New Digital Birth Certificate Based on Biometric and Documentary Data of the Child

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Abstract. This paper proposes a new format for a digital Birth Certificate. It contains a color photograph of the child's face and facial biometric characteristics, documentary information (child's full name, year of birth, etc.), information about the educational institution, and the full names of the mother and father. The developed software enables the creation of a digital Birth Certificate in the form of a BIO QR code that stores all the necessary documentary information about the child, which can be read by standard barcode scanners and software. The BIO QR code is embedded in the LSB layers of the color image of the child's face, allowing for the concealment of information, as the resulting image with embedded data is indistinguishable from the original. The proposed digital Birth Certificate is a GIF file consisting of a set of multimedia files (graphic, biometric, and documentary) that compactly store information about the child. The Digital Birth Certificate is a document that can be updated at various stages of a child's development and allows for the adjustment of documentary information and the characterization of their facial biometrics.

Keywords: digital birth certificate · QR code · BIO QR code · COLOR QR code · LSB layer · GIF file · biometric characteristic · biometric technologies · human phenotype

1 Introduction

In 2024, State Duma Deputy Sultan Khamzaev of the Russian Federation encountered a proposal to amend the form and content of the birth certificate. In her address to the Deputy Prime Minister, Deputy Tatyana Golikova proposed modernizing the document by adding photographs of the child at various stages of development (ages three, five, and seven). Furthermore, she proposed creating a new digital version of the certificate, which would be accessible through the government services portal. The deputy argued the need for such changes, as the document's format is inconsistent with modern digitalization and security requirements.

With the rapid development of digital technologies and the transition to electronic document management, the birth certificate form is being introduced. The lack of a digital version of the certificate and its administrator on digital platforms such as Gosuslugi makes it ineffective for identifying and recording minors. Implementing this new form

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will allow the creation of a certificate that will simplify citizen interactions with the government and enhance the protection of personal data. One of the key issues with the current form of birth certificate is its inability to prevent children from being unexpectedly transported across borders. The lack of photographs of the child in the document allow criminals to use forged documents to transport children, posing serious risks to their safety. This is especially relevant given the increasing number of international marriages and divorces, when one parent may have a child without the consent of the other parent.

Based on the above, it can be concluded that developing a new type of birth certificate is essential. This would include both verbal information (a description of the child and the parents) and graphic information (photographs of the child at various stages of development). Furthermore, the document should be available in digital form, which would simplify the identification and accounting process and improve child safety. Implementing such changes would address issues related to the illegal removal of children, the search for missing children, and their identification, ultimately enhancing the protection of minors' rights. The introduction of photographs and the adoption of a document format allow volunteer organizations to more quickly and accurately locate missing children, speeding their successful recovery. The new document format must be developed with modern technology and security requirements in mind to ensure the protection of the interests of children and their parents.

1.1 The Origin and Development of the Identity Card

The development of the passport system as a mechanism for identification of a person began in Europe in the 14th century, when international travel for trade and other purposes required the introduction of identity documents. The first travel documents contained information about the holder: first name, last name, hair and eye color, and nose shape. These documents can be considered as the prototypes of modern international passports. In the 15th century, they began to be issued not only to residents visiting another country but also to foreigners who needed to travel within the country.

In Russia, the history of the passport began in the 17th century with the introduction of so-called "dangerous letters" for persons traveling abroad. With the introduction of the passport system in 1724, peasants began to be issued "pass letters" necessary for traveling. Forgery of such documents was severely punished, including hard labor. The 19th century saw significant changes. In 1833, the "Code on Passports and Runaways" was approved, regulating the issuance and registration of passports. The Statute on Passport Documents, developed in 1894, provided for three types of passports: temporary passport books, poster passports, and permanent passport books.

After the October Revolution of 1917, the Soviet government introduced work books as identification documents. In 1930s, the passport system has modernized, and new passports began to contain a photograph of the holder.

After the war, the passport system underwent further standardization. Decrees of 1953 and 1974 introduced a uniform procedure for issuing passports, mandatory for all USSR citizens over 16 years of age. Passports recorded a person's last name, first name, patronymic, date and place of birth, marital status, and other information. Passports in Russia have evolved from simple travel documents to a comprehensive system of

personal identification, fulfilling the functions of monitoring, recording, and protecting citizens' rights.

However, it is worth noting that passports were and are currently issued to adults, while birth certificates are used for children. Before the Revolution, children born to commoners were registered in church parish registers; later, birth registers were introduced, which recorded the birth and issued a corresponding certificate. The document was called an "Extract from the Birth Register," popularly known as a "metric." In 1935, a decree of the Council of People's Commissars of the USSR approved a standard form for birth certificates and made their issuance mandatory. Currently, in the Russian Federation, the content of the Birth Certificate is regulated by Article 23 of Federal Law No. 143 of November 15, 1997.

1.2 Problems of Children's Travel Abroad

A significant number of children go missing in Russia every year. According to statistics, approximately 40,000 children disappear annually, and only a fraction of them are ever found [1–3]. The current birth certificate format creates problems when crossing the border, when proof of legal guardianship (parents) is required, when registering at educational institutions, and in other situations where confirmation of a minor's identity is required. This is especially true for children who are unable to provide information about themselves or for those separated from their families due to emergency situations.

Currently, the problem of illegal transporting children abroad is becoming increasingly pressing. This practice not only violates the rights of children and their legal guardians but also creates serious threats to the safety and well-being of minors.

According to international and national law, removing a child abroad without the consent of one of the parents or legal guardians violates the rights of the child and their legal guardians. In particular, the Hague Convention on the Civil Aspects of International Child Abduction of October 25, 1980, establishes mechanisms for the return of children illegally removed abroad. However, the use of false documents significantly complicates the process of identifying and preventing such actions.

Forged documents used to remove children may include false passports, visas, travel consents from the other parent or guardian, and false birth certificates. Such documents are often produced with a high degree of authenticity, making them difficult to detect at border control. As a result, children may be taken to another country, where their whereabouts become difficult to determine.

1.3 Social and Psychological Consequences

The illegal removal of children abroad using false documents has serious social and psychological consequences for both the children themselves and their families. For a child, such a transfer can be a traumatic experience, especially if they find themselves in a foreign country without the support of loved ones. Children may face language barriers, culture shock, and a lack of access to education and healthcare.

For parents and legal guardians, the loss of a child is a difficult emotional ordeal. Searching for and returning a child can take years, leading to lengthy legal proceedings

and significant financial costs. Furthermore, such situations are often accompanied by conflicts between parents, which negatively impacts the psychological climate in the family.

1.4 Measures to Prevent the Removal of Children with Forged Documents

To prevent children from being taken abroad using forged documents, comprehensive measures are needed, including both tightening border controls and improving legislation. One key area is the implementation of modern technologies, such as biometric identification systems, which allow for more effective detection of forged documents when taking children abroad.

Biometric identification is the process of identifying an individual based on a person's unique physiological or behavioral characteristics [4–10]. Unlike traditional authentication methods, biometric data cannot be forgotten, lost, or transferred to another person, making it more reliable and convenient for identifying children when taking them abroad. Facial image identification, the most common biometric authentication methods, appears to be the most promising. This method is based on the analysis of unique facial features, such as the distance between the eyes, the shape of the nose, cheekbones, and other parameters. However, if a person's appearance changes, this can lead to errors, meaning an incorrect decision will be made that the person is not the one depicted on the document.

This is precisely the main problem with identifying children—their appearance changes dramatically over a short period of time (sometimes less than a year). The shape of the nose, the contour of the face, the relationships between facial features (eyes, nose, mouth), and so on change. It is believed that significant changes in a person (not related to injury or surgery) end around age 25. However, these changes are most noticeable in children under 14–15 years of age. Therefore, issuing children a passport that is valid for 5–10 years and contains only one image at the time of issue creates problems during identification at customs control. A solution to this problem could be a new version of the electronic Birth Certificate, which will contain not only documentary information about the child, but also a current image of the child, as well as biometric characteristics, allowing for significantly more accurate identification, thereby preventing the illegal removal of children outside the Russian Federation.

1.5 Ways to Solve the Problem

It should be noted that border crossings typically require document checks for a large number of people. Adding a large amount of data to enable more precise identification can increase the time it takes inspectors to complete the check. Therefore, to optimize and accelerate this process, it is necessary to implement a method that will make this check as quick as possible. An obvious solution is to use barcoding methods for storing and transmitting data, which are widely used in various fields [12].

The idea of using barcodes to identify people during electronic payments was first presented in 1999 in [13]. In 2009, works [15, 16] appeared that proposed describing all information about a person's face using a set of black and white horizontal lines (brow line, eye line, and lip line), thus forming a binary code, which the authors called a

"biological barcode." Later, researchers [17] noted that transforming a biological barcode into a standard one would allow its use for identifying people. However, the authors were unable to propose approaches that would generate such a barcode.

Methods for constructing and applying a biological barcode for comparing facial images were first presented in the monograph [5]. The monograph proposed an algorithm closest to the concept of a linear "biological barcode," based on the use of a gradient in a sliding window. The problem with this approach is the impossibility of obtaining a stable code for facial images of the same person if they have different characteristics (e.g., different facial sizes in the images, head tilts, or emotions).

The next step in the development of methods for generating a barcode based on human biometric characteristics (facial expression) was the publication of works [6, 7]. The method proposed in [6] is based on constructing a luminance histogram for a grayscale image generated from the original color image, then averaging the histogram over a limited number of luminance intervals, quantizing the resulting values in the decimal range from 0 to 9, and converting the resulting data into a linear EAN-8 barcode using a standard algorithm. This approach also has some limitations, but is more stable than the one discussed previously.

The barcode generation method proposed in [7] and formalized in [8] involves calculating the distance between two identical mirror-image windows on a facial image, which move downwards in increments from the hair/forehead boundary to the lower boundary of the nose. The luminance gradients of this image are then calculated. The resulting gradients are then normalized, discretized, and the resulting values are averaged. To generate a standard image barcode, the resulting values are quantized to a decimal range from 0 to 9. The study demonstrated that the resulting barcode is stable under changes in the local dimensions of faces, their rotation, angle changes, and mirror rotation around a vertical axis, as well as in the presence of facial expressions and age-related changes. However, this method does not require significant computational effort or specialized image processing software. Since protecting children's facial images requires combining them with biometric facial characteristics and presenting them together in a single "digital portrait," it is necessary to study methods for embedding documentary and other information into barcodes.

1.6 Overview of Solutions that Use QR Codes in Personal Documents

The use of barcodes has become an effective tool during the COVID-19 pandemic, allowing you to track the vaccination status of citizens. QR TIGER [18] proposed to use QR codes for the Health Passport, storing information about human health in it. The passport contains medical history, information about allergies, the need to take medications, etc. Scanning a QR code with a smartphone allows you to access all medical information about a person. This makes it easier to transfer, share, and store important health information.

However, this QR code does not allow you to identify a person and is essentially only a way to access information about him. The same can be said for the Multimedia QR Code proposed [12] – the QR code stores only the URL that redirects the user to a landing page or a location in the cloud where the media file or PDF, PNG, JPEG, MP4 file, or Excel spreadsheets and Word files are stored.

The first work devoted to embedding biometric information in barcodes was [9]. This paper provides a list, characteristics and volume of facial biometric information used for bar coding. It is shown that the criteria for choosing a barcode for storing documentary, graphic and biometric information about a person are: sufficiency of color images of faces and anthropometric points for recording and storing information; the ability to write: numbers, special characters, numerical matrices, alphabetic information in Cyrillic and Latin; maximum geometric dimension; ease of writing and reading information and the popularity of using a barcode.

Only two-dimensional barcodes most fully meet these criteria, namely GS1 QR code, which has a capacity of 7089 digits or 4296 alphanumeric characters. At the same time, it can be used to build not only a color QR code [5–7, 20], but also a color barcode, which has the structure of halftone and color images [21, 22].

At the same time, several layers of QR codes, combined into a common layered structure, form a colored QR code [20], which has a data volume three times larger than a standard one. Such a color QR code is essentially an image and can be recorded in RGB scale, and the use of the.png (portable network graphics) format allows you to resize the image without losing information when reading from the color QR code.

The idea of creating and reading a color QR code is presented in Fig. 1. However, the use of such QR codes can reduce the likelihood of detecting a read error, as well as waste of color image resources, since all three images store the same message.

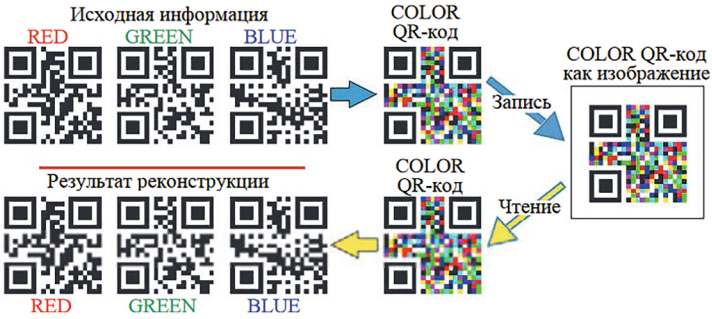

Fig. 1. Idea of creating and reading a color QR code [22]

Thus, you can modify this approach by putting different information in different layers of the image, and use a color image of a face as a drawing. This served as the basis for the approach to the formation of the BIO QR code proposed in [9]. Here, in order to obtain a BIO QR code, biometric information is prepared, which must be placed in the code. This information is recorded in the form of a QR code and embedded in the color image by replacing its G component (see Fig. 2). However, this substitution makes it impossible to obtain a color image of the face, since the image will be incorrect when merging the layers.

In [11], a method is proposed for embedding three different QR codes with biometric information about a person into pre-zeroed virtual LSB layers of the Red, Green and Blue components of a color face image. The size of each QR code must be equal to

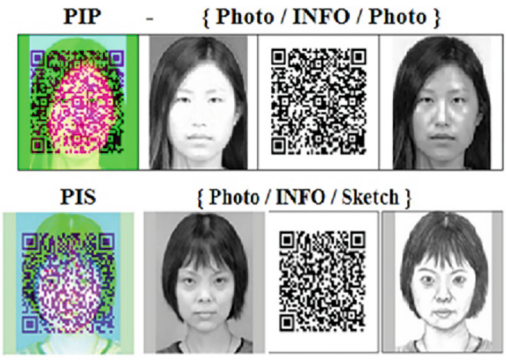

Fig. 2. PIP and PIS options for QR code [9]

the size of the original face image. In the paper [23], an example of using an animated biometric QR code is given to implement the procedure of control and identification of people by placing it on passes. This QR code, despite the fact that it contains a minimum amount of personal information, can provide identification of a person.

A number of works are devoted to hiding information stored in QR codes in order to restrict access to it. For example, [24] proposes a hybrid scheme based on a QR code and a discrete wavelet transform (DWT), which makes it possible to protect information. In [25], it is proposed to encrypt information before placing it in a QR code. In [26], a QR code is used as a container, and the information contained in it can be read only if there is a secret key generated by the authors' algorithm. However, despite the presence of a large number of bar coding technologies for identifying people, none of them fully satisfies the implementation of a modern birth certificate on its basis.

1.7 Requirements for the Content of the Birth Certificate

Facial image recognition is becoming one of the key elements of the digital identity of an "electronic citizen", therefore it is necessary to present all facial data in a form that ensures their protection from unauthorized use, modification or substitution and transmission without loss of information.

The existing Birth Certificate has lost its relevance, so it is necessary to develop an option for submitting a new digital Birth Certificate for a child, which should include:

a color photo of the child's face and the characteristics of his facial biometrics - phenotype (face shape, hair and eye color, skin color, special features); documentary information - surname, name, patronymic of the child, date and place of birth, gender; information about the educational institution (if attending); Name, patronymic, surname and color photos of his parents.

All documentary information contained in the digital Birth Certificate must be read by standard scanners and software. Such certificate should be a supplementable document at different stages of a child's development (e.g., at the age of three, seven, and ten) with the ability to correct documentary information and facial biometrics. The most promising is the use of colored biometric QR codes and the storage of information about the child inside his image in LSB layers.

A child's digital birth certificate must be represented by a set of multimedia files (graphic, biometric and documentary) that compactly store the necessary (or all of the above) information with free or secure access to all data.

Graphic multimedia files must represent: images of faces, binary and color QR codes, BIO QR codes, and multi-component QR codes (with mixed graphics) presented in.gif format. The original image of the child's face should be used as an empty container, in which colored QR codes with messages representing biometric or documentary data are embedded in them. Biometric multimedia files should consist of binary and color QR codes containing phenotypic data about the child's face (if necessary, physical, anthropometric characteristics can be added). Documentary multimedia files are binary and color QR codes containing real data about the child (gender, full name, date and place of birth, special features (face shape, hair and eye color, skin color), as well as documentary information about the child's parents. All media files should be able to store and transmit the information attached to them. At the same time, reading the contents of all multimedia files and a hard copy (paper document) should be performed in standard ways.

2 Description of Technologies for the Formation of a New Digital Birth Certificate for a Child

2.1 Biometric BIO QR Code

A digital image is a rectangular matrix consisting of M rows and N columns, each element of which contains the color of a pixel [27]. For color images, several components are used, and the color of the pixel is represented by the corresponding number of numerical values. Blue. Then the original size of the color image of the child's face is determined by three parameters: M × N × 3, where M and N are the number of rows and columns of the image, respectively.

According to the requirements of GOST [27], the size of the face image should be 320,240 × pixels, while the maximum barcode size is 177,177 × pixels GOST [28]. The barcode is added by 2 times, and the face image is supplemented with stripes of the appropriate size: a strip of 17 × 240 pixels is added at the top and bottom, and a strip of 354 57 pixels is added to the left and right.

2.2 Formation of an Information QR Code

To generate an information QR code containing documentary data about the child, a text message is prepared in the following format:

surname, first name, patronymic of the child//year of birth//full name of the mother//full name of the father.

If necessary, the content of the message may be changed at the request of the relevant state authorities.

A binary QR INFO code is generated for this message. For images of the child's face and the image of the QR code, the.png format is used, which allows you to realize the presentation of the QR code without compression noise, ensure the complete preservation

of information during memory operations and the absence of distortion of the information recorded in the QR code. Example of an informational QR code QR INFO generated by a message.

Shchegolev Aleksandr Dmitrievich//2…//Shchegoleva N… L…//Shchegolev D… Etc…. Shown in Fig. 3.



Fig. 3. Example of an informational QR code

2.3 Generation of a Biometric BIO QR Code

To generate a biometric BIO QR code in accordance with [11], it is necessary:

decompose the prepared image of the child's face (Sect. 2.1.1) into components R, G and B, so that: R = I(:,:,1); G = I(:,:,2); B = I(:,:,3), where I is a color image of the child's face with a size of 354 × 354 × 3; generate a color QR code by replacing the G layer with a 2× enlarged image of the generated QR INFO information code so that:

$$QR\ (:,:,1) = R;\ QR\ (:,:,2) = QR_{INFO};\ QR\ (:,:,3) = B.$$

An example of the obtained biometric BIO QR code obtained on the basis of the initial image of the child's face and the generated information QR code is shown in Fig. 4.



Fig. 4. Example of a biometric BIO QR code and its component

2.4 Embedding Biometric Information in LSB Layers

The use of a biometric BIO QR code in a digital birth certificate allows you to quickly read information about the child, but at the same time makes it available for use by attackers and can be replaced by them. Therefore, the amount of information stored in such a QR code is limited and contains only the full name of the child, his year of birth and the full name of his parents.

To increase the representativeness of information about the child, its security and universality, as well as the reliability of storage, it is necessary to embed biometric information in the color PNG image of the child's face. The requirement to provide graphic information only in PNG format is connected with the fact that it is needed to ensure that information is preserved in the LSB layer.

Steganography can be used. In this paper, it is proposed to use binary layers of color images to embed QR codes with information about the child. At the same time, images containing such QR codes remain without visual changes, retaining the possibility of subsequent data extraction. This can be done most effectively by placing the necessary information in LSB layers (LSB – Least Significant Bits), which will ensure that it is protected from unauthorized access.

2.5 Preparation of QR Codes with Biometric Information and Information About the Educational Institution

To embed in a color image, you need two QR codes with biometric information and information about the educational institution.

To generate ***a QR code with biometric information***, a text message is prepared with a description of the child's phenotype, which has the following format (instead of an ellipsis, a description corresponding to the child's face is inserted):

Surname Name Patronymic of the child//Year of birth//Age//Eye color: ...//Hair color: ...// Skin color: ...//Oval of the face: ...//Nose: ...//Ears: ...

If necessary, the content of the message can be changed.

This message generates a binary QR code$_{\text{QR PHENO.}}$ In this case, to compose a color QR code, you need to use the byte (halftone) format of QR codes in.png format. Such a recording takes up less memory space than recording in.jpg format, as shown in [29]. This method allows you to ensure the presentation of byte QR codes without compression noise, the preservation of information during memory exchanges and the absence of distortion of information recorded in the LSB layers of the QR code.

To generate a QR code with information about the educational institution in which the child is studying, a text message is prepared in the following format: surname first name patronymic of the child//year of birth//age//type of educational institution//educator (or class teacher)//phone number of the educator (or class teacher)//phone number of parents; Based on the prepared message, a QR code PASS is generated in a similar way to the QR code$_{\text{PHENO.}}$

2.6 Algorithm for Accessing Binary Layers of Color Images

A halftone image is a matrix A of size $M \times N$ with positive integers that determine the brightness of the pixel. The algorithm for accessing binary layers of a color image is based on the procedure for calculating the remainder by dividing all the values of the matrix A of size $M \times N$ by base 2 [11 $\times$], which will have values of 1 only in those pixels that correspond to odd values in matrix A, and the rest will have values equal to 0.

A color image is represented by a matrix C of size M × N × 3, consisting of three components – R, G, B, each of which has the size M × N. As a result of the calculation D = mod(C, 2), we get an image matrix D of size $M \times N \times 3$ containing 1 in those pixels that correspond to odd values in each layer of the matrix C and zeros in the remaining pixels. Each component of a color image can be decomposed into 8 "virtual bit slices" containing only zeros and ones, each of which corresponds to its own multiplier: 128, 64, 32, 16, 8, 4, 2, and 1. A multiplier of 1 corresponds to the last, Least Significant Bits (LSB). The algorithm for accessing binary layers of a color image is described in [29]. An example of decomposing a color image of a child's face into binary layers is shown in Fig. 5.

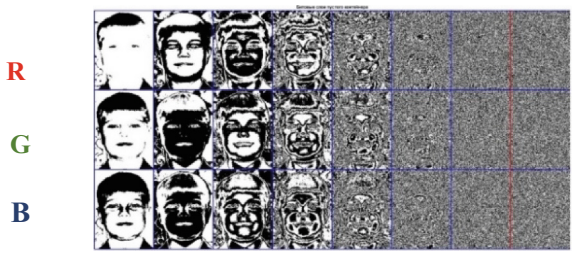

Fig. 5. Decomposing a color image into binary layers

Embedding QR codes in an image is based on "zeroing the LSB layers" of components R, G and B of a color image and placing the corresponding QR codes in the zeroed LSB layers [29]. Figure 6 shows LSB layers of a color image of a child's face with QR codes embedded in them. The remaining layers 2–8 do not change.

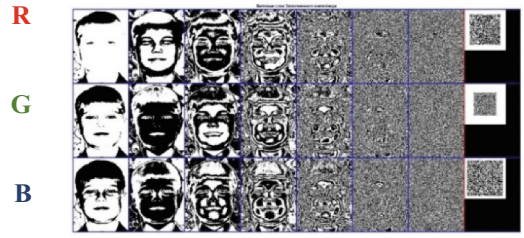

Fig. 6. LSB layers of a color image of the child's face with QR codes attached to them

The scheme of embedding QR codes in a color image of a face in accordance with the one proposed in [11] is shown in Fig. 7.

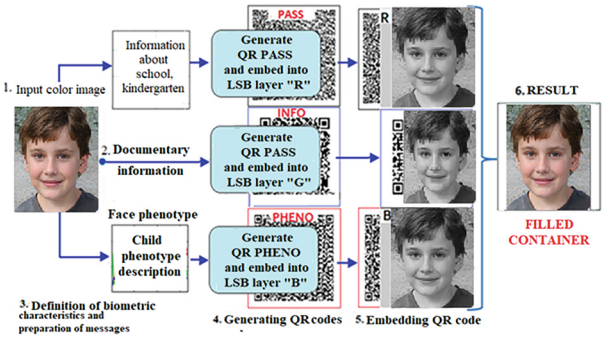

Fig. 7. Scheme for embedding QR codes in a color face image

The methods described above allow you to use the biometric characteristics of the child's face and supplement them with documentary information about him, as well as store this information in standard QR codes embedded in the LSB layers of the R, G and B components of the input color image of the face. At the same time, the resulting image with embedded QR codes containing information is a color container image that compactly stores all facial biometric and documentary information about the child.

This approach increases the security, universality and safety of information, which will ensure the restriction of open access to it, as well as make it possible to exchange information according to standards within the framework of international cooperation without losing any of its part and/or changing it. It is worth noting that QR codes embedded in a color image are not visually detectable, and information about the child can only be read and deciphered by specialists who have an idea of the rules for generating messages for generating QR codes. If it is needed to protect the information, the approach, suggested in [24], can be used, where the information is being encrypted first, then the QR codes are formed.

2.7 Submission of Birth Certificate Information in GIF Format

The GIF (Graphics Interchange Format) format was developed in 1987 at CompuServe. The structure of a GIF file depends on the version (GIF87a or GIF89a). In either version, the GIF file has a 13-byte header at the beginning that contains a signature that lists the GIF file type, GIF version number, and other information. To store images, the GIF format uses an indexed palette that has a palette of 256 colors. Each image in the file is accompanied by its own color table [30].

GIF files have the following advantages: provide lossless compression; GIF format is supported by all modern web browsers and operating systems (Windows, macOS, iOS, Android, etc.); viewing GIF files is possible on almost any modern device (PC, smartphone, tablet); GIF files are not modified when transferred to the server, which ensures the immutability of the information contained in them; Widespread use of this type of file.

The restrictions are: if an excessive number of images are used, it can reach a large size; GIFs need to be optimized, but a number of effective optimization algorithms have been proposed; for editing, you need to use the functions of correct reading and

formation of a new GIF file; a color palette of 256 colors (this is enough to represent the information of a digital birth certificate).

It is worth noting that GIF files are a set of images that appear for viewing in turn, which allows you to see all the information [10]. It is this feature that determines the choice of this format for the child's digital birth certificate, namely the ability to store in it not only documentary data in the form of a BIO QR code, but also photos of the child himself at the age at which he crosses the border, unlike the photo that is in the passport. Note that a biometric passport is issued for 10 years, and during this time the child's appearance and life circumstances can change significantly: for example, the child's hair or eye color changes, or due to the death of parents, he or she has a guardian or adoptive parents, the child can move to another educational institution, new special signs will appear, etc.

To streamline the information entered into the Digital Certificate, it is proposed to use the following template (if necessary, it can be changed or supplemented):

A photo of the child (for example, current or taken when crossing the state border for the first time).

Photo of the mother (guardian, legal representative, adoptive mother)
Photo of the father (guardian, adoptive father)
For age 1 (e.g. 1 year):
a photo of a child aged 1 year;
BIO QR code for age 1 year.
For age 2 (e.g. 3 years):
a photo of a 3-year-old child;
BIO QR code for age 3.
. . .
For age L (e.g. 17 years):
Photo of a child aged 17;
BIO QR code for age 17.

An example of the described content of the Birth Certificate file in GIF format is shown in Fig. 8.

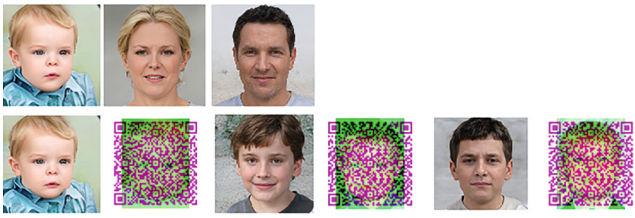

Fig. 8. Example of possible contents of a Birth Certificate file in GIF format

Presentation of the Birth Certificate as a GIF file allows you to store and view the information contained (biometric and documentary data about the child and his/her

parents (guardians, legal representatives) in it on any medium (smartphone, tablet, PC), using almost any operating system (Windows, macOS, iOS, Android, etc.).

3 Results

The developed application accepts as input a set of graphic, documentary and biometric information about the child and his parents.

XExample:

Documentary data

Surname: Shchegolev.

Full name: Alexander.

Fathername: Dmitrievich.

Year of birth: 2003.

Mother: Shchegoleva N… L…

Father: Shchegolev D… And…

Educational institution: SBEI Secondary School "Academic Gymnasium No56"// class teacher: T… Oh… N…// Phone: 322223322// Parents' phone: + 7.

Biometric data

Eye Color: Green// Hair Color: Blonde// Skin Color: White// Facial Oval: Round// Nose: Straight// Ears: Musical.

Graphic data

Photos of a child aged 2, 5, 9 years and photos of parents are given in Fig. 9.



Fig. 9. Sample Input Graphics

The process of generating a BIO QR code based on the entered documentary data and the image of the child is shown in Fig. 10: for age 2 years 5 years 9 years. The content of QR codes for different ages is distinguished by the explicit indication of the child's age in the photo.

An example of embedding information in LSB, layers of the child's face, QR codes with documentary and biometric information recorded in them are shown in Fig. 11. The information objects that are formed for the digital birth certificate of a child are shown in Fig. 12.

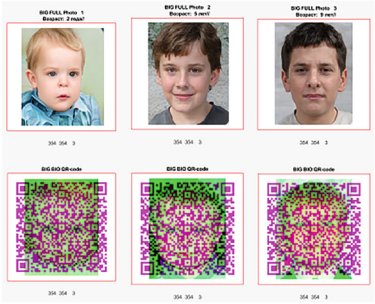

Fig. 10. Biometric QR code and BIO QR code components for child's face image (age 2 years, 5 years, 9 years)

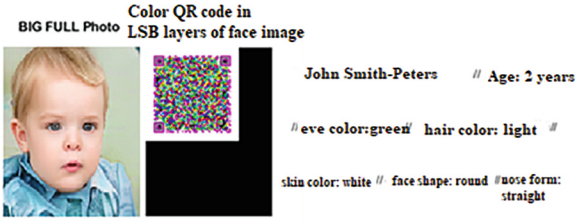

Fig. 11. Color QR code embedded in LSB layers of the child's face image, containing documentary and biometric information (age 2 years)

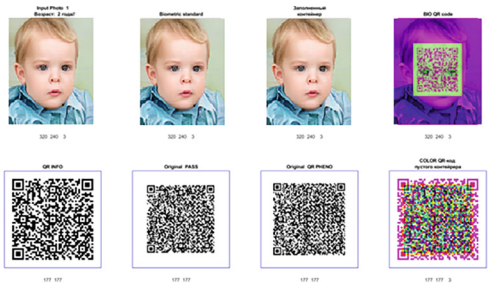

Fig. 12. Information objects that are formed for the digital Birth Certificate of a child (age 2 years)

A GIF file of a digital birth certificate for a child aged 9 years consists of the images shown in Fig. 13.



Fig. 13. Content of the GIF file of the child's birth certificate (age 9 years)

It should be noted that the content of GIF files for different ages of the child is different - for each next trip of the child outside the Russian Federation, a photo of the child and a BIO QR code corresponding to his current age are added. At the same time, an image of the child's face is generated with QR codes embedded in the LSB layers of the child's face image containing up-to-date documentary and biometric information, which is stored in the databases of state bodies (for example, in the Federal Migration Service (FMS of Russia).

In this case, the current age of the child is entered, and it is also possible to enter all the necessary data that have changed: appearance and special features, educational institution, change of surname, appearance of guardians or legal representatives of the child, etc.

4 Conclusion

1. The analysis showed that in order to protect children from illegal export abroad, a document is needed that includes not only documentary information, but also biometric information of the child, which will allow him to be accurately identified, which will increase the level of safety of children.
2. In this work, a new format of the child's digital birth certificate is proposed, which presents a color photo of the child's face and the characteristics of his facial biometrics, documentary information (full name of the child, year of birth, etc.), information about the educational institution, as well as the full names of the mother and father.
3. Software has been developed that allows you to generate a digital Certificate, which is a BIO QR code that stores all the necessary documentary information about the child. All documentary information contained in a digital birth certificate can be read by standard barcode scanners and software.
4. The developed software allows you to embed documentary and biometric information in the form of QR codes into LSB layers of a color image of the child's face for storage in the databases of government agencies, which allows you to hide the information, since the resulting image with embedded data does not differ from the original.
5. Software has been developed that allows you to generate and view a digital Birth Certificate of a child in a GIF file, consisting of a set of multimedia files (graphic, biometric and documentary), compactly storing information about the child.
6. A digital birth certificate is a supplementable document at different stages of a child's development and allows you to correct documentary information and characterize his/her facial biometrics.

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