Equipment for Documents Authenticity Verification Based on Optical NDT Method

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Abstract. The new types of equipment designed for documents, securities, banknotes and other printed and manuscript materials examination based on optical NDT method are discussed. The basic area of application of reviewed instruments – documents quality evaluation when issued, authenticity verification and detection of falsification signs or traces of illegal changes of original document in the process of its handling.

Introduction

One of the ways of economical safety provision of subjects of economical activity is their equipping with technical means and instruments providing documents, securities, banknotes, IDs, excise and special marks, high quality printed materials, etc. authenticity verification as well as revealing of any illegal impacts on the above items. High quality printed products, as a rule, are protected by means of wide range of purposely incorporated protective means provided due to use of special technologies, polygraphic and physico-chemical processing methods that warrantee this or that level of protection from possible falsifications.

Most part of means used for documents protection cannot be revealed without use of purposely designed equipment including optical ones. Between protection means the following can be mentioned:

- Absence in paper of special compounds fluorescent in presence of ultra-violet (UV) illumination;
- Presence of randomly allocated protective fibers fluorescent in presence of visible or infra-red (IR) radiation;
- Presence in paper cloth with printed on it microelements of protective hairs and stripes;
- Polygraphic cameo printing;
- Micro printing that can become visible only in case of 7-10x magnification;
- Protective dye marks fluorescent in visible range in presence of UV illumination;
- Metametric pair of dyes one of which is transparent and other one is not in presence of IR radiation;
- Dyes possessing various transparency factors for different wave length of IR radiation;
- Dyes fluorescent in presence of IR illumination;
- Dyes able for anti-stokes fluorescence in presence of IR illumination;
- Laminar layers with various properties.

Some information about ways and methods of documents and printed materials protection is confidential and is not subject to open publication.
1. Equipment for documents and printed materials authenticity verification

The main goal of development of equipment for documents authenticity verification is to provide instruments able to verify the signs of documents genuineness or reveal the specific signs of their partial or total falsification, to find traces and type of made in the original illegal modifications or corrections as scribing, additional writings and not allowed corrections, washing and etching of initial documents details, performance elements replacement (newly inserted pages, photos), seal integrity violations. Also the equipment should provide restoration of images occasionally or purposely hidden under ink or between glued pages.

“Spectrum-RII” has been gaining experience to develop such kind of instruments during 20 years of work in this direction. The wide range of instruments was developed and produced during these years: starting with hand-held, performing one-two functions and simple to operate instruments up to large, integral installations (stationary and mobile ones) providing verification of most signs of documents authenticity.

The equipment provides separate or integral examination of checked documents in spectral range of 400…1050nm in reflected, through-passing and luminescent radiation in 250…1000nm range.

1.1 Portable instruments

The widest area of applications is to solve the tasks of border passport control, where the priority is given to the verification of ID documents with various types of performance and in conditions of the people flow. By this very special requirement is explained the fact of visual examination selection for documents checking, when talking visual it means direct examination or examination with the help of image brightness amplifiers or TV-channels.

The most part of developed and used instruments have output for connection with PC that helps to process data, keep records and create data base.

When developing new instruments they are modular that helps to configure system in accordance with actual task and increase the functional options to follow up the changes introduced to protect documents. Some types of instruments can be used for industrial applications, for instance, UV illuminators can be used for NDT.

One of the latest developments – portable, hand-held UV illuminator “Shag-4” (see Fig. 1) with increased radiation level (dominant wave length 365nm). It is designed to solve wide range of forensics and anti-terrorism tasks as well as to perform luminescent flaw detection on site when required are longer distances at which examination is carried out.

The illuminator provides illumination intensity 1mW/cm² at distance 200mm. Its power supply can be from battery (12 V DC) that provides 3.5h continuous operation or from mains 220V/ 50Hz via adapter.

It has self-contained charging unit and indicator of battery capacity.

Fig. 1. Overview of UV illuminator “Shag-4”.
One more sample of hand held instruments for documents and securities verification is “Korund-MTV» (see Fig. 2). It is designed for visual documents examination on site. It combines two illumination channels: one – IR radiation and second – UV radiation. The verification is based on documents examination in reflected IR and luminescent visible optical range that occur when the document page is illuminated by IR- or UV-radiation source. This two modes are basic ones when examination is preformed in non-stationary and not purposely equipped check-points and on-site.

As it was mentioned above the instrument has two channels. UV channel incorporates a matrix of UV LEDs instead of commonly used fluorescent UV lamps; dominant wavelength is 365nm. The working procedure in fact presents direct visual check-up of examined document.

The IR channel incorporates IR illuminator based on LEDs, i.e. matrix of IR LEDs, miniature video camera with lens (resolution 400 TV-lines (TVL), that registers IR reflected radiation) and IR radiation pass filter, micro display on which the image is presented and eyepiece with diopter regulation to zoom the image.

Unlike other available analogs in the instruments the use is made of IR illuminator radiating two wave lengths. This makes it possible to compare imagers in different radiations and reveal marks applied with different protective IR dyes. Depending on the wave length the radiation absorption differs and this improves examination results reliability as well as broadens the area of applications. In case, if the instrument will be used in stationary conditions, it has video output to provide images visualization on external video viewing device or PC display. Optionally it can be equipped with storage module with memory capacity 100 shorts.

1.2 Table top equipment

To provide work in stationary conditions the table top systems were developed. These systems have modular design.

As examples of such equipment can be presented the IR video magnifier “Genetika-LTV” and criminalistic block “Genetika-02.01” (see. Fig. 3). The IR-magnifier is designed for documents examination in reflected and luminescent IR radiation when dual range of top IR, side IR and top green-blue radiations are used. Images obtained by means of miniature video camera with input long wave cut-off filter in different illumination ranges are displayed on LCD. The size of viewed object part within image field is 18 x 24mm in case
of standard lens use. When the lens is replaced it is possible to achieve the size of examined area of 24 x 36mm.

![Fig. 3. Overview of IR-magnifier "Genetika-LTV" and criminalistic block “Genetika-0.2-01”](image)

The criminalistic block provide examination of documents with page size 297 x 210mm; in it used are UV illuminator as well as top, bottom and side illuminators operating in visible light range. This block is widely used in check points of border passport control.

At the stage of above equipment development the possibility of their integration in unified complex “Genetika-02.02” was forecast. The last complex provides verification of most authenticity signs of most documents and reveal of standard traces of falsifications. All this make the verification procedure efficient and fast. Besides standard blocks and modules this complex additionally can be equipped with auxiliary modules in accordance with customer specific requirements.

Presented above systems and instruments nowadays are used not only at border check points but at law enforcement institutions and other commercial structures of Russia and CIS.

1.3 Portable instruments for IDs and passports verification

One more modern demand of customers – necessity to have portable equipment providing detailed examination of documents on site. There are several problems to be solved in this case: limited sizes and weight, low power consumption, self-contained power sources providing long continuous operation on-site, various types of radiation sources providing required type of illumination and some others. This task was successfully solved by development of portable set “Korund-TV” (see Fig. 4) that is carried in case and weights 7.5kg.

In this system provided are the following types of documents examination. Examination in reflected, pass through and luminescent visible and IR ranges. Required type of radiation is generated by UV illuminators and top, side and bottom illuminators operating in visible and IR ranges. Those different range light sources can be mounted inside the case or be remote.

The examination in visible range presents simple and direct viewing of appropriately illuminated document by operator. While examination in IR-range requires use of special instruments and means, in presented case this is done with the help of built-in video channel and examination results are presented on video monitor. In the system there are connectors to display obtained images on external video viewing unit or PC.
Separate line of development explained by currently introduced system of IDs and passports computerized coding. At final stage is development of “Kopas” instrument that will provide display on the screen of passport page or visa presented in UV, visible and IR radiations together with the area of machine-recognizable lines and output for further storage in external databases.

Below (Fig. 5, 6, 7, 8, 9 & 10) presented are examples of various documents, bank notes and special text samples examination carried on with the help of presented instruments and systems.

I.a)  I.b)    II.a)  II.b)

Fig. 5. Detection of poor quality fake bank note of 100USD based on luminescent illumination (I) and reveal of false watermarks in presence of UV illumination (II)
(a) - real bank note; (b) – false bank note
Fig. 6. Distribution of metametric dye on real and fake bank notes of 100 rubles and 100 euro in reflected IR radiation
(a) - image in visible light; (b) – image in reflected IR radiation

Fig. 7. Detection of high “quality” fake bank note of 100USD fabricated with use of authentic paper and having high quality printing performance in reflected IR-radiation.
(a) - real bank note; (b) – false bank note

Fig. 8. Distribution of metametric dye and visualization of special IR dye on passport of Russian citizen. Used is reflected IR- radiation in two wave length ranges
Fig. 9. Restoration of initial writing after made adscript done by the ball pen of the same color as the original one.
Images in visible (a) and luminescent IR (b) radiation ranges

Fig. 10. Detection of etched stamp on the passport page.
Images in visible (a) and luminescent IR (b) radiation ranges

**Conclusions**

In the world where globalization processes become the part of everyday life the importance to provide economical and social safety becomes more and more important. The instruments providing verification of personal, economical and social documents authenticity help to improve safety and solve tasks of safety to wild extend in easy and efficient manner.