Integration and Evaluation

Bas Boom
Objectives

O5.1: Define component and datastructure that allows quick integration
O5.2: Evaluation that targets both Research and Marine Biology perspectives
O5.3: Achieve successful integration
O5.4: Achieve successful evaluation
Outline

- design
- evaluation
- integration
- processing

THE UNIVERSITY of EDINBURGH
Grand Design - Recap

Communication
Component retrieves input from storage facilities
Component saves output in storage facilities

Storage Facilities
Store all data (video, records, ontologies)
Simple interface to query and store data
Same Datastore Definitions use by everybody
1\textsuperscript{st} Year State

- Interface
- Annotation Interface
- IP DB
- Fish Detection
- Fish Recognition
- VM (detection)
- VM others
- VM Recognition
- VM Workflow
- videos
- NAS

Amsterdam

Catania
2nd Year State

- Fish Detection
- Temp Workflow
- Fish Recognition
- Temp Workflow
- Fish Detection
- Fish Recognition
- Windrider (96 cores)
- IP DB
- Network Attached Storage
- Database Server
- VM (detection) 8 cores
- VM (recognition) 8 cores
- Rest of computers 50 cores
- Central Node
- Workflow
- Interface
- Webserver (Amsterdam)
Current State

European Webserver

Taiwan Webserver

Workers Nodes (N workers nodes)

Fish Detection
Fish Recognition

Network Attached Storage

IP DB

Database Server

Workflow

Central Node

videos

Interface

summary

summary

Interface

summary

Fish Detection
Fish Recognition

Fish Detection
Fish Recognition

Fish Recognition

Fish Recognition

Fish Recognition

Fish Recognition

Fish Recognition
Network Diagram
Integration Video
## Data Processed

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Processed videos</td>
<td>44944 (8.5%)</td>
<td>18606 (3.5%)</td>
<td>530660 (100%)</td>
<td>271722 (51.4%)</td>
</tr>
<tr>
<td>Processed Normal videos</td>
<td></td>
<td></td>
<td>75806 (100%)</td>
<td>74906 (98.91%)</td>
</tr>
<tr>
<td>Fish Trajectories</td>
<td>6m</td>
<td>2m</td>
<td>124m</td>
<td>53m</td>
</tr>
<tr>
<td>Fish Detections</td>
<td>60m</td>
<td>19m</td>
<td>1445m</td>
<td>654m</td>
</tr>
<tr>
<td>Speed (10 minute video)</td>
<td>40 min (std 83 min)</td>
<td>175 (std 381 min)</td>
<td>12 min (std 12 min)</td>
<td>160 min (std 246 min)</td>
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<tr>
<td>Table Name</td>
<td>Row count</td>
<td>Physical Size</td>
<td>Note</td>
<td></td>
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<td>----------------------------------</td>
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<td>----------------------------------------------------------------------</td>
<td></td>
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<tr>
<td>fish detection for fish species</td>
<td>1445.41M</td>
<td>322.26G</td>
<td>Abstracted information each detected object</td>
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<tr>
<td>fish</td>
<td>663.93M</td>
<td>24.67G</td>
<td>Correlated of fish object to species catalog</td>
<td></td>
</tr>
<tr>
<td>traj species</td>
<td>124.28M</td>
<td>21.01G</td>
<td>Abstracted information of tracked fish objects</td>
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<tr>
<td>frame class</td>
<td>97.29M</td>
<td>3.58G</td>
<td>Correlated tracking trajectory to species catalog</td>
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<tr>
<td>fish species cert</td>
<td>11.61M</td>
<td>2.65G</td>
<td>Classification of video quality detailed to frames</td>
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<tr>
<td>summary camera 39</td>
<td>32.55M</td>
<td>1.29G</td>
<td>Summary of det/rec certainty</td>
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<tr>
<td>summary camera 46</td>
<td>7.13M</td>
<td>1.24G</td>
<td>Aggregation of information on camera id</td>
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<tr>
<td>video</td>
<td>0.63M</td>
<td>0.14G</td>
<td></td>
<td></td>
</tr>
<tr>
<td>processed videos</td>
<td>0.78M</td>
<td>0.12G</td>
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Supporting Evaluation

Evaluation of the computer vision data using Ground-Truth Annotation:
- Fish Detection/Segmentation
- Fish Recognition
- Recognition of unknown species
- Fish Behaviour

Interfaces for annotation:
Fish Game

Fish Detection: locating the fish in the video frames (available at facebook)

80 users
1300 game sessions
>260K clicks
Perla

Object Detection:
Webinterface for accurate segmentation of fish and objects

50 users, 35 videos, 13000 objects
63000 annotations
Automatic Clustering Support

Fish Recognition: Webinterface for annotation of fish species

Subset is filter for 5 most common Species

40 users, 1800 videos, 90275 objects, 516,088 annotations
Fish behaviour retrieval

Web interface for retrieving fish behaviour patterns based on fish co-occurrence: group, solo, pairing

1567 events annotated
Fish Recognition Game

More refined labeling
  e.g., New species, "unknown" species, images with high disagreement

Entertainment as incentives:
  Users get feedback from the system
Evaluation of separate components is already discussed:

- **User Interface: Usability Studies**

<table>
<thead>
<tr>
<th>Confidence</th>
<th>All Answers (%)</th>
<th>No Usability Issues (%)</th>
<th>With Usability Issues (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Wrong</td>
<td>Right</td>
</tr>
<tr>
<td>Very High</td>
<td>86 (43)</td>
<td>19 (9.5)</td>
<td>69 (48.3)</td>
</tr>
<tr>
<td>High</td>
<td>55 (27.5)</td>
<td>10 (5)</td>
<td>40 (28)</td>
</tr>
<tr>
<td>Moderate</td>
<td>16 (8)</td>
<td>5 (2.5)</td>
<td>8 (5.6)</td>
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<tr>
<td>Low</td>
<td>1 (0.5)</td>
<td>6 (3)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Very Low</td>
<td>1 (0.5)</td>
<td>1 (0.5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>159 (79.5%)</td>
<td>41 (20.5%)</td>
<td>118 (82.6%)</td>
</tr>
</tbody>
</table>

- **Data processing:**
  - 100% processed by fish detection
  - 52% processed by fish recognition
Fish Video for Biologists

- unknown object: 624
- Dascyllus Reticulatus: 1725
- Chromis Margaritifer: 2
- Plectrogly-Phidodon dickii: 64
- Acanthurus nigrofuscus: 43
- Scolopsis Bilineate: 37
- Amphiprion Clarkii: 10
- Hemigymnus fasciatus: 1
- Abudefduf vaigiensis: 4
- Neoglyphidodon nigroris: 2

total (without unknown objects): 2512

total (without unknown objects): 1888
Conclusion

Integration of the Entire System achieved

Massive number of videos processed
(45287 hours = 1886 days) with all software

Information accessible to marine ecology community

Strong system design which resulted rapid/flexible software development
Scientific Innovations

Entire System will appear in Ecological Informatics, allowing marine ecology new methodologies for their studies

Probably the biggest public analyses video dataset in science at the moment (different interesting annotated subsets, ImageCLEF)

Development of GroundTruth annotation tools (trade off between obtain information and accuracy)
Questions/Discussion