The Use of Laser Technology to Protect Passport Photographs[1]

Rudolf L. van Renesse[2]

"The passport is a human being's noblest part. It comes into being much less simply than people themselves do. A human being can come into the world anywhere, in the most careless way; but a passport, never. For that reason it is recognized when it is good, whereas a human being can be very, very good yet go unrecognized."

Bertolt Brecht

The recorded history of passports goes back to about 450 BC. Nehemiah, an official of the Persian King Artaxerxes, asked permission to travel to Judah. The King provided Nehemiah with a letter "to the governors of the province beyond the river", with a request for safe passage through their lands. Obviously, the holder of this royal letter was expected to be Nehemiah, although the letter itself probably provided no proof of that. Many passports today still contain a request to this extent. Such "letters of request" now called passports became popular during the reign of King Louis XIV of France (1638-1715). The King granted personally signed documents to his court favourites, which were coined in French "passe port" or “passe porte”, respectively referring to passing through a port or through a city gate. However, the word construction dates back to the early fifteenth century. Until the end of the nineteenth century personal descriptions on paper, often hand-written, were adequate to identify an individual. It was only during World War I, with the rise of commercial photography, that photographs were added to such documents of identification.

This new technology added significant security to the identification process, because just robbing a “passe port” and passing for the robbed person became virtually impossible. Unfortunately, the binding between document and photograph used to be poor. The photo was generally glued to the document or fastened by means of staples or tubular rivets. Ink stamps and dry seal cachets (dry embossing) were soon used to further bond photo and document. Because these techniques are quite simple, numerous manners were soon found to successfully swap passport photographs without the alteration being very obvious.

Rudolf L. Van Renesse (1940) was a senior research engineer with TNO Institute of Applied Physics, Delft, The Netherlands from 1966 until 2002, after which he started VanRenesse Consulting, The Hague, The Netherlands.
Van Renesse is engaged in projects on document security for government departments, banking and financial institutions and industry within the Netherlands and abroad.
He is the editor of the textbook “Optical Document Security” and organises the biannual conferences on “Optical Security and Counterfeit Deterrence Techniques” in San José, CA, USA.
Van Renesse published tens of articles on these subjects and teaches national and international courses on document security.

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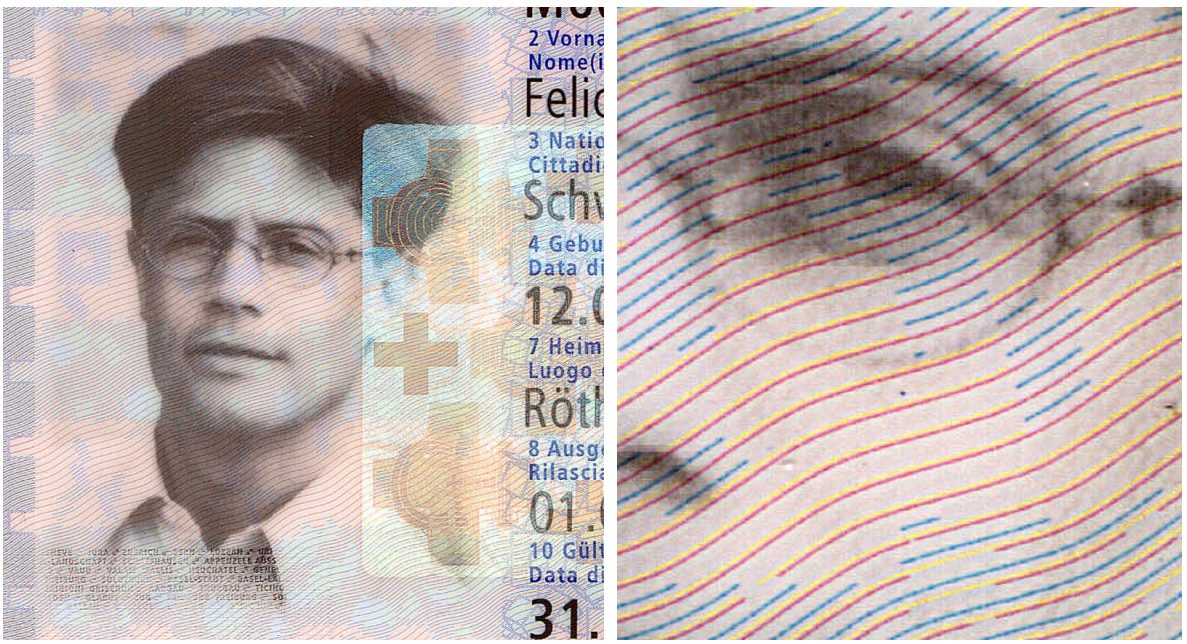
[2] VanRenesse Consulting, Willem de Zwijgerlaan 5, 2582 ED, The Hague, The Netherlands, email ruud_van_renesse@zonnet.nl, www.vanrenesse-consulting.com.

Example of the application of tubular rivets and an ink stamp to bind a photo to a 1975 Dutch passport identity page.

More recent measures to thwart photo swapping involve the application of hot melt transparent overlays. But, the photo still remaining a separate item, such laminates appear not always to be a significant impediment and sometimes even assist the forger in his attempts to get access to the passport photo. Moreover, the edges of the photos tend to cut through the overlay film during intensive use of the passport.

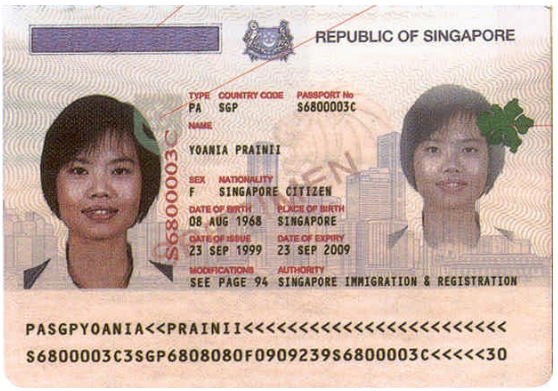
Laser engraved integrated passport photographs

Evidently, the existence of a separate physical photograph is the prime problem and the logical response is to integrate the photo into the document by digital ink printing techniques or even by laser engraving laser sensitised polymer substrates such as pvc and polycarbonate. The latter substrates generally constitute the inner layer of a laminate consisting of a few virtually inseparable layers so that the laser engraved portrait is shielded from direct mechanical access. This technique of fully integrated passport photographs is rapidly becoming a world standard. The new Swiss passport provides an example of a laser engraved portrait that is additionally integrated with a background printing of yellow, magenta and cyan curved lines. Additionally, the portrait is partly overlaid with a kinegram that is also buried within the laminate.



The identity page of the 2003 Swiss passport provides an example of a laser engraved passport photograph, integrated within a polycarbonate laminate and merged with a printed background design.

Obviously, this modern approach forms a formidable threshold against successful photo swapping. A further measure, making the life of the forger miserable, is the inclusion of a so-called "shadow photograph", a repetition of the passport photograph, elsewhere in the design on the identity page. Examples are the Malta and the Singapore passports.



Example of "shadow photograph" printed additionally to the integrated photograph in the Singapore passport.

(Source: Keesing Identity Checker.)

Nevertheless, for the naked eye, a large part of these current techniques can be deceptively imitated with digital image processing and printing techniques. Such techniques are currently within the ability of the multitude of owners of cheap digital computer and software steered equipment. Current scanners and printers allow a 1200 dpi reproduction of almost microscopic details that can be exposed as fake only by experts. However, the prime function of a passport is to allow its authentication in first line. That is, inspection without the equipment and expertise that is available to experts. Non-experts should be enabled to authenticate passports in first line with sufficient confidence.
A few simple rules apply:

1. Security features should enable simple and easy inspection in first line. A passport photograph is an example.
2. Security features should be based on high technology that does not allow deceptive imitations. But, passport photographs can be deceptively imitated.
3. Preferably, variable information should be represented with the use of significantly divergent techniques, requiring expertise in widely different fields. Shadow images do not comply with this requirement.

Laser perforated replications of the passport photograph

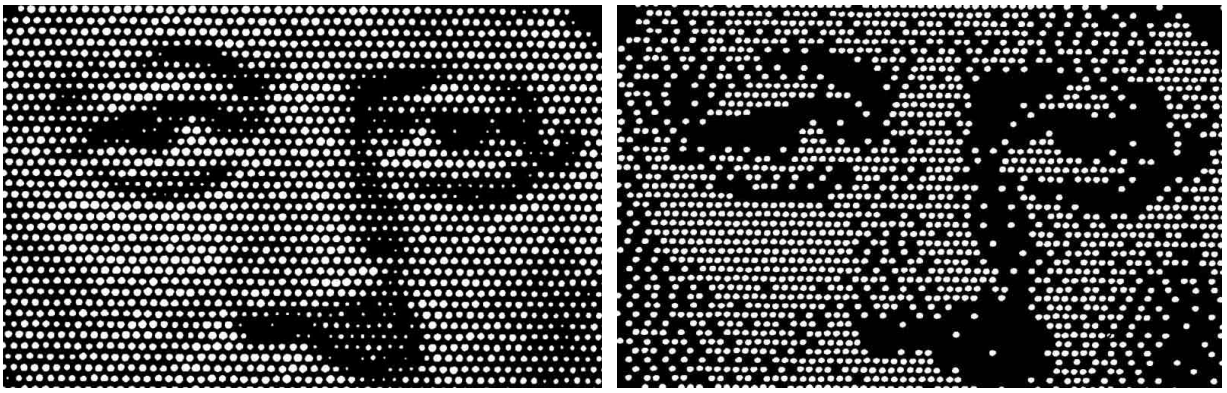
Examples of techniques that comply with the third requirement are the holographic replication of the conventional portrait as a Holographic Shadow Picture (HSP) on the new German travel document and the perforated portrait (ImagePerf) on the new travel documents of Belgium, Estonia, The Netherlands and Switzerland. I would like to discuss the HSP on a next occasion and I will further concentrate on ImagePerf here.

Holographic shadow picture (HSP) next to the conventional portrait on the new German travel document and holographic replication of OCR printing. The HSP is flat artwork and not in 3D.

The perforated holes on the front of the identity page have diameters smaller than one twentieth of a millimeter, so that the perforated image is invisible under normal lighting conditions and does not interfere with the printed design.

ImagePerf consists of tiny holes that are perforated through a plastic or paper substrate by a focussed laser beam. By modulating the laser beam power, the dot size can be modulated, while by spatially steering the laser beam, the dot frequency can be modulated. Both modulation techniques allow creating perforated portraits that, against the light, appear as halftone images for the unaided eye. Because the conventional portrait and the ImagePerf portrait are based upon the same image data, the facial and image characteristics can be simply compared for resemblance.

ImagePerf is invariably applied using dot size modulation, which renders the image ten or more apparent grey levels. The resolution of ImagePerf is 57 dpi and the image dimensions generally are 33 x 44 mm, the ICAO standard for passport photos. The number of holes per image is approximately 5000. Although one might expect that the presence of so many holes would deteriorate the mechanical strength of the page, this appears not the case. For example ID-1 cards with ImagePerf appear to meet more than three times the ISO standard 10373 requirements for bending and torsion.



Perforated portraits in a paper substrate: dot size modulation (left) and dot frequency modulation (right). Image size 10 x 14 mm (left) and 12 x 17 mm (right).

The application of two fully different techniques to represent the portrait raises virtually insurmountable barriers for counterfeiter and forger. Creating an acceptable perforated portrait in dot size modulation, without having access to the dedicated laser equipment may be next to impossible. Drilled imitations are necessarily frequency modulated and lack quality because the fineness of the laser perforated holes cannot be achieved. Removing an ImagePerf portrait from an identity page and subsequently perforating a passable new portrait in its place, presents the next level of difficulty.

An interesting characteristic of laser perforated holes is that they are tapered (cone-shaped), being larger in size at the laser beam entrance surface than at the beam exit surface, an effect that is visible only under strong magnification and provides a second line authentication feature.
If the laser perforation is carried out under oblique angles with the substrate and if the substrate is sufficiently thick, image elements can be created that become visible under oblique angles. This additional feature is coined “Tilted Laser Image” (TLI) and it provides a further threshold against imitation. ImagePerf/TLI is a registered trademark of Enschede/Sdu and Industrial Automation Integrators (IAI) both in the Netherlands. An example of ImagePerf/TLI is found in the Dutch 2001 passport and ID-card.

In diffuse reflection

In transmission

ImagePerf/TLI in a 0.8 mm thick poly-carbonate sample card.

In transmission, under normal observation, the photograph of the bearer is visible, while the letters NLD appear under oblique observation.

A variation on the TLI, suitable for thin substrates such as paper, can be realised by perforating image elements with either vertical or horizontal slit-shaped holes. In transmission, under oblique angles, slits will only transmit light when observed along their longer dimensions, as demonstrated in the figure below. Because slit shaped perforations are hard to imitate, this feature provides additional first line security.

Laser perforated weak zones to protect against delamination

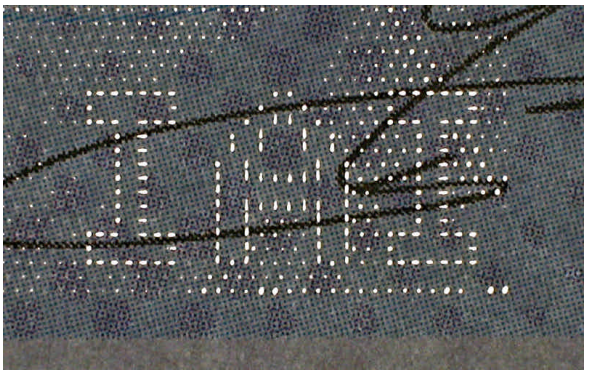
Again another application of laser perforation aims at introducing a local weakening of a paper identity page around the inserted passport photograph before lamination. The laser perforated fragile structures consist of variously shaped slits, referred to as “DestriPerf”, a trademark of Industrial Automation Integrators (IAI), The Netherlands.

If photo swapping by delamination or splitting of the identity page is undertaken, the forces exerted on the paper substrate expectedly lead to visible and irreparable damage of the substrate. Examples of DestriPerf are found in later issues of the 1997 Dutch passport.

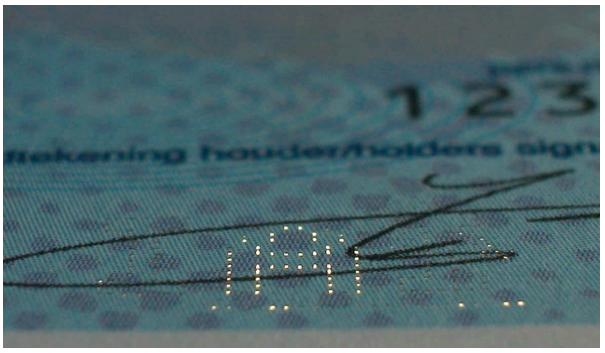
Discussion

Laser technology has increasingly contributed to document security, embossed holograms undoubtedly being the first application and the HSP being the most recent one. Laser processing techniques appear pre-eminently suitable to introduce secure variable information into identity documents. The application of laser-technology to document security has only begun to reveal its potential and we may expect to see further fascinating discoveries in this field.

ImagePerf consisting of vertical and horizontal slit-shaped holes observed in transmission under oblique angles.



Normal observation in transmission: overview and detail



Oblique observation in transmission: along horizontal slits and along vertical slits

DestriPerf in the paper data page of a Dutch passport in transmitted light.
The perforated line structures are designed to self-destruct by delamination forces from all directions.
Apart from the laser perforated DestriPerf structures, highlight bar watermarks are present around the passport photograph with the same anti-tamper functionality.
As a further measure against photo swapping, the passport photograph is punch marked with the City of issue zip code, the characters NL and a toothed edge.