Use of Neuron Networks for Planning the Correct Selection of Plant Samples in Precision Agriculture Technologies

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INTRODUCTION

Precision farming technologies are becoming a necessity based on climate changes and fundamental changes in the cost structure of agricultural production. Precision agriculture is based on differentiated crop treatment based on real data about their condition. Unfortunately, in Ukraine, the density of sensor equipment in the plant industry is fundamentally lower than in the USA and the EU. Accordingly, it is necessary to solve these issues directly on the spot in a limited time.

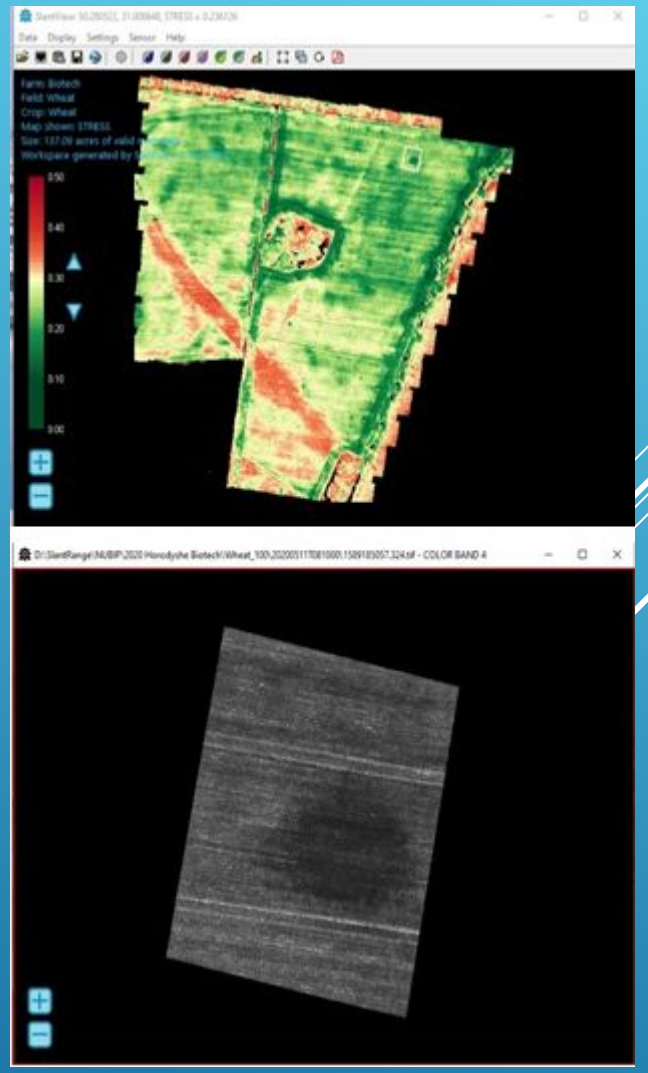
Accordingly, the **aim of the work** is the development of methodical approaches to determine the optimal places for the selection of control samples of plants in conditions of different conditions of crop moisture.

LITERATURE REVIEW

- Sampling is advisable to be carried out using robots, since means of accurate positioning are necessary in any case, since visual positioning according to landmarks in the field is not always possible
- Relative to UAVs, the state of hydration can be estimated using a thermal imager, but significant errors are possible in drought conditions
- When taking samples, it is technically possible to measure soil moisture, but reliable consideration of the dynamics of changes in the state of moisture supply of plants, especially in drought conditions, has doubtful prospects
- A possible variant of remote establishment of the state of plants is the assessment of the parameters of the distribution of indices on the site. In addition to the maximum of the distribution, the Gaussian parameter of the distribution, such as the standard deviation w, is informative

METHODOLOGY OF THE EXPERIMENT

- Research was conducted on production fields in 2019-2020 in Boryspil district of Kyiv region with coordinates 50°16' N, 30°58'E 50.0347.
- The Slantrane 3p system mounted on the base of the DJI Matrice 600 Pro UAV was used for spectral research.
- Data on separate spectral channels and vegetation indices calculated by the Slantview program were considered.
- The maximum detail (GSD 0.04 m/pixel) was obtained from the image window of the Slantview software (available variants of the NDVI index - Green, Red and RedEdge).



RESULTS AND DISCUSSION

Assessment of the nature of the distribution

Gaussian function, it better describes the peak values and it is easier to adapt it to the variable size of the experimental area, which is important for the industrial implementation of solutions

$$N = A \times exp^{\frac{-(X-xc)^2}{2w^2}}$$

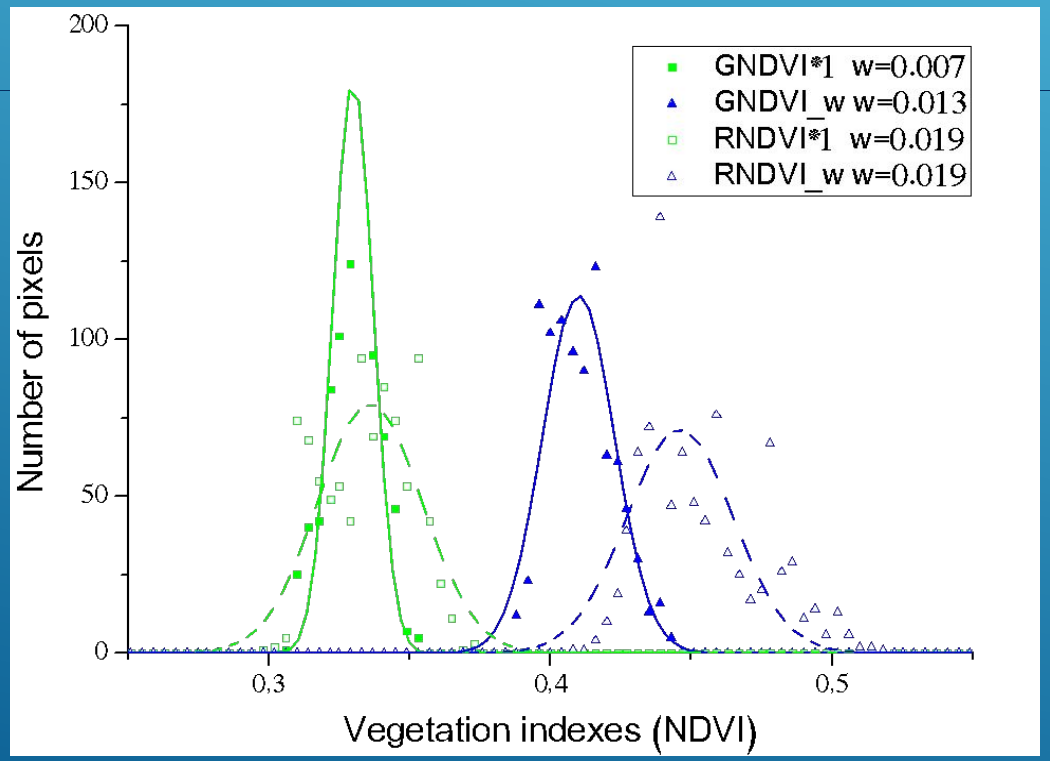
where: N is the number of measurements (in our case, the number of pixels); X is the intensity of the color component, A is the amplitude; xc – average value; w is the standard deviation (corresponds to the value of A/2).

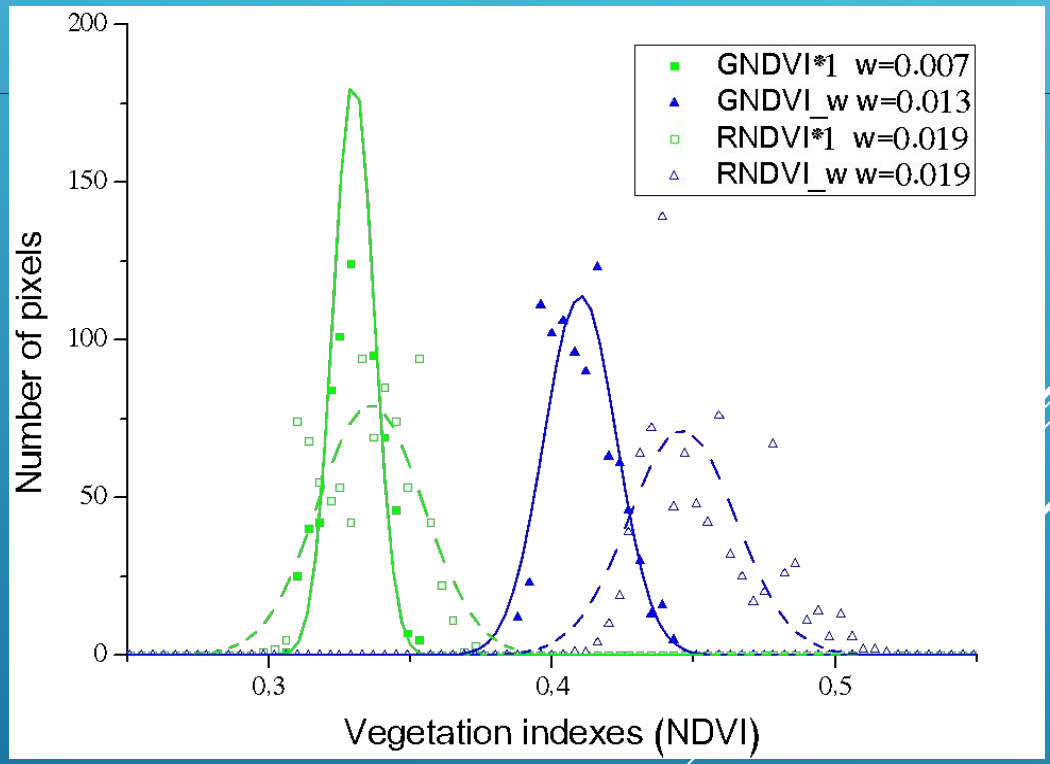
Results of approximation of experimental data using

	Green		Red		RedEDGE		NIR	
	1	water	1	water	1	water	1	water
xc	98	88	89	79	65,3	65	42	48,5
w	22	23	22,2	18,6	15	15,7	10,7	11,3
A	107	105	101	121	153	149	217	202

RESULTS AND DISCUSSION

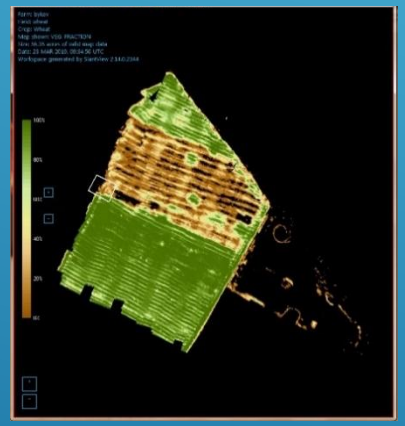
Dependence of the number of pixels on the value of the vegetation index GNDVI and RNDVI: where _1 is a normal state, _w is an increased state of water supply

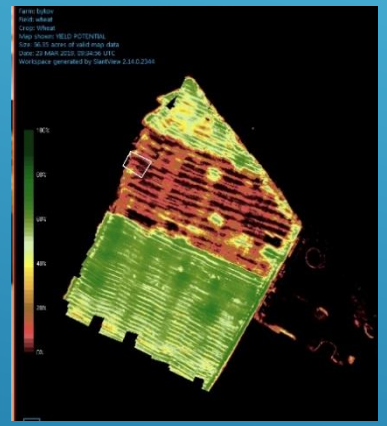


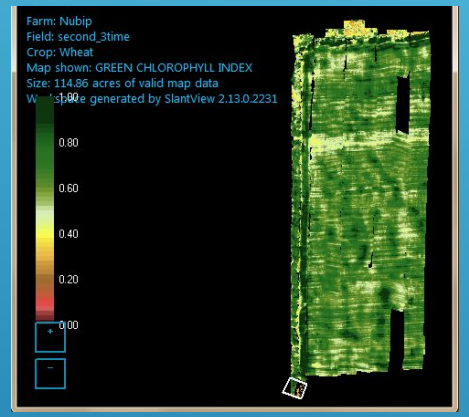


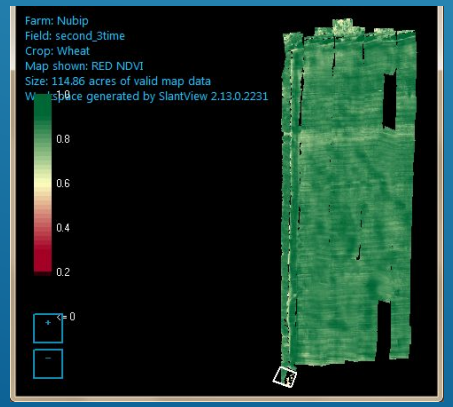
RESULTS AND DISCUSSION

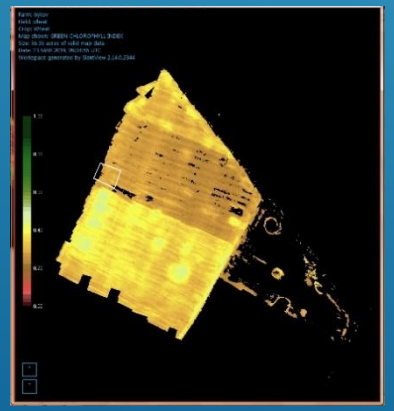
The data set (pictured by a UAV) for training a neural network

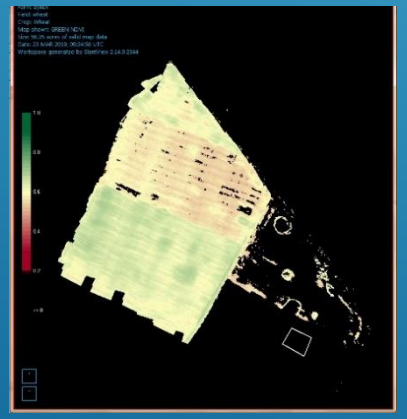












RESULTS AND DISCUSSION

Convolutional neural network learning code listing

```
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.preprocessing.image import ImageDataGenerator

# Data loading and preparation
train_datagen = ImageDataGenerator(rescale=1.0/255.0) # Normalization of pixel values
train_generator = train_datagen.flow_from_directory(
    'path/to/training_data',
    target_size=(1270, 840),  # Image size
    batch_size=32,
    class_mode='binary')   #Binary classification

# building a convolutional neural network
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(1270, 840, 3)),
    MaxPooling2D((2, 2)),
    Conv2D(1270, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Conv2D(2540, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Flatten(),
    Dense(2540, activation='relu'),
    Dense(1, activation='sigmoid')
])

# Compilation
model.compile(optimizer=Adam(learning_rate=0.001),
              loss='binary_crossentropy',
              metrics=['accuracy'])
```

Network Testing

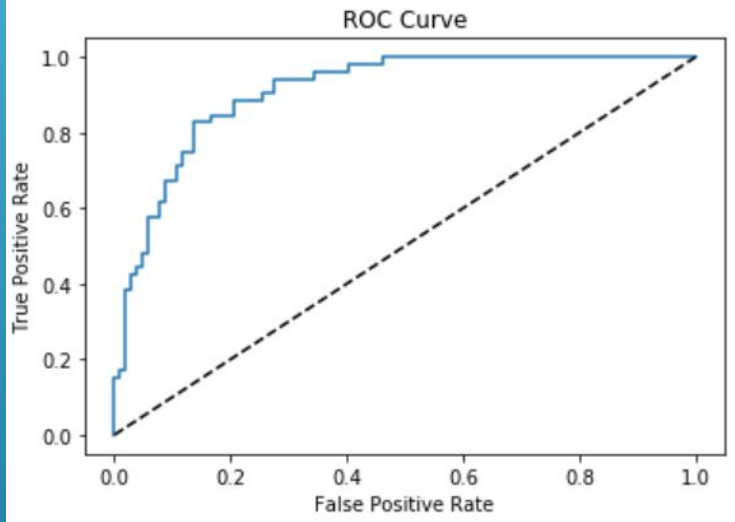
```
score = model.evaluate_generator(test_set, steps=100)

for idx, metric in enumerate(model.metrics_names):
    print("{}: {}".format(metric, score[idx]))
```

```
loss: 0.475635891854763
acc: 0.80375
```

ROC curve of trained CNN

```
y_test_pred_probs = model.predict(X_test)
FPR, TPR, _ = roc_curve(y_test, y_test_pred_probs)
plt.plot(FPR, TPR)
plt.plot([0,1],[0,1],'--', color='black') #diagonal line
plt.title('ROC Curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.show()
plt.clf()
```

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CONCLUSIONS

- The assessment of the nature of the distribution of both individual spectral channels and their combination in the form of vegetation indices turned out to be unprepared for the identification of uneven water supply of areas.
- The red channel and its derivatives turned out to be the most promising in the direction of identifying the water supply of wheat.
- The use of neural networks made it possible to identify probable areas with increased water supply on the maps of the distribution of vegetation indices in the field.
- The duration of the identification using neural networks will not interfere with the sampling procedure, thanks to which such a procedure can be effectively implemented in agronomic practices

THANK YOU FOR YOUR ATTENTION!

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