DC 00 01 2A 31 00 01 2C A1 00 01 2E U..'Ü..*1..,¡...
0003:8590 E4 00 01 31 1E 00 01 33 B6 00 01 35 FE 00 01 37 ä..1...3¶..5þ..7
0003:85A0 B8 00 01 3A 2D 00 01 3C A4 00 01 3F 27 00 01 41 ¸..:-..<¤..?'..A
0003:85B0 69 00 01 4C C8 00 01 4F CE 00 01 53 24 00 01 55 i..LÈ..OÎ..S$..U
0003:85C0 90 00 01 58 A1 00 01 5B 88 00 01 5D DE 00 01 64 ...X¡..[...]Þ..d
0003:85D0 06 00 01 6A 17 00 01 6C CA 00 01 6F 6F 00 01 71 ...j...lÊ..oo..q
```

Original file MOOV box hexdump



```
0003:8860 04 8C 73 74 63 6F 00 11 04 20 00 00 01 1F 00 00 ..stco... ......
0003:8870 00 24 00 00 06 E4 00 00 09 73 00 00 14 65 00 00 .$...ä...s...e..
0003:8880 1F 05 00 00 22 8E 00 00 25 82 00 00 28 8D 00 00 ...."...%...(...
0003:8890 2A DC 00 00 2E 25 00 00 30 D6 00 00 35 5E 00 00 *Ü...%..0Ö..5^..
0003:88A0 3D 03 00 00 44 D9 00 00 48 60 00 00 4B 50 00 00 =...DÙ..H`..KP..
0003:88B0 4D C9 00 00 50 BF 00 00 53 FB 00 00 57 0C 00 00 MÉ..P¿..Sû..W...
0003:88C0 59 C6 00 00 5C EC 00 00 5F AC 00 00 62 49 00 00 YÆ..\ì.._¬..bI..
0003:88D0 63 E8 00 00 66 53 00 00 68 CA 00 00 6B 3B 00 00 cè..fS..hÊ..k;..
0003:88E0 6D B5 00 00 70 9A 00 00 75 3C 00 00 7A 0D 00 00 mµ..p...u<..z...
0003:88F0 7D 91 00 00 80 90 00 00 84 04 00 00 87 1D 00 00 }...............
0003:8900 8A 2B 00 00 8C BF 00 00 8F 6D 00 00 91 E6 00 00 .+...¿...m...æ..
0003:8910 93 66 00 00 95 70 00 00 97 92 00 00 99 B9 00 00 .f...p.......¹..
0003:8920 A0 45 00 00 A6 EF 00 00 AA 9B 00 00 AD 30 00 00  E..¦ï..ª... 0..
0003:8930 AF 62 00 00 B2 B7 00 00 B5 8C 00 00 B8 97 00 00 ¯b..²·..µ...¸...
0003:8940 BB 30 00 00 BD BB 00 00 C0 0A 00 00 C4 9D 00 00 »0..½»..À...Ä...
0003:8950 C9 6F 00 00 CC 23 00 00 CF 73 00 00 D2 B9 00 00 Éo..Ì#..Ïs..Ò¹..
0003:8960 D5 C5 00 00 D8 B0 00 00 DB 84 00 00 DE 79 00 00 ÕÅ..Ø°..Û...Þy..
0003:8970 E0 7B 00 00 E2 D2 00 00 E9 BF 00 00 F0 B7 00 00 à{..âÒ..é¿..ð·..
0003:8980 F4 1E 00 00 F7 1F 00 00 FA 17 00 00 FC E8 00 00 ô...÷...ú...üè..
0003:8990 FE BE 00 01 01 87 00 01 04 05 00 01 06 6F 00 01 þ¾...........o..
0003:89A0 08 D0 00 01 0B 20 00 01 0D 43 00 01 0F 9D 00 01 .Ð... ...C......
0003:89B0 10 F6 00 01 13 15 00 01 15 28 00 01 17 92 00 01 .ö.......(......
0003:89C0 1B 9B 00 01 1F 21 00 01 22 6F 00 01 25 14 00 01 .....!.."o..%...
0003:89D0 26 AA 00 01 29 35 00 01 2B 8E 00 01 2E 02 00 01 &ª..)5..+.......
0003:89E0 30 49 00 01 32 87 00 01 35 23 00 01 37 6F 00 01 0I..2...5#..7o..
0003:89F0 39 2C 00 01 3B A5 00 01 3E 20 00 01 40 A7 00 01 9,..;¥..> ..@§..
0003:8A00 42 ED 00 01 4E 50 00 01 51 5A 00 01 54 B4 00 01 Bí..NP..QZ..T´..
0003:8A10 57 23 00 01 5A 38 00 01 5D 23 00 01 5F 7D 00 01 W#..Z8..]#.._}..
0003:8A20 65 A9 00 01 6B BE 00 01 6E 75 00 01 71 1E 00 01 e©..k¾..nu..q...
```

Stego-file MOOV box hexdump

OpenPuff Stego-analyzed - Structural Attack (6)

Secret information is hidden inside the the MOOV box

Once again it could not be proved …

… due to two reasons:

- The fact that the secret information is encrypted
- The use of deniable steganography techniques

Anti-Forensics

Pursuits to make the analysis and/or examination of evidence difficult or impossible to conduct

- Encryption and steganography among the ways

Relies on several weaknesses of the forensic process

- Human element, dependency on tools

There is always the chance of being detected using these techniques

- Resisting to these unpredictable attacks is also possible …
- … even when forced to provide a valid password to extract the data

Anti-Forensics - Deniable Steganography

Camouflage based technique

- Even if the steganalyst is able to state that data is being hidden, allows the breaker to convincingly deny that fact

OpenPuff implements deniable steganography

- Possible to hide two different messages in the cover file
    - One which contains the sensitive data
    - One which although is plausible to be considered sensitive, the user is willingly to give away

One of the reasons why the statistical attacks are ineffective

CONCLUSION

Conclusion

Techniques used on images and audio can also be applied to videos

- Most common use the spacial domain (LSB) and the frequency domain (DCT)

Statistical analysis can reveal the presence of hidden data

- However it is a difficult process to carry out
- Hidden information tends to be nearly impossible to be detectable

Best way to prevent steganography would be to alter or destroy files which are considered suspicious

- New video compression methods where less redundant bits are available is also a possibility

Future Work

The attacks performed proved to be insufficient to determine the hidden information

- It would be interesting to assess if the hidden information can be retrieved

Questions?