AFORO: An interactive shape analysis and classification system for fish otoliths

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Outline of Talk

- Objectives
- Morphological Descriptors. An overview
- Where we are?
- Software Tools used
- Entity-RelationShip Diagram
- How to Populate the Database?
- Logical Web Application Flow
- Shape Analysis
- Browsing the Database
Objectives

Develop tools to manage, search and visualize multimedia data on DataBases (Internet) based on its contents.

1) To build an otolith database of well identified and catalogued samples. We will start from the documental base existing in the Institut de Ciències del Mar (CMIMA-CSIC). The database is regularly updated and at present (07/04/2004) it contains a total of 908 high resolution images corresponding to 182 species and 71 families from the Western Mediterranean and Antartica.

2) To provide a system to automatically extract the shape contours and compute some numerical descriptors.

3) To develop an expert system to classify and search among the database based on contours descriptors (in development).
Otoliths are characterized by specific morphological characters

Graphic representation using drawn lines appears in publications of:

- taxonomy
- phylogeney
- paleontology
- paleoecology
- trophic relationships
- archeology

Recently, digital photographs are incorporated into otolith description
Otolith measurements are used in:
- taxonomy (species identification)
- fisheries (stock identification, ageing)
- functional morphology and ecomorphology

In the last years, the application of digital image processing and analysis techniques in otolith studies has increased.
AFORO database assembles image otoliths, morphometrics and shape analysis.

ICM Collection and database (908 sagitta images from 182 species, 71 families and 19 orders, mainly Mediterranean and Antartica at 2004/07/07)

Web AFORO

Web/ database interface

Graphic and morphological information

AFORO Shape Analysis of Fish Otoliths

Sardina pilchardus (European pilchard)

Fish ID: 5961
Genus: Sardina
Species: pilchardus
Type: TL
Length: 135

Date: From: N/A
Age: N/A
Comments: BARCELONA, Dra. Montserrat Demestre
Inst. Code: 7.4SL

Related Otoliths: 5964(175) 5963(160) 5962(145) 5961(135) 5960(125) 5965(110) 5966(90) 5959(105)

Results: Download the full resolution image (TIFF)
Otolith morphometry
AFORO database was developed under PostgreSQL 7.1.3-2 DBMS.

The application was built as a Java Web Application (as a Web ARchive WAR file) allowing an easy deployment in an application server like Tomcat 4.1.30.

The application was developed using Java Server Pages (JSP) and JavaBeans but also HTML and, far below, JavaScript.

Libraries used:
- **JAI**\(^{(1)}\) Java library (to create and convert from TIF to PNG the otolith images on the fly and also in otolith analysis)
- **JDBC**\(^{(1)}\) library (to connect Java app. to PostgreSQL DBMS)
- **ImageJ**\(^{(2)}\) (to extract otolith contour).

\(^{(1)}\) Sun Microsystems (http://www.sun.com/)
\(^{(2)}\) National Institutes of Health, USA. (http://rsb.info.nih.gov/ij/)
Entity-RelationShip Diagram

Entity Relationship
AFORO DATABASE
Diagram

RESULT
resultID
raw_filename
raw_pathname
type
format
filesize
description
url
keywords
creation_date
last_modified_date
originator
source_institute
quality_code
otolithID (FK)
index

OTOLITH
otolithID
institute_otolith_code
otolith_type
side
which_part
predator_species
comments
fishID (FK)

CONTACT
contactID
name
affiliation
e-mail
otolithID (FK)

FISH
fishID
fish_length_type
length
age
sex
weight
maturity
order_family
genus
species
subspecies
common_name
date_rectangle
marsden
division
latitude
longitude
comments
sourceID (FK)

SOURCE
sourceID
source_code
station_number
cruise_number
ship_name
fish_number
sample_number
Populating all database information but result table (otolith image):

➢ Traditionally, most of the otolith information we have has been stored in formats compatible with Microsoft Excel files.
➢ It is easy to connect Microsoft Access to PostgreSQL database to populate data using an ODBC connector.

So, “cut and pasting” data from Excel to Access turned out to be a database population (SQL INSERT).

Populating result files:

➢ For result files (now devoted only to TIF images corresponding to Sagitta Otolith) it is developed a small Web Application (HTML file + Servlet to upload the file and update the result table).

➢ Libraries used:
  ➢ commons-fileupload (http://jakarta.tomcat.org)
  ➢ JDBC.
Upload Otolith Image App.

Upload Result Information

This is a Web Application to upload otolith images and its information. Before to make a result upload it is necessary to know the otolithid at which result information is related to. You could click TestOtolith button to know otolithid information related to institute_otolith_information. It is also possible to know the files uploaded yet with TestFilename button. Also it is possible to changes what you want in the SQL query, to adapt your needs.

Result Information

Type of the file [WP]

Format [TIF]

Creation date (yyyy-mm-dd)

Source Institute [CMMA]

Originator (e-mail) [toni@icm.csic.es]

Keywords

Description

Otolith ID

File to upload [Browse]

Submit

TestFilename  TestOtolith
Shape Analysis

- Shape analysis is a set of descriptors obtained from otolith contour:
  - Fourier descriptors
  - Wavelet coefficients\(^{(1)}\)
  - Curvature Scale Space\(^{(1)}\) (related to inflection points of contour found at different smooth levels).

- Contour is obtained from original image applying Otsu algorithm (Otsu, 1979). This method is very sensitive to a well processed, so well contrasted images separating clearly the otolith than background information.

- Classification system is in progress\(^{(1)}\)

\(^{(1)}\) attend next presentations from Dr. Jaume Piera and Dr. Vicenç Parisi if interested
This recorded browsing web session shows the possibilities of AFORO Database.
Usage Statistics for AFORO Project hosted in lea.cmima.csic.es

Summary Period: Last 12 Months
Generated 05-Jul-2004 04:04 CEST

Summary by Month

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• AFORO WEB PAGE
http://aforo.cmima.csic.es/

(old link still working: http://lea.cmima.csic.es:8180/aforo)

• For any question, comment... related to data collection
Antoni Lombarte
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• For tech questions
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People participating in AFORO project:

- Dr. Antoni Lombarte Carrera (ICM-CSIC)
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- Dr. Vicenç Parisi Baradad (UPC)
- Dr. Jaume Piera Fernández (UPC)
- Dr. Emilio García Ladona (ICM-CSIC)
- Mr. Oscar Chic (ICM-CSIC)

Thanks also to:

Dr. Manuel Graña coordinator of AVG-ION (Aforo project) and Dr. Beatriz Morales-Nin coordinator of IBACS project

AFORO has been funded by Ministry of Science and Technology (code TIC2000-0376-p4-04)