Fish tracking in underwater videos
PLAN

▷ Professional career
▷ Introduction: Problem and objective
▷ State of the art
▷ Required tasks
Professional career
PROFESSIONAL CAREER

▷ Computer and multimedia license, ISAMM, Tunisia
   Final project: Interactive virtual tour, maya3d, Unity3d
▷ International master of Biometrics, UPEC, Paris
   First project: handwritten language recognition, matlab
   Second project: static sign language recognition, c++ OpenCV
Introduction
TRACKING

- **Tracking** is the process of locating a moving object over time.
- We need to use object recognition techniques for tracking.
What is prediction?

▷ How can we predict or estimate something we can not see or touch?

You can predict this rocket trajectory by solving some equations but..
What is prediction?
▷ How can we predict or estimate something we can not see or touch? 

You can predict this rocket trajectory
By solving some equations but...

Problem 1
Simulation of long period
Of time might cause accumulation of error
What is prediction?
▷ How can we predict or estimate something we can not see or touch?

You can predict this rocket trajectory by solving some equations but...

Problem 1
Simulation of long period of time might cause accumulation of error

Problem 2
Smallest error of initial value might cause a drastic change of estimated trajectory
We might think that good measurement could solve the problem.

But single measurement might not be enough to estimate the location of rocket accurately.

**Solution**

Combine prediction and measurement.
INTRODUCTION

▷ Underwater videos are quite blurry
▷ The background is moving
▷ Fish behavior: high number of fishes with large movement and variation of the shape

How to recognize fishes and track them?
State of the art
idTracker

- Multi-tracking algorithm that extracts a characteristic fingerprint from each animal in a video (Tracking by identification)

<table>
<thead>
<tr>
<th>Intensity 1 – Intensity 2</th>
<th>Distance</th>
<th>Diff. of intensities</th>
<th>Number of pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>600</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>800</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
We identify every non-overlapping fish in every frame

Best match
idTracker

Advantages:
▷ The rate of error propagation is very low
▷ The system achieves more than 99% frames correctly assigned
▷ The program extracts automatically the reference images from the video

“videos”
idTracker

Threshholding: method used for image segmentation, in order to discriminate foreground from background.

Limitations:
▷ Difficult to set threshold
▷ Sensitive to noise
Conditions for the system:
▷ idTracker doesn’t work on short, blurry videos
▷ Animals should have enough contrast against the background
▷ The system requires homogeneous illumination
▷ We have to initialize the total number of fishes that will appear in the video.
PARTICLE FILTER

Particle: $X_t = \{x, y, w, h\}$, weight: $W_t$
PARTICLE FILTER

**Principle:**
▷ Distribution of particles
▷ Weight calculation: Bhattacharyya distance

\[
D_B(p, q) = -\ln(BC(p, q))
\]

where

\[
BC(p, q) = \sum_{x \in X} \sqrt{p(x)q(x)}
\]

▷ Resampling
PARTICLE FILTER

**Principle:**
▷ Descriptor updating
  Transformation of the shape
  Occlusion
▷ Template thumbnails
CONVOLUTION NEURAL NETWORK

▷ Invariant feature extractor
▷ Fish could be detected automatically
▷ No need to template thumbnails
▷ The CNN feature representation often outperforms hand-crafted features.

<table>
<thead>
<tr>
<th>Species</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mice</td>
<td>0.01</td>
</tr>
<tr>
<td>Fruit flies</td>
<td>0.04</td>
</tr>
<tr>
<td>Zebrafish</td>
<td>0.94</td>
</tr>
<tr>
<td>Medaka fish</td>
<td>0.02</td>
</tr>
</tbody>
</table>
REQUIRED TASKS

▷ Embed python in c/c++
▷ Evaluate the robustness of feature vectors
▷ Evaluate the particle filter
▷ Evaluate the battacharyya distance
▷ Measure the time where the system did not record any error
THANK YOU!