BIOHLIT

Application of a neural network approach to the task of the arena marking for the behavioral test «Open Field»

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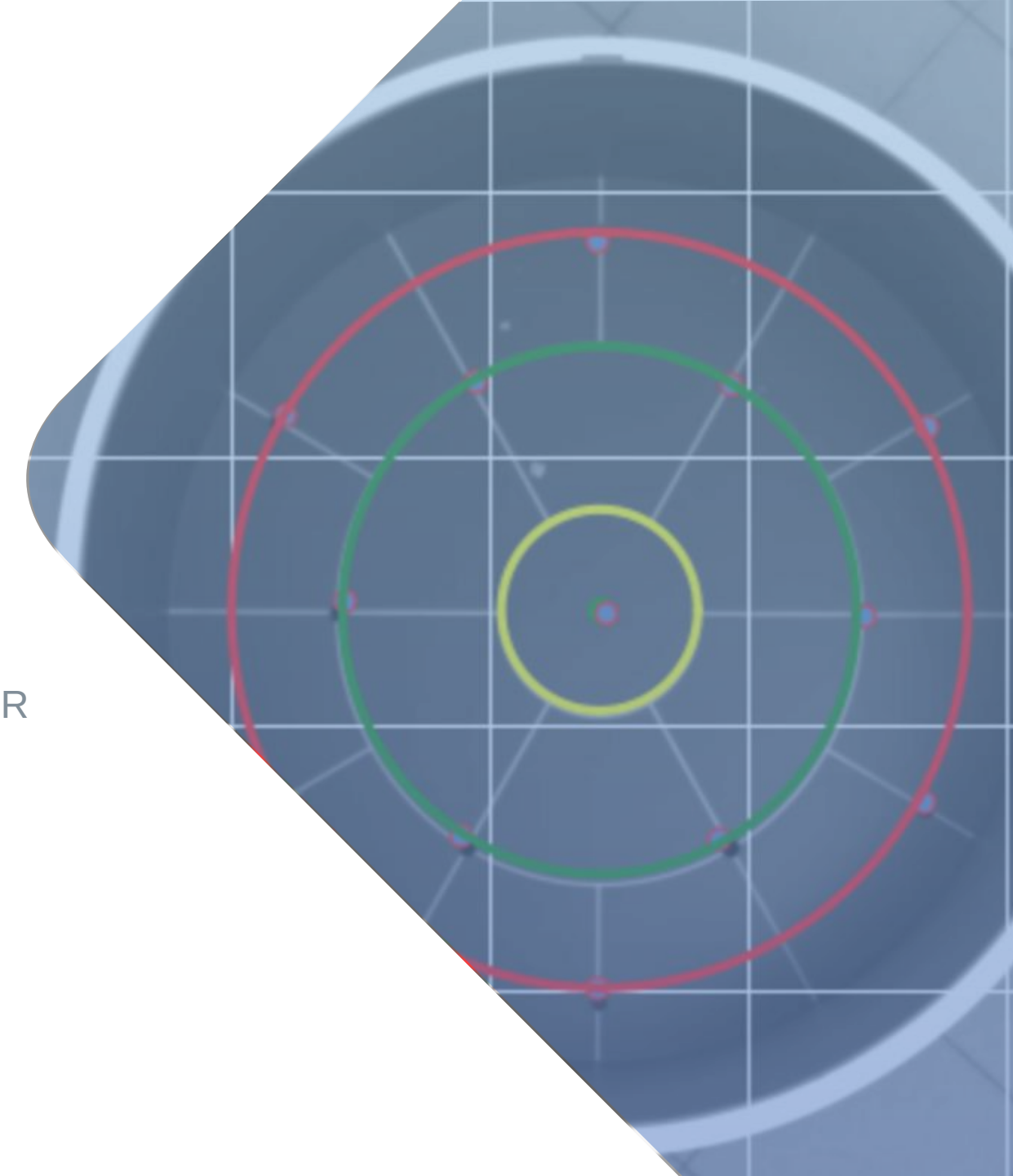

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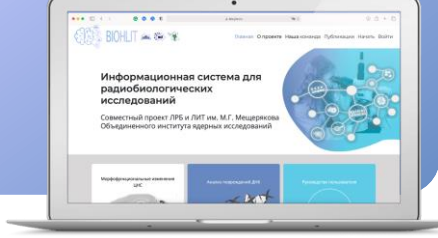


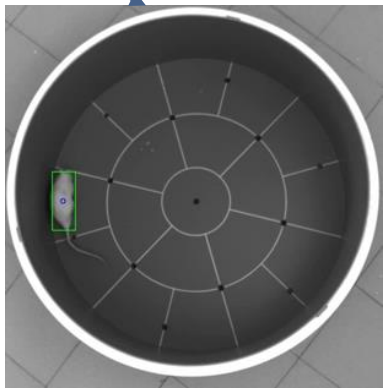
The urgency

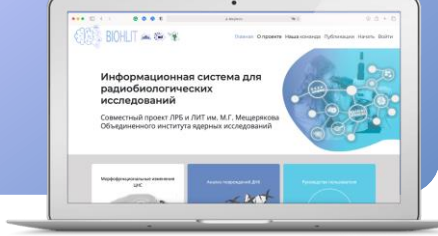
The module of the information system is necessary to solve the following tasks:

1. Improving the detection of rodents in test installations;
2. Automation of recognition of individual behavioral acts (grooming, racks, etc.) and their registration;
3. Storage of video material of the conducted experiments.

- The behavioral tests:
  1. **Open Field**
  2. T-maze
  3. Morris water maze

Behavioral Laboratory Room (JINR LRB)

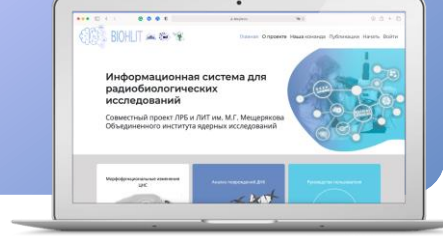




Arena «Open Field»

The considered behavioral test has a form of round arena with the chequered-marked sectors and holes. The observation procedure on the laboratory animals takes 3-6 minutes.

The “Open Field” test-system allows to register the general activity of animals. To this aim, we fix the quantity of passed sectors together with the number of intersections of the marked center. Also, we check how many holes, standings upright with/without supports, standings still and motions on one place the animals did.

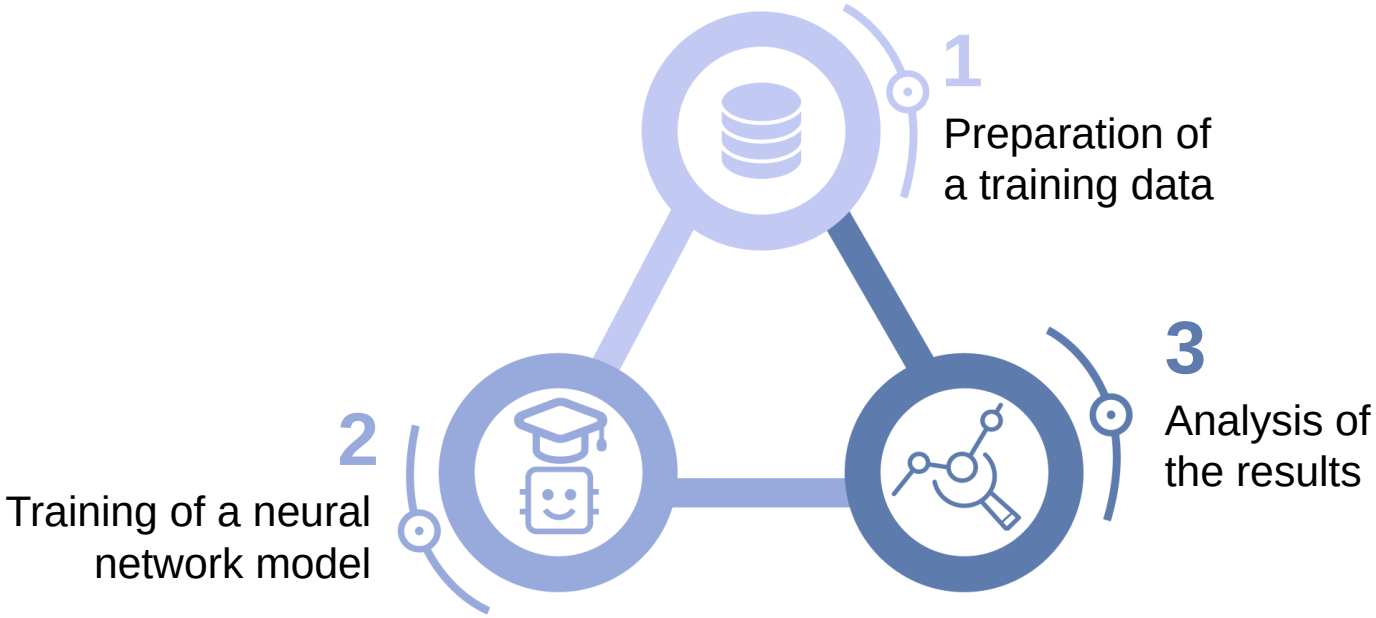


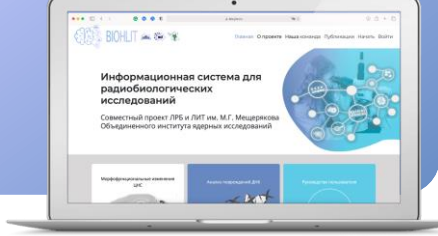
Goal

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.

Tasks

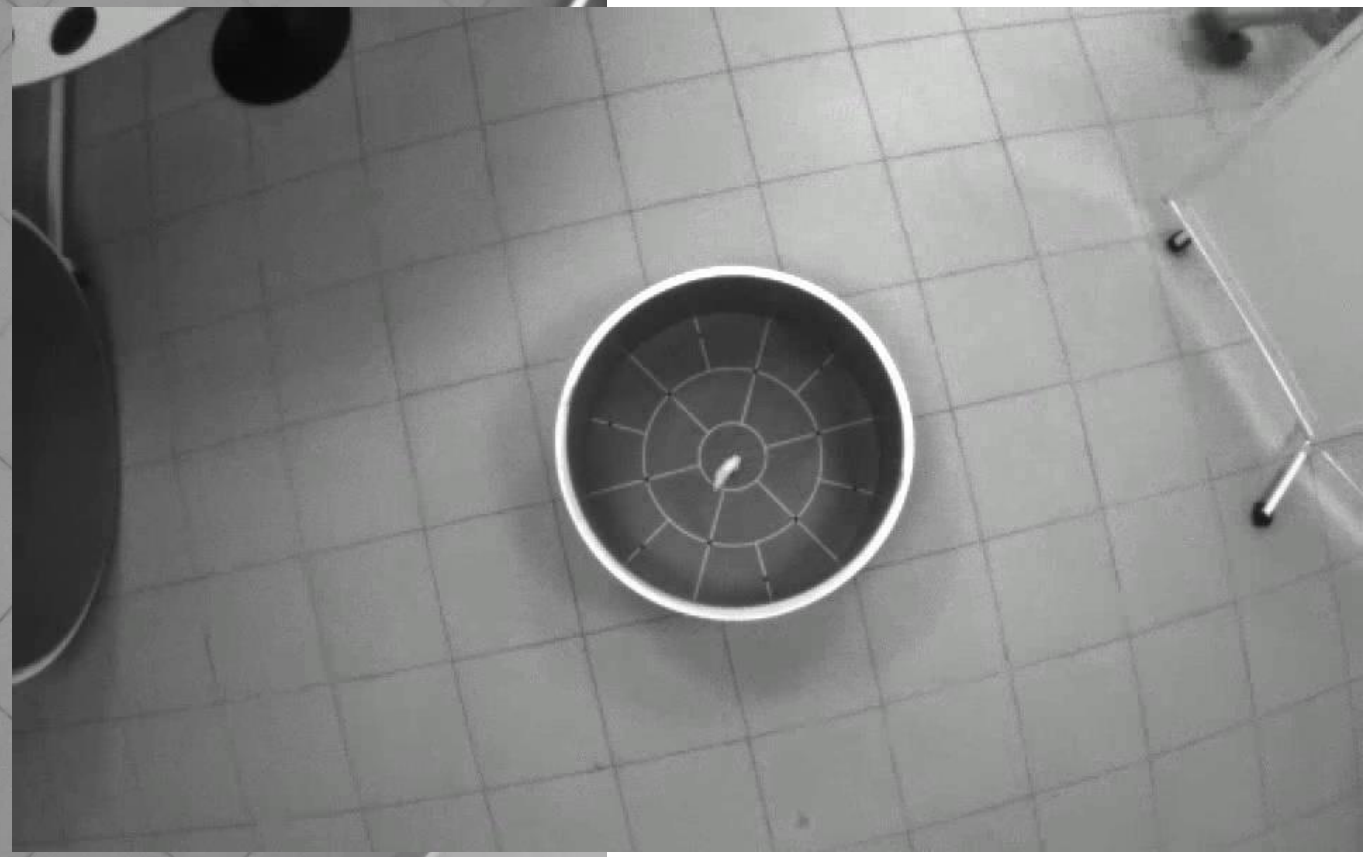




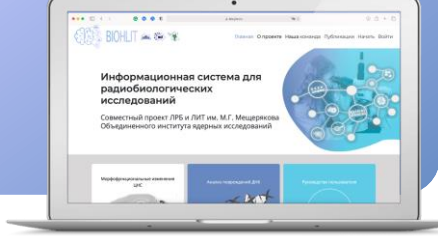
Input data

Videos of different formats and resolutions.
Total number: 36

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



Problem 1. *Classical computer vision algorithms are time-consuming.*
Problem 2. *Each video has a different illumination.*



The method of characteristic points

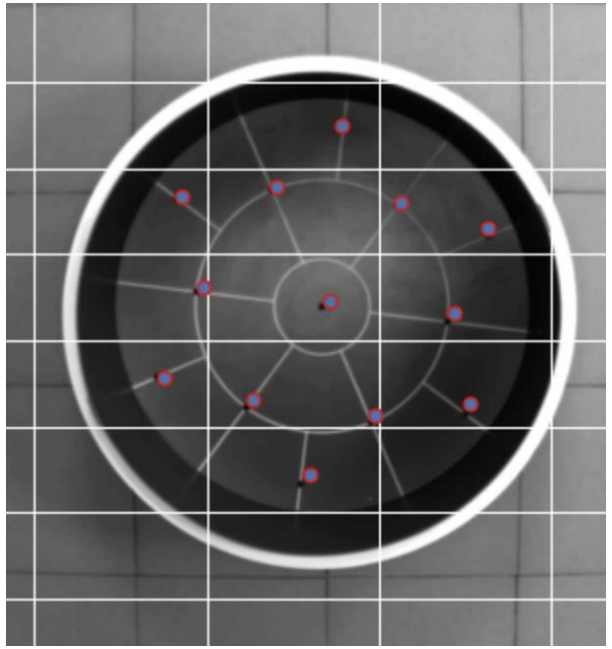
One of the approaches was chosen due to the idea of the characteristic points method for recognizing car numbers.

Resource:

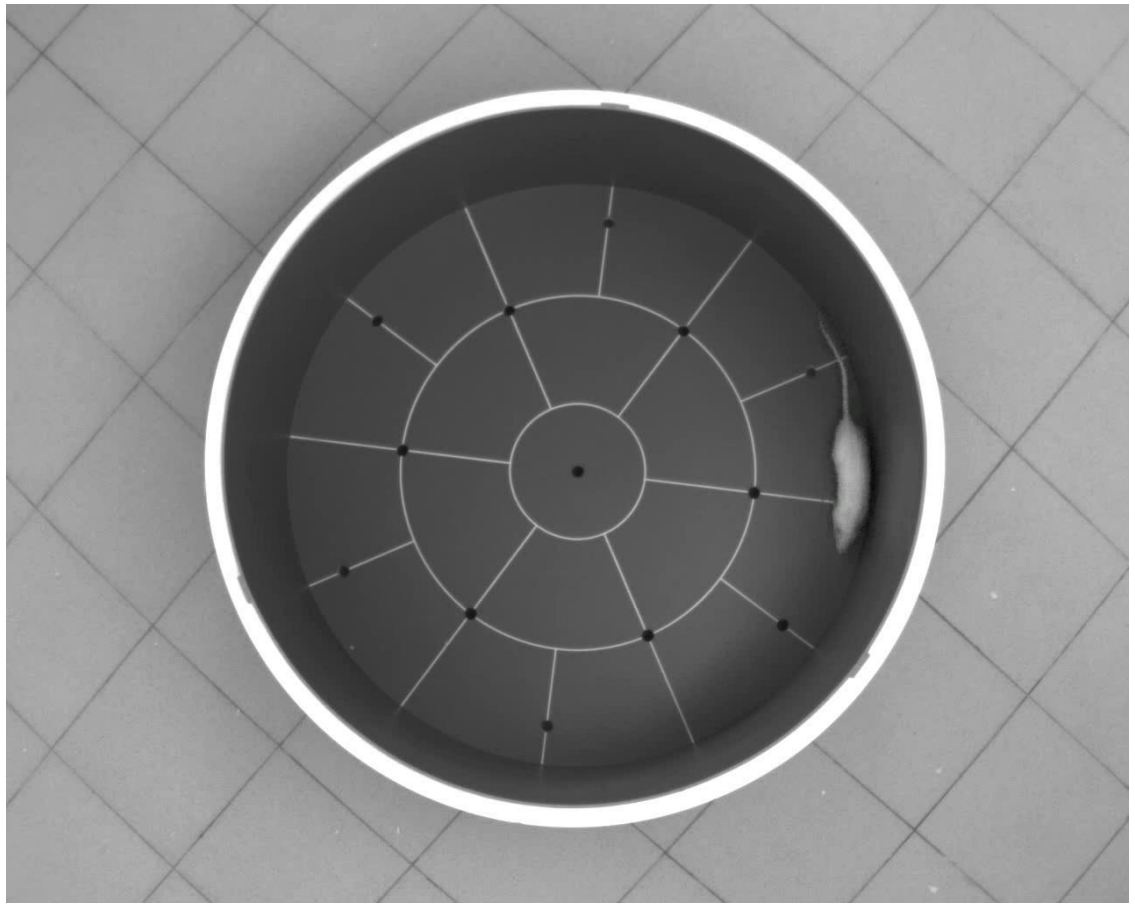
Input parameters: an image with an arena;

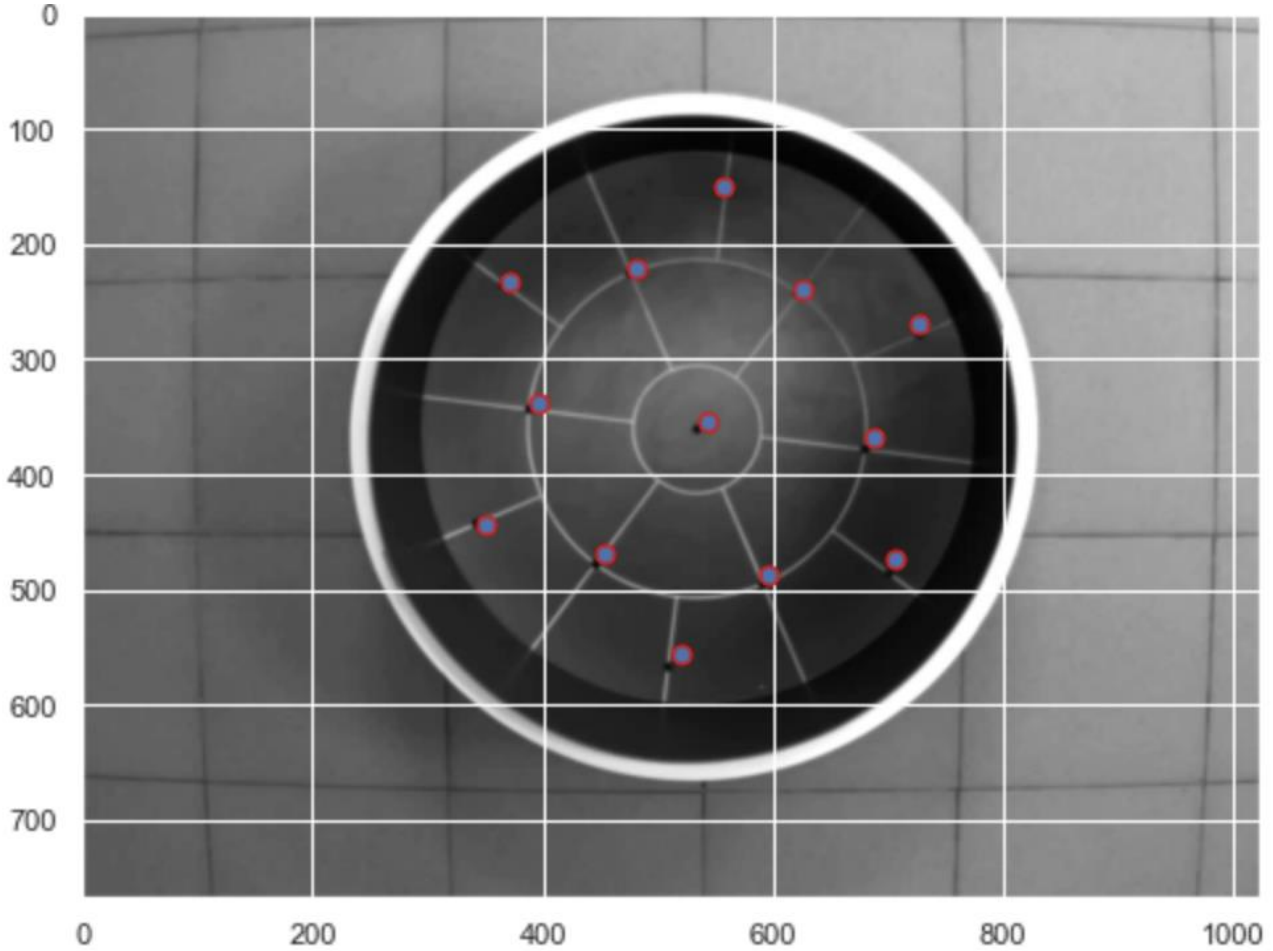
Output parameters: coordinates of key points for which holes are selected. They are on every image

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

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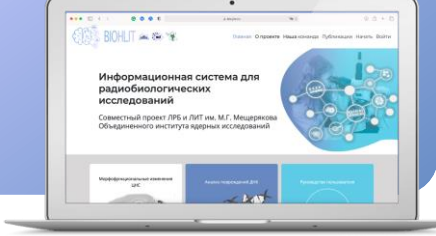
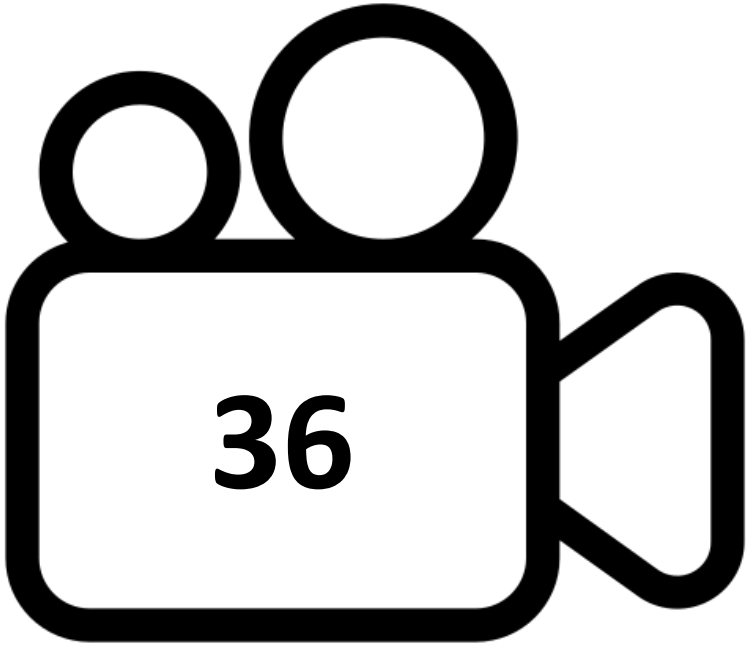
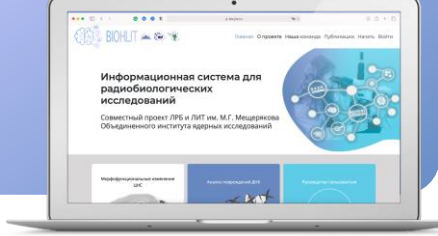




The first frame

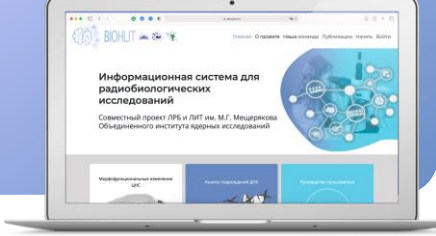
***Problem 3**. Insufficient data to solve the task*



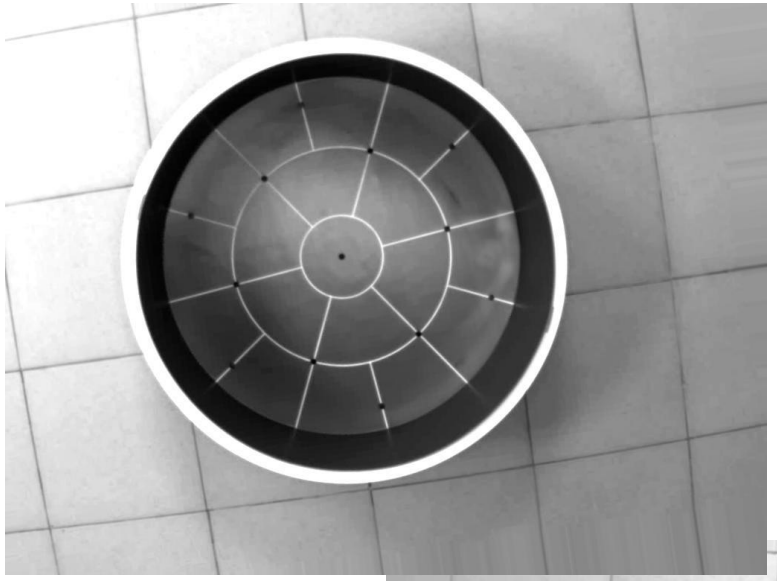
ImageDataGenerator (keras)

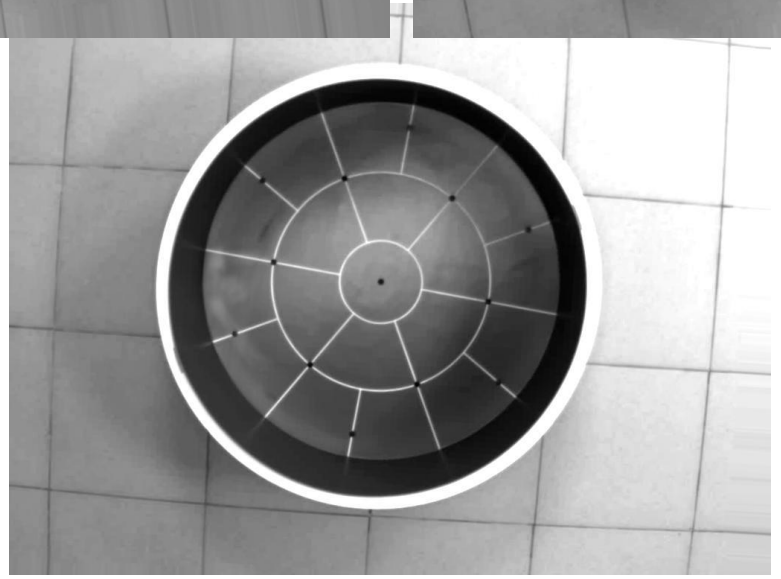
In [66]:

```
datagen = ImageDataGenerator(
    rotation_range=10,
    width_shift_range=0.1,
    height_shift_range=0.1,
    shear_range=0.2,
#     zoom_range=0.2,
    horizontal_flip=True,
    brightness_range=[1.5,1.5],
  #  rescale=1.1, # меняет форму!!!
  #  vertical_flip=True,
    fill_mode='nearest'
)
```

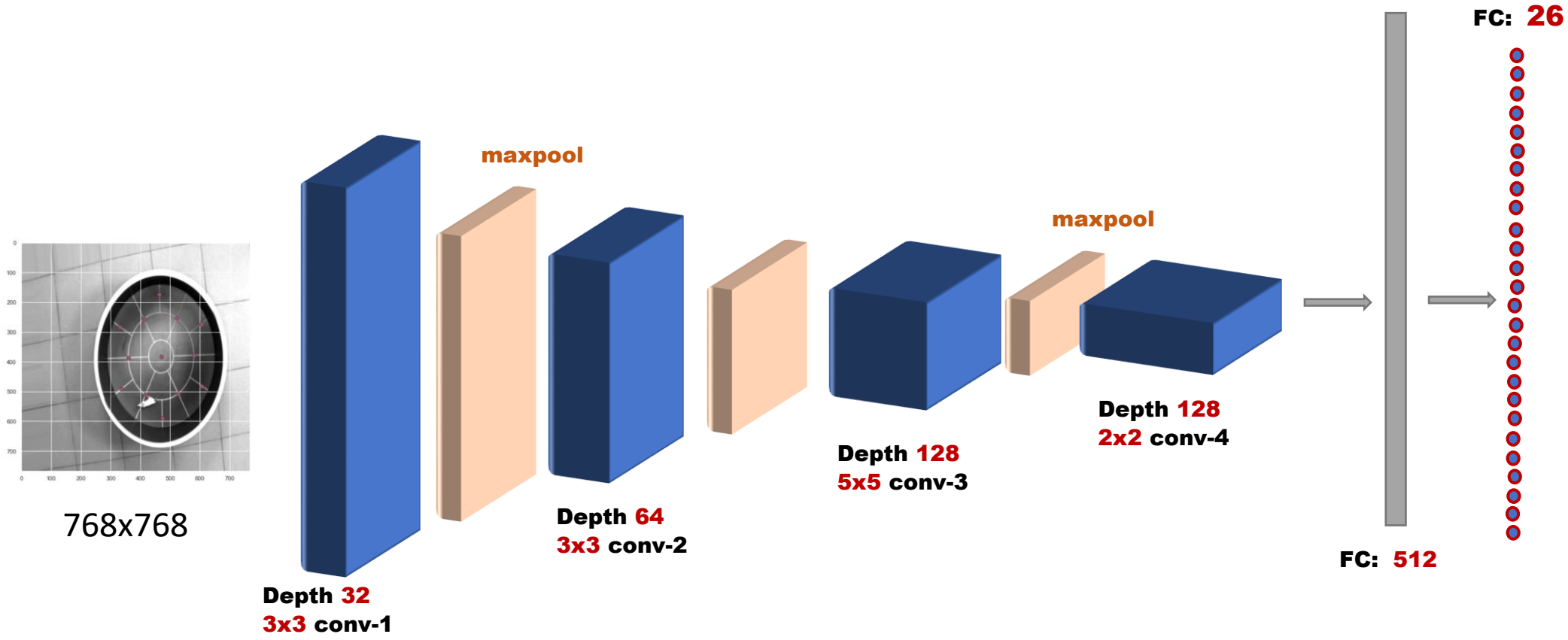


Dataset Expansion



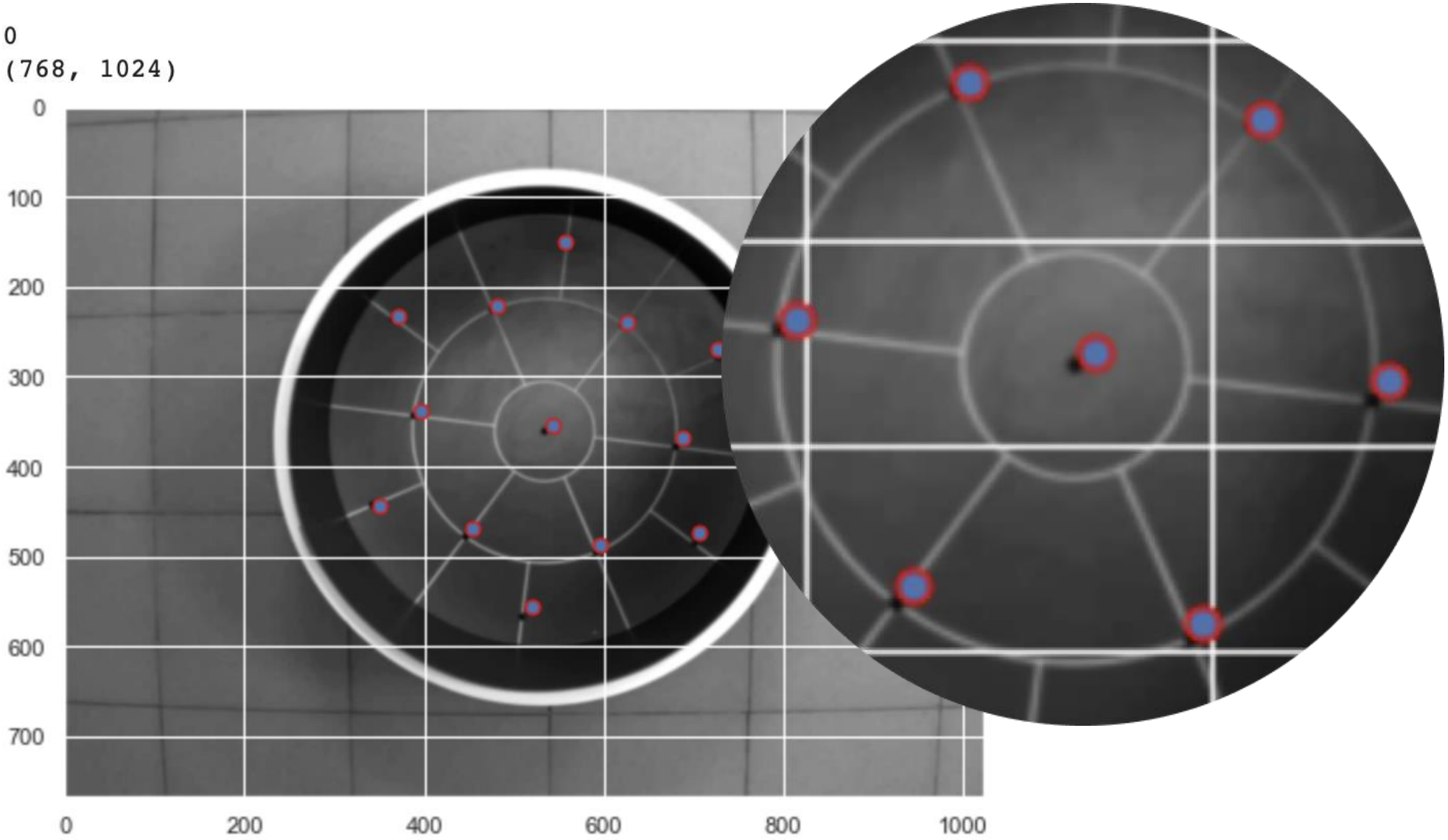




Convolutional Neural network architecture



The result of training a convolutional neural network

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 768, 768, 1)]     0

 conv2d (Conv2D)             (None, 383, 383, 32)      320

 max_pooling2d (MaxPooling2D  (None, 191, 191, 32)     0
 )

 conv2d_1 (Conv2D)           (None, 95, 95, 64)        18496

 max_pooling2d_1 (MaxPooling  (None, 47, 47, 64)       0
 2D)

 conv2d_2 (Conv2D)           (None, 22, 22, 128)       204928

 max_pooling2d_2 (MaxPooling  (None, 11, 11, 128)      0
 2D)

 conv2d_3 (Conv2D)           (None, 10, 10, 128)       65664

 max_pooling2d_3 (MaxPooling  (None, 5, 5, 128)        0
 2D)

 flatten (Flatten)           (None, 3200)              0

 dense (Dense)               (None, 512)               1638912

 dense_1 (Dense)             (None, 26)                13338

=================================================================
Total params: 1,941,658
Trainable params: 1,941,658
Non-trainable params: 0
```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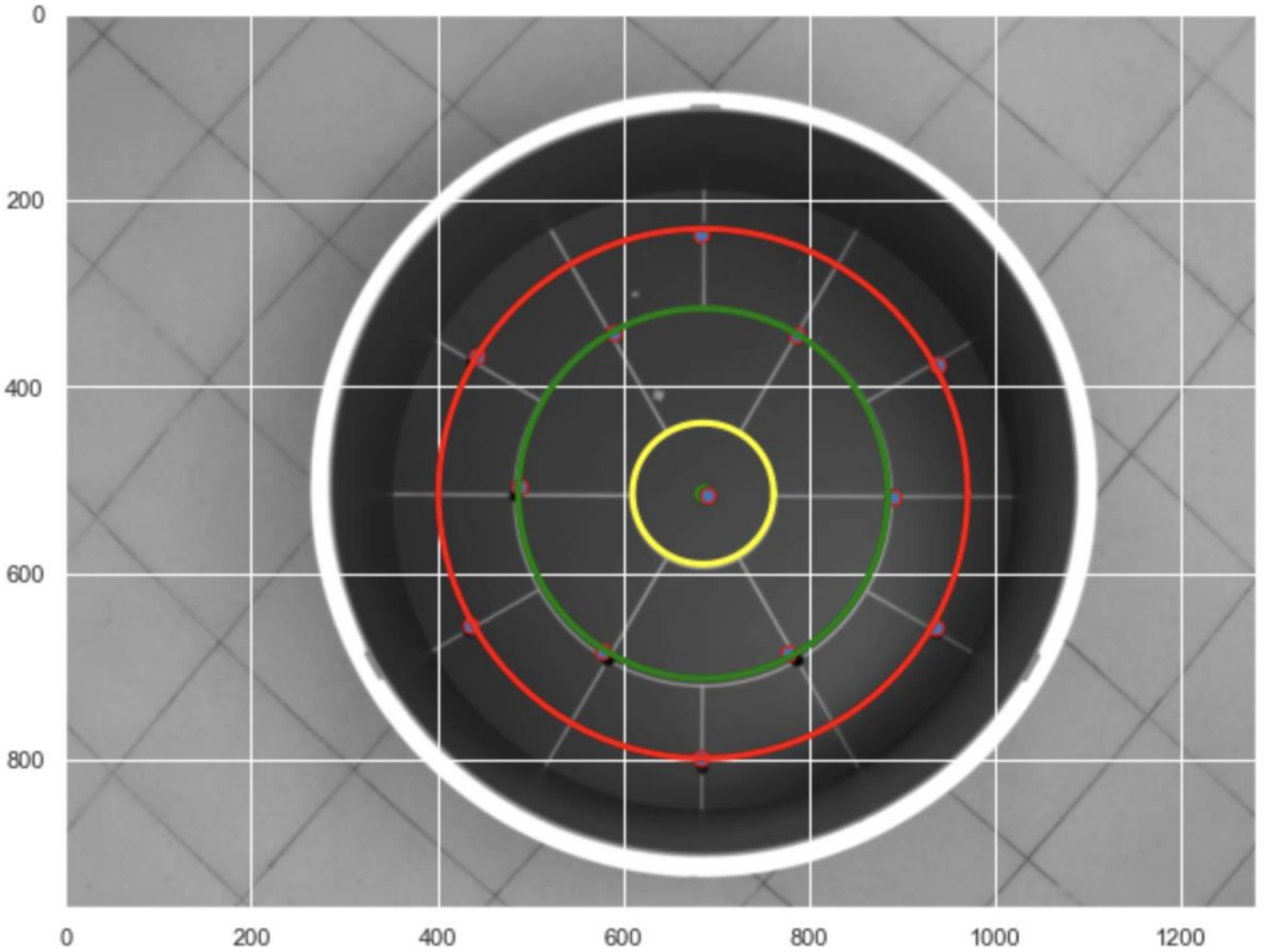
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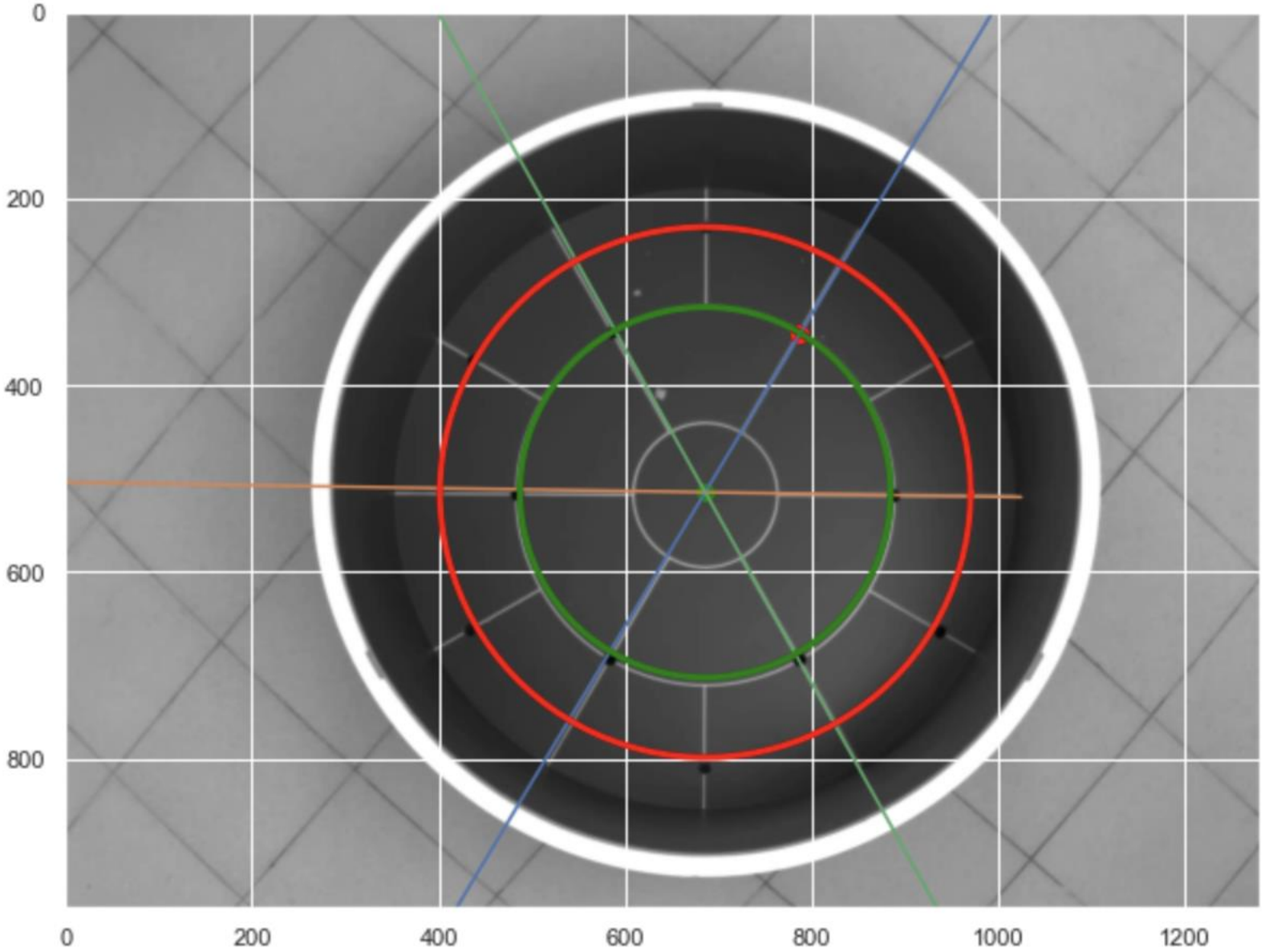
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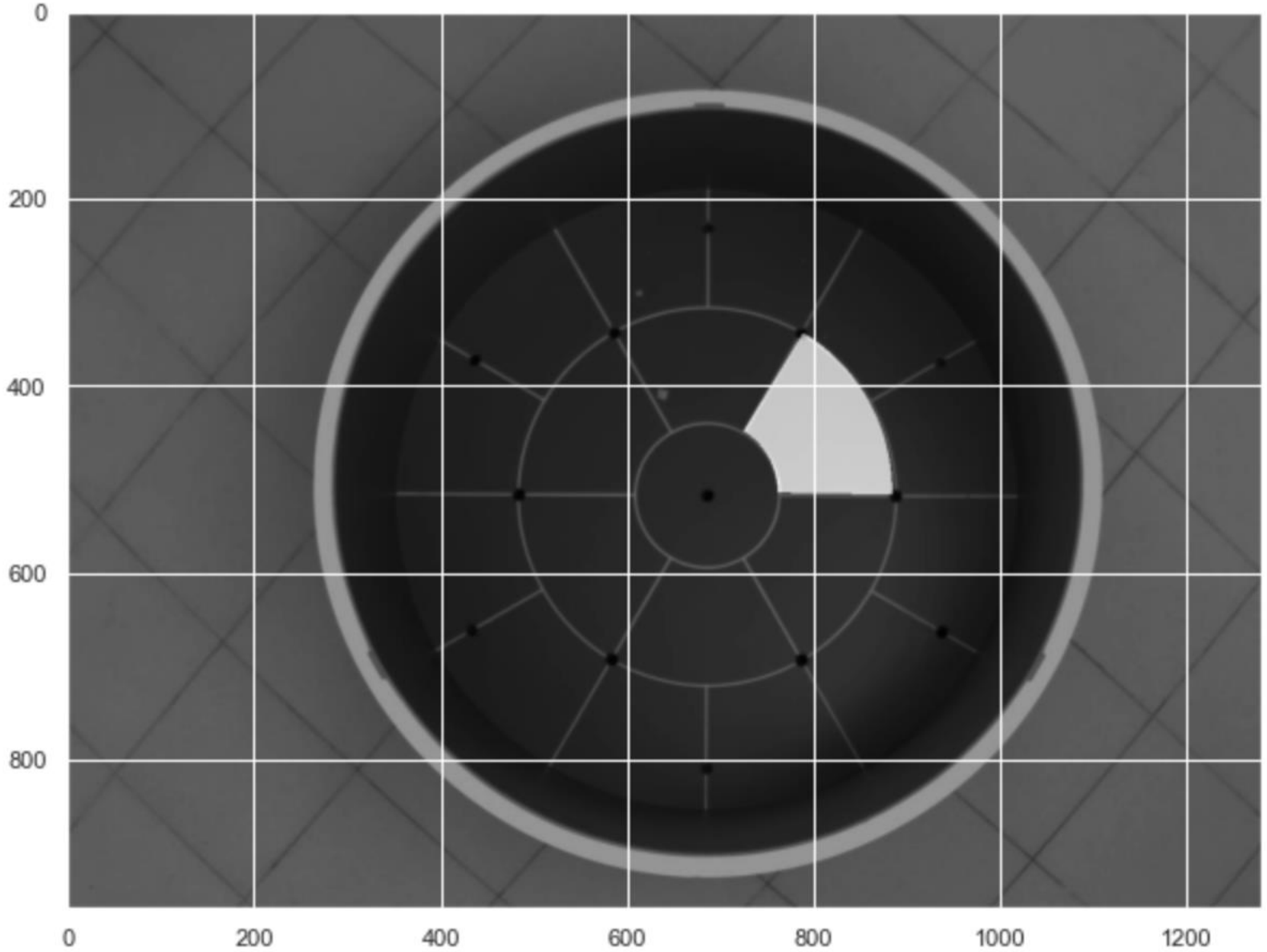
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Conclusion

- The developed approach showes the effectiveness of the method.
- To improve the result, it is necessary to expand the dataset.

Thank you for your attention!