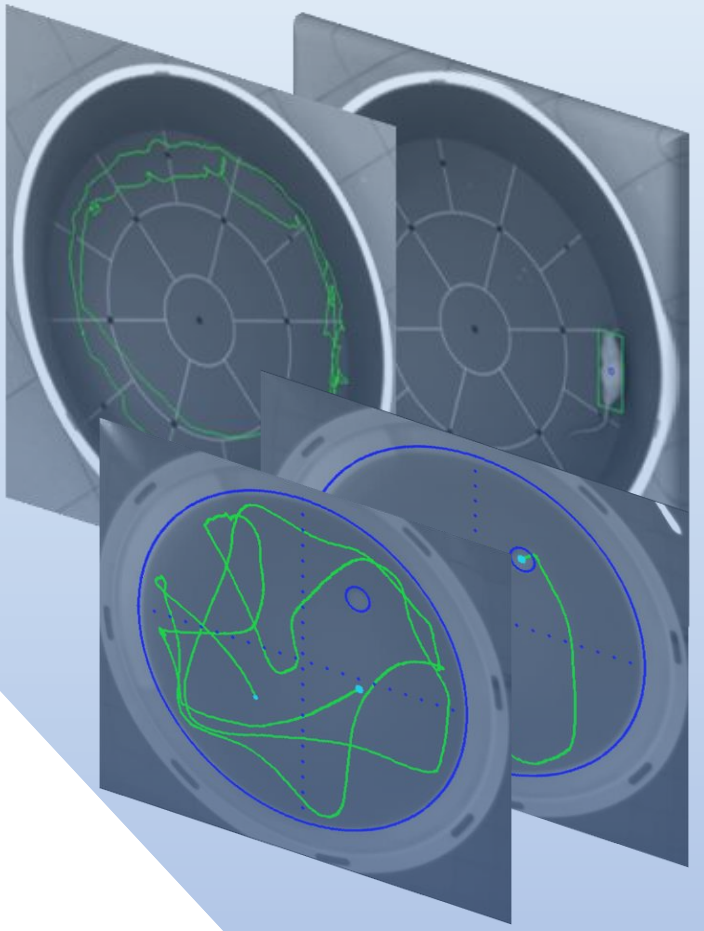
«Morris Waret Maze» and «Open field»: Development of web-services prototypes for automation of the videodata analysis for the behavioral tests



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BIOHLIT group

Meshcheryakov Laboratory of Information Technologies, JINR

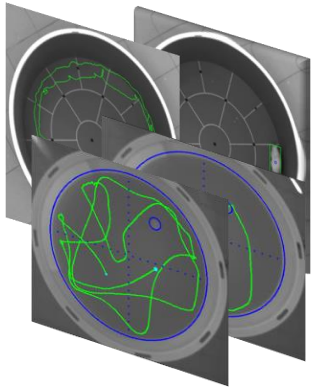
Anikina A.I., Bezhanyan T. Zh., Butenko Yu.A., Zuev M.I., Nechaevskiy A.V., Podgainy D.V., Streltsova O.I.

Laboratory of Radiation Biology, JINR

Boreyko A.V., Zadnepryanec M.G., Kolesnikova I.A., Lalkovicova M.G., Lyakhova K.N. Severiukhin Yu.S., Utina D.M., Chausov V.N., Chramko T.S.

In collaboration with University of Belgrade

Coordinator: Dr Marko Ćosić



In collaboration with Germany:

Streltsov Alexei I., Gromov E.

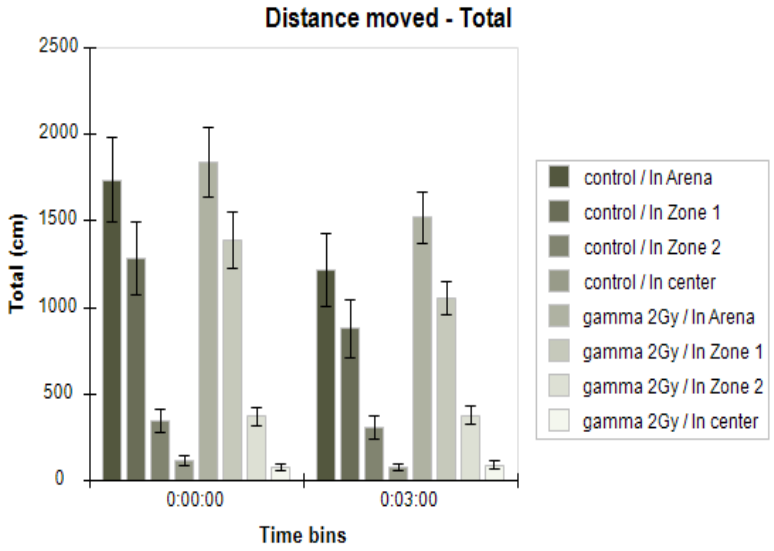
In collaboration with

Stadnik A.V.

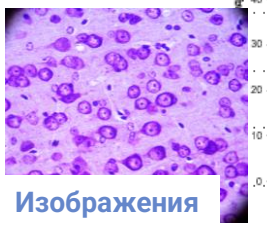
Complex analysis of the obtained results at all stages of the study

Stage 1

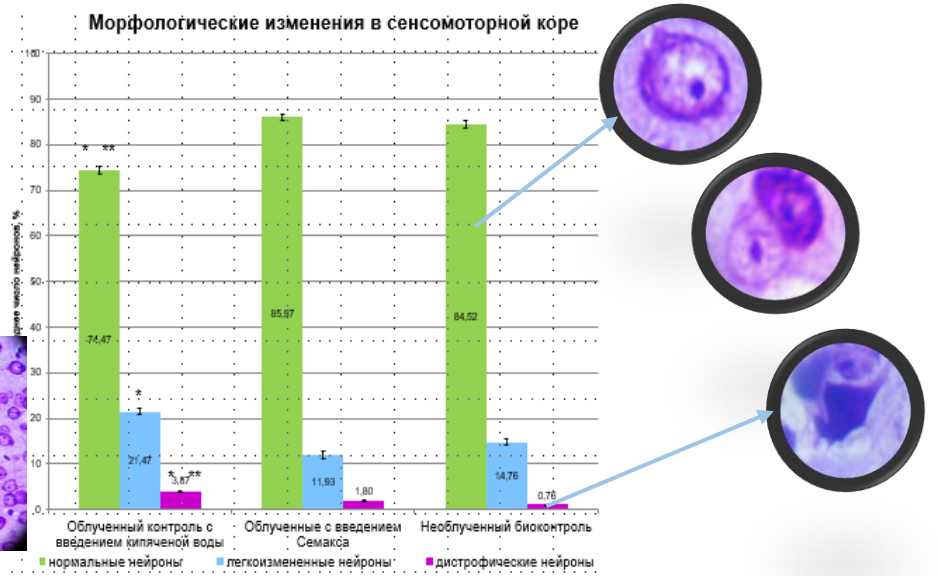
Видео



Stage 2



Изображения



The IS is necessary for:

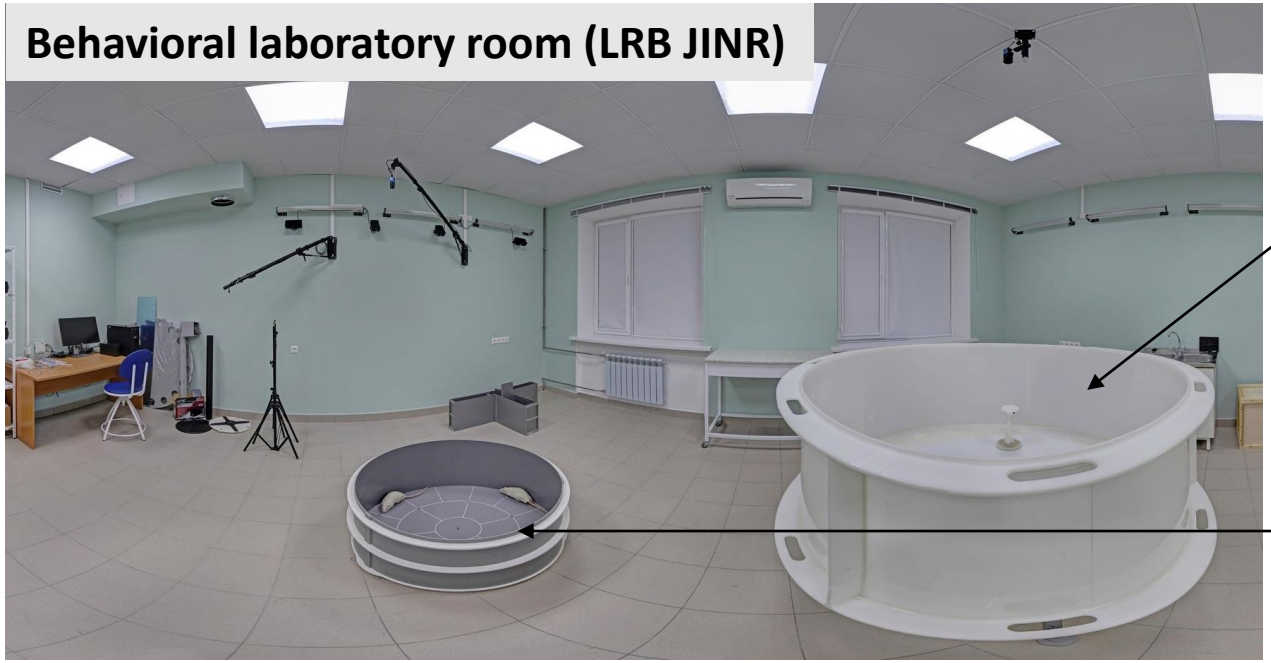
- **Storing** the entire array of experimental data (photo and video materials, pdf, excel, doc files with information about the experiment) minimizing the risk of information losing.
- **Convenient access** to all members of the research group and the ability to carry out both step-by-step and complex data analysis in a single information space.
- **Reducing the time** spent on data processing, increasing the speed of obtaining high-quality results and reducing the subjectivity of the approach to processing experimental data.

Analysis of b behavioral reactions of laboratory animals

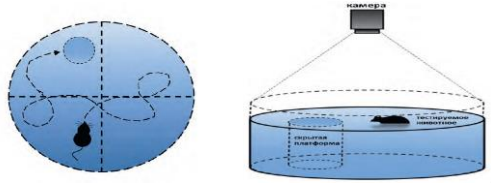
We implement the analysis of behaviour reactions of laboratory animals in order to understand the influence of ionizing radiations and the possible impact on the pharmacological medications.

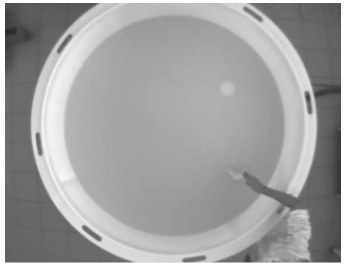
From the viewpoint of data analysis, it is necessary to store and to analyse the **videodata** which reflect the behaviour reactions of laboratory animals during the experiment where the specialized stands have been used.

Behavioral laboratory room (LRB JINR)

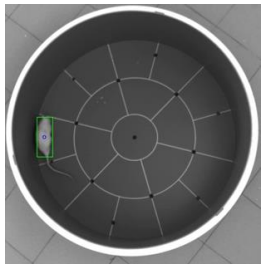


Test system “Water Maze”



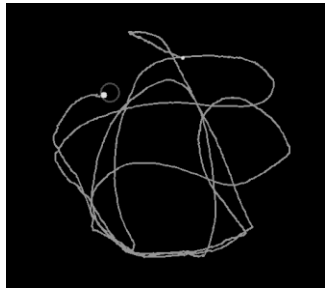


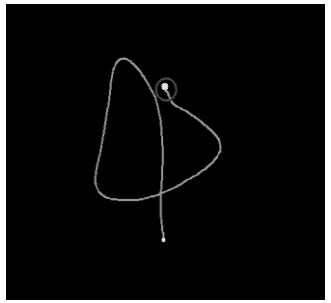
Test system “Open Field”

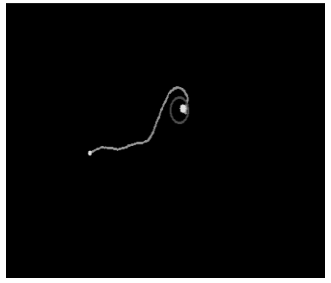


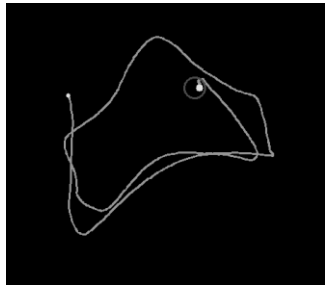
Morris Water Maze

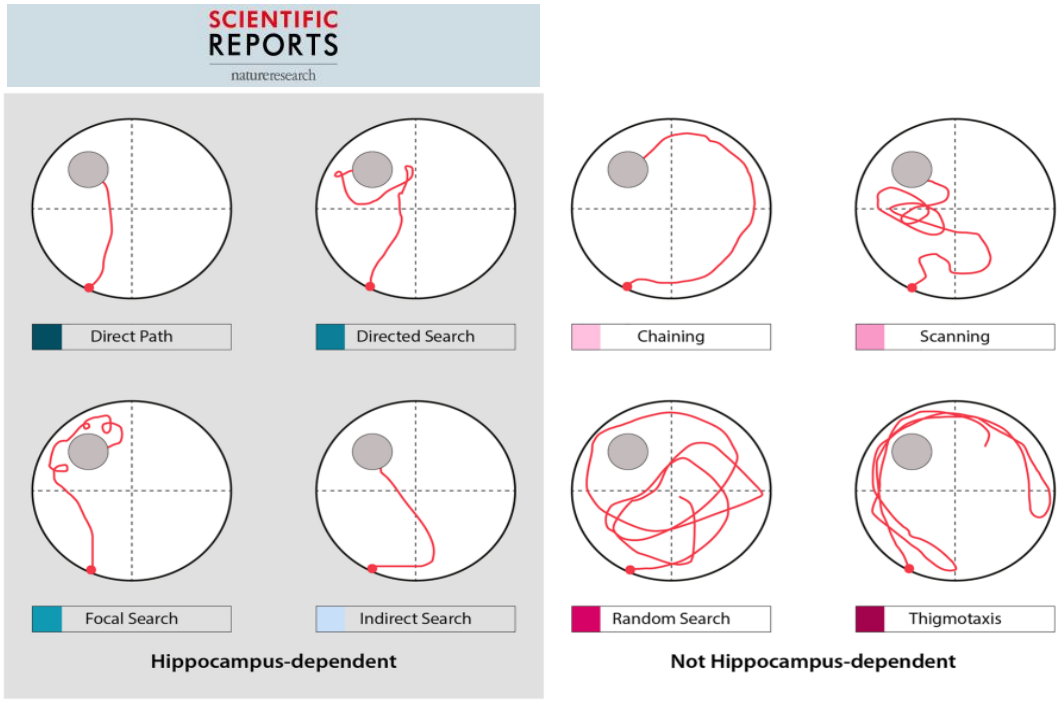
Trajectory classification

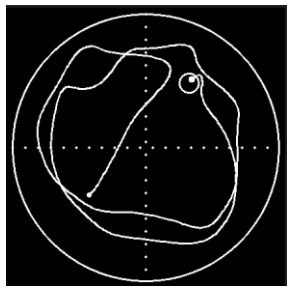


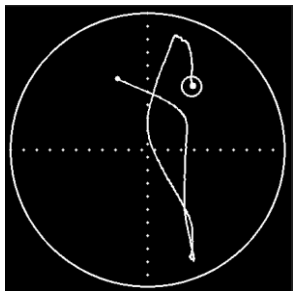


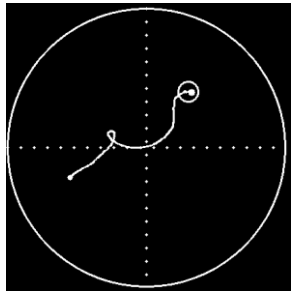


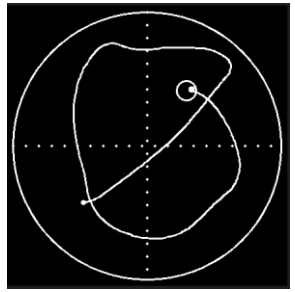




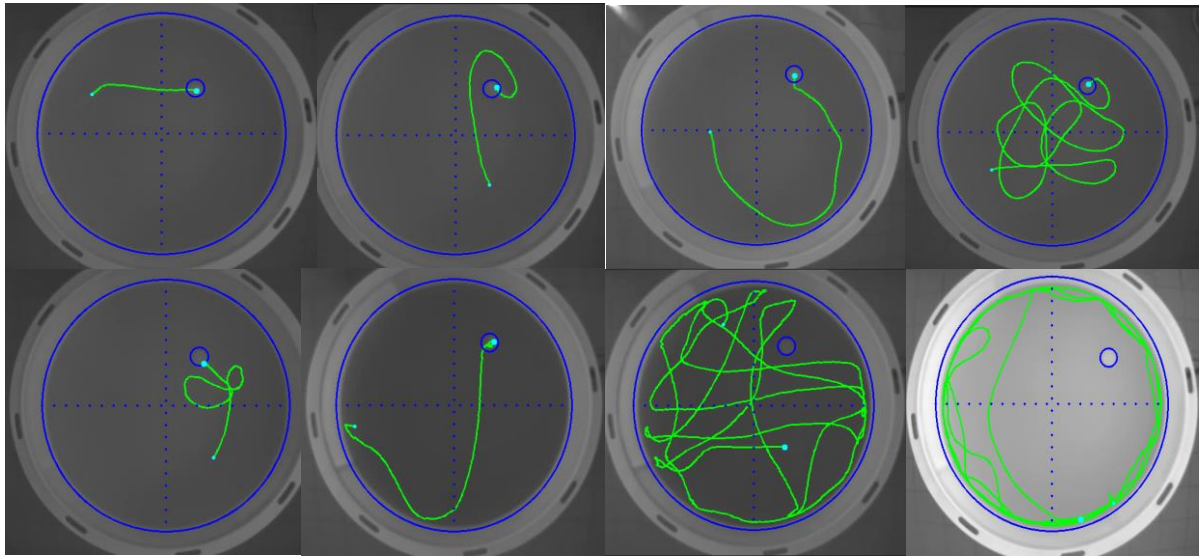






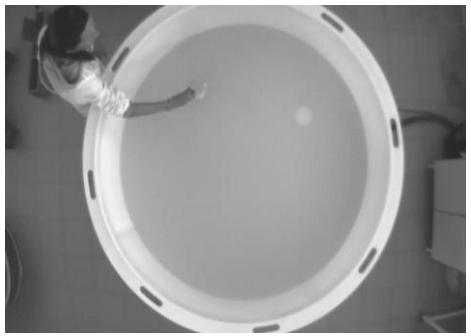
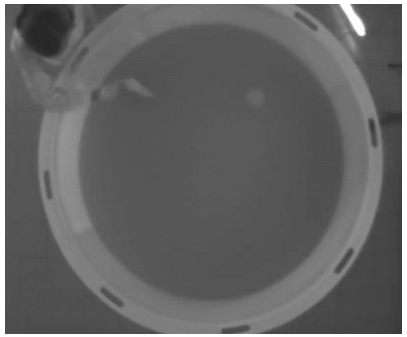
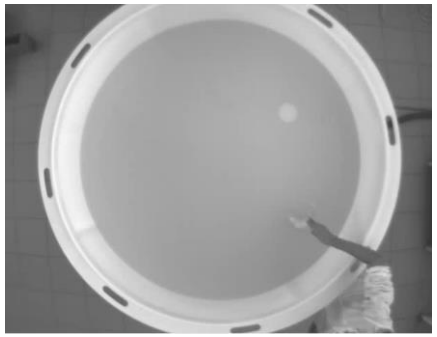
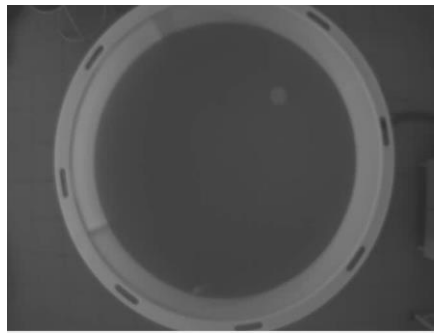
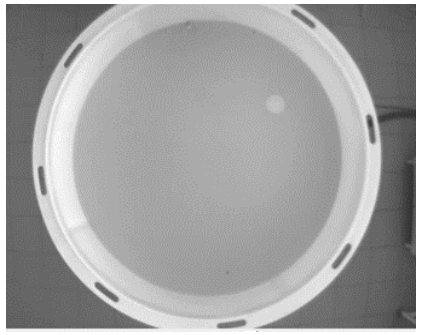


Search strategy analysis of Tg4-42 Alzheimer Mice in the Morris Water Maze reveals early spatial navigation deficits Nadine Curdt, Franziska Schmitt, Caroline Bouter at all Springer Nature Logo March 2022 Scientific Reports 12(1):5451 DOI: 10.1038/s41598-022-09270-1 LicenseCC BY 4.0



Main dificulties

1. Different conditions for each video/experiment (water reflection, lighting, movable background, size of lab. animal).
2. Determination of the beginning of motion of a laboratory animal.
3. Problem with detecting moving object and ets…

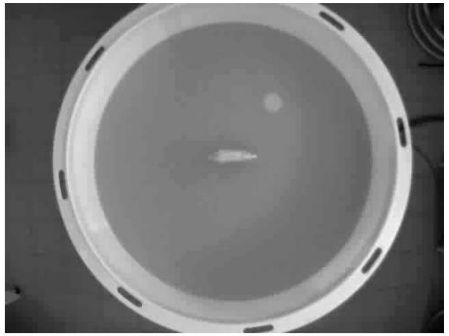






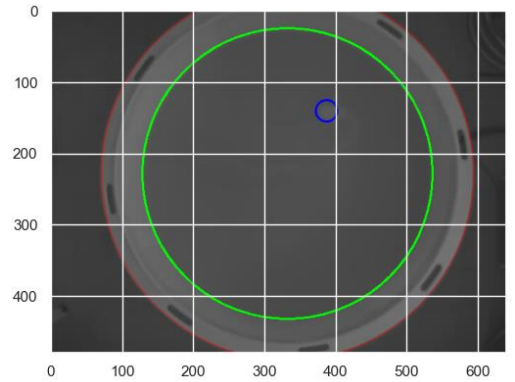
Object tracking. The approach is based on computer vision algorithms

Algorithm development for trajectory construction (creating training sample)

Algorithm

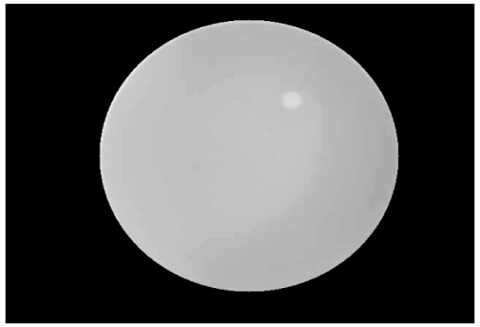
- Median image construction
- Filtering
- Hough transformation

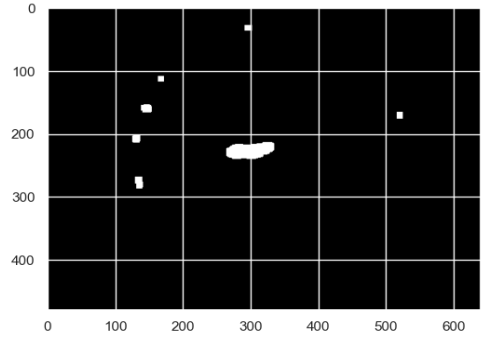


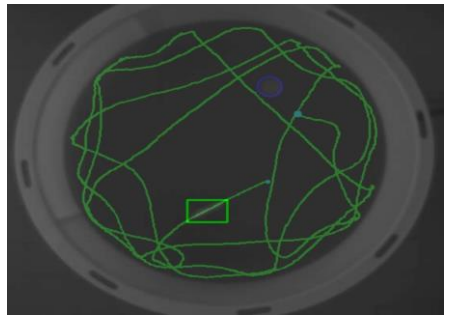


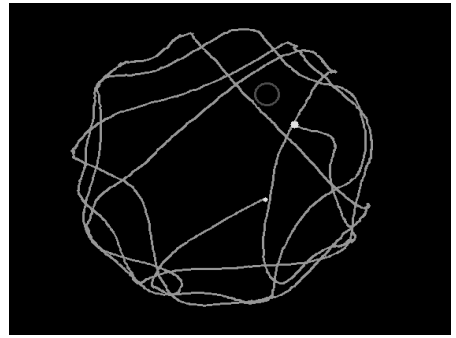
Setup field marking

- Finding external boundary of the pool
- Finding internal boundary (ROI)
- Finding platform location



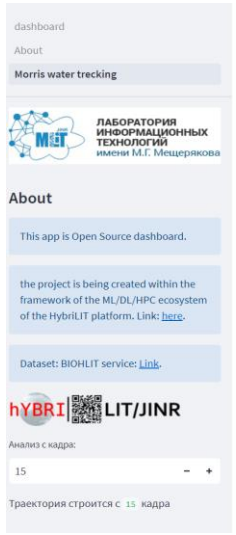


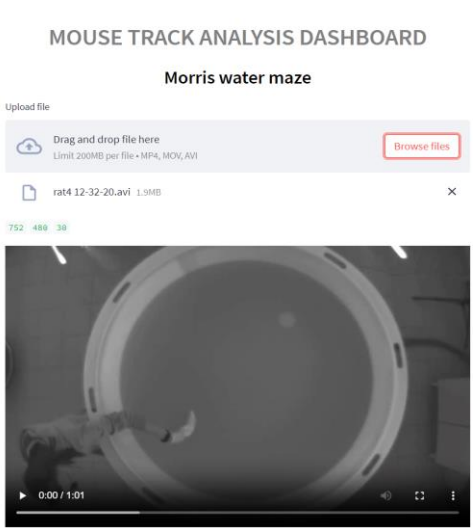


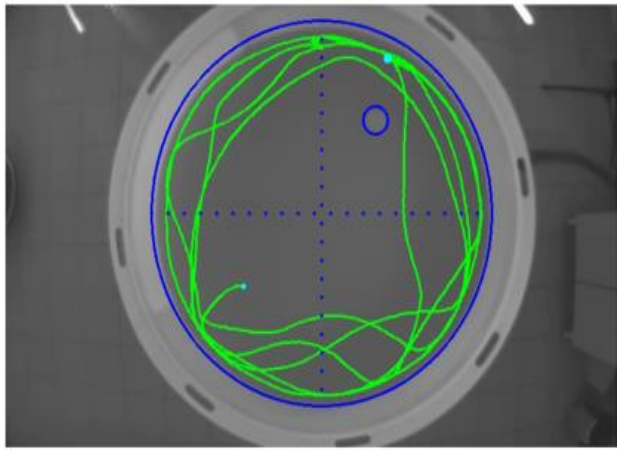


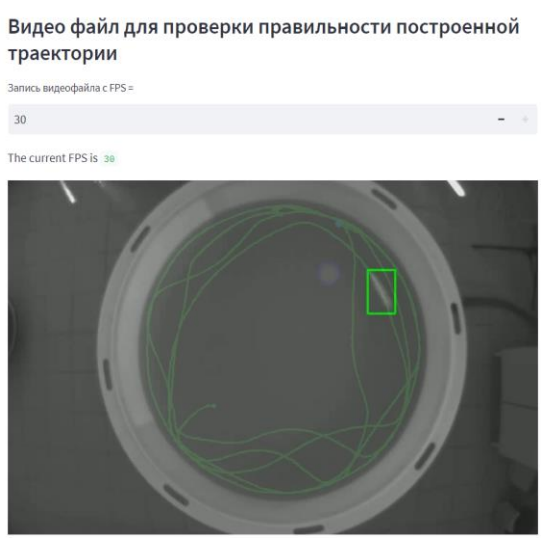
Tracking (modification):
Addition of local tracking (after detection of object on first frames, further detected in limited area)

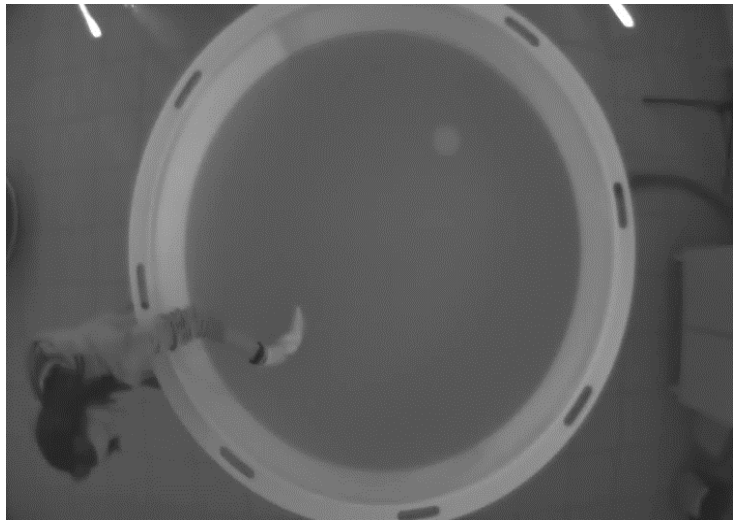
Prototype web service for dataset of «Morris Water Maze» behavioral test

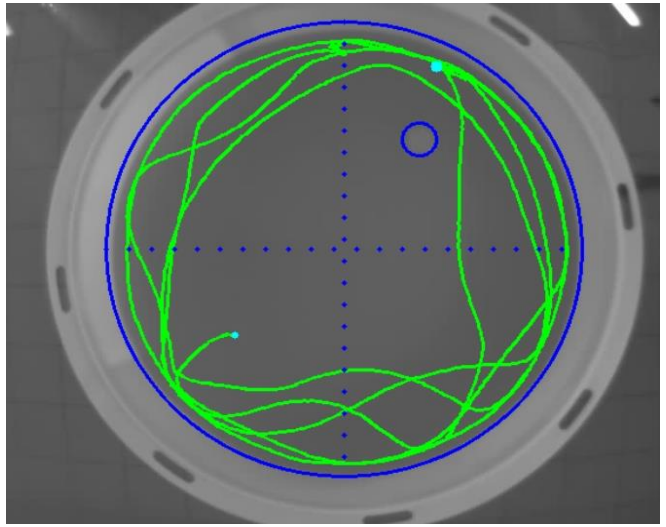


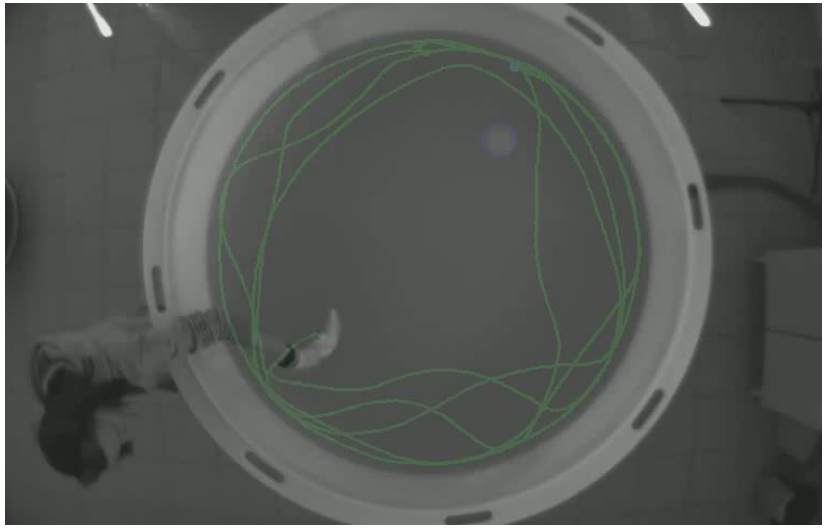












Main dificulties

1. Each video has a different illumination, different formats and resolutions.
2. Insufficient data to solve the task.

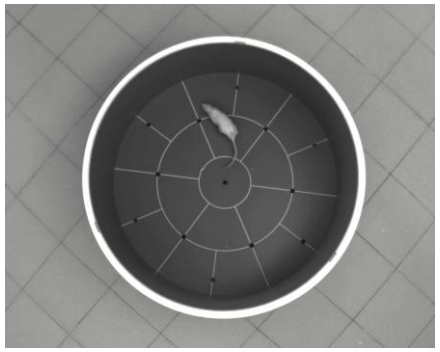
Input data Total number: 36

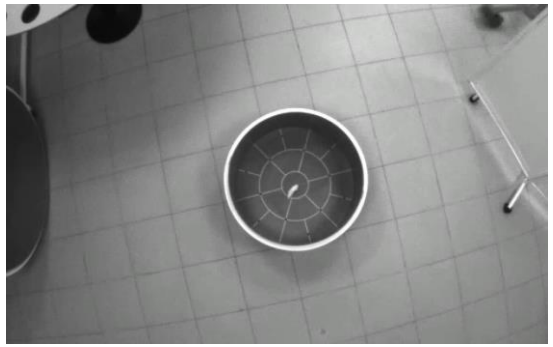
- (1024, 1280, 3)
- (768, 1024, 3)
- (1080, 1920, 3)
- (960, 1280, 3)

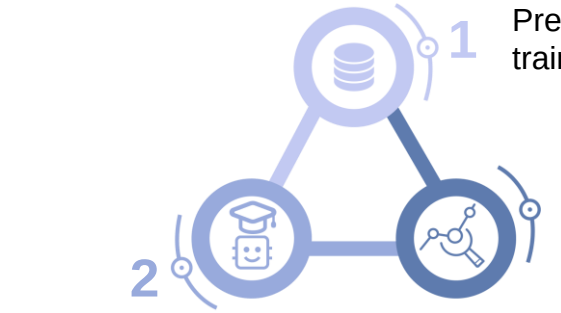
Goal

Development of an algorithm based on a neural network approach for marking the arena "Open Field". Namely, finding circles (radii) and sectors in the image that are necessary for the following:

- counting of the passed sectors,
- fixing the stay of the laboratory animal in the center, in the inner or outer zone.







The method of characteristic points

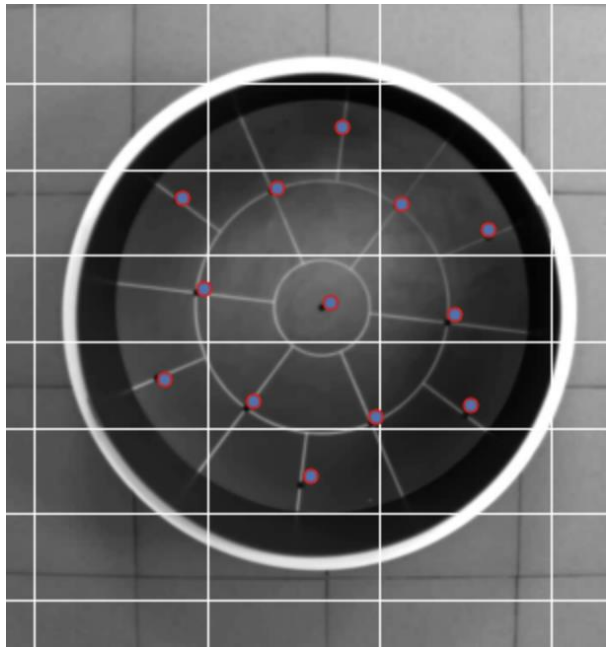
One of the approaches was chosen due to the idea of the characteristic points method for recognizing car numbers.

Resource:

Input parameters: an image with an arena;

Output parameters: coordinates of key points for which holes are selected. They are on every image

To train a convolutional neural network, a marked-up data set with the coordinates of characteristic points arranged in the same order has been prepared

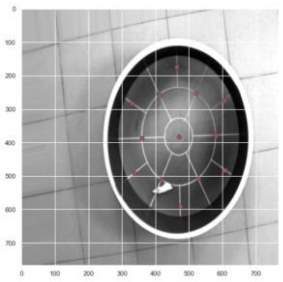


+ csv

BIOHLIT

Dataset Expansion

Convolutional Neural network architecture



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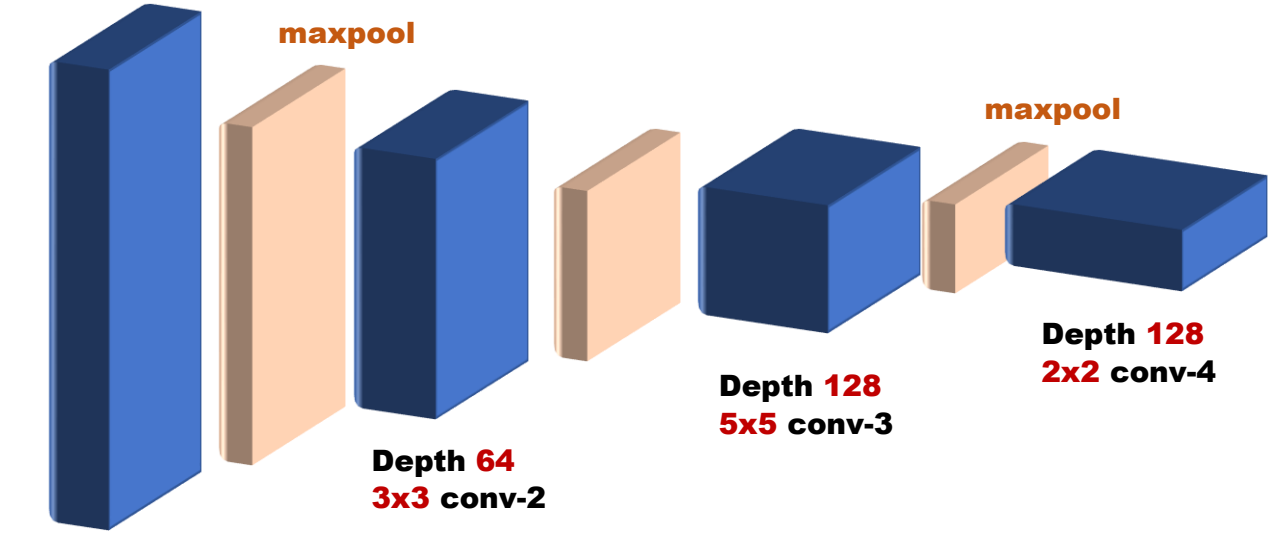
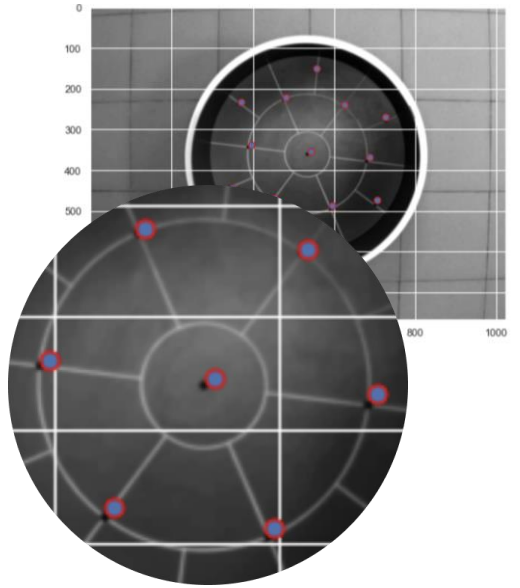
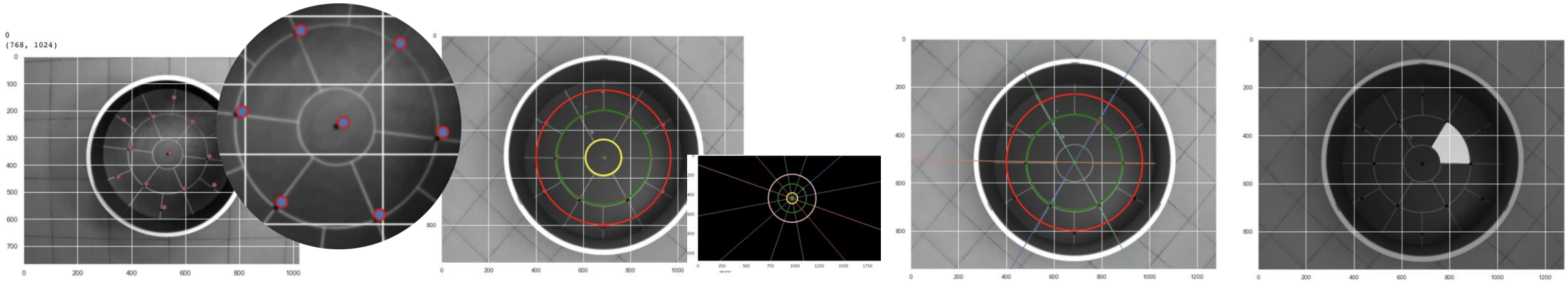
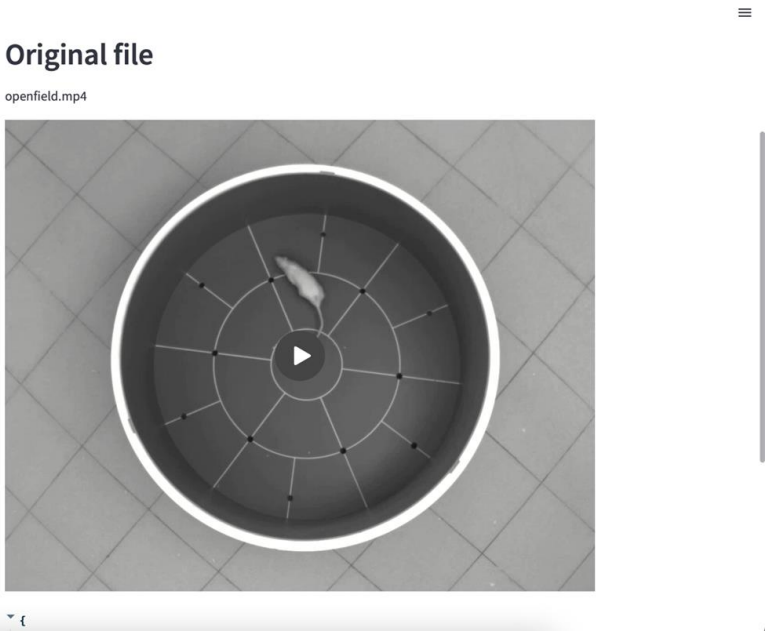
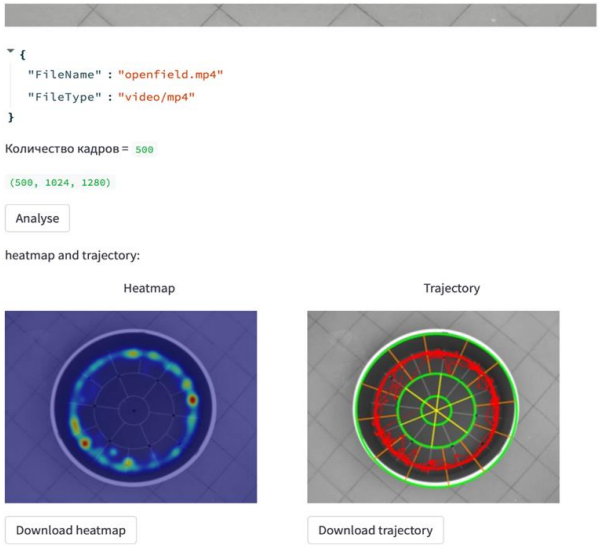




Analysis of behavioral responses of laboratory animals (calculation of sectors crossing and web service prototype)





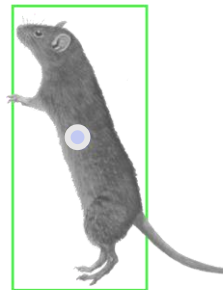


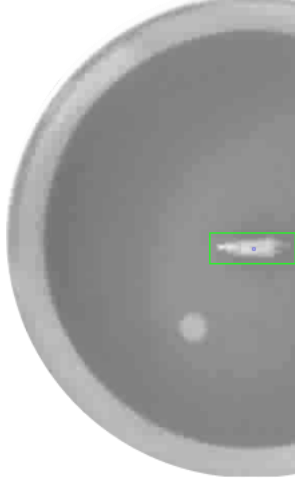
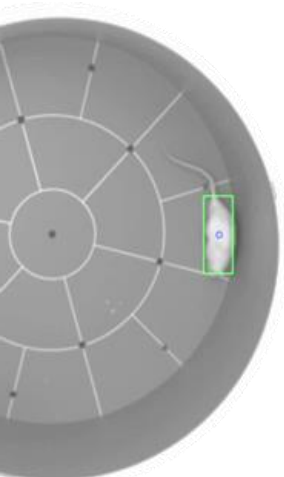
«Morris Water Maze»

- We develop and verify the tracking algorithm for more than 450 experimental data.
- The sample including more than 450 trajectories has been made.
- We develop the proto-type of web-service to form the dataset of trajectory classifications.

«Open field»

- Based on the neural network approach, the algorithm for marking of Open field device has been developed.
- The circles of arena together with the corresponding sectors have been indicated for the counting of passed sectors.
- The proto-type of web-service has been developed. It allows to create the heat map that fixs the existance of laboratory animals into the different zones of arena. Also it gives the possibility to count the corresponding sectors.





Thank you for your attention!