

Digital Water Marking on Bank Notes

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As the printing industry evolves to a digital platform, the challenge of designing security documents that copy poorly becomes increasingly difficult. As digital printing equipment becomes easier and less expensive to operate and maintain, more widely placed in new environments, with better quality and output design flexibility, the opportunity to counterfeit expands and the profile of the counterfeiter is altered accordingly. This has led bank note authorities to change their strategies for conducting banknote design, public education and enforcement activities, establish cooperative efforts to deter use of digital equipment to counterfeit, and to aid enforcement.

When inexpensive color printing first became reality with the introduction of color copiers less than 20 years ago, bank note security designers explored ways to foil counterfeiters based on the weaknesses in the equipment. Use of these types of features, such as metameric inks, out-of-gamut colors and interference screens, were meant to produce copies obviously different from the originals. Now, such features are insufficient to address today's printing capabilities, and other ways to deter counterfeiting have been sought. Today, bank notes are highly engineered products with many restrictions imposed by production, processing and usage needs.

What is water mark?

A watermark is a picture that shows up faintly behind the text on a page. This is a nice effect to tie a theme into your document. Watermarks can cover an entire page or can be smaller and placed on a specific area of a page. It is a recognizable image or pattern in paper that appears as various shades of lightness/darkness when viewed by transmitted light (or when viewed by reflected light, atop a dark background), caused by thickness or density variations in the paper. There are two main ways of producing watermarks in paper; the *dandy roll process*, and the more complex *cylinder mould process*.

Watermarks vary greatly in their visibility; while some are obvious on casual inspection, others require some study to pick out. Various aids have been developed, such as *watermark fluid* that wets the paper without damaging it. Watermarks are often used as security features of banknotes, passports, postage stamps, and other documents to prevent counterfeiting. A watermark is very useful in the examination of a paper. Encoding an identifying code into digitized music, video, picture or other file is known as a digital watermark.

A watermark is made by impressing a water-coated metal stamp or *dandy roll* onto the paper during manufacturing. These watermarks were first introduced in Bologna, Italy, in 1282; however the dandy roll was invented in 1826 by John Marshall. Watermarks have been used by papermakers to identify their product, and also on postage stamps, currency, and other government documents to discourage counterfeiting. In France, they were introduced during World War II by the Vichy regime, and counterfeited by people such as Adolfo Kaminsky. The invention of the dandy roll revolutionised the

watermark process and made it much easier for a company to watermark their paper.

With the advent of digital works (pictures, music, film and so on) digital watermarks have also been developed, however they are not always used in quite the same way as watermarks in documents. This is because, at least for the moment, it seems impractical to try and prevent people from making copies of computerised files, as computers will readily make perfect copies of the files they hold –something essential for backup and recovery.

The first types of digital watermarks you will see are those which are visible or obvious, and are intended to be so. These are usually images that are superimposed upon a still picture or a moving picture. The intention is either that in the event the images are copied then the ownership is not in dispute, or to prevent any realistic commercial use of the images if they are copied because their quality would not be acceptable. The second types of watermarks are invisible. These digital watermarks are created by embedding extra information, commonly in the form of digital patterns, into the computer files containing the images or sounds to be protected. For this to be successful, the addition of the image to the information in the file must have no noticeable effect as far as the person seeing the subsequent picture or hearing the sound.

Processes of Water Marking

The ***dandy roll*** is a light roller covered by material similar to window screen that is embossed with a pattern. Faint lines are made by ***laid wires*** that run parallel to the axis of the dandy roll, and the bold lines are made by ***chain wires*** that run around the circumference to secure the laid wires to the roll from the outside. Because the chain wires are located on the outside of the laid wires, they have a greater influence on the impression in the pulp, hence their bolder appearance than the laid wire lines.

This embossing is transferred to the pulp fibres, compressing and reducing their thickness in that area. Because the patterned portion of the page is thinner, it transmits more light through and therefore has a lighter appearance than the surrounding paper. If these lines are distinct and parallel, and/or there is a watermark, then the paper is termed ***laid paper***. If the lines appear as a mesh or are indiscernible, and/or there is no watermark, then it is called ***wove paper***. This method is called **line drawing watermarks**.

Another type of watermark is called the **cylinder mould watermark**. A shaded watermark, first used in 1848, incorporates tonal depth and creates a greyscale image. Instead of using a wire covering for the dandy roll, the shaded watermark is created by areas of relief on the roll's own surface. Once dry, the paper may then be rolled again to produce a watermark of even thickness but with varying density. The resulting watermark is generally much clearer and more detailed than those made by the Dandy Roll process, and as such Cylinder Mould Watermark Paper is the preferred type of watermarked paper for banknotes, passports, motor vehicle titles, and other documents where it is an important anti-counterfeiting measure.

Water Mark on Bank Notes:

Most people are familiar with two types of document watermarks which can be found in banknotes or on checks. In banknotes, these are recognizable designs that are put into the paper on which the documents are printed, whilst in checks they tend to be specific patterns. These watermarks are normally used to

prevent people from being able to make fake copies, and, therefore, to be confident that the banknote or document is authentic.

There are also a number of specialized printing techniques that make it possible to have printed watermarks that will vanish or appear if a protected document is photocopied or scanned. However, these rely upon high quality printing processes if they are to be successfully created. That is why documents using this technique are normally professionally printed, and distributed as paper documents rather than in electronic form. There are other printing techniques that produce 'raised' printing, use magnetic inks or inks that will change color if they get wet (either with water or other liquids), but they are very specialized and are used together with watermarks to provide higher levels of document protection and copy prevention.

The water-mark of the paper, on which formerly reliance was placed almost exclusively, puts a difficulty in the way of the counterfeiter, but experience has shown that in ordinary circumstances it does not in itself afford adequate protection. The means by which it can be imitated are well known, and, since a distinct water-mark is incompatible with strong paper, the life of a water-marked note is much shorter than that of one printed upon plain paper. The best bank-note paper is made from pure linen rags and was formerly made by hand. Machine-made paper is however now largely used, as it possesses all the strength of hand-made and is much more uniform in thickness and texture.

In documents which pass current as money it is obviously the duty of the bank or government issuing them to take all reasonable means to prevent the public from being defrauded by the substitution of counterfeits; and a bank whose circulation depends upon the confidence of the public must do so in its own interests to insure the acceptance of its notes. This principle is now recognized by all issuing institutions, but in practice there is room for improvement in the issues of many important establishments, partly because of the disinclination of the directors of a bank to change the form of an issue to which the public is accustomed, partly because of the difficulty of deciding what is really a secure note, and in certain cases because, owing to exceptional circumstances, an issue may be practically immune from forgery although the notes themselves present little or no difficulty in imitation. The features essential to the security of an issue are (1) absolute identity in appearance of all notes of the issue; (2) adequate protection by properly-selected colors against photographic reproduction; and (3) high-class engraving comprising geometric lathe work and well-executed vignettes. In addition it is important that the design of the note should be striking and pleasing to the eye, and the inscription legible.

The notes of the Bank of England are printed in the bank from surface-plates in black without color or special protection except the water-mark in the paper. They are never reissued after being once returned to the bank and their average life is very short, about six weeks, so that a dirty or worn Bank of England note is practically never seen. This arrangement, coupled with the difficulty of negotiating forged notes in England, the lowest denomination being *f*5, accounts for the comparative immunity from forgery of the bank's issues.

Machine readable data is digitally watermarked into banknotes. Such watermarking can be optically sensed and detected by various devices. In response, such devices can intervene to prevent banknote reproduction. This arrangement addresses various problems, e.g., the use of digital image editing tools to circumvent other banknote anti-copy systems.

The present article relates to the use of digital watermarking in connection with banknotes and other security documents. In India, Each banknote has its amount written in 15 languages. On the obverse side, the denomination is written in English and Hindi. On the reverse of each note is a language panel that displays the denomination of the note in 15 of the 22 official languages of India. The languages are displayed in the alphabetical order. The languages included on the panel are Assamese, Bengali, Gujarati, Kannada, Kashmiri, Konkani, Malayalam, Marathi, Nepali, Oriya, Punjabi, Sanskrit, Tamil, Telugu and Urdu.

Security features incorporated in Indian Bank Notes through water marking

- Watermark - White side panel of notes has Mahatma Gandhi watermark.
- Security thread - All notes have a silver security band with inscriptions visible when held against light which reads Bharat in Hindi and RBI in English.
- Latent image - On notes with denominations of ₹20 and upwards, a vertical band on the right side of the Mahatma Gandhi's portrait contains a latent image showing the respective denominational value in numeral which is visible only when the note is held horizontally at eye level.
- Microlettering - Numeral denominational value is visible under magnifying glass between security thread and latent image.
- Intaglio - On notes with denominations of ₹20 and upwards, the portrait of Mahatma Gandhi, the Reserve Bank seal, guarantee and promise clause, Ashoka Pillar Emblem on the left, RBI Governor's signature are printed in intaglio i.e. in raised prints.
- Identification Mark - On the left of the watermark window different shapes are printed in Intaglio for various denominations (₹20 - Vertical Rectangle, ₹50 - Square, ₹100 -Triangle, ₹500 - Circle, ₹1000 - Diamond). This also helps the visually impaired to identify the denomination.
- Fluorescence - Number panels glow under ultra-violet light.
- Optically variable ink - Notes of ₹500 and ₹1000 have their numerals printed in optically variable ink. Number appears green when note is held flat but changes to blue when viewed at angle.
- See through Register - Floral design printed on the front and the back of the note coincides and perfectly overlap each other when viewed against light.
- EURion constellation - A pattern of symbols found on the banknote helps software detect the presence of a banknote in a digital image so that it can prevent its reproduction with devices such as color photocopiers.

Advantages of using document watermarks

So using watermarks with protected documents offers many advantages to a publisher:

- as a copying deterrent
- as a means of identifying the source of a printed document
- as a means of determining whether a document has been altered

Problems of Digital Watermarking

Digital watermarking techniques are already effectively used in associated copy control applications and broadcast monitoring systems. In combination with digital rights management frameworks, they can solve the limitation of the intellectual property dilemma in audio- and image-related business areas. However, the main intellectual property problems cannot be solved by all existing watermarking methods. Watermarking techniques behave differently in different attack operations or applications. Simple, noncomplex methods are not very resistant to JPEG and JPEG 2000 compression, but are resistant to normal image operations. Complex and difficult watermarking techniques based on discrete, fast Fourier, or wavelet transformations are, by contrast, very robust against compression techniques, but lack resistance in normal image operations. Today, most watermarking methods cannot reach the main approach. It is still a wide and attractive field for further research in which innovative methods and techniques may be established.

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