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Development of hardware-software for cardiac-monitoring systems

Heartbeat, body temperature and blood pressure are among the most important parameters of the human body. Medical specialists can analyze and diagnose various diseases by measuring these parameters with the help of various medical equipment. In this article, the process of developing a remote cardiac-motoring system has discussed. In addition, using the Bluetooth module an implementation of the procedure for remote monitoring of the patient's electrocardiogram is presented.

Keywords: ECG system, Bluetooth module, microcontroller, monitoring system, AD8232 module, electrocardiography.

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STRUCTURE OF OPERATORS OF QUANTUM ALGORITHMS

Abstract: The article (paper) proposes the structure of operators of quantum algorithms, its mathematical and schematic representation. The general structure of the universal quantum algorithm in the form of diagrams is realized in the article (paper). The diagram presents the main elements, their properties, functions of the quantum algorithm. Each block of the schematic diagrams are decomposed of successive processes and stages of quantum algorithms.

Keywords: Quantum algorithm, entanglement, superposition, quantum computation, interference, Hadamard operator, quantum block, unitary matrix.

Introduction. At present, active research and physical realization of a quantum computing is conducting in the world. Prototypes of computing devices have already been built in different parts of the world at different times, but there is not yet a full-fledged quantum calculator that simulates quantum computing on a computer with a classical architecture in order to study and further design a quantum calculator.

The result of the quantum algorithm is of a probabilistic nature. Due to a small increase in the number of operations in the algorithm and to maximize the entanglement of qubits, can be arbitrarily approximate the probability of obtaining the correct result to unity [1].

1. Functions and types of quantum operators in designing quantum algorithms.

The process of designing a quantum algorithm consists of a matrix form of the representation of three operators [2] [3]. Superposition (S), quantum entanglement [2] (entangled states) (UF) and interference (Int). In general, the structure of the quantum algorithm, as the basis of quantum computation, can be represented as following

$$QAY= [(Int \otimes {}^{n}Id)* U_f]^{h+1} * [{}^{n}H \otimes {}^{m}S] \quad (1)$$

Where Id is an identical operator, ⊗ symbol is a tensor product; S is an operator of superposition and finally, H is a Hadamard operators.

In Fig. 1 describes the structure of the operators of quantum algorithms, equivalent to the expression. The input of the quantum algorithm is always given a binary function f. This function is represented as a mapping that divides the image of each input binary string. First, the function f is coded as a unitary matrix operator U_F that depends on f function properties. The resulting matrix operator U_F is included in the structure of a cable cell, a unitary matrix whose structure depends on the U_F matrix and on the problem that the algorithm must solve [1].

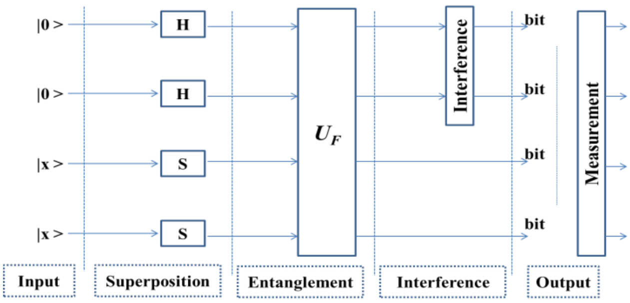

Fig. 1. Structure of operators of quantum algorithms.

The superposition contains all the information needed to solve a specific task/problem. Due to the superposition creation, a measurement operation is performed to extract the information. Consecutive use of the quantum operator and measurement of the result characterizes the quantum block. It is executed k times to derive a set of basis vectors. This measurement is not a deterministic operation, therefore the resulting basis vectors will be different. Therefore, each of them will contain only a part of the information needed to solve a particular task/problem [4].

2. General structure of the quantum algorithm

Schematic diagram of the simulation of a quantum algorithm operation on a classical computing device is illustrated in Fig. 2. The quantum block in this figure performs the alternate application of the quantum operator and the measurement of the result. It is executed n times to obtain a set of basis vectors. Since measurement is not a deterministic operation, the resulting basis vectors will be the same, and each of them will contain only a part of the information needed to solve the problem [5].

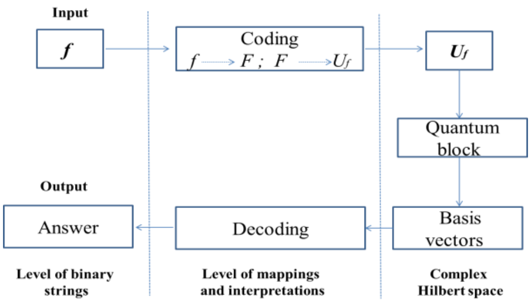

Fig. 2. Schematic diagram of the quantum algorithm.

The final phase of the quantum algorithm is the interpretation of the set of basis vectors for the solution of a specific task/problem with a certain probability value [1-2].

2.1. Encoding block

The work diagram of the encoding block is shown in Fig. 3.

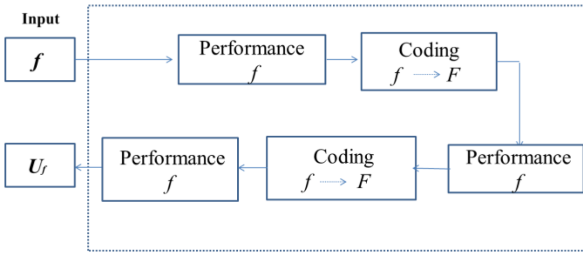

Fig. 3. Decomposition of encoding block..

Step 1. The representation table of the function $f:\{0,1\}^{n+m} \rightarrow \{0,1\}^{n+m}$ is transformed into a representation table of a unitary function $F:\{0,1\}^{n+m} \rightarrow \{0,1\}^{n+m}$ such that

$$F(x_0,\ldots\ldots x_{n-1}, y_0,\ldots\ldots y_{n-1}) = (x_0,\ldots\ldots x_{n-1}, f(x_0,\ldots\ldots x_{n-1}))\otimes(y_0,\ldots\ldots y_{n-1}) \quad (2)$$

The necessity of such a change is related to the unitarity condition for the operator U_F. It is reversible and can not represent two different inputs into the same output values [6]. Since this operator is a matrix mapping of the function F, it must be invertible. Reversibility is carried out by increasing the number of bits and describing the function F instead of f.

Step 2. The representation of the function F is transformed into a representation, according to the following restrictions.

$$\forall s \in \{0,1\}^{n+m} : U_m\,[\tau(s)] = \tau[F(s)] \quad (3)$$

The encoding table $\tau:\{0,1\}^{n+m} \rightarrow C^{2n+m}$, where C^{2n+m} is the resultant Hilbert space, defined as:

$$\tau(0) = \begin{matrix}1\\0\end{matrix} = |0>,\ \tau(1) = \begin{matrix}0\\1\end{matrix} = |1> \qquad (4)$$

$$\tau(x_0,\ldots\ldots x_{n+m-1}) = \tau(x_0) \otimes\ldots\otimes \tau(x_{n+m-1}) = |x_0,\ldots\ldots x_{n+m-1}> \quad (5)$$

Step 3. The representation of U_F is transformed into a matrix operator according to the following rule:

$$[U_{Fij}]=1 \Leftrightarrow U_F\,|i> = |j> \quad (6)$$

This rule is easy to understand if we consider |i> and |j> as columns of a vector. By distributing these columns according to the canonical basis, UF determines the permutation of the rows of the identity matrix. In a general form, the series |i> is mapped into the series |j> [3].

2.2. Quantum block

The main element of a quantum block is a quantum cell.

Its form depends on the properties of the matrix of the operator [7]. The matrix operator U_F, which is the output of the encoding block, in this structure is the input of the quantum block.

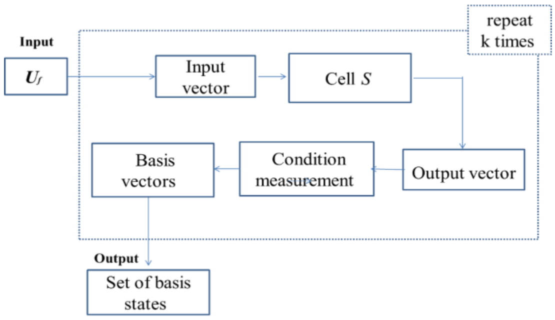

Fig. 4. Decomposition of quantum block.

The unitary matrix is applied k times to the initial canonical vector |i> of dimension 2^{n+m}. The resultant complex linear combination of basis vectors is measured by producing one basic vector $|x_i>$ as a result. All the measured basis vectors $\{x_1 \ldots. x_k\}$ come together.

The resulting set is the output of a quantum block.

The decoding unit includes an interpretation of the set of basis vectors. Decoding of basic vectors consists in their transformation into binary strings. Then they are used as the coefficients of some equation or for extracting the answer. The structure of the decoding unit depends significantly on the nature of the problem being solved, and is essentially one or other of the classical algorithms.

The last part of the quantum algorithm contains a block of interpretation of a set of basis vectors that allows you to isolate a finite, meaningful solution of the problem under study with a certain probability [8].

Summarizing all of the above, it is worth noting that the developed and proposed general structure of the quantum algorithm finds a successful implementation in the software development and implementation of quantum simulators as auxiliary external modules. As for the structure of quantum algorithms operators, it is universal and, in general, does not depend on the properties and solved problems of a particular quantum algorithm.

Conclusion. The mathematical and schematic representation structure of the operators of quantum algorithms is proposed in the paper. Detailed decomposition of each block of the schematic diagram of the description of sequential processes and stages of quantum algorithms is performed. The general structure of the universal quantum algorithm is realized as diagrams that reveal the basic elements, their properties, functions and place in the work of the quantum algorithm.

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СТРУКТУРА ОПЕРАТОРОВ КВАНТОВЫХ АЛГОРИТМОВ

В статье предлагается структура операторов квантовых алгоритмов, ее математическое и схематическое представление. В статье реализована общая структура универсального квантового алгоритма в виде диаграмм. На диаграмме представлены основные элементы, их свойства, функции квантового алгоритма. Каждый блок принципиальных схем разбит на последовательные процессы и этапы квантовых алгоритмов.

Ключевые слова: квантовый алгоритм, запутывание, суперпозиция, квантовые вычисления, интерференция, оператор Адамара, квантовый блок, унитарная матрица.

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УДК 004.93

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КРЕДИТ-МОДУЛ ТИЗИМИ ТУЗИЛМАСИ ТАРКИБИДА БИЛИМЛАРНИ АДАПТИВ БАҲОЛАШНИ АВТОМАТЛАШТИРИШ

Мақолада таълим жараёнларида талабалар билмини адаптив баҳолашнинг автоматлаштириш масаласи ва уни замонавий кредит-модул тизими тузилмасига киритишнинг назарий ва амалий муаммолари ўрганилган, ўқитишга асосланган таниб олиш (распознавания) усуллари ёрдамида билимларни адаптив баҳолаш масаласи кўриб чиқилган. Билимларни адаптив назорат қилишнинг турли усуллари мавжуд, бироқ бу усуллар қатор камчиликларга эга: ўқитиш босқичида катта хажмдаги ахборотларни талаб этади ва таниб олиш босқичида компьютер хотирасидан сезиларли хажмда жой эгаллайди, ўқитилаётган объектнинг ноаниқ жавобларини ҳисобга олмайди ва ҳ.к. Шунга кўра, кредит-модул тизимига асосланган таълим тизимларида билимларни адаптив баҳолашда чизиқли-бўлакли аппроксимация усули ва баҳоларни ҳисоблаш алгоритмларига асосланган усуллардан фойдаланиш имконияти тадқиқ этилди. Кредит-модуль тизимида билимларни адаптив баҳолаш жараёнини автоматлаштиришда махсус дастурий таъминотни ишлаб чиқиш концепцияси таклиф этилди.

Калит сўзлар: адаптив баҳолаш, кредит-модул тизими, классификация, баҳоларни ҳисоблаш алгоритмлари, чизиқли-бўлакли аппроксимация усули

Кириш. Таълим жараёнларининг кредит-модул тизими – бу ўқув жараёнларини ташкил этиш модели бўлиб, у ўқитиш ва зачёт кредит (билимни баҳолаш) жараёнларини ягона модуль технологиясига асосланган ва талаба ўқув юкламасини ўлчови сифатида шаклланган [3]. Шунингдек кредит-модул тизими ўқув жараёнларини ташкил этишнинг ночизиқли модели сифатида ҳам қараш мумкин. Ночизиқли таълим тизими – бу ўқув жараёнини ташкил этиш усули бўлиб, унда таълимнинг умумийлигини сақлаган ҳолда, талабанинг ўқув материалларини ўзлаштиришда индивидуал шаклда ўқув жараёнини шакллантириш имкониятини беради. Бундай ҳолат ўқув жараёнлардаги "мустақил таълим" қисмини активациялаш имкониятини берган ҳолда, ҳар бир талаба билмини адаптив баҳолаш, зачёт бирлиги (Халқаро миқёсида билимини баҳолаш) ва модулнинг ягоналаштириш имкониятини беради. Шундай қилиб, зачёт бирликлари ва таълим модули ягоналиги талабанинг ўқув жараёнидаги таълим траекториясини самарали лойиҳалашда муҳим аҳамиятга эга ва бу траектория ўқув жараёнининг ажралмас қисми бўлади. Кредит-модуль тизимида, ўқув жараёнининг маълум цикли бўйича ўқиладиган фанлар рўйхати, ҳар бир фан бўйича ўқув материаллари, олинган билимларни баҳолаш тизими таклиф этилади. Талабанинг таълим траекториясини шакллантириш учун вариантлар, талабанинг интеллектуал имкониятларидан келиб чиққан ҳолда амалга оширилади. Ривожланган давлатлардаги олий таълим муассасаларида кредит-модул тизимининг жорий қилиниши бўйича ўтказилган назарий ва амалий таҳлиллар кредит-модул