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Iris Recognition Used for the Implementation of a Green-Passports System Regarding the Vaccination against the SARS-CoV-2 Virus for the UE Citizens

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Abstract: The coronavirus pandemic started with some infections in China in December 2019, and in Europe it started very strongly after March 2020. The first countries severely affected were Italy and Spain. Due to the lack of specific treatment for COVID19 disease caused by the SARS-CoV-2 virus, much work has been done to create highly effective vaccines to limit the spread of this disease. After the vaccination started, each country issued a document to each vaccinated person regarding the accomplishment of this. Also, when crossing the state border between certain countries within the European Union and beyond, it is required to present such a document. In order to improve these checks, the appropriateness of using biometric iris recognition technology to replace that document will be explored. Thus, it is proposed that when a person is given a dose of vaccine, this is supposed to be entered into an international database together with the image of the person's iris. When it will be required the proof of vaccination, a check of the person's iris will be performed in the database, and the date and time of administration of the vaccine will be provided. The main problem eliminated in this way will be related to the suspicion of forgery of the document presented in printed format. For people who do not want to record biometric data in an international database, it remains the option to travel only after performing a RT-PCR test.

Keywords: iris; biometric system; vaccination; green passports; UE citizens

1. Introduction

The coronavirus disease was first announced on the last day of 2019. It was happening in Wuhan region from the People's Republic of China. The SARS is the acronym for "Severe acute respiratory syndrome" and the virus that causes this syndrome was first identified in 2003. It is an animal-specific virus that passed to humans through various conditions and opportunities, being known in specific literature as causing zoonotic viral diseases. For the virus identified in 2003 it wasn't developed any vaccine and there is no specific treatment and only supportive medication was initiated on infected people. In 2012, the Middle-East respiratory syndrome-related coronavirus (MERS-CoV) was identified and infected some of the population.

The pandemic of COVID-19 was declared as a pandemic by World Health Organization (WHO) on 11 March 2020 and since then it spread very quickly all over the world. More than 171 million people were

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infected up to 4 June 2021, with more than 3.7 million confirmed deaths. Since the beginning of vaccination there were administered almost 1.6 billion doses.

After the beginning of vaccination, the national institutions issued different type of proof of vaccination. Some of them are in digitally signed documents and then printed, resulting in the fact that the authenticity of this kind of copies cannot be generally proved. That's why we proposed a solution of inserting iris biometric data in database that can be internationally accessed, in order to verify if someone that pretends that was vaccinated is indeed immunized with the specific serum.

2. Iris Recognition

The iris is considered to be one of the safest biometric features that can be used in recognizing people. The beginnings of the use of the iris are quite recent, starting with a first patent in this field, issued to ophthalmologists Leonard Flom and Aran Safir, who in 1987 patented a "Iris Recognition System", with US patent number 4,641,349. However, this invention had no mathematical basis, the idea being taken over by Dr. John Daugman of the University of Cambridge. He managed to use an integral-differential operator to determine the outer and inner contours of the iris. He also proposed using the Hamming distance to determine the authenticity of an iris in the recognition process, after transforming it from Cartesian coordinates into polar coordinates and obtaining the code of that iris. Prof. Daugman patented these discoveries, and was issued U.S. Patent No. 5,291,560. However, this professor, in the preface to the book "Handbook of Iris Recognition" (Springer, 2013), refers to another much older work by Alphonse Bertillon, published in 1892, which is called "Tableau des nuances de the human iris". The concerns of the author of this paper include several ways of identifying criminals, he being the one who proposed a first system of recording them by the method of measuring several dimensions of the human body (called the "anthropometric method").

The iris is the colored part of the eye, which is an inner organ visible on the outside. The iris is created during pregnancy and its structure remains virtually unchanged throughout life (except for accidental or intentional interventions on it). From the center to the outside, the human eye is composed of: pupil, iris and outside it is the sclera, or "white of the eye". The figure 1 shows the left eye of the main author of the paper, explaining its components.

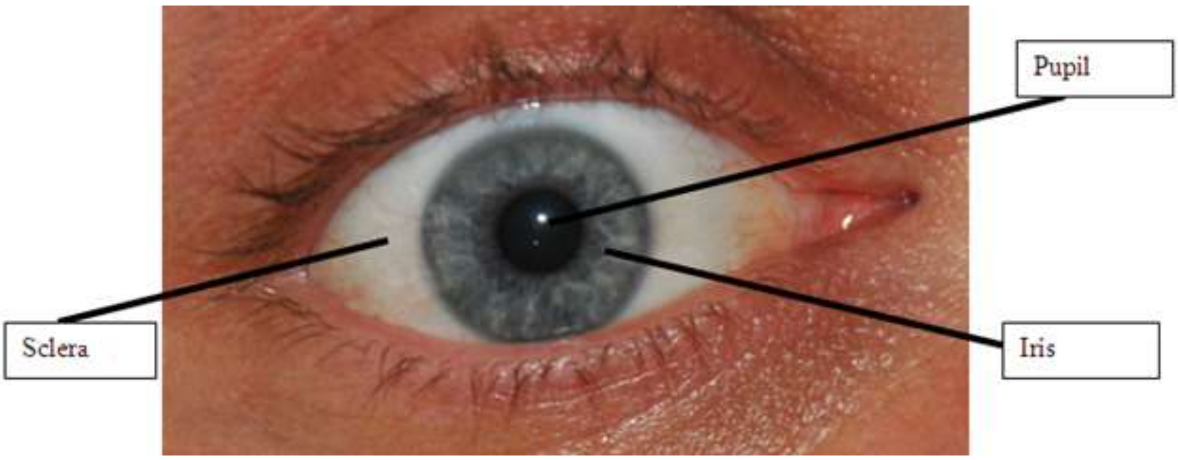

Figure 1. Components of the Human Eye (Own Photo)

It is observed that not only the image of the iris can be captured, but also the image of the eye and the areas around it (eyelids and eyelashes), which can overlap the area of interest. Therefore, one of the purposes is to extract a maximum amount of information about the iris.

The principle behind the accurate extraction of the iris is based on the color variation between the pupil and the iris (the pupil is black in a healthy person) and between the iris and the sclerotic (which is theoretically much lighter in color than the iris). However, certain diseases may influence these initial assumptions:

- cataract leads to opacification of the lens, the pupil becoming whitish; it is more difficult to determine the boundary between the iris and the pupil, especially in people who have a very slightly pigmented iris color;
- conjunctivitis colors the sclerotia red, thus being more difficult to determine the outer border of the iris.

There may also be certain genetic abnormalities, which can give different shapes to the components of the eye. That is why such a system of recognition of people after the iris must also adapt to such cases (which, fortunately, are quite rare).

Apart from the color variation, it must be considered that the pupil does not have a perfectly circular shape, being rather oval in shape. Also, usually the center of the pupil does not coincide with the center of the iris, ophthalmologists saying that it is closer to the nasal area of the eye.

In the case of normal forms of irises, in the literature have been proposed several methods for extracting the characteristics of the iris, the most important being:

1. **John Daugman's method** (Daugman, 2002) **-** is based on an integral-differential operator applied to image intensities. Figure 2 shows a flagship image of this method, taken from Professor Daugman's website (John Daugman's webpage, n.d.). The method is considered to be the most developed to date. In the upper left part of the image is the iris code obtained by his method, and in the main image you can see the eye taken from a camera, which determined the borders from the pupil and sclera, as well as the borders with the upper and lower eyelids. The useful information used to generate the IrisCode (presented in the upper left of the figure 2) is inside the 4 boundaries described above. These methods of determining boundaries are also set out in his patent, with the specification that it was published without prior review by the author, thus containing certain drafting errors, in particular the formulas in it.

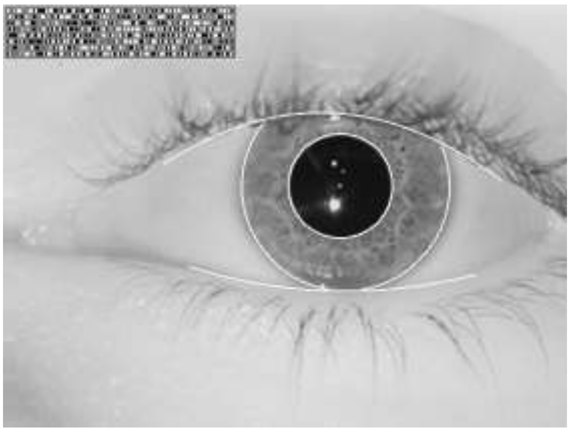

Figure 2. Segmented Image of the Iris with IrisCode ™ (Daugman, 2002)

2. Wildes' Method (Wildes, 1997) **-** is based on the article "Iris recognition: an emerging biometric technology" published in 1997 by Richard P. Wildes. His method differs from that of John Daugman in search mode. It has been less studied and applied in practice. Figure 3 shows an image with the localized iris in this paper.

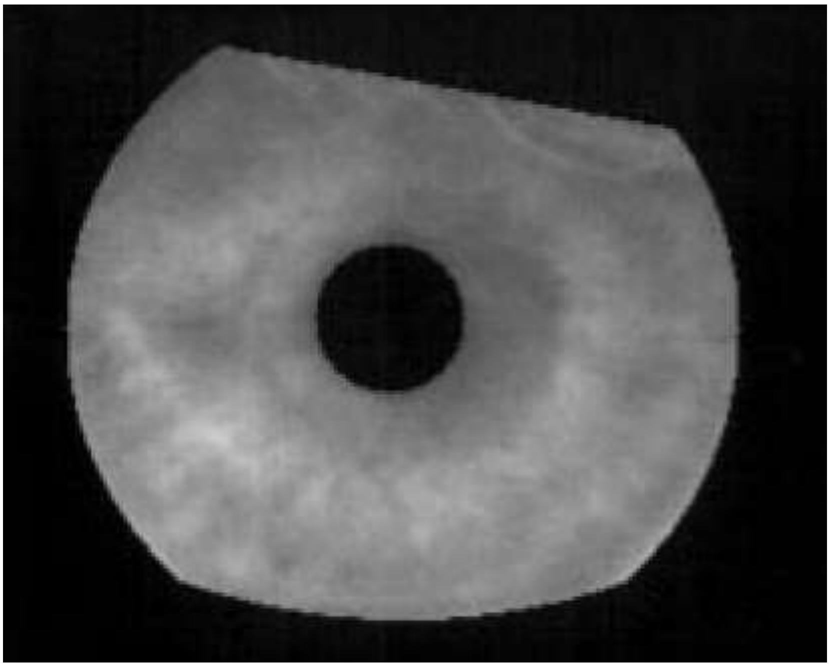

Figure 3. Iris Localization According to Wildes' Method (Wildes, 1997)

A practical implementation is Libor Masek's undergraduate thesis, written in 2003. It also contains a code in MatLab, which is very useful in developing further implementations of iris recognition. The code is not encrypted and is available online free of charge. It was also taken over by the National Institute for Standards and Technologies (NIST), a prestigious government institution in the United States, being translated from MatLab into C ++, within the VASIR application - Video-based Automatic System for Iris Recognition (version 2.2 beta appeared in December 2013). Another practical implementation is represented by the application "Iris Recognition System" from the company Advanced Source Code (developed by Luigi Rosa) and costs €30. The author provides a demo in an encrypted form, the code being also written in MatLab. And this application is based on Libor Masek's method, with the specification that the execution time has been improved by 94% (ie about 16 times).

There are several challenges in recognizing people after the iris, including processing images obtained in difficult or real-time conditions, as well as irises that are "protected" by contact lenses. Thus, the captured images will not usually have a high quality and additional steps will be required in their processing. Another challenge - in fact valid for all existing biometric systems - is to determine the authenticity of the iris presented for processing. Thus, we will try to eliminate fakes (represented by photos, some very well done, even in 3D printing technology) through various tests, some of which will require the actual participation of the user (for example the movement of the eye to one side and the other, up and down) or not (the human iris has the property of "hippus", which means that it contracts or dilates 1-2 times per second even in constant lighting conditions, and a high-performance device can detect this). Another challenge is that a clear image of a very small object (the iris has a size of less than 2 cm in the case of minimal dilation of the pupil) must be taken from a relatively large distance and in conditions of movement, which leads to the need to use high-performance devices.

3. Implementation of Green Passports

Proof of vaccination are provided after the serum has been administered to someone. In Romania, there is a standard format, as it can be seen in Figure 4. The downloaded passport is digitally signed by the Public Health National Institute, but the paper version cannot be directly verified for authenticity.

Figure 4. Proof of Vaccination with Digital Signature

The proof of vaccination contains the following data:

- Name;
- Surname;
- Sex;
- Age;
- Address;
- CNP – Personal Numeric Code – an unique national number;
- ID series and number;
- Informations about the vaccine:
  - Type;
  - Product;
  - Batch number;

- Expiration date;
- Date of vaccination.

- Name of the vaccination center
- Digital signature details

This proof of vaccination can be presented to state frontier officers in order to allow the boarding cross. But, there are different type of proofs provided by each country and it is difficult to check for the authenticity of every type of this kind of act.

That's why we proposed that the biometric data from the vaccinated person's iris should have inserted in a database that could be generally accessed by specific entities in order to simply verify whether if the person was vaccinated or not.

If someone refuses or is unable to provide iris biometric data, it still can travel outside national or international borders, but only after doing a RT-PCR test.

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