
DATALOGIC STRUCTURE FOR INTELLIGENT SYSTEM FOR AREAS LOCALIZATION IN PHOTOS WITH THE REMAINS OF BUILDINGS USING NEURAL NETWORK

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In today's conditions of active development of image processing and deep learning technologies, automated detection and localization of objects in photographic images are critically important for many areas, in particular for post-conflict infrastructure reconstruction and monitoring of destruction in crisis regions [1]. As convolutional and transformer architectures continue to evolve, their ability to process increasingly large volumes of real-time satellite and aerial imagery will facilitate near-instantaneous damage mapping over wide geographic areas. In the near future, this could allow disaster agencies to deploy resources with unprecedented precision, sending heavy equipment, medical aid and search and rescue teams to the worst-hit areas within minutes of a catastrophic event. Moreover, the integration of onboard inference capabilities into unmanned aerial vehicles (UAVs) promises to extend the reach of these neural systems into environments that are inaccessible or too dangerous for human operators, enabling dynamic reconnaissance flights that continuously update damage assessments as field conditions evolve [2].

Beyond immediate crisis response, the application of these detection networks is poised to impact long-term strategies for urban resilience. By systematically cataloging structural damage over successive natural disasters, municipalities can create predictive vulnerability models that account for building age, construction materials, and local environmental stressors. Combined with geographic information system (GIS) layers and historical urban data, neural network results can inform zoning regulations, retrofit priorities, and targeted strengthening projects aimed at mitigating the effects of future earthquakes, storms, or armed conflict [3]. This shift to data-driven infrastructure planning has the potential to reduce economic losses and save lives by proactively identifying the weakest links in the urban fabric before a natural disaster strikes again.

In the field of cultural heritage, neural detection of debris fields will be critical for digital preservation and archaeological research. Highly accurate segmentation of

collapsed structures can be used for photogrammetric reconstruction pipelines, creating accurate 3D models of historic buildings from scattered debris. Such virtual reconstructions not only support scientific research, but also allow displaced communities to regain a visual memory of their monuments, promoting a sense of continuity and identity after destruction. As these techniques are combined with advances in multispectral and hyperspectral imaging, they can even reveal hidden architectural features beneath layers of dust and undergrowth, revealing previously unknown aspects of culturally significant sites [4].

Technological convergence will further enhance the impact of neural network-based detection systems. Edge computing hardware optimized for deep learning, when deployed alongside cloud-based analytics platforms, will create a seamless pipeline from image capture to actionable insights. Advances in model compression and quantization will enable highly accurate detection algorithms to run on low-power devices used by first responders, while maintaining performance even in bandwidth-constrained or offline scenarios [5]. At the same time, research into explainable AI will unlock the secrets of the decision-making processes in these networks, providing transparency into why certain regions of debris are marked, and building trust among users. Overall, the horizon of neural network-based detection of damaged building sites is extremely broad, spanning emergency response, strategic urban fortification, heritage restoration, and the development of reliable, interpretable artificial intelligence systems that together increase our resilience to natural and man-made disasters [6].

The relevance of designing a database structure for an intelligent system for neural network detection and localization of areas with the remains of destroyed buildings is due to the fact that it is organized and structured data sets that serve as the basis for the formation of new knowledge, which becomes available in the process of their analytical processing. The design of the relational structure of the database should ensure not only the effective storage of primary information, but also create conditions for further expansion of the boundaries of scientific research through the systematic accumulation, processing and reuse of data.

Therefore, the database should be designed taking into account the requirements for machine learning models, interoperability between various components of the system, as well as the possibility of its further development and adaptation to changing conditions of use.

The purpose of the work is designing of datalogic structure for intelligent system for areas localization in photos with the remains of buildings using neural network.

The proposed scheme of the approach to neural network detection and localization of areas with remains of destroyed buildings in photo images implements step-by-step processing of photo images in order to detect and localize areas with remains of destroyed buildings and their classification. The input includes photo images, as well as pre-trained machine learning models: for detection and localization of areas with remains of destroyed buildings and for classification of remains of destroyed buildings.

The first step is pre-processing of photo images, which includes normalization, scaling and other procedures necessary to ensure the correct operation of subsequent stages of analysis. The second step involves using the YOLO model to detect and localize areas in the image where remains of building materials are present. As a result, the system outputs the coordinates of the localization areas and determines the types of building materials present in the image.

This approach provides an effective combination of object detection and multiclass classification for the detection and localization of areas with the remains of destroyed buildings on photographic images. To test the approach, software was created, a screenshot of which is shown in Figure 1.

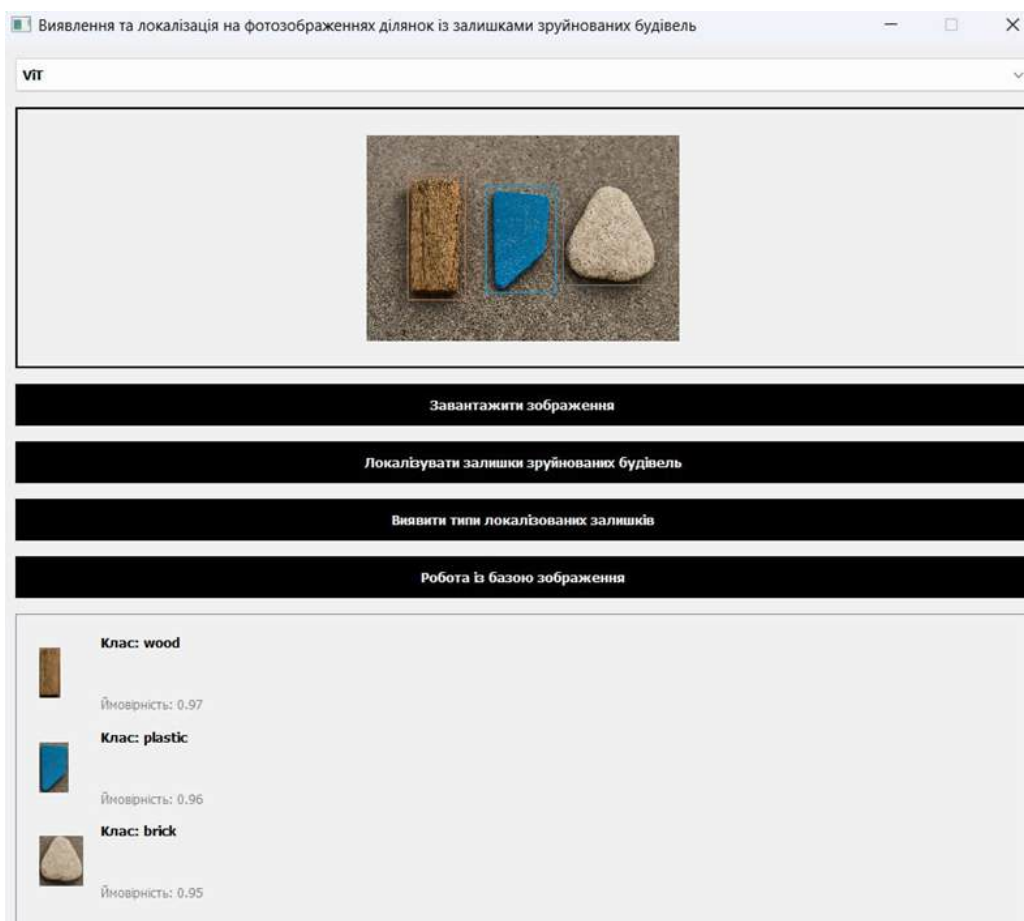


Figure 1. Software for areas localization in photos with the remains of buildings using neural network

To ensure the preservation of the results of the detection, localization and multiclass classification of the remains of destroyed buildings, a relational database was designed, the data logical model of which is shown in Figure 2.

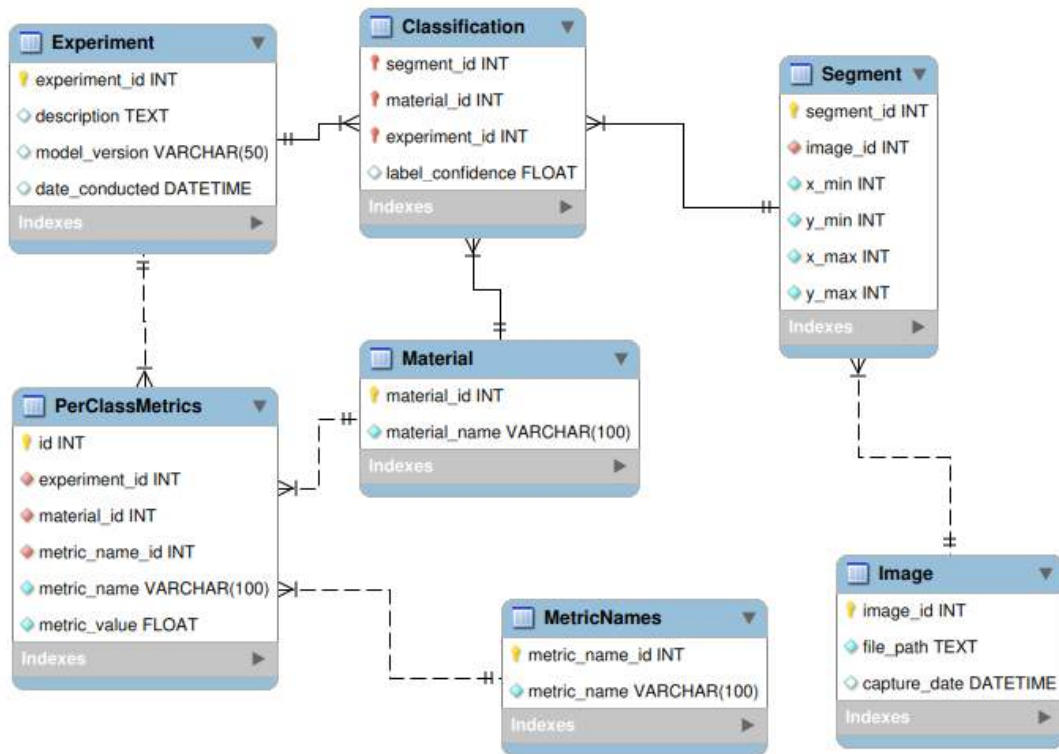


Figure 2. Datalogic structure for intelligent system for areas localization in photos with the remains of buildings

The "Image" table is designed to store information about photo images used in experiments. Table attributes: unique image identifier "image_id" (INT), image file path "file_path" (TEXT), capture date "capture_date" (DATETIME).

The "Segment" table is designed to store information about image segments that contain localized areas with fragments of building materials. Table attributes: unique segment identifier "segment_id" (INT), image identifier "image_id" (INT), minimum x-axis coordinates "x_min" (INT), minimum y-axis coordinates "y_min" (INT), maximum x-axis coordinates "x_max" (INT), maximum y-axis coordinates "y_max" (INT).

The "Material" table is designed to store information about types of building materials that can be detected in image segments. Table attributes: unique material identifier "material_id" (INT), material name "material_name" (VARCHAR(100)).

The "Experiment" table is designed to store information about experiments conducted on the classification and localization of building materials in images. Table attributes: unique experiment identifier "experiment_id" (INT), experiment description "description" (TEXT), model version "model_version" (VARCHAR(50)), date of conduct "date_conducted" (DATETIME).

The "Classification" table is designed to store the results of classifying image segments by material types. Table attributes: segment identifier "segment_id" (INT), material identifier "material_id" (INT), experiment identifier "experiment_id" (INT), classification confidence "label_confidence" (FLOAT).

The "PerClassMetrics" table is designed to store classification metrics for each material type separately within the experiments. Table attributes: unique metric

identifier "id" (INT), experiment identifier "experiment_id" (INT), material identifier "material_id" (INT), metric name "metric_name" (VARCHAR(100)), metric value "metric_value" (FLOAT).

The "MetricNames" table is designed to store metric names, such as accuracy, precision, recall, F1-score. Table attributes: unique metric identifier "metric_name_id" (INT), metric name "metric_name" (VARCHAR(100)).

Thanks to the use of the database, it was possible to implement the systematization and storage of classification results, which provides the ability to generate analytical reports and train new versions of models using historical data.

Thus, the developed approach is integrated into an intelligent information system with a database, which ensures effective storage, processing and further use of data, and therefore increases the productivity and accuracy of the system in real conditions.

References

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