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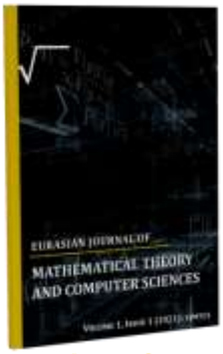

HARDWARE-SOFTWARE COMPLEXES FOR THE PRIMARY DIAGNOSIS OF GASTROENTEROLOGICAL DISEASES

Yakhshiboyev R.E.

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ABSTRACT

This article discusses software and hardware systems for primary diagnostics. Relations with the Decree of the President of the Republic of Uzbekistan, No. PP - 4996 of February 17, 2021 "On measures to create conditions for the accelerated introduction of artificial intelligence technologies." and in accordance with the strategy "Digital Uzbekistan - 2030", an analysis of software and hardware systems for the primary diagnosis of gastroenterological diseases was made. Based on the analysis, a scientific study was carried out jointly with gastroenterologists at the clinic of the Tashkent Medical Academy.

The technical characteristics, cost, manufacturers and the process of diagnosing were studied. The analysis of software and hardware systems for the primary diagnosis of gastroenterological diseases is divided into two parts: classical tools and modern tools for diagnosing gastroenterological diseases.

A comparison is made of the technical characteristics, cost, manufacturers and process of diagnosing classical instruments for diagnosing gastroenterological diseases and modern instruments for diagnosing gastroenterological diseases.

In the last part of the article, a new software and hardware complex "Saliva" was proposed, which operates on the basis of modern artificial intelligence technology, that is, a deep machine learning algorithm was used. Based on the algorithm of deep machine learning, Random Forest was adapted to the proposed "Saliva" hardware and software system.

This article presents an analysis of hardware and software used in gastroenterology. Currently, artificial intelligence is widely used in the field of medicine.

Gastroenterological diseases take the 2nd place in the ranking of world diseases. For this reason, in the 2nd clinic of the Tashkent Medical Academy, together with gastroenterologists, an analysis of the hardware and software systems used in gastroenterology was carried out [1,2].

In the field of gastroenterology, taking into account the time spent on timely and accurate diagnosis of a patient, in cooperation with gastroenterologists, a software and hardware complex has been developed that operates on the basis of a machine learning algorithm, which can be an additional assistant to a gastroenterologist [3,4].

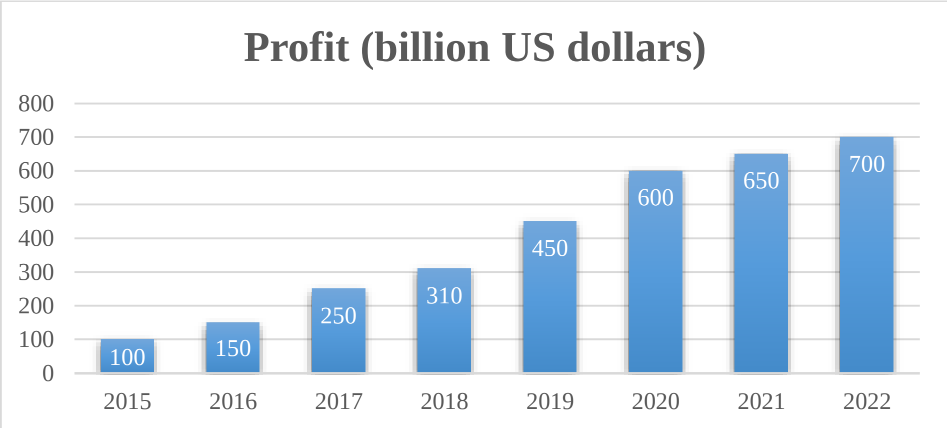

Fig 1. Trend in the development of medical software and hardware systems.

Used in gastroenterology:

Endoscopies: gastroscopes, gastroduodenoscopes, duodenoscopes, esophagoscopes, colonoscopes, video gastroscope, thin gastrofibroscope, gastro-fibroscope, cystofibroscope;

Electrogastroenterography: Gastroentero-monitor, Gastromanometer, Acidogastrometer, Acidogastromonitor.

Endoscopy - devices used for a complete study of the gastrointestinal tract. There are also three types of visual examination of the mucous membrane of the esophagus, stomach and duodenum 12:

- fibrogastroduodenoscopy (FGDS)
- esophagogastroduodenoscopy (EGDS)
- video esophagoduodenoscopy (VEGDS)

Endoscopy is a flexible tube, inside this tube is a fiber optic system for viewing from inside the gastrointestinal tract. To perform an endoscopy procedure, the gastroenterologist must be aware of the patient's presence of gastrointestinal diseases, surgeries and such conditions, for example, whether the patient has experienced a myocardial infarction or stroke, and whether there is still an allergy to medications.

Endoscopy is performed on an empty stomach, that is, the complete exclusion of food 6-8 hours before the endoscopy procedure. Before the procedure, the patient must undergo local anesthesia. The process of the endoscopy procedure is shown in Figure 2. The procedure is done within 10 minutes. The study of endoscopy has its own complications, that is, from the side of the cardiovascular or respiratory systems:

• Complications of improper preparation.
• Complications of premedication and anesthesia.

- Complications that arise during the study.
- Complications arising from violation of the rules for processing endoscopes.
- Elderly age
- NYHA III-IV heart failure
- Aortic stenosis III-IV degree
- Severe lung pathology
- Bleeding tendency (prothrombin index <50%, thrombocytopenia <50,000/μl)
- Anemia (hemoglobin < 80 g/l)
- Emergency interventions

There is also an emerging consequence after endoscopy: an unpleasant sensation in the throat for 48 hours.

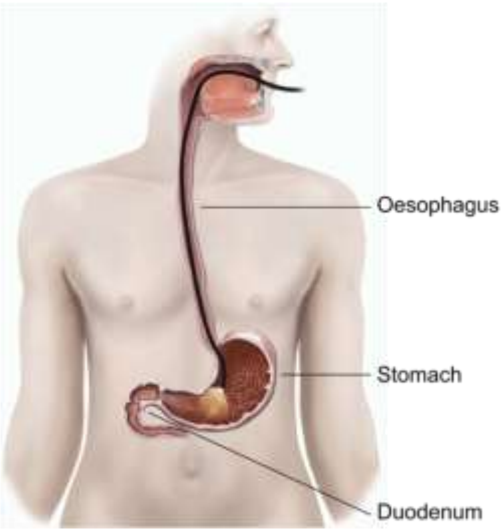

Fig 2. The process of the endoscopy procedure.

Electrogastroenterography is a method for examining the gastrointestinal tract using simultaneously biopotentials from various parts of the gastrointestinal tract. There are two types of methods for studying the motor-evacuation function of the gastrointestinal tract. The first group of studies: allows you to determine the contractile activity of the gastrointestinal tract and by measuring the pressure inside the gastrointestinal tract using balloons, microsensors, radio capsules, open water-perfusion catheters.

The second group of research: carried out electrophysiological methods based on the relationship of electrical and contractile activity of the gastrointestinal tract. They include the determination of biopotentials from electrodes fixed on the walls of the organs.

Figure 3. Three-dimensional electrogastroenterography of the patient is shown.

The purpose of using electrogastroenterography:

- determination of the type of violation - functional or mechanical;
- identification of the localization of the lesion (section of the gastrointestinal tract);
- choice of treatment method;
- selection of corrective therapy.

One of the study groups is patients with gastric and duodenal ulcers, in the pathogenesis of which motor disorders of the upper gastrointestinal tract play an important role.

Diseases of the small intestine. Peripheral electrogastroenterography is especially important for revealing its functional disorders.

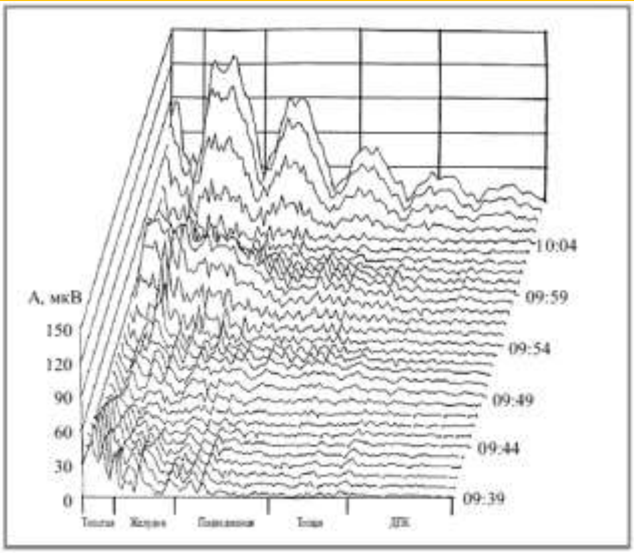

Figure 3. Three-dimensional electrogastroenterography of the patient.

Electrogastroenterography is also used in space experiments, that is, the condition of the gastrointestinal tract of an astronaut is checked during the flight. The research process is divided into 24 hours [5,6].

Fig 4. Hardware-software complex “Saliva”

Fig. 4. Hardware-software complex “Saliva” is shown. The “Saliva” hardware and software complex was developed jointly with gastroenterologists at the clinic of the Tashkent Medical Academy. The functional structure of the Saliva hardware-software complex is shown in Figure 4.

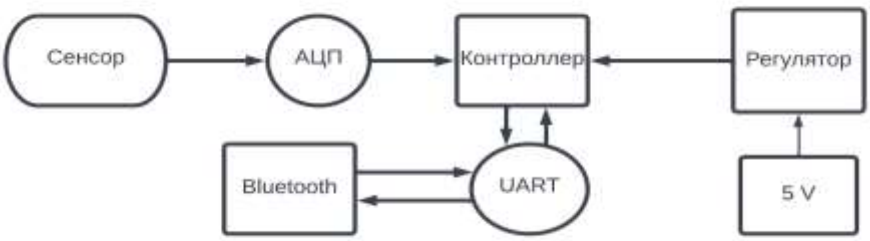

Fig. 5. Functional structure of the hardware-software complex "Saliva"

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1. Sensor - 7 channel saliva sensor
2. ADS1298 - ADC (analogue-to-digital converter);
3. Atmega328 - microcontroller;
4. Bluetooth HC-05 - Acts as a wireless module between Saliva device and computer.
5. LM2596_5V - Linear regulator developed by Texas Instrument for small devices.
6. External power supply.

The functional structure of the Saliva hardware-software complex was developed and used a 7-channel human saliva sensor. An analog-to-digital converter for obtaining analog data from human saliva and transmitting data in digital form to an Atmega 328 microcontroller [7,8]. After receiving, the digital data is transmitted via Bluetooth with the UART protocol to a smartphone or personal computer. Also, the Saliva hardware-software complex has a current regulator, that is, a 5V battery is used in the hardware-software complex. Figure 6 shows the structure of the Saliva hardware-software complex. Figure 6 fully shows how the Saliva hardware-software complex works [9,10].

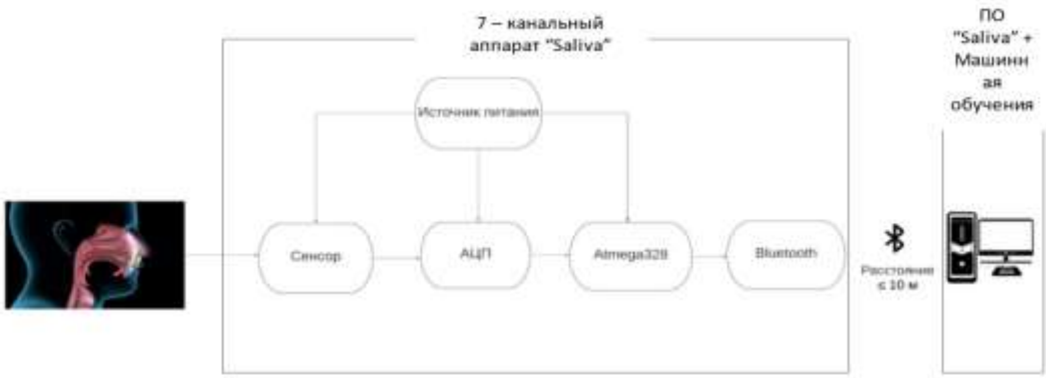

Figure 6. Structure of the hardware-software complex “Saliva”

Table 1. The composition of the saliva of a healthy person

№	The composition of saliva	Qty. (% and g/l)
1	Water	99,4-99,5 %
2	Organic and inorganic components	0,5-0,6 %
3	Squirrels	1,4-6,4 г/л
4	Mucin	0,8-6,0 г/л
5	cholesterol	0,02-0,5 г/л
6	Glucose	0,1-0,3 г/л
7	Ammonium	0,01-0,12 г/л
8	Uric acid	0,005-0,03 г/л

Table 1 shows the composition of the saliva of a healthy person, from the composition of a healthy person, 6 parameters were selected with gastroenterologists for further scientific research.

The selected parameters for the study are indicated in Table 2.

Table 2. Selected parameters for the study

Data set parameters	The name of the composition of saliva
Parameter_1	Squirrels
Parameter_2	Mucin
Parameter_3	cholesterol
Parameter_4	Glucose
Parameter_5	Ammonium
Parameter_6	Uric acid

With the help of the selected parameters, a database of patients was created, that is, huge data on patients was needed for research. The Random Forest (RF) machine learning algorithm has been upgraded. An algorithm for data exchange from the Saliva hardware-software complex to a smartphone or computer has been developed (Fig. 7) [11,12].

As a result of joint work with specialists, 5000 sample data were collected for primary diagnosis. With the help of the modernized Random Forest (RF) machine learning algorithm, the process of learning the sample data of patients was done, as a result, the accuracy of the primary diagnosis showed 98% in 2 minutes [13,14].

With the help of the developed hardware-software complex "Saliva" it is possible to speed up the process of primary diagnostics. The developed hardware-software complex “Saliva” can become an assistant to a gastroenterologist, ambulance specialists and medical staff of family clinics. Table 3 shows a detailed analysis of hardware and software systems in gastroenterology [15].

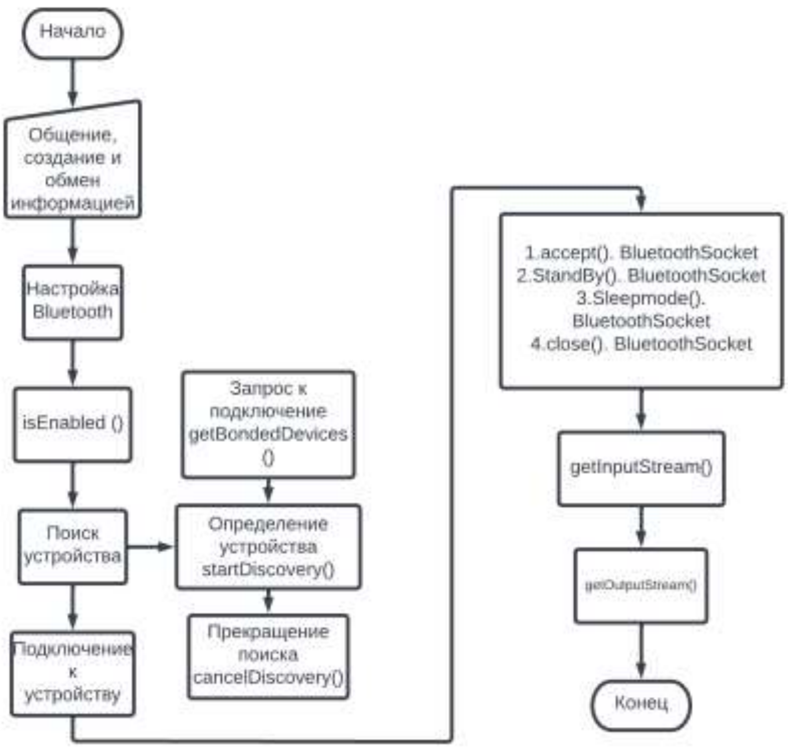

Fig 7. Steps for communication and data exchange between Saliva equipment and computer

Table 3. Analysis of hardware-software complexes of primary diagnostics

№	Device name	Price	Diagnosis time	Accuracy diagnosing
1	Gastroscope	14.5 million sum	30 minutes	70%
2	Gastroduodenoscope	40 million sum	20 minutes	80%
3	Duodenoscope	66 million sum	15 minutes	82%
4	Esophagoscope	72 million sum	20 minutes	84%
5	Colonoscope	420 million sum	10 minutes	90%
6	Videogastroscope	61 - 150 million soums	10 minutes	85%
7	Thin gastrofibroscope	90 million sum	25 minutes	80%
8	Gastrofibroscope	138 million sum	20 minutes	86%
9	Cystofibroscope	112 million sum	20 minutes	81%
10	Gastroenteromonitor	7.5 million sum	21 minutes	72,50%
11	Gastromanometer	71 million sum	10 minutes	84,50%
12	Acid gastrometer	71 million sum	3 hours	85,50%
13	Acidogastromonitor	71 million sum	3 hours	86,50%
14	Saliva	3 million sum	2 minutes	98%

CONCLUSION

Thus, the above devices enable the primary diagnosis of diseases of the gastrointestinal tract. This device is mainly used for preliminary diagnosis as a test for children and patients who experience discomfort when swallowing a tube.

Devices called "Saliva" are created using the latest technology, that is, using an artificial intelligence algorithm based on deep machine learning, preliminary diagnostics are carried out and high-precision results are obtained from patients.

References:

1. Yakhshiboyev R. E. Development of Software and Hardware Complex for Primary Diagnosis of Gastroenterological Diseases on the Basis of Deep Machine Learning //Nexus: Journal of Advances Studies of Engineering Science. – 2023. – Т. 2. – №. 1. – С. 9-20.

2. Muminov B. B. et al. Analysis of artificial intelligence algorithms for predicting gastroenterological diseases. – 2022.

3. Яхшибоева Д. Э., Эрметов Э. Я., Яхшибоев Р. Э. ПЕРСПЕКТИВЫ ИНФОРМАЦИОННО-ЦИФРОВЫХ ТЕХНОЛОГИЙ В МЕДИЦИНЕ //Замонавий клиник лаборатор ташхиси долзарб муаммолари. – 2022. – №. 1. – С. 193-194.

4. XXXXXXXXXXX X. ANALYSIS OF HARDWARE AND SOFTWARE FOR INITIAL DIAGNOSIS OF GASTROINTESTINAL DISEASES //Journal of new century innovations. – 2023. – Т. 20. – №. 1. – С. 75-90.

5. Яхшибоев Р. Э. и др. ПРОГНОЗ ИСПАРЕНИЯ ПОДЗЕМНЫХ ВОД С ИСПОЛЬЗОВАНИЕМ МНОЖЕСТВЕННОЙ ЛИНЕЙНОЙ РЕГРЕССИИ //Journal of new century innovations. – 2023. – Т. 20. – №. 1. – С. 91-99.

6. Яхшибоев Р. Э. РАЗРАБОТКА ПРОГРАММНО-АППАРАТНОГО КОМПЛЕКСА НА ОСНОВЕ НЕЙРОННОЙ СЕТИ ДЛЯ ПЕРВИЧНОЙ ДИАГНОСТИКИ ГАСТРОЭНТЕРОЛОГИЧЕСКИХ ЗАБОЛЕВАНИЙ //Journal of new century innovations. – 2023. – Т. 20. – №. 1. – С. 108-119.
7. Яхшибоева Д. Э., Эрметов Э. Я., Яхшибоев Р. Э. РАЗВИТИЕ ЦИФРОВЫХ ТЕХНОЛОГИИ В МЕДИЦИНЕ //Journal of new century innovations. – 2023. – Т. 20. – №. 1. – С. 100-107.
8. Яхшибоев, Рустам, Мураталы Базарбаев, and Эркин Эрметов. "ПРИМЕНЕНИЕ НЕЙРОННЫХ СЕТЕЙ ДЛЯ ДИАГНОСТИКИ МЕДИЦИНСКИХ ЗАБОЛЕВАНИЙ." (2023).
9. Яхшибоев, Рустам, et al. "РАЗРАБОТКА МОДЕЛИ РАСПОЗНАВАНИЯ ГРАФИЧЕСКИХ ОБЪЕКТОВ НА ОСНОВЕ МЕТОДА «TRANSFER LEARNING» ДЛЯ ДИАГНОСТИКИ В СФЕРЕ ЗДРАВООХРАНЕНИИ." (2023).
10. Yaxshiboyev R. et al. ANALYSIS OF THE PROCESS OF DEEP MACHINE LEARNING BASED ON THE RESULTS OBTAINED FOR PRIMARY DIAGNOSTICS OF GASTROENTEROLOGICAL DISEASES //CAJM. – 2022.
11. Yakhshiboyev R. E. DEVELOPMENT OF A HARDWARE MODULES FOR THE PRIMARY DIAGNOSIS OF GASTROINTESTINAL DISEASES //Proceedings of International Conference on Scientific Research in Natural and Social Sciences. – 2023. – Т. 2. – №. 1. – С. 84-90.
12. Яхшибоев Р., Сиддиков Б. ЦИФРОВЫЕ ТЕХНОЛОГИИ ДЛЯ ПЕРВИЧНОЙ ДИАГНОСТИКЕ РАЗНЫХ МЕДИЦИНСКИХ ЗАБОЛЕВАНИЙ //Innovations in Technology and Science Education. – 2022. – Т. 1. – №. 4. – С. 94-105.
13. Yaxshiboyev R. Development of a model of object recognition in images based on the «transfer learning» method //Central asian journal of education and computer sciences (CAJECS). – 2022. – Т. 1. – №. 4. – С. 36-41.
14. Yaxshiboyev R. Development of a software and hardware complex for primary diagnostics based on deep machine learning //Central asian journal of education and computer sciences (CAJECS). – 2022. – Т. 1. – №. 4. – С. 20-24.
15. Yaxshiboyev R., Yaxshiboyeva D. Analysis of algorithms for prediction and preliminary diagnostics of gastroenterological diseases //Central asian journal of education and computer sciences (CAJECS). – 2022. – Т. 1. – №. 2. – С. 49-56.