Bigfoot

www.videogorillas.com

The Company.

Video Gorillas is a media-focused product and services company that develops state-of-the-art video technology incorporating machine learning, neural networks, visual analysis, object recognition, and live streaming. The company is headquartered in Los Angeles with engineering based in Kiev.

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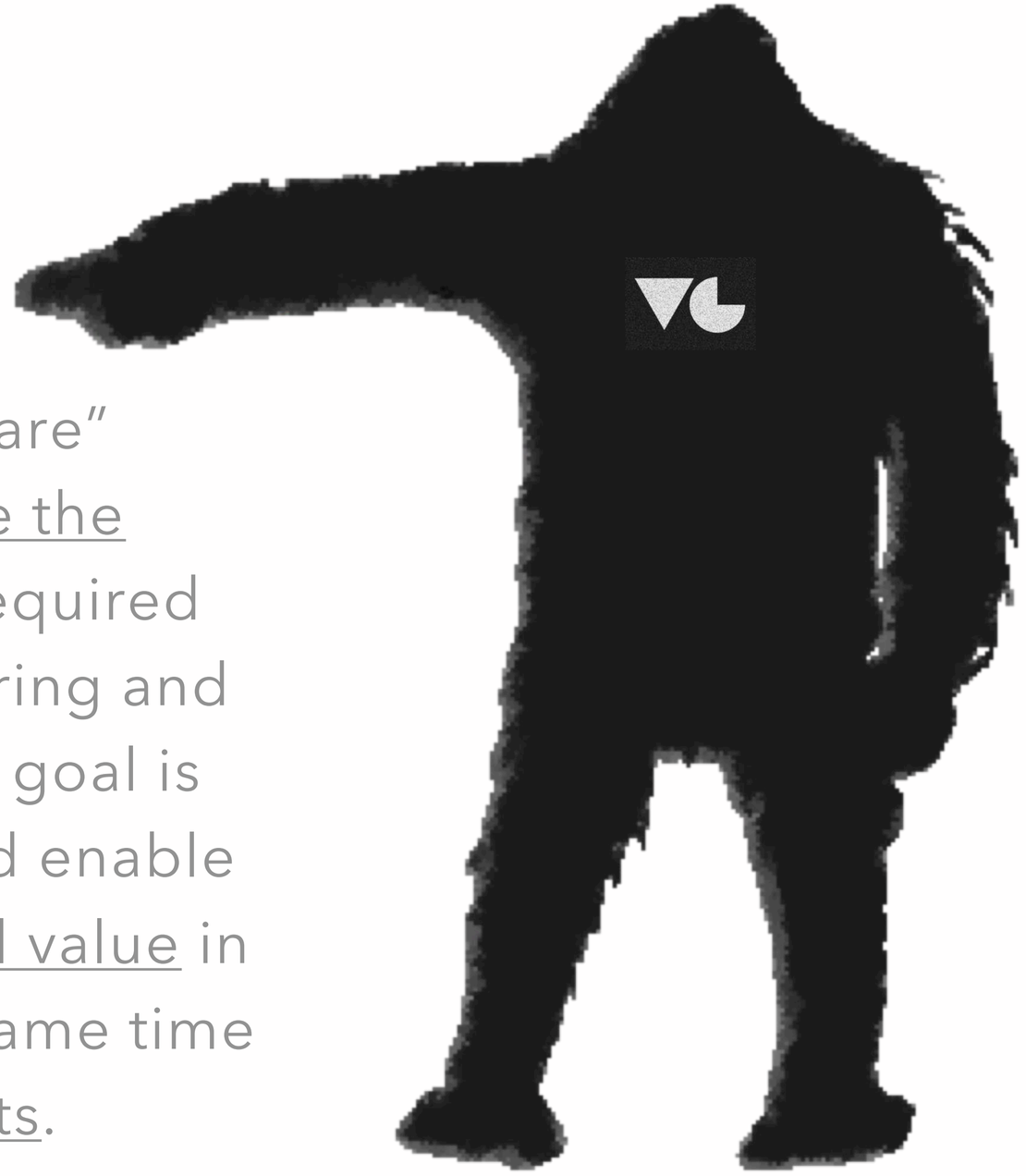
Domain Expertise.

- machine learning (neural networks, deep learning)
- image and video analysis
- development and optimization for computer vision
- algorithm research
- motion analysis
- natural language processing (NLP)
- neural language modeling
- video engineering
- video processing
- web applications with the focus on video streaming
- high-performance applications development
- system performance optimization
- augmented reality
- front-end development (web and mobile)
- front-end development of responsive design solution
- cross-browser/ multiple platform support
- high-load computing and scalability
- architecting cloud and hybrid solutions

The Mission.

Bigfoot. The Bigfoot “Frame Compare” solution was developed to decrease the amount of manual labor currently required in many asset management / mastering and preservation workflows. The overall goal is to help decrease time to market and enable content owners to unlock additional value in their content libraries while at the same time support ongoing preservation efforts.



The Voodoo.

Frequency Domain Descriptor (FDD)

Abstract: Systems and methods for image analysis and recognition are disclosed, in particular the methods for interest point description. An interest point and its surrounding area is broken into subareas, a frequency domain description of each area is created by applying discrete Fourier transform (DFT). Frequency domain features are than coded bitwise by comparing them to predefined thresholds....

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Why develop FDD?

- We knew early on that **pixel matching** methods had limitations and would not support many media & entertainment use cases

- So we looked at existing **interest point matching** methods (SURF / SIFT)

  Interest point matching enables support for:

  - Matching zoomed / cropped frames in reference master to film scans

  - Matching VFX heavy shots in reference master to film scans, clean plates and green screen elements

- As we continued our research we determined that SURF and SIFT would not work at scale due to inefficient processing speeds and large index sizes.

- These were the drivers that lead to the development of FDD

The History of Bigfoot.

The history of the innovation

- 2007 R&D related to object tracking for facial recognition
- 2008 Built a prototype using SIFT for finding high res versions of thumbnails used in DVD menus
- 2009 Problems uncovered using SURF and SIFT at scale
- 2010 Initial development of Video Gorillas Frequency Domain Descriptor (FDD) begins
- 2011 Sony Conform POC: Designing Women test with Colorworks
- 2012 FDD development continues based on success of real world POC with Sony
- 2013 FDD Patent application filed
- 2014 Bigfoot V0 Released
- 2016 Patent for FDD Issued
- 2017 Bigfoot V1 rolled out commercially to multiple customers
- 2018 Development of Bigfoot 2.0 begins

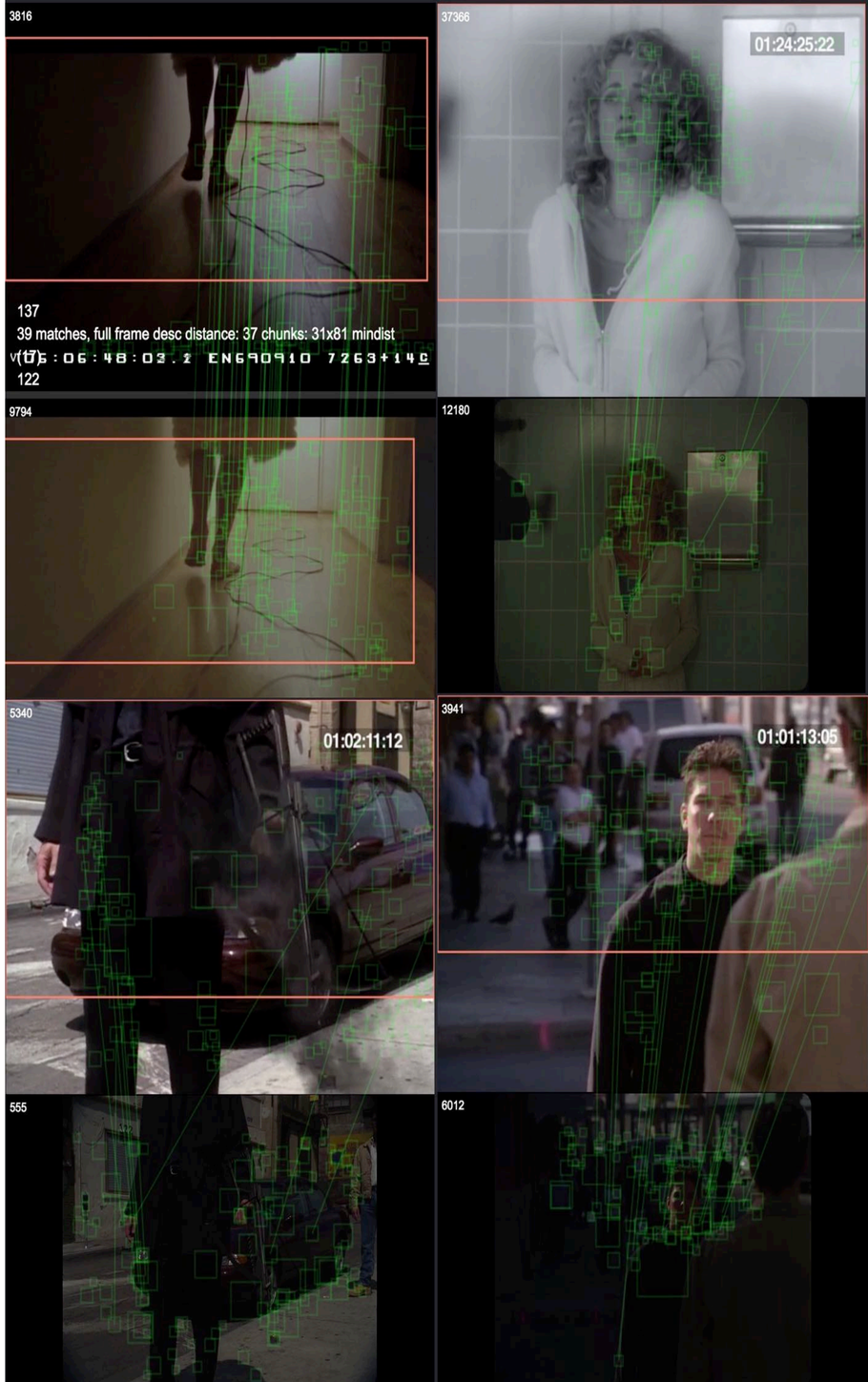
Product Snapshot.

- **VG Proprietary Technology:** Bigfoot leverages Video Gorillas patented computer vision / visual analysis , Frequency Domain Descriptor (FDD) and machine learning technology to find like “interest points” common across a series of images / frames.

- **Purpose built Use Case centric UI’s:** Front end validation UI’s for Conform and Compare use-cases (built to work in a web browser) are used by operators to validate and approve Bigfoot results

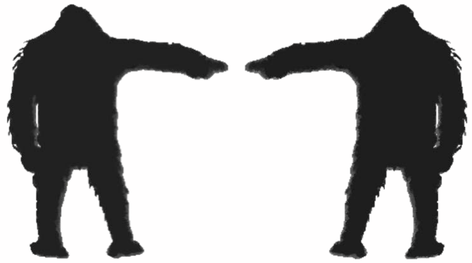
- **Flexible deployment:** Bigfoot can be deployed on premises or in a cloud environment

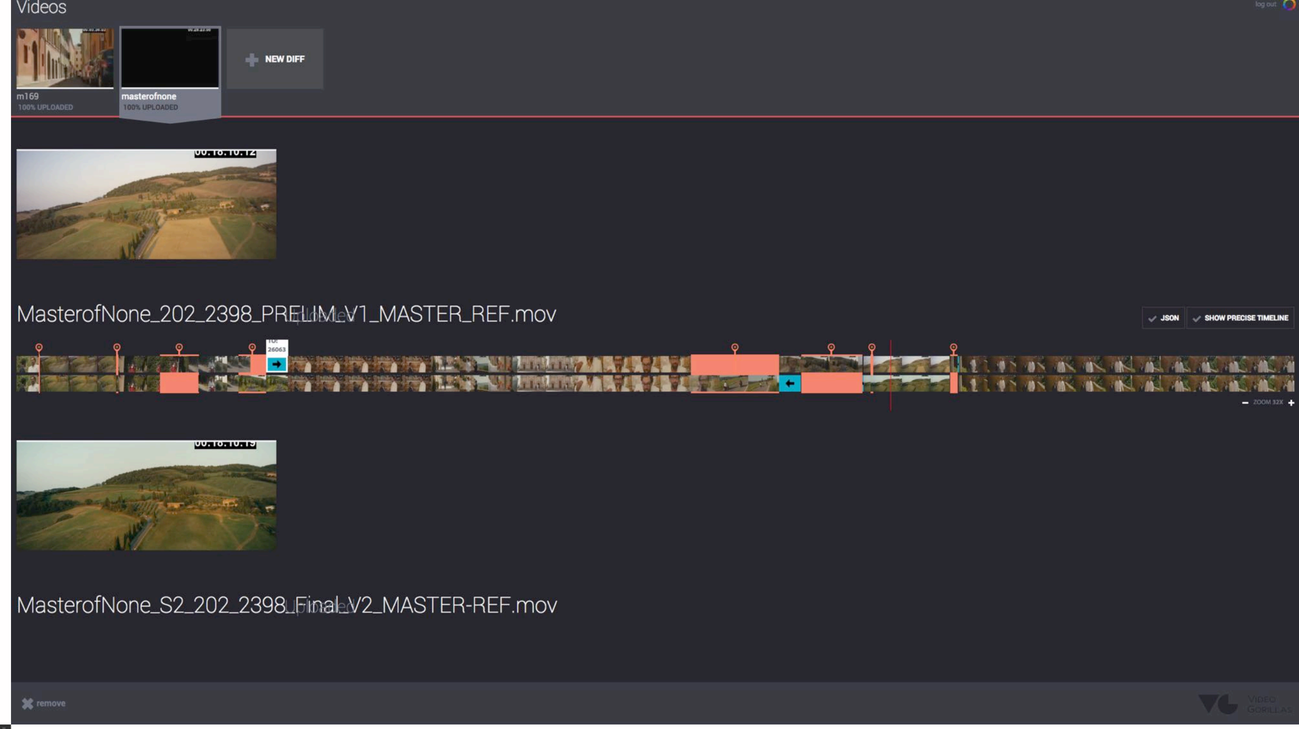
- **Reusable Indexes:** Once the Bigfoot index exists Bigfoot can continue to support a myriad of ongoing use cases related to media asset management workflows



Real World Use Case.

Compare.





Bigfoot Compare analyzes the following:

Differential analysis of picture cuts / versions

- Frames that are unique between the two cuts
- Frames that are common between the two cuts (in the same sequence)
- Frames that are common between the two cuts that have been shifted / moved

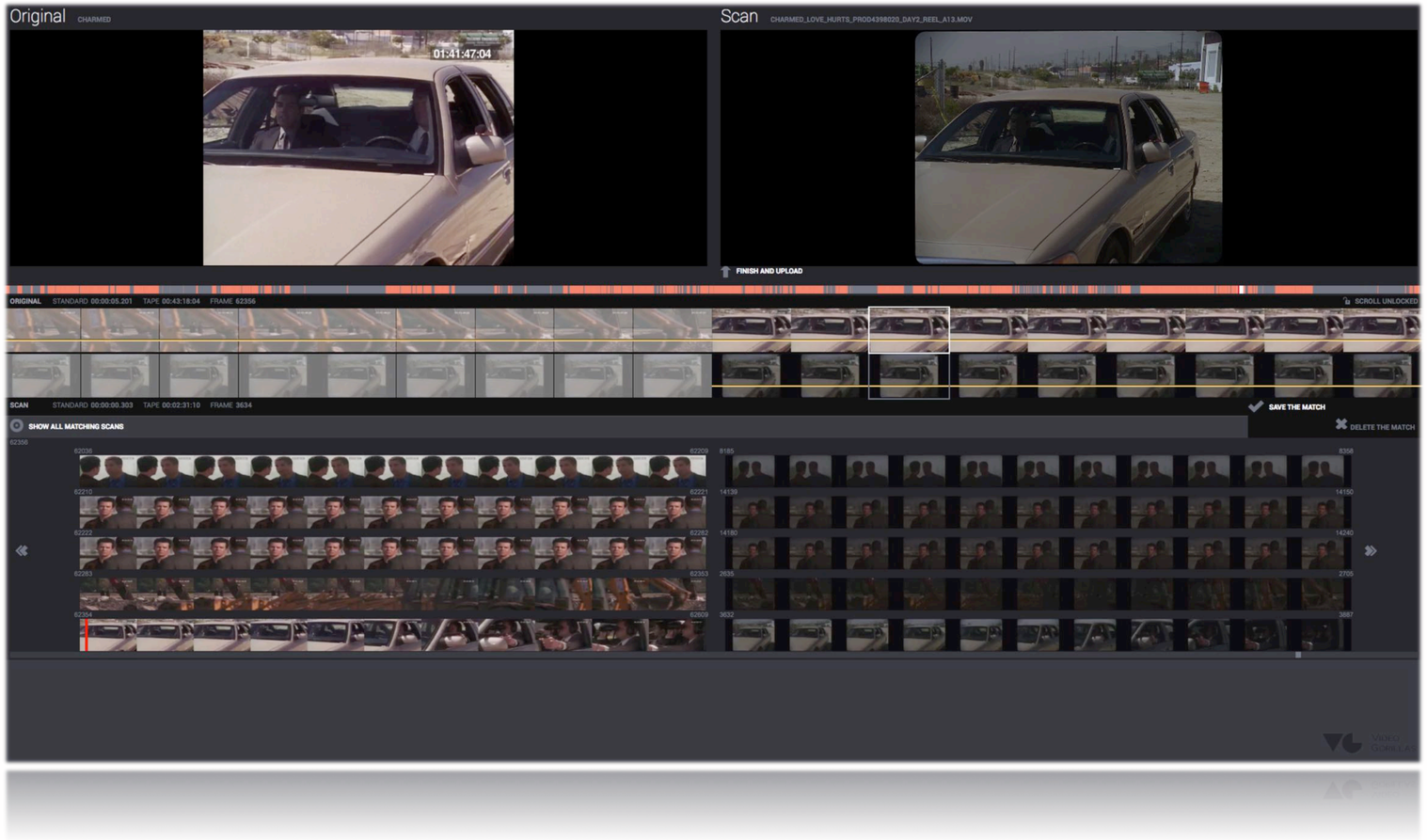
Frame match analysis of common frames found in differential analysis

- Are the common frames identical (In development)

Real World Use Case. Conform

Restoration / Remastering - Film Scans / reference picture auto conform

By comparing the frames from the reference picture to the frames from the scans Bigfoot can reconstruct the timeline, using the sequences of frames that have the most FDD interest points in common.



Additional conform / matching use cases Bigfoot can solve:

- A/B reels / reference picture conform
- Matching VFX plates / green screen to reference picture
- Trailer reconstruction from scans
- News reel reconstruction
- Matching stock footage

The Conform Problem.

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Project: 35mm Film
List Title: 35mm 24 FPS

35mm 24 FPS — 10 events — handles = -1
Picture 1 — 0 dupes — total footage: 74+04
Assemble List — 0 opticals — total time: 00:00:49:14

	Footage	Duration	First/Last Key	Address TC	Cam Roll	Sc/Tk	Clip Name
1.	0+00	10+04	KW 42 9137-4866+15	06:22:47:24	A85	A10G/2	A10G/2
	10+03		4877+02	06:22:54:18			
2.	10+04	8+04	KW 35 3532-5791+11	06:18:07:29	A83	A10B/1	A10B/1
	18+07		5799+14	06:18:13:13			
3.	18+08	11+07	KW 42 9137-4884+05	06:22:59:11	A85	A10G/2	A10G/2
	29+14		4895+11	06:23:06:29			
4.	29+15	12+04	KW 35 3532-5812+01	06:18:21:16	A83	A10B/1	A10B/1
	42+02		5824+04	06:18:29:20			
5.	42+03	5+07	KW 42 9137-4904+14	06:23:13:03	A85	A10G/2	A10G/2
	47+09		4910+04	06:23:16:20			
6.	47+10	4+00	KW 46 7331-2663+04	06:25:54:15	A87	A10K/1	A10K/1
	51+09		2667+03	06:25:57:04			
7.	51+10	2+09	KW 42 9137-4914+01	06:23:19:06	A85	A10G/2	A10G/2
	54+02		4916+09	06:23:20:26			
8.	54+03	10+11	KW 35 3532-5907+07	06:19:25:04	A83	A10C/1	A10C/1
	64+13		5918+01	06:19:32:06			
9.	64+14	4+12	KW 42 9137-4926+01	06:23:27:06	A85	A10G/2	A10G/2
	69+09		4930+12	06:23:30:10			
10.	69+10	4+10	KW 35 3532-5923+00	06:19:35:15	A83	A10C/1	A10C/1
	74+03		5927+09	06:19:38:16			

(end of Assemble List)

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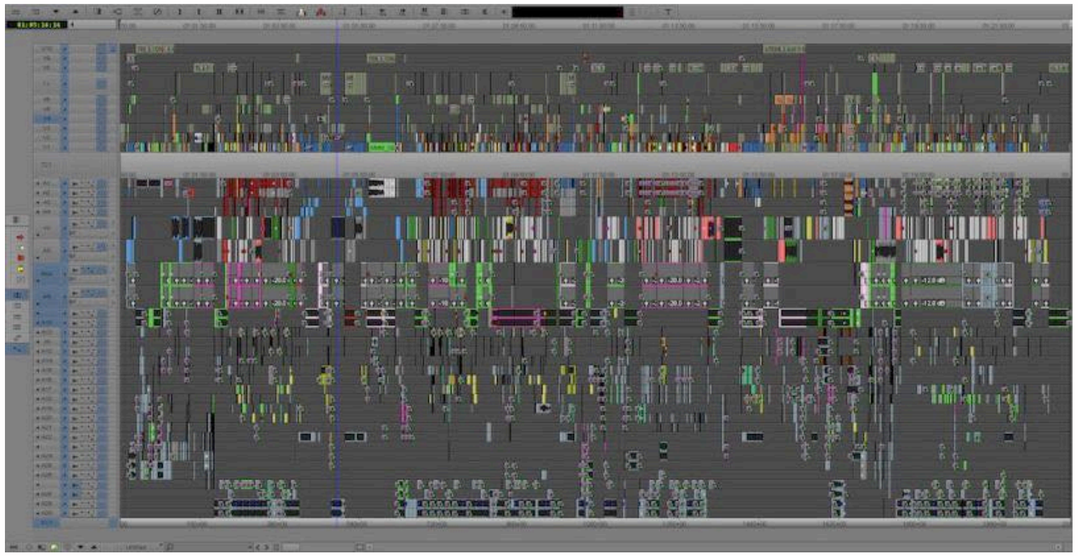
The Old Way. Conform.



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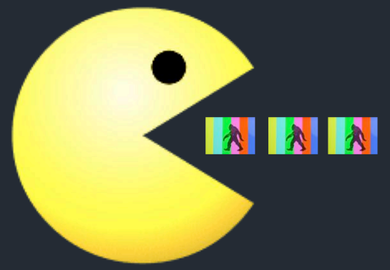
/eyematching

- Usually done in an edit suite / high opportunity cost for the facility
- Conform step is the bottleneck / difficult to scale other parts of the workflow
- The scans are stored on expensive storage until the conform is done
- Expensive / skilled labor doing work that is not creative
- Time consuming and inefficient
- Expensive for everyone
- Hard to justify ROI (content owners / facilities)

The Bigfoot Way. Conform.

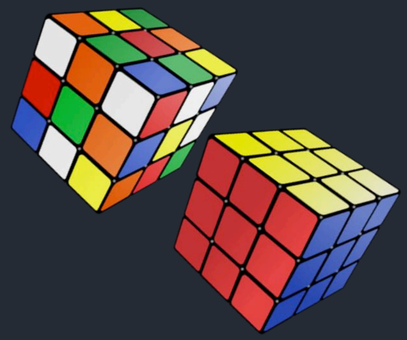
4 Steps.



Step 1. Ingest reference file / create Bigfoot project

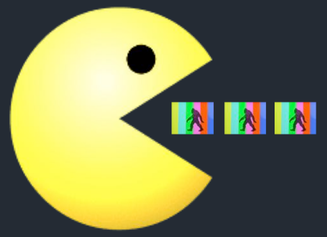
Step 2. Create Bigfoot Packages for scans (CPU)

Step 3. Bigfoot analysis (GPU)



Step 4. Bigfoot results validation

The Workflow. Conform.



Step 1. Ingest reference picture / create Bigfoot project

A. Reference picture registered in the Bigfoot service via
- Rest API
- Watch Folder (Usually a directory on the same storage as the scans)

B. Bigfoot Project created for the unique title / episode
- Once this project is created all respective Bigfoot packages for the same title are grouped together

C. Scans for the project can now be registered / ingested in Bigfoot

The Workflow. Conform.

Step 2. Create Bigfoot Packages for scans (CPU)

A. Once Ref Picture has been ingested into the Bigfoot service Bigfoot package creation for the scans is initiated

B. There are 2 ways of configuring the BF package creation workflow:

1. wait for all scans to complete then kick off package generation (default - light integration)

2. creation of bigfoot packages as they are written to storage (tight integration required)

The Workflow. Conform.

Step 2. Create Bigfoot Packages for scans (CPU)

Additional info:

- Input format support includes: DPX, MXF, ProRes, H.264 and any other format supported in FFMPEG
- Resolution and color are not important factors in the analysis step so proxies can be used if necessary
- Scan file names are passed / preserved in Bigfoot / required for valid EDL creation
- BF indexes are created for the project (ref picture and scans) and written to storage for current and future use (i.e. Flash-backs)
- Bigfoot packages are lightweight

The Workflow. Conform.

Step 2. Create Bigfoot Packages for scans (CPU)

The Bigfoot Package Contains:

- Video proxies (HLS / MPEG DASH)
- Frequency Domain Descriptor (FDD) binary metadata for Bigfoot analysis
- Bigfoot project package / project metadata / match maps / Bigfoot analysis results (one per unique episode / feature ingested)

The Workflow. Conform.

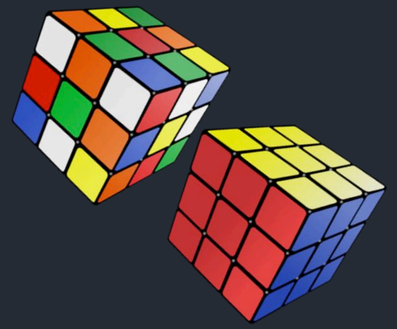
Step 3. Bigfoot analysis (GPU)

A. The Bigfoot matching / compare process begins once Bigfoot packages for the reference picture and scans have been created

B. In this process every frame of the reference picture is compared to every frame of every scan

C. FDD match results are recorded and written into the Bigfoot project directory of each title and can be reused for future analysis

The Workflow. Conform.



Step 4. Bigfoot results

A. Once the analysis step is complete results are delivered back into the Bigfoot Validation UI and / or via JSON / XML etc.

B. A light validation is performed by an operator; Bigfoot match precision is 98% and our recall is 99%

C. Once validated the results can be exported as an XML / JSON file or an EDL (CMX 3600 / FCP XML)

D. Results are then used downstream in finishing workflows

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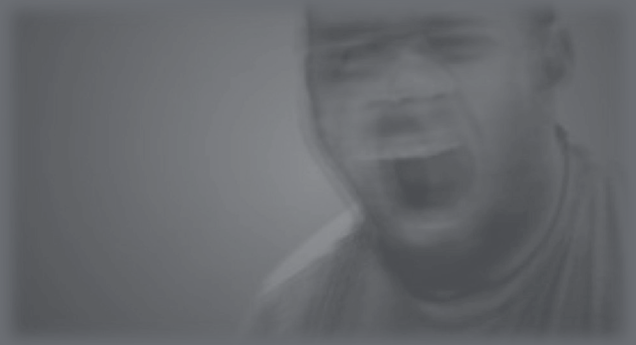

The Old Way. Numbers.

/eyematching

EPISODE 42

1 Hour show (Heavy VFX)

Reference file duration 00:49:30

89 scans total duration 14:56:20 (~16TB)

1.3M frames / ~80,000 ft of film

Eye Matching Conform: ~8 - 10 Days

The Bigfoot Way.
Numbers.

/Bigfoot

EPISODE 42
1 Hour show (Heavy VFX)
Reference file duration 00:49:30
89 scans total duration 14:56:20
(~16TB)
1.3M frames / ~80,000 ft of film

Bigfoot Conform: ~10 - 12 Hours

Time required by workflow step

Steps 1&2 - Ingest / Bigfoot Package Creation (DPX Source)
in 11:31:41 on 8-core processor
in 07:42:27 on 12-core processor
In 02:53:25 on a 32-core processor

Bigfoot Package file size = 34GB

Step 3 – Bigfoot Analysis
In 05:10:49 on NVidia GeForce Titan Xp 12 Gb

Step 4 – Bigfoot Results / Validation
In ~02:00:00 – 04:00:00

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The Bigfoot Way.
Real Benefits.

Increased throughput

- Unused scans can be moved off storage much faster
- More material can be scanned through the facility without changes to existing storage footprint
- Conform step is no longer the bottleneck; as a result scanning and finishing operations can now be scaled up
- Decrease time to market / Easier to justify ROI to the business

Non intrusive to existing operation

- Bigfoot wedges into existing scanning operation / infrastructure
- Edit suite no longer required
- Expensive labor no longer required
- Workflow is slightly modified so very little change management required

Improved visibility related to project health

Understand and solve source issues faster (i.e. missing elements / stock footage / VFX etc)

Demo.

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Research.

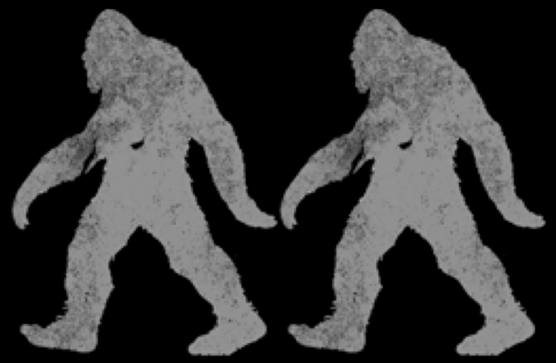
BIGFOOT  .0

image super-resolution using deep convolutional adversarial networks

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Thank You!
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