

**SECTION: INFORMATION TECHNOLOGY AND
CYBERSECURITY**

**DATALOGIC MODEL FOR IMAGE RECOGNITION BY
CONVOLUTIONAL NEURAL NETWORK USING CLOUD
SERVICES**

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Neural networks are part of machine learning and are the basis for deep learning algorithms. They are organized as layers of nodes, including an input layer, one or more hidden layers, and an output layer. Each node interacts with the other, having its own weight and threshold. If the output of any node exceeds the set threshold, this node is activated, transmitting data to the next level of the network. Otherwise, the data does not pass to the next level of the network [1].

In this work, images of potato fruits are used as objects for recognition by a convolutional neural network using cloud services for neural network detection of their diseases. The use of neural network detection of potato diseases from photographs is relevant for both farmers and the agricultural sector as a whole, as it can contribute to increased efficiency, environmental sustainability, and economic growth. A neural network approach to detecting potato fruit diseases from photographs uses artificial intelligence technologies to create models that automatically recognize disease symptoms in images. To solve this problem, convolutional neural networks should be used.

The aim of the work is to develop a dataset model of a database for an information system for recognizing diseases of potato fruits by a convolutional neural network using cloud services.

The information system will consist of two modules, a database and a trained neural network model for detecting a disease from an input image. The interconnection diagram of the modules is shown in Figure 1.

The module for working with the database will perform the following functions:

- viewing the information contained in the database [2];
- adding new records to the database;
- deleting existing records from the database.

This functionality will allow the user to fully familiarize themselves with the content of the dataset and add new images and data about potato fruits.

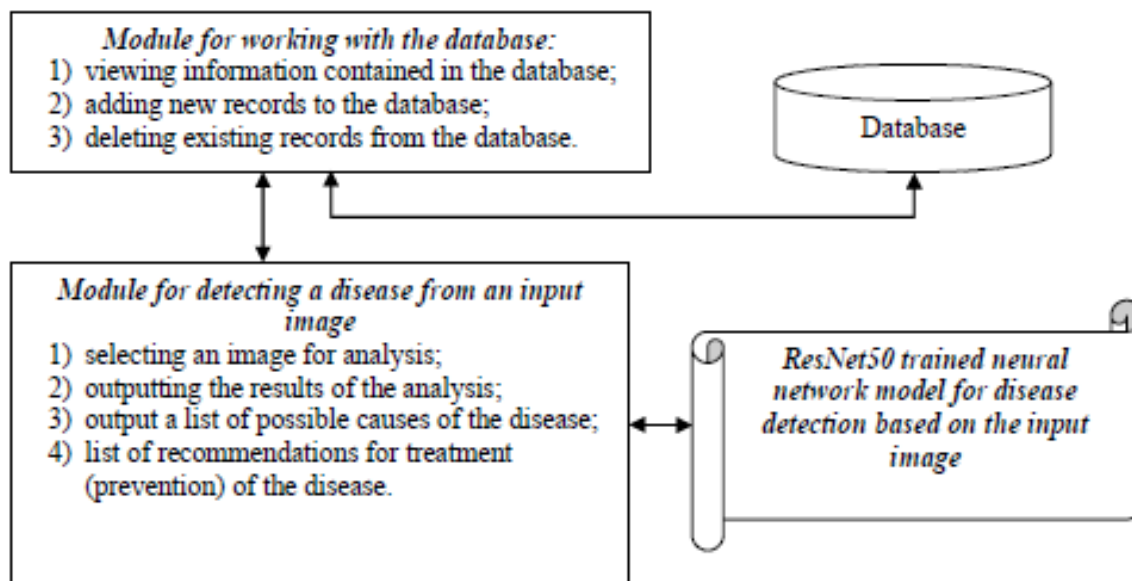


Figure 1. Scheme of interaction of information system modules.

The module for detecting a disease from an input image is designed for user interaction with a neural network model and determining the probable disease of a potato fetus from an image. In particular, the following functions are implemented in the subsystem:

- image selection for analysis;
- displaying the results of the analysis;
- list of possible causes of the disease;
- list of recommendations for treatment (prevention) of the disease.

The method of neural network detection of potato fruit diseases from photo images is designed to convert input data in the form of a photo image of potato fruit and the trained ResNet50 neural network into output data in the form of a probable disease of potato fruit and recommendations for combating the identified disease. The input data of the method of neural network detection of potato fruit diseases from photo images are photo images of potato fruits and the previously trained ResNet50 neural network. The method works in three main steps, the first of which is image loading and pre-processing [3]. The image for further processing by the neural network is scaled to a size of 224 by 224 pixels.

The second step is neural network detection of the disease, for which the pre-processed image is fed to the ResNet50 neural network, which performs the

classification stage. The third step is to provide results and recommendations based on the neural network assessment of the disease. For the most likely disease, the user will be provided with recommendations for elimination and ways to improve the result. The output of the method is the probable disease of potato fruit and recommendations for combating the existing disease.

The creation of a database structure for an application based on the method of neural network detection of potato fruit diseases will ensure efficient storage, organization, and quick access to data, which is critical for the proper operation of the system. Figure 2 shows the dataset model of the application database based on the method of neural network detection of potato fruit diseases based on image analysis.

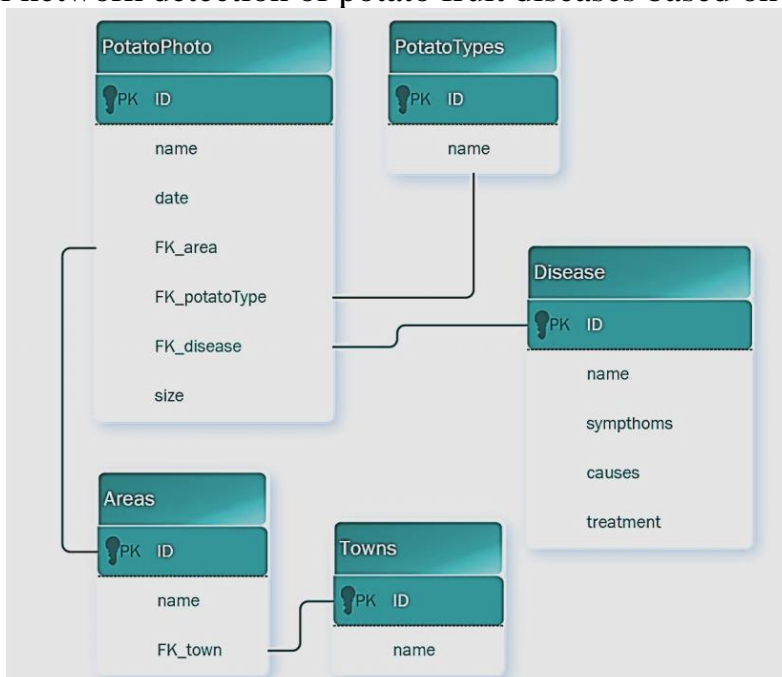


Figure 2. Datalogical model of a database for an information system for recognizing diseases of potato fruits by a convolutional neural network using cloud services.

The «PotatoPhoto» table stores data about the image of potato fruits, namely, fields for the name of the photo, date and time of shooting, the area where the potatoes were grown, the variety of potatoes, the diagnosed disease, and the image dimension. Attributes of the «PotatoPhoto» table:

- ID, data type «int» – primary key, unique identifier of the photo image of the potato fruit;
- name, data type «varchar(255)» – the name of the photo file;
- date, data type «datetime» – date and time of taking a photo of potato fruit;
- FK_area, data type «int» – secondary key, a reference to the «Areas» table entry to be compared with the corresponding entry for the area where the potato grew;
- FK_potatoType, data type «int» – secondary key, a reference to the «PotatoTypes» table entry to be matched with the corresponding potato variety record;
- FK_disease, data type «int» – secondary key, a reference to the «Diseases» table entry to be matched with the corresponding potato fruit disease record;

- size, data type «int» – dimension of the photo image of potato fruit.

The PotatoTypes table is used to store the names of potato varieties. Table attributes:

- ID primary key, data type «int». Unique identifier of the potato variety name;
- name, data type «varchar(255)» – name of the potato variety;

The «Areas» table is used to store the names and coordinates of the plots where potatoes are grown. Table attributes:

- ID – primary key, data type «int», a unique identifier of the land plot where potatoes are grown;

- name, data type «varchar(255)» – name of the potato variety;

– FK_Town, data type «int» – secondary key, a link to the «Towns» table entry for matching with the corresponding entry for the city in which the plot is located.

The «Towns» table is intended for storing the names of cities where land plots are located. Attributes of the «Towns» table:

- ID, data type «int» – primary key. Unique identifier of the potato variety name;

- name, data type «varchar(255)» – name of the city.

The «Disease» table is used to store information about diseases that can be diagnosed during the study. The table contains fields for recording the name of the disease of potato fruit, the causes of this disease, symptoms and treatment recommendations. Attributes of the «PotatoPhoto» table:

- ID, data type «int» – primary key. Unique identifier of the photo of the potato fruit;

- name, data type «varchar(255)» – name of the disease;

– symptoms, data type «varchar(255)» – a description of the symptoms that can occur with this disease;

– causes, data type «varchar(255)» – a description of the causes that can provoke the disease;

– treatment, data type «varchar(255)» – description of recommendations for treatment of the disease.

Thus, we implemented a database for an information system for neural network detection of potato fruit diseases based on image analysis, which will allow efficient and quick access to the necessary information when the user works with the application.

The main form of the information system based on PyCharm [4] is «ImageAnalysis», where the user interacts with the neural network model for recognizing potato diseases (Figure 3). On this form, the user can work with a pre-selected photo on the «Work with Images» form or choose another. To do this, click on the «Select image» button, after which the file explorer window will open. After selecting the required image, you can proceed to its analysis by clicking the «Analyze» button.

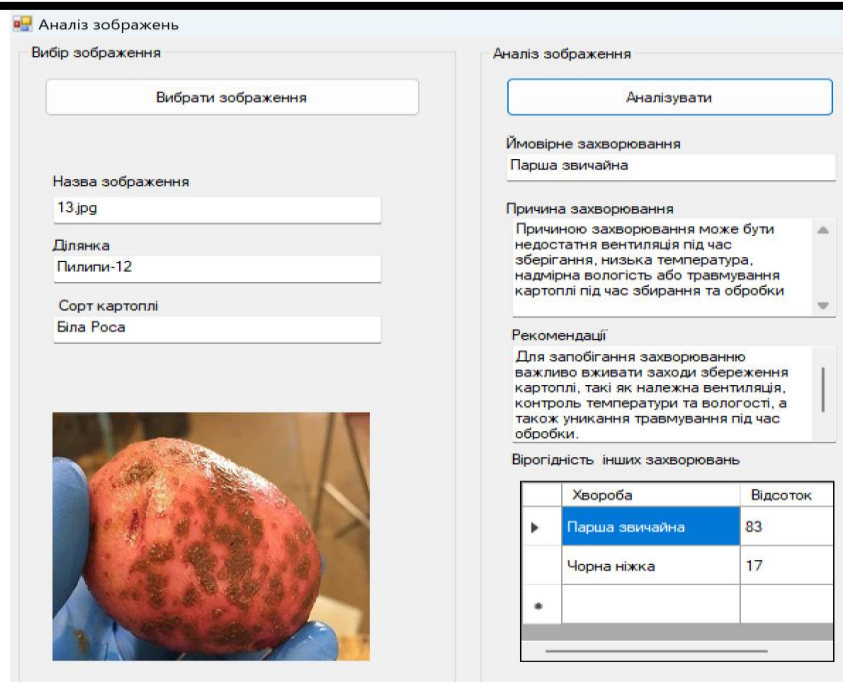


Figure 3. An example of working with the «ImageAnalysis» form

Thus, the software and database for neural network detection of potato fruit diseases from photographs were implemented and the features of the implementation of the software components of the system were described. A neural network model for recognizing diseases of potato fruits was created and trained, and a convenient and understandable user interface was created for further work.

The developed database and information system for recognizing potato fruit diseases by a convolutional neural network using cloud services allow for the rapid detection of diseases, which helps farmers to make effective decisions on the application of control measures and plant protection. In addition, given its high accuracy (0.96 per 100 training epochs), the software can be used as a tool for research and monitoring of plant health in agriculture, as well as for the development of new methods and technologies to increase yields and reduce crop losses.

References

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