MBARI Media Management

Tools for Turning Video into Data

Brian Schlining
MBARI Media Management

Video Annotation and Reference System

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M3
Video Annotation and Reference System
VARS
B. Schlining
About MBARI
underwater video ...
A novel approach

- Collect a lot of video
- Systematically catalogued = easily retrievable
- Managed as institutional resource
Video workflow

At sea...

Control Room - video recording & preliminary analysis

Onshore - video archiving

Video Lab - comprehensive annotation
Today - scientific value

- Annotation expertise
- Video Annotation and Reference (VARS) software
  - 27,000 hours of video
  - 6+ million observations

Central management & careful cataloguing =

- Exploration, discovery, biodiversity baselines, long term monitoring
- 400+ peer-reviewed publications

Visualize and understand...ecosystem dynamics, biogeochemical cycles, and human impacts
Program development history

Single platform support - ROV video recordings

**Single media type - TAPES**
Program development history

Single platform support - ROV video recordings

1990
- 640x480 SD analog Beta SP videotape

1995
- 720x486 SD digital DigiBeta videotape

2000
- 1920x1080 HD digital D5 videotape

2005

2010

2015
- 1920x1080 HD digital video data files

Current project

Modern & versatile annotation

640x480 SD analog Beta SP videotape

720x486 SD digital DigiBeta videotape

1920x1080 HD digital D5 videotape

Data Products (DSG)

External dissemination (software + data)

Refined annotation (VARS)

Controlled annotation

Crude annotation


MBARI Media Management (M3)

Multiple platform support - MiniROV, AUV, Rover, observatory, etc.

Multiple platform support - MiniROV, AUV, Rover, observatory, etc.

Single media type - TAPES

Multiple media types - TAPES, FILES, and STILL IMAGES
Exploring the field

➔ Institutions
  ◆ Ocean Networks Canada (Neptune)
  ◆ Okeanos Explorer (NOAA)
  ◆ Nautilus
  ◆ WHOI (Alvin)
  ◆ R/V Thompson, MARS cable network
  ◆ Pacific Research Platform (Cinegrid industrial collaboration)
  ◆ Schmidt Ocean Institute
  ◆ JAMSTEC

➔ Industry (news and film)
  ◆ NHK, CNN, KQED
  ◆ National Geographic
  ◆ WWF
  ◆ Field experts: Adam Wilt, Larry Jordan

➔ Museums
  ◆ USC Digital Library
  ◆ US Holocaust Museum
  ◆ Smithsonian Institution Archives

Relevancy, failures, success in technology and workflow
So ... what did MBARI build?

1. Video Capture and Archiving
So … what did MBARI build?

1. Video Capture and Archiving

2. Video and Annotation Management Services
So ... what did MBARI build?

2. Video and Annotation Management Services

1. Video Capture and Archiving

3. Video Annotation applications
Video signal is routed to a video capture box.
Video Capture

**Blackmagic Intensity (or similar) - Video capture with Thunderbolt or USB 3.0**

**Mac with at least 4 CPU cores**

**Media Recorder by Softron**

**Video signal is routed to a video capture box**

**Video Encoding**

**Video Files are written to a RAID/LTO archive**
Video Capture

Video Files are written to a RAID/LTO archive

RAID

Redundant RAID/LTO Controllers

LTO Archive
Video Capture

Video is recorded in 15 minute chunks

Video Files are written to a RAID/LTO archive

ProRes HQ

H264/MP4
Video Capture

Video is recorded in 15 minute chunks

*Video Files are written to a RAID/LTO archive*

- ProRes HQ ~ 25GB
- H264/MP4 ~ 2.5GB
Video Capture

Each video has correct creation-time metadata

Video Files are written to A RAID/LTO archive

2018-09-22T10:25:01Z
2018-09-22T10:40:01Z
2018-09-22T10:55:01Z
2018-09-22T11:05:01Z
2018-09-22T11:20:01Z

ProRes HQ
H264/MP4
Video Capture

140 dives/year
x 2 ships
x 8 hours/dive
x 4 videos/hour
x 2 versions/video
------------------------
= 17920 videos/year
Video Capture

Video Files are written to a RAID/LTO archive

8960 ProRes
x 25 GB
+ 8960 H264
x 2.5 GB

= 246400 GB/year
= 246.4 TB/year
Video Capture

Video Files are written to a RAID/LTO archive.
Video Capture

SneakerNet

File Storage is Made Available to M3 Services
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File Storage is Made Available to M3 Services

- **File System**: Manages incoming uploads from annotation apps.

- **Web Services**:
  - penoptes
  - /panoptes/v1
  - /videos
  - /panoptes/v1
  - /vm/v1
  - /kb/v1
  - /accounts/v1
  - /anno/v1

- **Web Server**:
  - Nginx
  - /videos
  - /panoptes/v1
  - /vm/v1
  - /kb/v1

- **User Applications**:
  - vars-annotation
  - vars-kb
  - vars-query

- **RabbitMQ**:
  - manages inter-app communications
  - annotation exchange
  - concept exchange
  - new video exchange

- **Knowledgebase App**
  - Talks directly to the database. Post changes to a concept name to RabbitMQ.

- **Query App**
  - Talks directly to an annotation database. Only uses annotation view, just like current VARS. Uses KB REST API for retrieving concept information.

- **Annotation App**
  - Uses only REST APIs.

- **Syncs KB changes with Annotations**
  - KB posts changes to rabbitmq. This service listens for changes and updates ALL annotations (even if we setup additional annotation databases).
Watches the filesystem for new videos.

Extracts metadata from new videos.
Watches the filesystem for new videos.

Extracts metadata from new videos

Registers video with video-asset manager
Image Service

Video Asset Service

Knowledgebase

User Service

Annotation Service
M3 Microservices

Toolkit for building video annotation applications

- Image Service
- Video Asset Service
- Knowledgebase
- User Service
- Annotation Service
Discrete microservices
- A microservice
  - provides a web API
  - owns its own data
  - does one thing and does it well
  - Independent of other services
Microservices pros:

1. Independent
   a. Do not need to understand entire system
   b. Services can be written in different programming languages
   c. Use appropriate data-store (database, text file, NoSQL)
   d. Easy to upgrade and deploy
Microservices pros:

1. Independent
2. Scalable
Microservices pros:

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Microservices pros:

1. Independent
2. Scalable
3. Language Agnostic
   a. HTTP
   b. REST
   c. JSON

Python:
```python
j = requests.get('http://foo.org/concept/Nanomia').json()
```

Matlab:
```matlab
j = webread('http://foo.org/concept/Nanomia')
```

R:
```r
j <- fromJSON(
  readLines('http://foo.org/concept/Nanomia'))
```

Perl:
```perl
$j==0&&($C++,$C>=$a&&($C=0));$j==2&&($C||($C=$a),$C--);
$j==3&&($R++,$R>=$a&&($R=0));$j==1&&($R||($R=@B),$R--);}
KP($){push@S,shift}KJ(){pop@S||0}KX(){@S[-1,-2]=@S[-2,-1]}KR(){push@S,$S[-1]}KW($$){"Z".$[0]."Z,K{".$[1]."};"KG($){($_)=(@;$_)=@;y\/<\'/;$W$a," X;P(J$ _ J)"}KD($){($a)=@;W$a,ZP Z.$a}KE($){($_)=(@a)
  =@;y/0123/>^<\'/;W $_,"N $a")};```
Microservices pros:

1. Independent
2. Scalable
3. Language Agnostic
4. Easy to Customize (via Docker)

# Dockerfile

```
FROM mbari/annosaurus
ADD conf ${APP_HOME}/conf
ADD lib ${APP_HOME}/lib
EXPOSE 8080
ENTRYPOINT ${APP_HOME}/bin/jetty-main
```
Microservices pros:
1. Independent
2. Scalable
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4. Easy to Customize (via Docker)

```bash
# Dockerfile
FROM mbari/annosaurus
ADD conf ${APP_HOME}/conf
ADD lib ${APP_HOME}/lib
EXPOSE 8080
ENTRYPOINT ${APP_HOME}/bin/jetty-main

docker build -t m3/annosaurus .
docker run -p 8080:8080 m3/annosaurus
```
File Storage is Made Available to M3 Services

Web Services
- panoptes
- vampire-squid
- /panoptes/v1
- /vampire/v1
- /accounts/v1
- /anno/v1

Web Server
- Nginx
  - annotation exchange
  - concept exchange
  - new video exchange

User Applications
- vars-annotation
- vars-kb
- vars-query
- vars-anno-sync

Databases
- m3_video_assets
- m3_annotations

Annotation App
- Uses only REST API's.

Knowledgebase App
- Talks directly to the database. Post changes to a concept name to RabbitMQ.

Query App
- Talks directly to the annotation database. Only uses 'annotation' view, just like current VARS. Uses KB REST API for retrieving concept information.

Syncs KB changes w/ Annotations
- KB posts changes to rabbitmq. This service listens for changes and updates ALL annotations (even if we setup additional annotation databases).
M3 Microservices

- Image Service
- Video Asset Service
- Knowledgebase
- User Service
- Annotation Service
Answers the questions:
Where is the video?
What recorded the video?
When was the video recorded?
What is the video’s deployment id?
... other video metadata
M3 Microservices

- Defines annotation terms
- Provides hierarchy (e.g. phylogeny)

Greatly improves consistency and searchability of annotations

Knowledgebase
Spelling Matters

Quiz time - Which is the correct spelling for the cockatoo squid’s family?

A. Cranchiidae  
B. Cranciidae  
C. Cranchida  
D. Crancidae
Spelling Matters

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A. Cranchiidae  
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D. Crancidae

Wouldn’t it be great if you could just use ‘cockatoo squid’?
M3 Microservices

Annotation Service
Anatomy of an Annotation

Media Identifier (UUID)
Anatomy of an Annotation

Media Identifier (UUID)
Index into Media (Elapsed time)

65432 millis
Anatomy of an Annotation

Media Identifier (UUID)

Index into Media (Elapsed time)

Concept name (constrained by knowledgebase terms)

Grimpoteuthis

65432 millis
Anatomy of an Annotation

- **Media Identifier** (UUID)
- **Index into Media** (Elapsed time)
- **Concept name** (constrained by knowledgebase terms)
- **Other data** (date/time, position, CTD, description, etc.)

- Grimpoteuthis
- 2013-05-06T03:20:03Z, 36.21111, -121.3322, surface-color | self | white, ...
- 65432 millis
VARS/M3
VARS Annotation
VARS Annotation

Customizable by each user
VARS Annotation

Customizable by each user

Constrained vocabulary
VARS Annotation

- Customizable by each user
- Constrained vocabulary
- Add details to each annotation
VARS Annotation

Customizable by each user

Constrained vocabulary

Add details to each annotation

Capture Images from Video
VARS Query

Simple, Flexible Query tool

Q: Find all squid eating something between 500 and 1200 meters.

Q: Find all jellies seen on expedition IN2017.

Q: Find a particular species of sea cucumbers on rocky substrate.
Future Proofing
Future Proofing

Independently Evolving Components

Video Asset Manager
Annotation service
Image Archiver
Knowledgebase
Future Proofing

Native Video Players for different needs
Future Proofing

Integrate or Create Custom Annotation Applications
Novel Applications

Example: Find all annotations of *Nanomia bijuga* and extract images from the video
Novel Applications

- Video Asset Manager
- Annotation service
- Image Archiver
- Knowledgebase

Automated Detector and Classifier
Open-source

https://hub.docker.com/u/mbari/

https://github.com/mbari-media-management
Acknowledgements

For more information:

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Current MBARI team
Thank you!