UDC 004.93(045)
DOI:10.18372/1990-5548.86.20559

[1]V. M. Sineglazov,
[2]R. S. Tsymbaliuk
[3]V. V. Khaziyev,
[4]Y. V. Roienko,

INTELLECTUAL DIAGNOSIS OF THYROID TUMORS

[1]Aviation Computer-Integrated Complexes Department, Faculty of Air Navigation Electronics and Telecommunications, State University "Kyiv Aviation Institute",, Kyiv, Ukraine
[2]National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
[3,4]Kyiv Municipal Clinical Hospital 18, Kyiv, Ukraine
E-mails: [1]svm@nau.edu.ua ORCID 0000-0002-3297-9060,
[2]tsymbaljuk2001@gmail.com ORCID 0009-0008-3525-8892,
[3]khaziev6544@gmail.com ORCID 0000-0003-4568-0364,
[4]royenko2@gmail.com ORCID 0009-0001-1838-0852

Abstract*—The article is devoted to the intelligent diagnosis of thyroid tumors, the diagnosis of papillary thyroid cancer based on general information, ultrasound images, and pathohistological images. It examines modern approaches to the intelligent diagnosis of thyroid tumors using machine learning and artificial intelligence methods. The types of medical intelligent systems, their architecture, accuracy, and the set of tasks they perform for the classification of thyroid cancer are considered. The problems of papillary thyroid cancer are considered, the specifics of the disease and the signs by which it is diagnosed are described. The main tasks of an intelligent system capable of automatically analyzing patient medical data and supporting clinical decision-making by an endocrinologist, segmenting and classifying thyroid tumors are outlined. The equipment used to form the training sample is described, and the process of data collection for building an intelligent medical system is described. The task to be solved is set. The metrics by which the accuracy of the intelligent medical system will be evaluated are characterized. The architecture of the intelligent medical system is presented, its main blocks are characterized, and the functionality of each block is described. A UML diagram is presented, according to which the intelligent medical system will operate. The data that will be used to form the training sample is presented, indicating its type, dimension, how the data is collected, and how this data will be used to train the intelligent medical system. The results of the study are aimed at improving the effectiveness of early detection of thyroid pathologies and reducing the number of false diagnoses, creating a convenient tool that will reduce the time it takes for a doctor to diagnose the disease and increase the accuracy of diagnosing papillary thyroid cancer.*

Keywords—Artificial intelligence; machine learning; neural networks; medical intelligent systems; thyroid cancer; tumor diagnosis.

I. INTRODUCTION

Thyroid cancer (TC) is a dangerous oncological disease. In 2021, more than 2 million cases of TC were registered, with a prevalence of up to 23.1 patients per 100,000 people [1] – [4]. The etiology of TC has not been definitively determined, but there are a number of factors that increase the risk of the disease:

1) the effects of ionizing radiation, especially in childhood;

2) genetic mutations, in particular RET mutations in medullary cancer;

3) chronic thyroid diseases, such as thyroiditis or goiter;

4) excess body weight and obesity, which are considered possible risk factors; female gender and certain age groups where the risk increases [5] – [8].

According to WHO data, TC ranks 7th in terms of prevalence and 24th in terms of mortality among other cancers, with a high survival rate (over 99% five-year survival rate for localized papillary carcinoma). In Ukraine, a similar trend in the incidence of TC was observed between 2001 and 2019 [9] – [12].

Thyroid cancer negatively affects the quality of life of patients. Treatment and follow-up of patients with TC are lengthy and require significant resources. After thyroidectomy, patients require lifelong hormone replacement therapy, regular monitoring of thyroid hormone and thyroglobulin levels, and follow-up instrumental examinations. This results in a significant financial burden for both patients and the healthcare system. Studies conducted in the United States indicate an increased risk of financial hardship and possible bankruptcy among people undergoing treatment for TC [13].

Thus, the study of TC, its prevention, and early diagnosis require improvement and new effective methods.

II. Problems of Papillary Thyroid Cancer

Papillary thyroid cancer (PTC) is a well-differentiated, slow-growing, localized tumor with the potential to metastasize. The disease is more commonly diagnosed in women aged 20–55 and much less frequently in men. In addition to gender and age, risk factors for papillary PTC include genetic factors and iodine deficiency. The main role in the development of papillary cancer is played by exposure to ionizing radiation, most often in childhood, which leads to malignant neoplasms. This includes radiation exposure to the head and neck (frequent X-rays). Doctors also note the influence of other factors, such as harmful habits (nicotine, alcohol), a sedentary lifestyle, and working in hazardous industries. Severe stress also has an impact [14], [15].

Most often, thyroid neoplasms are diagnosed using ultrasound (US) of the thyroid gland, which determines the parameters of the tumor and evaluates the associated lymph nodes in the neck to detect metastasis. US allows detecting thyroid nodules suspicious for cancer and prescribing fine needle aspiration biopsy (FNAB) to determine the type of neoplasm. During this procedure, a thin needle is inserted into the nodule under ultrasound or palpation guidance. Cells from the nodule are aspirated and examined by a cytologist. PTC can have different macroscopic morphology, and its diagnosis is based on the study of the nuclear morphology of the neoplasm. Diagnostic features of nuclear morphology demonstrate a characteristic set of features by which PTC is classified (uneven nuclear contours, enlargement and elongation, clustering and overlapping, etc.) [16], [17].

As for treatment methods, the most effective approach for PTC is complete removal of the gland (total thyroidectomy). In some cases, only one lobe of the thyroid gland is removed (lobectomy), leaving the other half intact. If the tumor is found to be malignant, radioiodine therapy (RAI) is performed after surgery to ablate the remaining tissue. Both groups of patients, those who have undergone complete removal of the gland and those who have retained part of it, are under close postoperative supervision. The recurrence rate is usually significantly lower in patients who have had complete removal of the thyroid gland compared to those who have undergone lobectomy.

Treatment of PTC may be accompanied by intraoperative and postoperative complications (aphonia, hypocalcemia, severe hypothyroidism, etc.).

III. Existing Methods

Artificial intelligence (AI) technologies are increasingly being used in surgery, dentistry, and oncology, playing a significant role in the diagnosis and processing of medical information [19], [20].

The review shows how AI is used to detect, analyze, and predict PTC [21]. There are three main types of tasks that can be solved using AI:

- classification (thyroid tumors are classified into one of several types depending on their histopathological characteristics and behavior);
- segmentation (identification of the tumor area in the image with the elimination of noise and irrelevant information);
- prediction (analysis of all patient data – genetic, lifestyle, radiation exposure, etc. – to predict the development of papillary thyroid cancer).

To solve these problems, both supervised methods (neural networks, SVM classification algorithms, KNN) and unsupervised methods (K-means clustering, entropy-based classification) are used.

Another study focused on predicting recurrences of differentiated TC. The main characteristics of the model were age, gender, smoking history, tumor properties, etc. The data was taken from the UCI Machine Learning Repository-383 records and 16 different features. After preprocessing, the data was divided into training and test samples. The model was created based on the TensorFlow Keras API using sigmoid and ReLU activation functions. The model's accuracy was 98% on training data and 96% on test data, indicating good generalization ability [22], [23].

Another study used AI technologies to support doctors in diagnosing thyroid pathologies. AI was used to automate image analysis, personalize and optimize the management of patients with thyroid nodules, and determine the type of tumor. The study showed that the AI model is capable of classifying the stage of cancer and risk categories for thyroid cancer [24], [25].

There are also studies that allow the recognition of rare types of thyroid cancer. This model showed high accuracy on various metrics and solved the problem of insufficient data sets for rare types of malignant neoplasms [26]. AI tools also reduce the number of unnecessary express biopsies, are capable of performing multiomics, analyzing large data sets, and identifying potential biomarkers [27], [28].

There are various ways to apply AI to the diagnosis of malignant thyroid neoplasms. Several studies analyze ultrasound images There is data from the analysis of 312,399 ultrasound images from 49,952 patients using a deep convolutional neural network (Deep CNN), achieving an accuracy of 86.5% and a sensitivity of 84.7%. Another study analyzed 18,049 images from 8,339 patients using TheNet algorithm, achieving an accuracy of 92.2% [29], [30].

Papillary thyroid cancer can be dangerous because it can metastasize to local or distant lymph nodes. Therefore, predicting the spread of the disease is critically important. Some researchers analyzed ultrasound images of lymph nodes to diagnose metastases and predict their occurrence in patients with papillary carcinoma. The results showed high accuracy and stable performance on both training and test datasets [31].

It was found that radiologists who use AI to identify malignant tumors achieve higher classification accuracy than those who work without its help. According to this study, AI improves the accuracy of thyroid tumor analysis and classification. Artificial intelligence systems demonstrate accuracy and AUC values comparable to those of experienced radiologists – 84% and 75.3%, respectively. Thus, combining the experience of specialists with the accuracy of AI systems can significantly improve the quality of tumor diagnosis and classification [32].

Thus, machine learning and AI technologies work well for diagnosis, predicting treatment outcomes, planning therapy, automating ultrasound image analysis, eliminating noise, and improving image quality. The use of AI increases the productivity of doctors, which leads to more effective medical practice and increased profitability. However, the use of AI requires improvement, careful data labeling, and validation by medical personnel. In addition, the ethical aspect of AI use remains unresolved in cases of incorrect diagnosis of disease [33].

IV. Tasks of the Intellectual System

In order to formulate the tasks of the intellectual system, it is necessary to define the signs and criteria for diagnosing thyroid pathology, namely

1) Patient complaints (fatigue, weight change, shortness of breath, neck pain, discomfort, excessive sweating, feeling hot).

2) Biochemistry (thyroxine, triiodothyronine, and calcitonin).

3) Test results. Identification of genetic predisposition to certain diseases.

4) Medical history. The patient's history of diseases that may affect the development of thyroid cancer.

5) Ultrasound examination. Ultrasound examination of thyroid nodules and search for suspicious nodules.

6) Pathomorphological examination of tumor tissue removed during surgery diagnosis of PTC.

The tasks of the intelligent system will be the initial processing of ultrasound images, noise removal, image filtering, highlighting suspicious nodes, and diagnosing papillary thyroid carcinoma. The intelligent system focuses on diagnosing papillary cancer specifically, as this type of cancer carries a risk of metastasis and further treatment depends on the type of tumor diagnosed.

After diagnosing PTC, the intelligent medical system aims to assess the risk of metastasis based on the previous history of the disease's progression. To do this, the intelligent medical system will learn from images of pathomorphological preparations of tumors in patients who have undergone thyroidectomy. A retrospective analysis of the database of patients who have had metastasis in the past will also be performed. Timely detection of PTC can prevent further metastasis and allow radioiodine therapy to be prescribed to the patient after surgery. Segmentation of the tumor on the ultrasound image. Tasks of the intellectual system are

1) Segmentation of the tumor on the ultrasound image.

2) Classification of the identified tumor (papillary carcinoma – non-papillary carcinoma).

3) Analysis of histological images.

4) Predicting the presence of metastases based on histological images.

V. Problem Statement

Let X be the space of features used to diagnose papillary thyroid cancer. The class set consists of two values $Y \in \{0,1\}$, where 0 is not papillary thyroid cancer and 1 – is papillary thyroid cancer. Given a training sample of N observations

$$D = \{(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)\},$$

where (x_1, y_1) are independent realizations of random variables (X, Y) The goal of the task is to construct a classifier

$$f : X \to \{0,1\}$$

with minimal classification error. To evaluate the accuracy of the model, the following metrics will be used

1) Accuracy (classification accuracy)

$$Accuracy = (\mathrm{TP} + \mathrm{TN}) / (\mathrm{TP} + \mathrm{TN} + \mathrm{FP} + \mathrm{FN}),$$

where TP is true positives; TN is true negatives; FP is true false positives; FN is false negatives.

2) AUC is the area under the ROC curve, which numerically evaluates the quality of the classifier in the range from 0 to 1.

VI. Architecture of the Intellectual System

The intelligent system consists of several blocks, each of which will process input data and generate a forecast. First, the system user interacts with the interface through which the patient's basic data is entered. Next, the control unit distributes the data between the main working units, which process the patient's basic data, ultrasound images, and histological images (if available). The ultrasound image processing unit diagnoses papillary cancer if present (segments the tumor on the general image), the general information processing unit provides metastasis predictions based on previous retrospective information, and, if histological images are available, the histological image processing unit provides information with an accurate diagnosis and the presence of metastases. The system units are shown in Fig. 1. Note that the system units that interact with images include noise removal, primary image processing, etc.

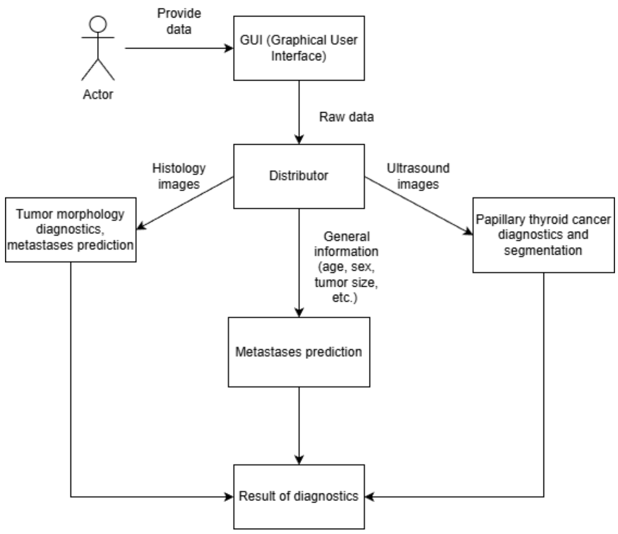

Fig. 1. Overall system architecture

The system consists of six blocks.

1) Graphical user interface – responsible for initial interaction with the user, where the user uploads patient data, ultrasound images, and histological images.

2) Distribution block – a service responsible for distributing data between other services.

3) Ultrasound image processing unit – a unit responsible for diagnosing papillary thyroid cancer and segmenting tumors on ultrasound images.

4) Histological image processing unit – a unit that examines the morphological structure of the tumor and determines whether the tumor will metastasize to local or distant lymph nodes.

5) General information processing unit – a unit that predicts tumor metastasis based on general information (gender, patient age, tumor size, etc.).

6) Results block – a block responsible for presenting results from all other services.

Thus, all blocks of the intelligent medical system are described, and the responsibilities of each block are outlined.

VII. Formation of the Training Sample

An intelligent medical system has several data sources from which it will learn to perform the tasks described above. During the examination, the doctor interviews the patient to find out general information, such as medical history (the patient's medical history, age, gender), asks if the patient has any complaints of typical symptoms of Laryngeal Cancer (cough, pain when swallowing, voice changes). The doctor then performs a visual examination for the presence of lumps in the neck. This is followed by an ultrasound scan to identify suspicious nodes. In this way, ultrasound images of tumors that were later diagnosed as PTC (using FNAB) were collected in tht database.

Below (Figs 2 – 4) examples of ultrasound images with PTC are presented.

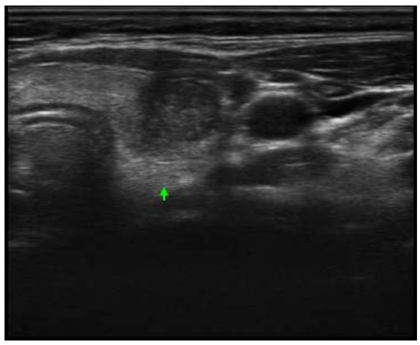

Fig. 2 mage of a thyroid tumor

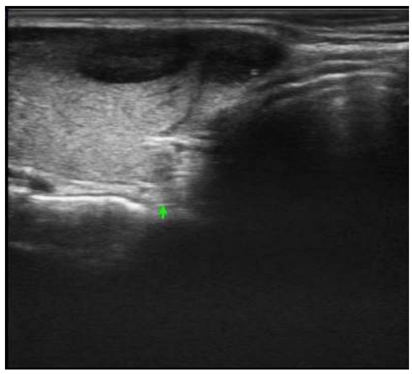

Fig. 3. Papillary thyroid cancer

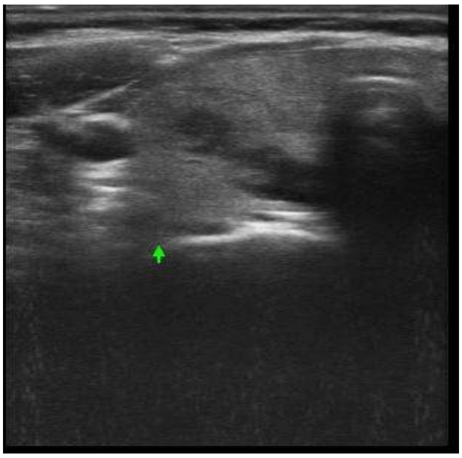

Fig. 4. Papillary thyroid cancer

The tumor is diagnosed by an ultrasound doctor and classified according to a number of criteria, such as: content, echogenicity, hydrophilic border, calcification, shape, contour, vascularization, elastography data, etc. Thus, this dataset of ultrasound images with the identification of nodes characterized as PTC allows training an intelligent medical system to recognize malignant neoplasms.

The ultrasound images were taken using a Toshiba Aplio 500 device (Fig. 5), which is approved by the Ministry of Health for diagnosing thyroid gland pathologies. This device has a sensor frequency of 7–12 MHz and supports the DICOM 3.0 protocol, which meets the needs of the study.

This device stores images with a resolution of 1232×824 pixels and a bit depth of 24.

Fig. 5. Toshiba Aplio 500 [34]

Thus, the database corresponds to Table I. The input variables are age, gender, ultrasound image, and the output variable is the node class. Thus, the intelligent medical system aims to recognize papillary cancer on an ultrasound image and segment it on the image by drawing a circle with a different color.

TABLE I. COMPONENTS OF DATABASE FOR MACHINE LEARNING

Age	Numerical
Sex	Categorical
Ultrasound image	Multimedia
Thyroid nodule type (papillary cancer – non-papillary cancer)	Categorical

VIII. CONCLUSION

Thus, the architecture of an intelligent medical system for diagnosing papillary thyroid cancer was presented, the main functional blocks were described, and their tasks were defined. The process of forming a training sample was described, and the tasks of the intelligent medical system were formulated.

REFERENCES

[1] J. Liu *et al*., “Global burden of thyroid cancer,” *Frontiers in Endocrinology*, 2025. https://doi.org/10.3389/fendo.2025.1644270.

[2] M. M. Chen *et al*., "Trends in incidence, metastasis, and mortality from thyroid cancer in the USA from 1975 to 2019: a population-based study of age, period, and cohort effects," *The Lancet Diabetes & Endocrinol.*, vol. 13, no. 3, pp. 188–195, Mar. 2025. https://doi.org/10.1016/S2213-8587(24)00310-3

[3] “Key Statistics for Thyroid Cancer,” *American Cancer Society*. Accessed: Nov. 20, 2025. Available: https://www.cancer.org/cancer/types/thyroid-cancer/about/key-statistics.html.

[4] J. Wang *et al*., “Epidemiological characteristics of thyroid cancer,” *International Journal of Molecular Sciences*, vol. 26, no. 11, 2025. https://doi.org/10.3390/ijms26115173.

[5] American Cancer Society, “What causes thyroid cancer?” Accessed: Nov. 20, 2025. Available: https://www.cancer.org/cancer/types/thyroid-cancer/causes-risks-prevention/what-causes.html.

[6] Medscape, “Thyroid cancer overview.” Accessed: Nov. 20, 2025. Available: https://emedicine.medscape.com/article/851968-overview.

[7] M. Kitahara, “Epidemiology of thyroid cancer,” *Cancer Epidemiology, Biomarkers & Prevention*, 2022. https://doi.org/10.1158/1055-9965.EPI-21-1359.

[8] S. Lopez, “Thyroid cancer facts,” Verywell Health, 2023. Accessed: Nov. 20, 2025. Available:

https://www.verywellhealth.com/facts-about-thyroid-cancer-6272405.

[9] “Number of cancer cases rising worldwide in 20–49 age group,” *Ukrinform*, Oct. 21 2025. [Online]. Available: https://www.ukrinform.ua/rubric-world/4049855-u-sviti-zrostae-kilkist-vipadkiv-raku-u-vikovij-kategorii-vid-20-do-49-rokiv.html.

[10] “Radiation Problems,” *Problems of Radiation Medicine and Radiobiology*, vol. 28, 2023. [Online]. Available: https://radiationproblems.org.ua/28_2023_eng_s176.html.

[11] S. H. Sung *et al.*, “Thyroid – fact sheet,” *Global Cancer Observatory: Cancer Today*. Lyon, France: International Agency for Research on Cancer, 2024 (update). [Online]. Available: https://gco.iarc.who.int/media/globocan/factsheets/cancers/32-thyroid-fact-sheet.pdf.

[12] American Cancer Society, “Thyroid cancer: Survival rates,” 2024. [Online]. Available: https://www.cancer.org/cancer/types/thyroid-cancer/detection-diagnosis-staging/survival-rates.html.

[13] H. A. Han *et al.*, “The cost and financial burden of thyroid cancer on patients in the US,” *JAMA Otolaryngology–Head & Neck Surgery*, vol. 148, no. 7, 2022. [Online]. Available: https://jamanetwork.com/journals/jamaotolaryngology/fullarticle/2792057. https://doi.org/10.1001/jamaoto.2022.0660

[14] M. T. Samà *et al.*, “Molecular biology of papillary thyroid microcarcinomas: What is new?” *Revista Portuguesa de Endocrinologia, Diabetes e Metabolismo*, vol. 11, no. 2, pp. 287–295, 2016. https://doi.org/10.1016/S1646-3439(16)30003-7.

[15] “Papillary thyroid cancer,” *Wikipedia*. [Online]. Available: https://en.wikipedia.org/wiki/Papillary_thyroid_cancer

[16] “Papillary thyroid carcinoma: An overview,” *American Journal of Clinical Pathology*, vol. 130, no. 7, pp. 1057–1062, 2006. https://meridian.allenpress.com/aplm/article/130/7/1057/459932/Papillary-Thyroid-Carcinoma-An-Overview.

[17] “Papillary Thyroid Cancer Columbia,” *University Department of Surgery*. [Online]. Available: https://columbiasurgery.org/conditions-and-treatments/papillary-thyroid-cancer.

[18] N. Eisemann *et al.*, "Nationwide real-world implementation of AI for cancer detection in population-based mammography screening," *Nature Medicine*, 2025. [Online]. Available: https://gmka.org/uk/news/shtuchnyj-intelekt-pidvyshhyv-tochnist-vyyavlennya-raku-molochnoyi-zalozy-u-programi-mamografichnogo-skryningu/.

[19] Clinical Oncology Ukraine, “Use of artificial intelligence in medicine, surgery, and oncology,” 2024. [Online]. Available: https://www.clinicaloncology.com.ua/article/33692/vikoristannya-shtuchnogo-intelektu-v-mediczini-hirurgi%D1%97-stomatologi%D1%97-onkologi%D1%97.

[20] *Ukraine Medical Journal,* “Impact of innovations in artificial intelligence on the efficiency of diagnostic procedures in oncology,” 2024. Available: https://umj.com.ua/uk/publikatsia-260483-vpliv-innovatsij-u-shtuchnomu-intelekti-na-efektivnist-diagnostichnih-protsedur-v-onkologiyi.

[21] Y. Habchi *et al.*, “AI in thyroid cancer diagnosis: Techniques, trends, and future directions,” *Systems*, vol. 11, no. 10, p. 519, 2023. https://doi.org/10.3390/systems11100519.

[22] M. A.-S. Ahmad and J. Haddad, “An explainable AI model for predicting the recurrence of differentiated thyroid cancer,” Dept. Med. Eng., Al-Ahliyya Amman Univ., Amman, Jordan.

[23] “UCI Machine Learning Repository,” *Differentiated Thyroid Cancer Recurrence Dataset*. [Online]. Available: https://archive.ics.uci.edu/dataset/915/differentiated+thyroid+cancer+recurrence.

[24] X. Li *et al.*, “Diagnosis of thyroid cancer using deep convolutional neural network models applied to sonographic images: A retrospective, multicohort, diagnostic study,” *The Lancet Oncology*, vol. 20, no. 2, pp. 193–201, 2018. https://doi.org/10.1016/S1470-2045(18)30762-9.

[25] “World’s first AI model for thyroid cancer diagnosis gives 90% accuracy and reduced consultation preparation time,” *eCancer*, Apr. 23, 2025. [Online]. Available: https://ecancer.org/en/news/26352-worlds-first-ai-model-for-thyroid-cancer-diagnosis-gives-90-accuracy-and-reduced-consultation-preparation-time.

[26] F. Dai *et al.*, “Improving AI models for rare thyroid cancer subtype by text-guided diffusion models,” *Nature Communications*, vol. 16, article 59478, 2025. https://doi.org/10.1038/s41467-025-59478-8.

[27] Q. Lu *et al.*, “Application progress of artificial intelligence in managing thyroid disease,” *Frontiers in Endocrinology*, vol. 16, Jun. 2025. https://doi.org/10.3389/fendo.2025.1578455.

[28] K. Shen, M. Tan, Y. Liu, X. Xu, and S. Yang, “From data to diagnosis: How artificial intelligence is revolutionizing preoperative assessment of thyroid nodules and cancer,” *European Journal of Surgical Oncology*, Version of Record, Jun. 20, 2025. https://doi.org/10.1016/j.ejso.2025.110191.

[29] E. J. Ha *et al.*, “Deep learning-based artificial intelligence model to assist thyroid nodule diagnosis and management: A multicentre diagnostic study,”

The Journal of Clinical Endocrinology & Metabolism, vol. 109, no. 2, pp. 527–535, 2024. https://doi.org/10.1210/clinem/dgad503

[30] Shen, P., P. Shen et al., "Explainable multimodal deep learning for predicting thyroid cancer lateral lymph node metastasis using ultrasound imaging," *Nature Communications*, vol. 16, p. 7052, 2025. https://doi.org/10.1038/s41467-025-62042-z.

[31] M. Ludwig *et al*., "The use of artificial intelligence in the diagnosis and classification of thyroid nodules: An update," *Cancers*, vol. 15, no. 3, p. 771, 2023. https://doi.org/10.3390/cancers15030771.

[32] Y. Li *et al*., "Clinical value of artificial intelligence in thyroid ultrasound: A prospective study from the real world," *European Radiology*, vol. 33, pp. 4513–4523, Jan. 2023. https://doi.org/10.1007/s00330-022-09378-y.

[33] Q. Lu, Y. Wu, J. Chang, L. Zhang, Q. Lv, та H. Sun, "Application progress of artificial intelligence in managing thyroid disease," Frontiers in Endocrinology, vol. 16, 2025, https://doi.org/10.3389/fendo.2025.1578455.

[34] *Ultrasound machine Toshiba Aplio 500*. [Online]. Available: https://rh.ua/uzd-aparat/uzd-aparat-skaner-toshiba-aplio-500. Accessed: Nov. 20, 2025.

Received September 27, 2025

Sineglazov Victor. ORCID 0000-0002-3297-9060. Doctor of Engineering Science. Professor.
Head of the Department Aviation Computer-Integrated Complexes, Faculty of Air Navigation Electronics and Telecommunications, State University "Kyiv Aviation Institute", Kyiv, Ukraine.
Education: Kyiv Polytechnic Institute, Kyiv, Ukraine, (1973).
Research area: Air Navigation, Air Traffic Control, Identification of Complex Systems, Wind/Solar power plant, artificial intelligence.
Publications: more than 800 papers.
E-mail: svm@kai.edu.ua

Tsymbaliuk Roman. ORCID 0009-0008-3525-8892. Postgraduate Student.
Department of Artificial Intelligence, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine.
Education: National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine, (2017).
Research interests: artificial neural networks, programming.
Publications: 1.
E-mail: tsymbaljuk2001@gmail.com

Khaziyev Vadym. ORCID 0000-0003-4568-0364. Doctor of Medical Sciences. Surgeon of the highest category.
Department of Endocrine Surgery. Kyiv City Clinical Hospital № 18, Endocrinological Center, Kyiv, Ukraine.
Education: Kharkiv Medical Institute, Kharkiv, Ukraine, (1988).
Research interests: Surgery, Endocrinology.
Publications: more than 200 papers.
E-mail: khaziev6544@gmail.com

Roienko Yurii. ORCID 0009-0001-1838-0852. Postgraduate Student.
Kyiv City Clinical Hospital № 18, Endocrinological Center, Kyiv, Ukraine.
Education: Bogomolets National Medical University.
Research interests: endocrine surgery.
Publications: 1.
E-mail: royenko2@gmail.com

В. М. Синєглазов, Р. С. Цимбалюк, В. В. Хазієв, Ю. В. Роєнко. Інтелектуальне діагностування пухлин щитовидної залози

Статтю присвячено інтелектуальному діагностуванню пухлин щитовидної залози, діагностуванню папілярного раку щитовидної залози на основі загальної інформації, УЗД зображень, патогістологічних знімків. Розглянуто сучасні підходи до інтелектуального діагностування пухлин щитовидної залози із застосуванням методів машинного навчання та штучного інтелекту. Розглянуто види медичних інтелектуальних систем, їх архітектуру, точність та сукупність задач, які вони виконують для класифікації раку щитовидної залози. Розглянуто проблеми папілярного раку щитовидної залози, описано специфіку захворювання та ознак, за якими воно діагностується. Окреслено основні завдавання інтелектуальної системи, здатної автоматично аналізувати медичні дані пацієнтів і підтримувати прийняття клінічних рішень лікарем-ендокринологом, сегментувати та класифікувати пухлину щитовидної залози. Описано обладнання, з допомогою якого формувалася навчальна вибірка, описано процес набирання даних для побудови інтелектуальної медичної системи. Поставлено задачу, яка буде розв'язуватись. Охарактеризовано метрики, за якими буде оцінюватись точність інтелектуальної медичної системи. Подано архітектуру інтелектуальної медичної системи, охарактеризовано основні її блоки, описано функціонал кожного блоку. Подано UML діаграму, за якою працюватиме інтелектуальна медична система. Подано дані, які будуть використовуватись для формування навчальної вибірки, вказано їх тип, розмірність, яким чином дані збираються, та як ці дані будуть використовуватись для навчання інтелектуальної медичної системи. Результати дослідження спрямовані на підвищення ефективності раннього виявлення патологій щитовидної залози та зменшення кількості хибних діагнозів, створення зручного інструменту, який скоротить час діагностування хвороби лікарем та підвищить точність діагностування папілярного раку щитовидної залози.

Ключові слова: штучний інтелект; машинне навчання; нейронні мережі; медичні інтелектуальні системи; рак щитовидної залози; діагностування пухлин.

Синєглазов Віктор Михайлович. ORCID 0000-0002-3297-9060. Доктор технічних наук. Професор.
Завідувач кафедрою авіаційних комп'ютерно-інтегрованих комплексів. Факультет аеронавігації, електроніки і телекомунікацій, Державний університет «Київський авіаційний інститут», Київ, Україна.
Освіта: Київський політехнічний інститут, Київ, Україна, (1973).
Напрям наукової діяльності: аеронавігація, управління повітряним рухом, ідентифікація складних систем, вітроенергетичні установки, штучний інтелект.
Кількість публікацій: більше 800 наукових робіт.
E-mail: svm@kai.edu.ua

Цимбалюк Роман Сергійович. ORCID 0009-0008-3525-8892. Аспірант.
Кафедра штучного інтелекту, Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, Україна.
Освіта: Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, Україна, (2017).
Напрям наукової діяльності: штучні нейронні мережі, програмування.
Кількість публікацій: 1.
E-mail: tsymbaljuk2001@gmail.com

Хазієв Вадим Віталійович. ORCID 0000-0003-4568-0364. Доктор медичних наук. Хірург вищої категорії.
Відділення ендокринної хірургії, Київська міська клінічна лікарня №18, Ендокринологічний центр, Київ, Україна.
Освіта: Харківський медичний інститут, Харків, Україна, (1988).
Напрям наукової діяльності: Ендокринологія, Хірургія.
Кількість публікацій: більше 200 наукових робіт.
E-mail: khaziev6544@gmail.com

Роєнко Юрій Васильович. ORCID 0009-0001-1838-0852. Аспірант.
Київська міська клінічна лікарня №18, Ендокринологічний центр, Київ, Україна.
Освіта: Національний медичний університет імені Ю. Богомольця, (2014).
Напрям наукової діяльності: ендокринна хірургія.
Кількість публікацій: 1.
E-mail: royenko2@gmail.com