IFISH FARM:

CLASSIFICATION AND ANALYSIS OF FISH BEHAVIOR USING EXTRACTED MOTION FEATURES

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Date: 04/07/2020

بالتعاون مع مركز بحوث الأسماك - جامعة قناة السويس

INTRODUCTION 1/2

- Fish Farming is one of the UN Goals to be enhanced by 2030.

- Different tasks in fish farms:
  - Anomalies insides pond

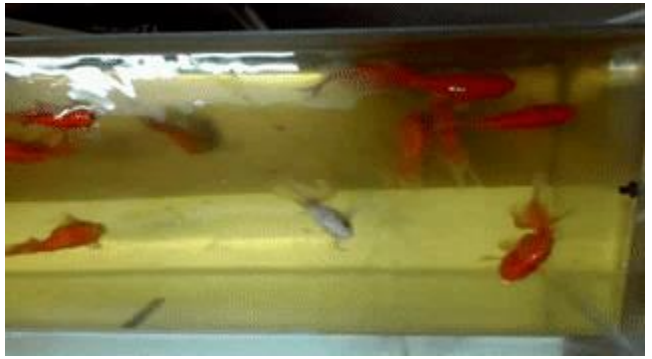
    (Speed, position ,trajectories ..etc)
  - Water quality monitoring.
    (Ammonia level detection)

- United Nations Goals

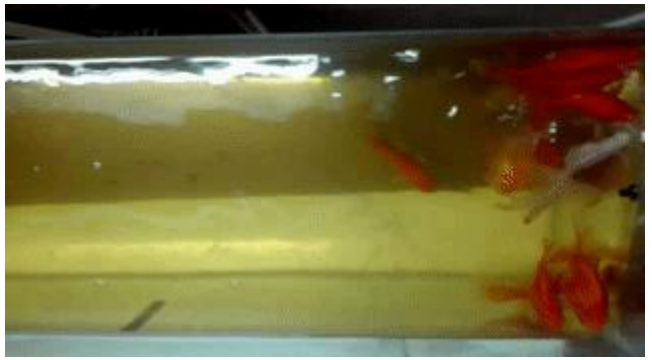
- Our team at the fish farm

INTRODUCTION 2/2

- **Challenges:**
  - Fish overlap
  - Water turbidity
  - Fish image dataset
- **Change fish movement indicates:**
  - Fish hunger.
  - Obstacles thrown in fish pond.
  - Change of water temperature.



Real Example of Normal Behavior



Real Example of Hunger Behavior

RELATED WORK (1/2): DETECTING ABNORMAL FISH TRAJECTORIES

- Video detection of abnormal trajectory.
- Outlier detection on each cluster was applied.
- The proposed method showed 13% false positive rate.

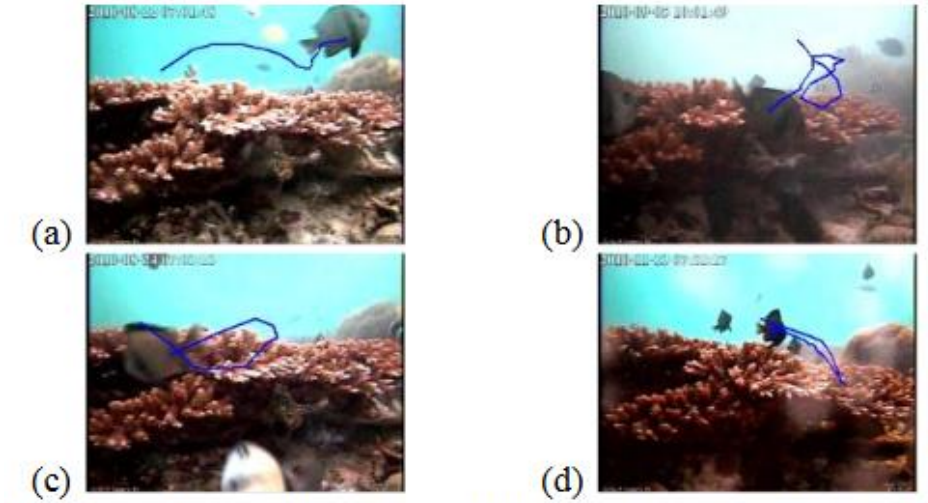
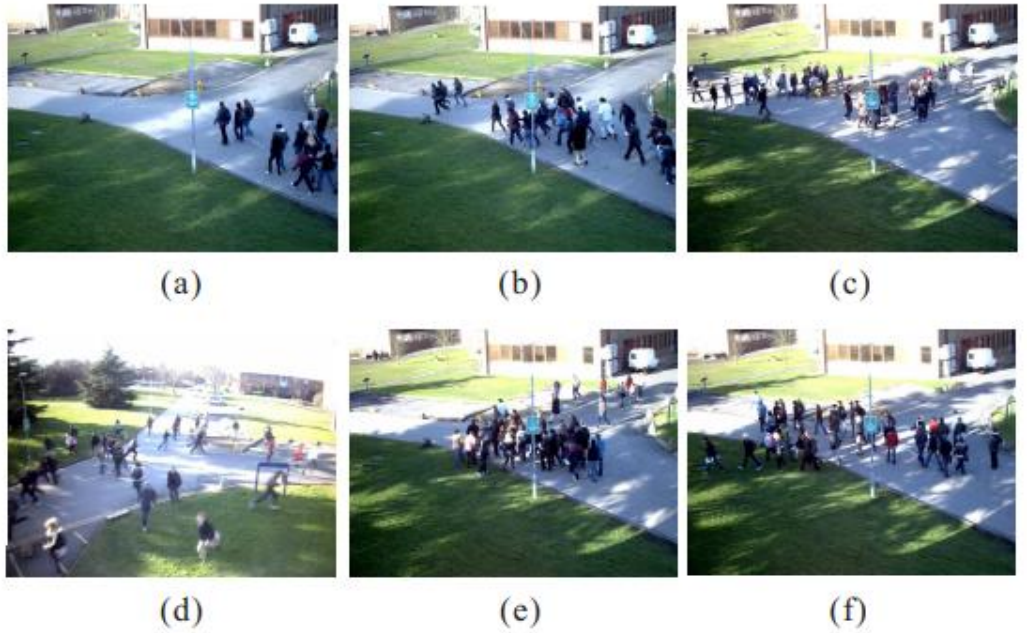


Fig. 4. (a-b) Examples of normal fish trajectories, (c-d) Examples of abnormal (rare) fish trajectories.

Beyan, C., & Fisher, R. B. (2013). *Detecting abnormal fish trajectories using clustered and labeled data.* ***2013 IEEE International Conference on Image Processing.***

RELATED WORK (2/2): CROWD MOVEMENT BEHAVIOR DETECTION

- Their aim is to detect behavioral patterns in crowds.
- They combine YOLO and cluster methods to detect different behaviors.
- The accuracy ranged between 80% and 95.7% in the 6 samples



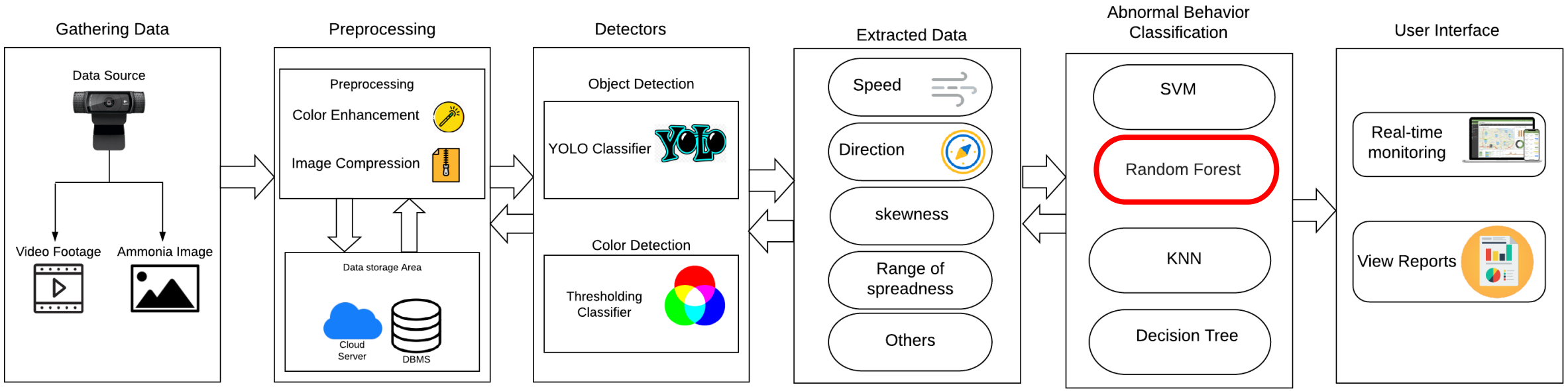
(a): Walking Sample (b): Running Sample
(c): Merging (d): Splitting
(e): Local Merging (f): Local Splitting

Yang, Meng, et al. "Cluster-based Crowd Movement Behavior Detection." 2018 Digital Image Computing: Techniques and Applications (DICTA). **IEEE, 2018.**

PROBLEM STATEMENT

Enhancing water visual while gathering fish trajectories to track fish in water and classify fish behaviors with a high accuracy and provide feedback to system users.

System Overview:



PREPROCESSING

- Multi-Scale Retinex (MSR)algorithm (Color enhancement)
- Data normalization using MinMax Scaler (minimize the range of values)
- Linear Regression (predict missing coordinates)
- Feature calculation

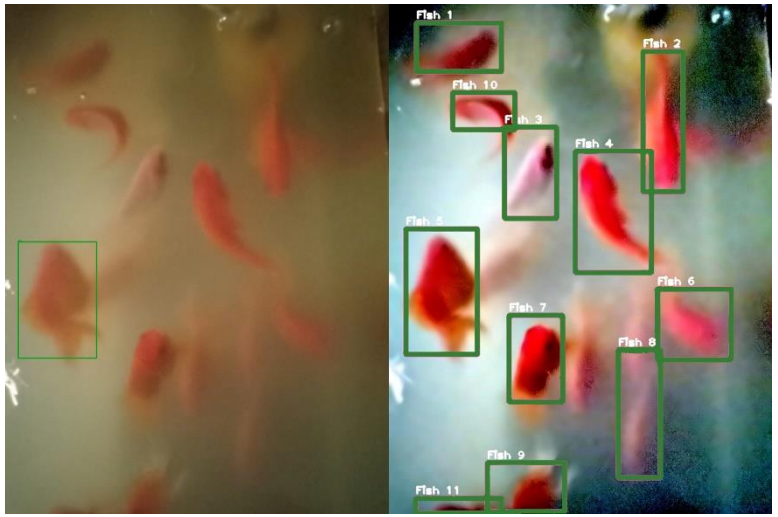
	A	B	C	D	E
1	247.3608	118.4455	255.3432	3.966707	544.8741
2	279.1649	162.1361	282.4677	4.16869	507.1022
3	355.954	197.7516	181.5143	3.641652	514.758
4	299.7165	120.9313	539.4998	3.328592	467.6209
5	282.2747	191.3427	179.2181	3.089392	440.0226
6	379.04	226.838	333.5877	3.563344	454.3697
7	204.5061	88.95902	376.1609	4.10502	572.3883
8	303.1878	166.7604	209.9169	3.816978	485.3046
9	380.207	239.252	874.0949	3.094262	445.9249

(a)

	A	B	C	D	E
1	0.493408	0.415981	0.104006	0.617785	0.749159
2	0.559393	0.574849	0.120537	0.67461	0.662461
3	0.718712	0.704354	0.059013	0.526335	0.680033
4	0.602033	0.42502	0.277178	0.438261	0.571839
5	0.565845	0.68105	0.057614	0.370965	0.508493
6	0.766609	0.810119	0.151691	0.504304	0.541424
7	0.404495	0.308762	0.177636	0.656697	0.812313
8	0.609235	0.591664	0.076322	0.57566	0.612429
9	0.769031	0.855259	0.481089	0.372335	0.52204

(b)

(a) Before normalization,
(b) after normalization

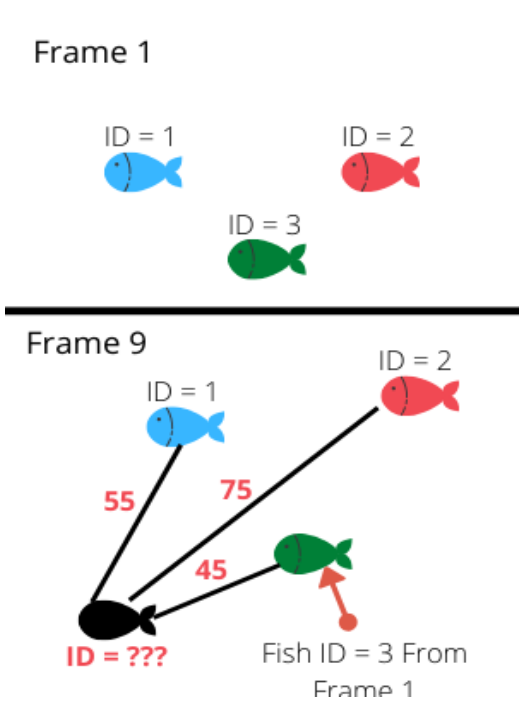


(c) (d)

(c) Before MSR enhancement,
(d) after MSR enhancement

PROCESSING 1/2:

- **Used algorithms:**
  - YOLO v3:
    (For detecting fish in ponds)
  - Euclidian distance tracking
    (Used to keep track of each detected fish)
  - Random forest: The majority votes of decision trees counts as the final classification.
    (To classify the fish behavior)



Euclidian distance tracking

PROCESSING 2/2:

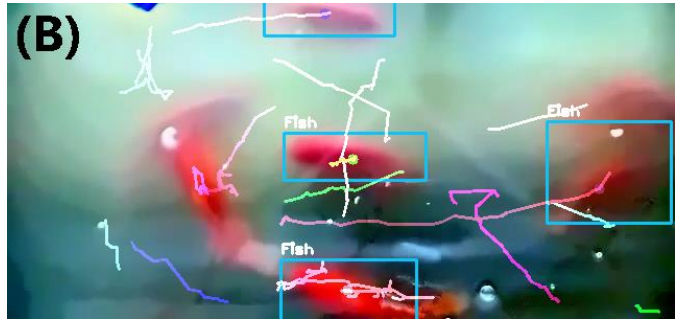
- **Design Choices:**

  - Linear SVM: behavior classification
  - KNN (at K = 3, 5, 7): behavior classification
  - Decision tree: behavior classification

  - Kmedoids: behavior clustering
  - Kmeans: behavior clustering

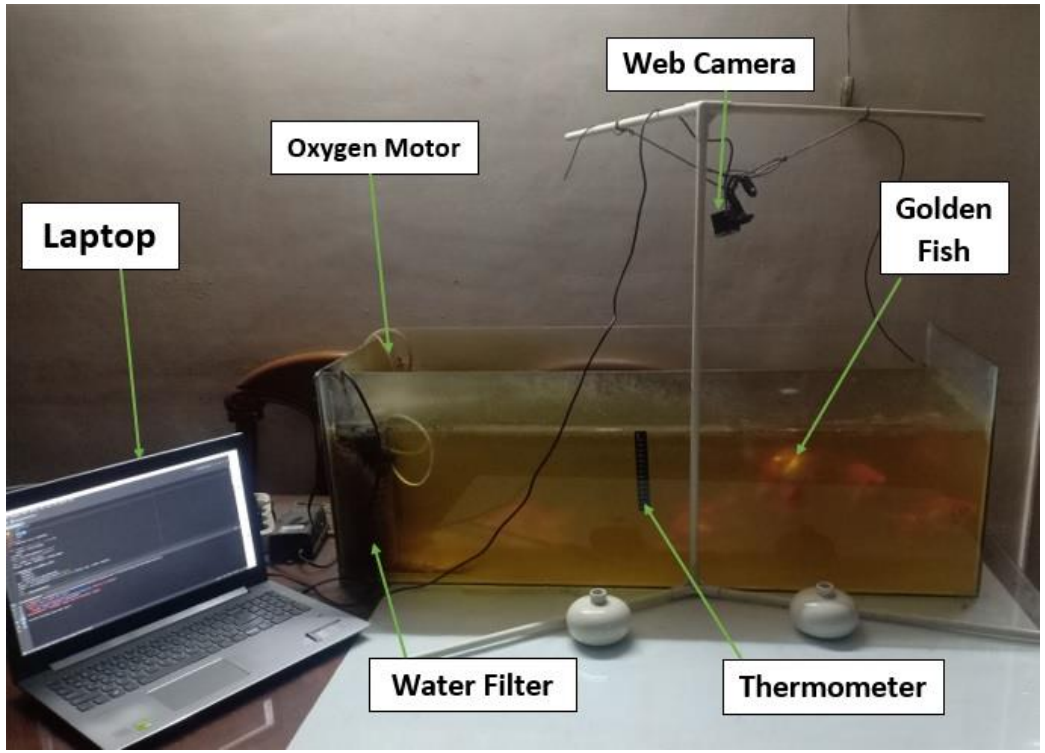
  - Optical flow: tracking trajectories

Optical flow tracking

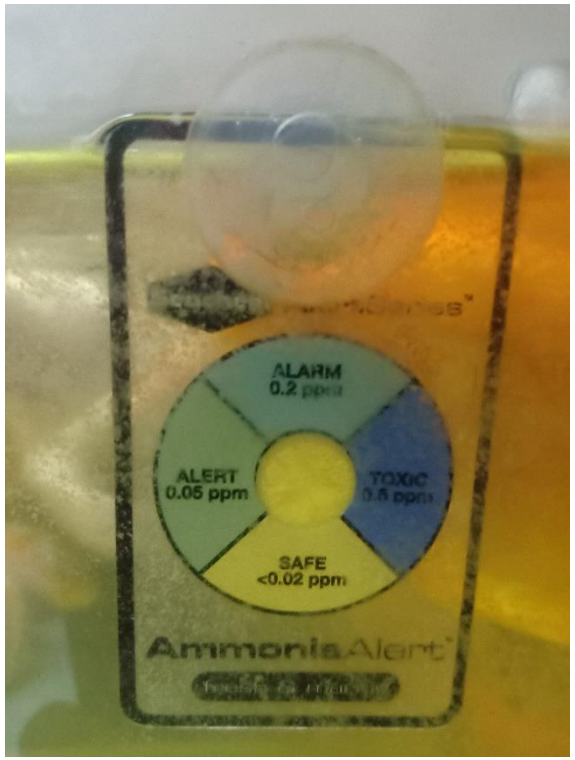


Euclidian distance tracking

EXPERIMENTS Setup



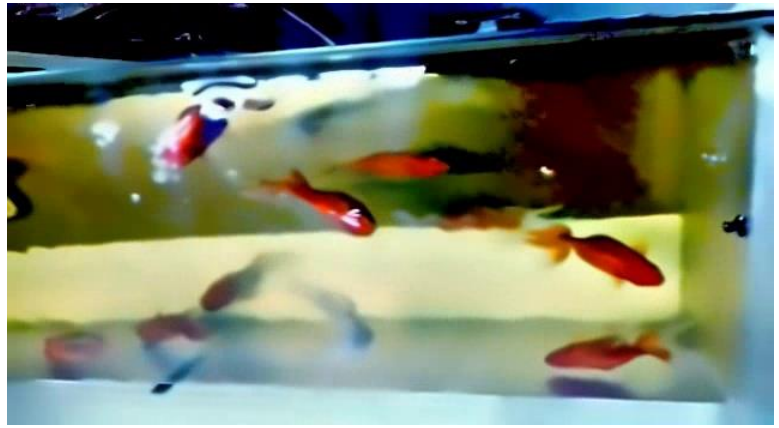
Experimental pond



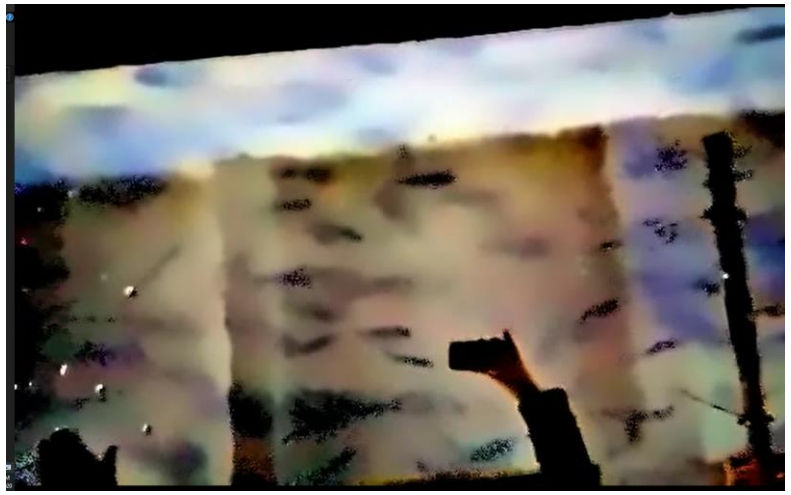
Ammonia paper

EXPERIMENTAL SET :

- Data-sets collected :
  - For the object detection:
    1. 2000 labeled fish image form our tank
    2. 400 labeled tilapia image from Suez canal fish farm
  - For the behavior classification:
    - 133 behavior samples in the dataset.
    - (40 obstacles, 43 hunger, 55 normal)



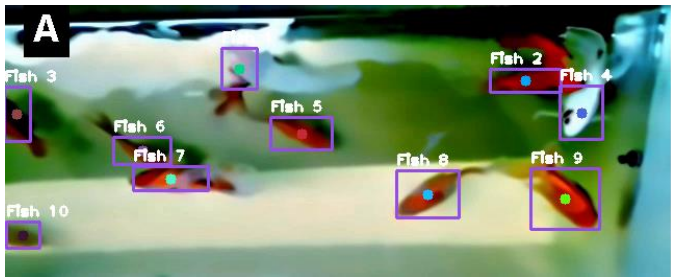
Our experimental tank



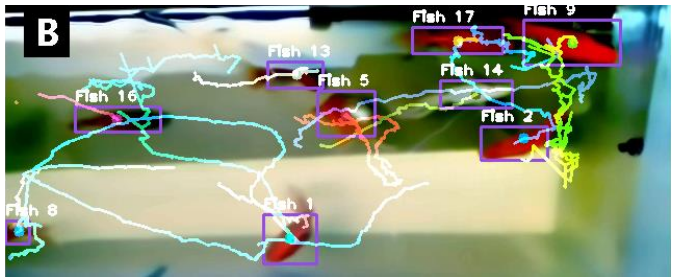
Real Image from Suez Canal University Fish farm tanks

EXPERIMENT 1/2: OBJECTIVE

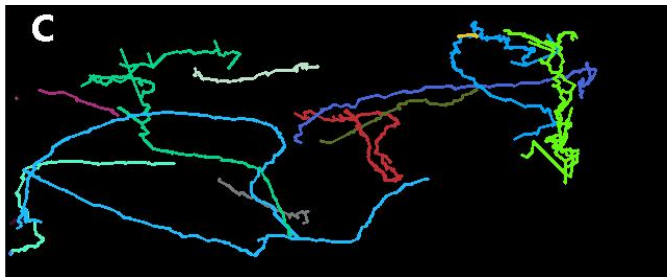
- Identify a suitable segmentation time to draw trajectories.
- Classification accuracy of normal and abnormal trajectories.



A: Fish Starting point



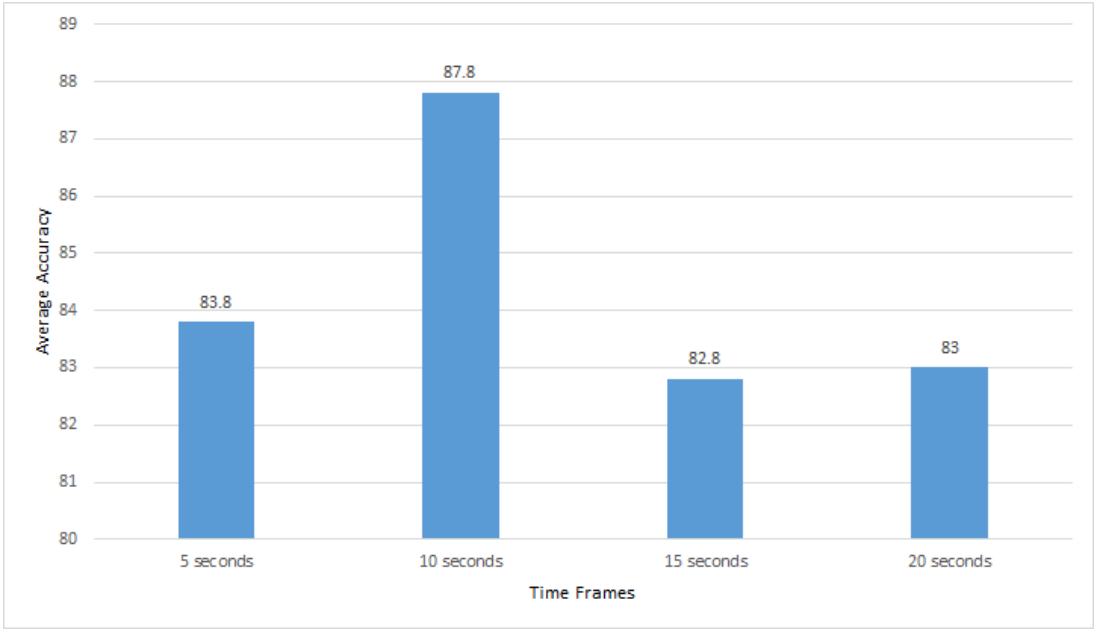
B: Fish Ending Point after the segmentation time



C: Final Trajectories drawn on black mask

EXPERIMENT 1/2: RESULTS

- 10 seconds was best segmentation time.
- Naïve Bayes achieved higher accuracy (90%).
- ANOVA test was conducted and The test returned a p-value = 0.0344.



Graph showing Average Accuracies of algorithms in comparison with time segmentation

Algorithm	5 seconds	10 seconds	15 seconds	20 seconds
NB	84%	90%	88%	87%
KNN (k=1)	82%	86%	80%	78%
KNN (k=3)	85%	89%	82%	87%
KNN (k=5)	86%	88%	84%	85%
RF	82%	86%	80%	78%

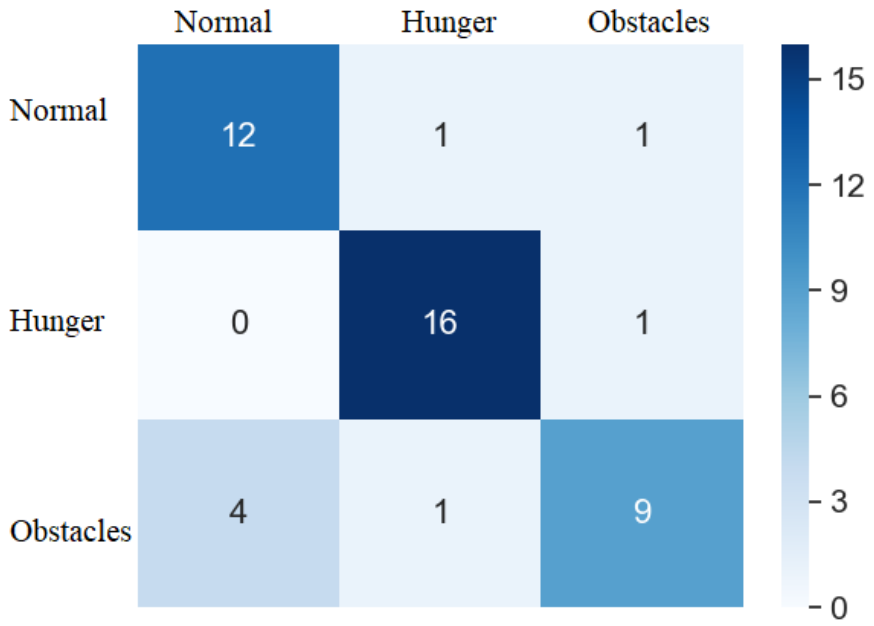
Algorithms Comparison

EXPERIMENT 2/2: OBJECTIVE

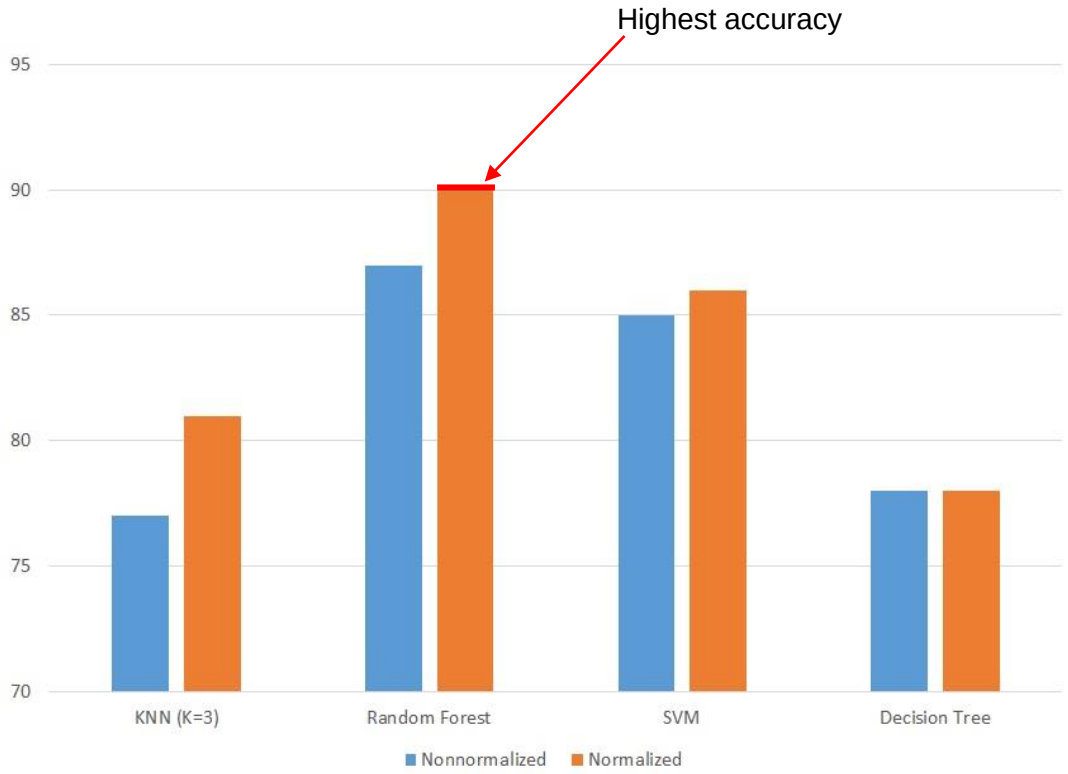
- Accuracy of classifying fish behaviors (normal, hunger, and obstacles)
- Features normalization using Min-Max scaling improves the classification accuracy

EXPERIMENTS 2/2: RESULTS

- Cross-Validation was applied to achieve accurate accuracy results.
- All algorithms achieved better results with **normalization**
- Random forest achieved 90% higher accuracy.



Random forest confusion matrix



Tested algorithms with and without normalization

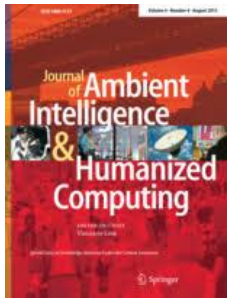
OUR CONTRIBUTIONS

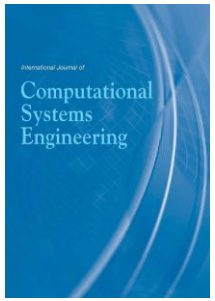
Problem 1: Enhancing Fish Detection and Tracking
Paper 1 (Published): MSR-YOLO: Method to Enhance Fish Detection and Tracking in Fish Farms [1]
Conference: ANT2020 (***ElSevier***)

Problem 2: Trajectories Tracking and Classification
Paper 2 (Accepted & Awaiting Publication): Detecting Abnormal Fish Behavior Using Motion Trajectories
Conference: MobiSPC2020 (***ElSevier***)

Problem 3: Different Behaviors Classification
Paper 3 (Under Review): Classification and Analysis of Fish Behavior Using Extracted Motion Features
Journal: International Journal of Computational Systems Engineering

Problem 4: Enhancing Fish Detection and Tracking
Paper 4 (Under Review): YOLO Fish Detection with Euclidean Tracking in Fish Farms
Journal: Journal of Ambient Intelligence and Humanized Computing (***Springer***)





[1]: https://www.sciencedirect.com/science/article/pii/S1877050920305615

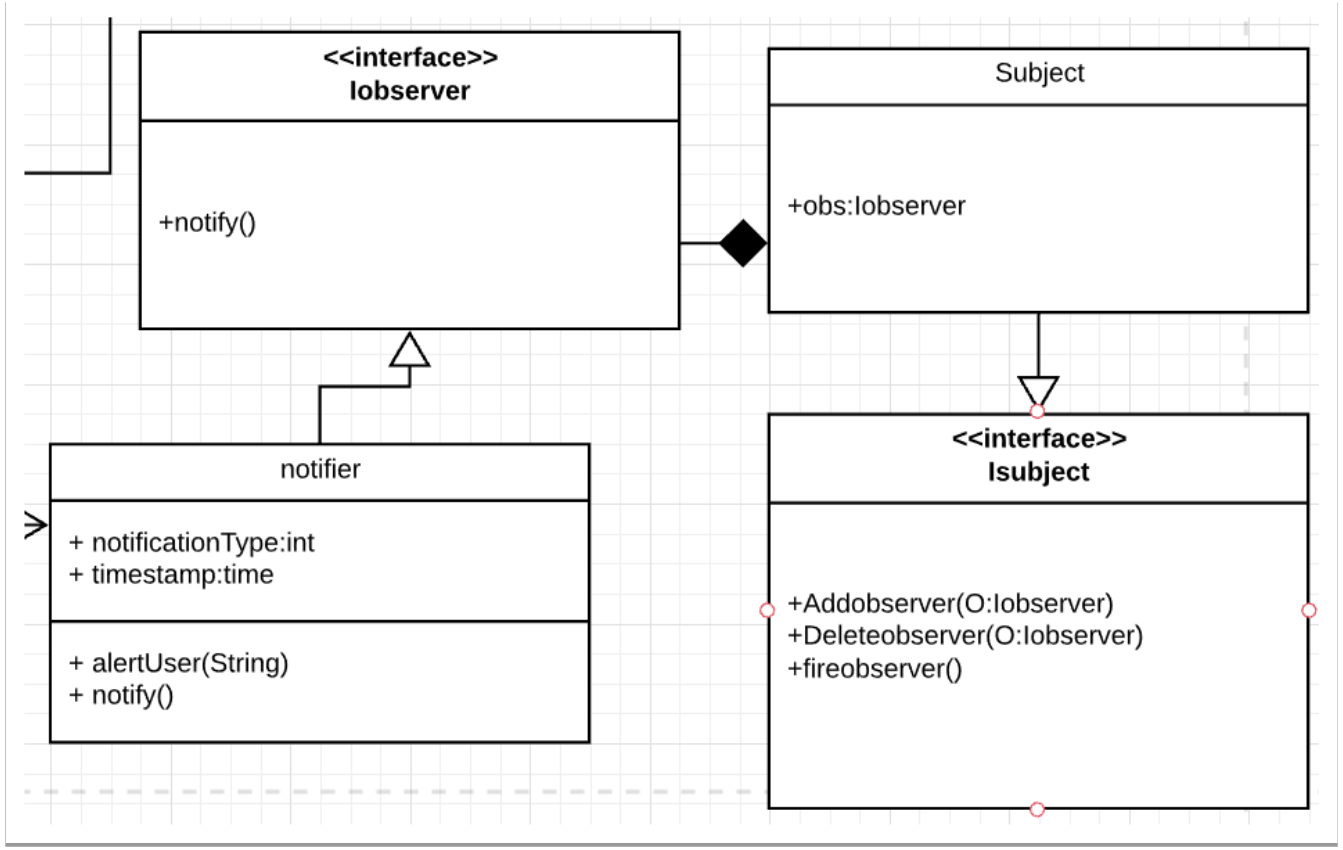
DEMO

Any Questions?

Thank You.

DESIGN PATTERNS

- MVC(Model View Controller)
- Observer
- Singleton



PAPERS 1/4:PUBLISHED PAPER

The paper was published in Elsevier ANT 2020 Conference
https://www.sciencedirect.com/science/article/pii/S1877050920305615

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ELSEVIER

Procedia Computer Science

Volume 170, 2020, Pages 539-546

MSR-YOLO: Method to Enhance Fish Detection and Tracking in Fish Farms

Hussam El-Din Mohamed [a] ✉, Ali Fadl [a], Omar Anas [a], Youssef Wageeh [a], Noha ElMasry [a], Ayman Nabil [a], Ayman Atia [b, c]

Show more

https://doi.org/10.1016/j.procs.2020.03.123

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PAPERS 2/4: WAITING FOR PUBLISHING PAPER

-The paper will be published in El Sevier MobiSPC 2020 Conference.

MobiSPC

Paper ID: 47
Paper Title: Detecting Abnormal Fish Behavior Using Motion Trajectories InUbiquitous Environments
Authors: Hussam Eldin Mohamed

has been accepted as a Full Paper at the 17th International Conference on Mobile Systems and Pervasive Computing.

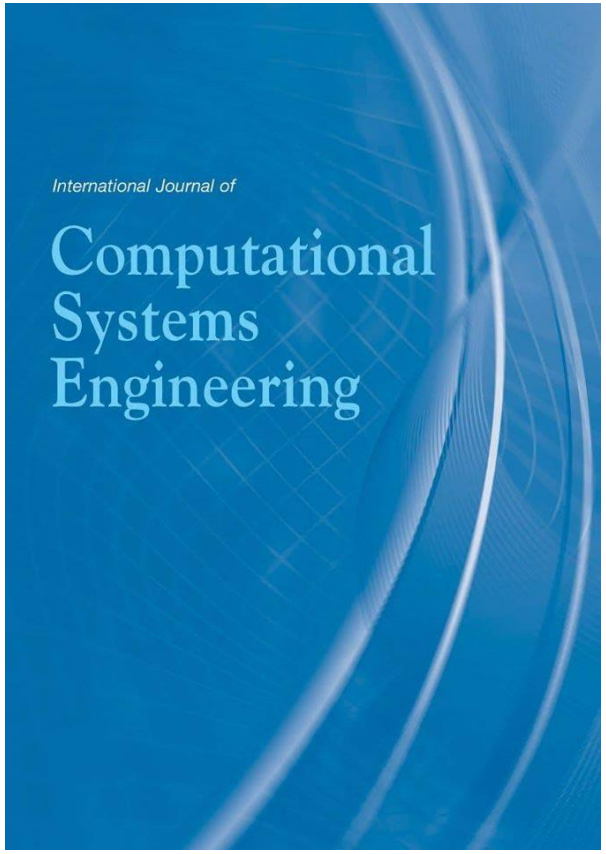
ELSEVIER

PAPER 3/4: UNDER REVIEW

- Our third paper was submitted in the International Journal of Computational Systems Engineering and currently under review.

Dear **Ali Fadl**,

You have successfully submitted your article "***Classification and Analysis of Fish Behavior Using Extracted Motion Features***" for the International Journal of Computational Systems Engineering.
Your submission code is **IJCSYSE-299750**
Please use this code when you contact us regarding your submission.



PAPERS 4/4: UNDER REVIEW

Our Fourth Paper was submitted into Journal of Ambient Intelligence and Humanized Computing (JAIHC) and is currently under review.

Special Issue - Invitation (Springer JAIHC) Inbox ×

ANT-2020 <ant2020@easychair.org> Fri, May 29, 8:42 PM

to me

Dear Hussam Eldin,

After a detailed discussion by the committee responsible for the selection of papers for the special issue "Journal of Ambient Intelligence and Humanized Computing (JAIHC) IF: 1.91", we managed to short-list a few papers.

We are happy to announce that your paper 112 - MSR-YOLO: Method to Enhance Fish Detection and Tracking in Fish Farms has been selected by the committee.

- Invitation Mail

Dear authors,

We received your submission to JAIHC-2020 (Journal of Ambient Intelligence and Humanized Computing):

Authors : Youssef Wageeh, Hussam Eldin Mohamed, Ali Fadl, Omar Anas, Noha Elmasry, Ayman Nabil and Ayman Atia
Title : MSR-YOLO: Method to Enhance Fish Detection and Tracking in Fish Farms
Number : 1

The submission was uploaded by Hussam Eldin Mohamed <hussameldin1606106@miuegypt.edu.eg>. You can access it via the JAIHC-2020 EasyChair Web page

- Submission Mail

PRE EXPERIMENTS 3/3:

- Enhance the detection model using a larger dataset.
- Enhance the extracted coordinates of fish using linear regression and tracking .

	A	B	C	D	E
1	0	0	0	0	0
2	0	0	153	186	404
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0

-Old model coordinates

	A	B	C	D	E
1	2	98	368	104	283
2	0	100	366	105	0
3	1	100	366	106	295
4	2	100	366	106	279
5	3	102	369	105	286
6	1	100	369	105	286
7	1	101	369	104	284
8	6	101	370	103	282
9	9	99	370	101	273

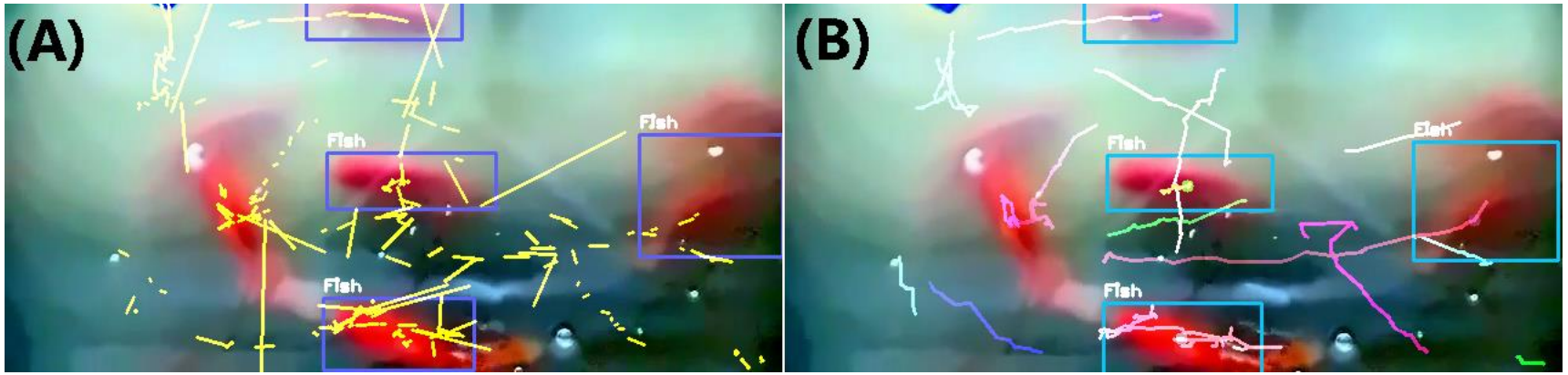
-New model coordinates

EXPERIMENTS 3/3: OBJECTIVE

- Compare between the performance of two methods that are used to draw fish trajectories and track their movements.
- Combination of YOLO and optical flow previously compared with the trajectories and tracking method combination with YOLO used in our system.

EXPERIMENTS 3/3: RESULTS

- The two methods tracked all fish detected by YOLO due to the combination done with it.
- The trajectories drawn using the tracking method and yolo gives better results as it draws each line without scattering and tracks every detected fish.
- Reduced overhead done by optical flow



RELATED WORK: REAL-TIME ABNORMAL EVENT DETECTION

- The aim is to develop an unsupervised method to detect anomal events in crowded scenes.

- They used:
  1. Spatio-temporal descriptor (STACOG)
  2. K-medoids clustering algorithm

- the proposed method processing time is faster than the best competing method by 26%.

Their system demo

Nady, Ahmed & Atia, Ayman & Abutabl, Amal. (2018). Real-time abnormal event detection in crowded scenes. Journal of Theoretical and Applied Information Technology. 96. 6064-6075.