

Watermarking

5 Field of the Invention

This invention relates to watermarking of documents and refers particularly, though not exclusively, to a system for the embedding of an optical watermark in a document.

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Background to the Invention

Digital watermarking is a modern form of the ancient art of steganography, used to hide information inside other information (images, documents, audio and video data, and so forth). A watermark is a hidden message within digital or printed media. With digital media it is integrated with the content of the data file itself and therefore requires no extra storage.

Two types of watermarks exist: a visible watermark and an invisible watermark. A visible watermark is a visible translucent image, which is overlaid on a primary image. It usually consists of logo or the seal of the organization that holds rights to the primary image. A visible watermark allows the primary image to be viewed, but clearly marks the document as the property of the organization. An invisible watermark is an overlaid signal (media), which cannot be seen, but can be detected algorithmically.

Digital watermarking has been used as a means to identify the owner and distributor of the digital data. Unique codes are embedded into a digital media and these codes can be used for a variety of purposes, e.g., date/time stamp, identity of source, identity of content, transaction status, ownership etc.

Optical watermarking differs from traditional watermarking in that the watermark extracted occurs using optical and visual methods such as photocopying. This enables visual confirmation of whether a document is an original, or has been photocopied or scanned.

Summary of the invention

In a first preferred aspect there is provided a printable watermark image for embedding into a document for printing. The image comprising an image background having a average intensity of a first colour; and an indicator region also having said average intensity of the first colour. At least the indicator region intensity is the result of a dithered arrangement of at least two different intensities. The resolution of the watermark image, the dithered arrangement and the at least two intensities are selected such that the colour and intensity of the image background, and the indicator region, appear uniform to the naked eye but the indicator region becomes apparent to the naked eye after processing the printed image with a copying device operating as a low pass filter.

The average intensity of the image background may be the result of a dithered arrangement of two or more different intensities. The range of said two or more intensities of the indicator region may be greater than the range of the two or more intensities of the image background. The image background and said indicator region may be a uniform colour. The watermark image may include a visible mark region which is of a different colour than the uniform colour or of a different area averaged intensity than the image background and the indicator region.

The watermark image may comprise at least three regions, each region having a first colour selected from a set of at least two colours. The at least three regions may comprise a first region of about 15% of the surface area of the watermark, a middle region of about 70% of the surface area of the watermark, and a second region of about 15% of the surface area of the watermark. The first and second regions may be of the same colour. The middle region may be interposed between and may be of a different colour. The boundary between the regions may be characterised by a change pattern.

In a second preferred aspect of the invention, there is provided a method of generating a printable watermark image for combining into a printable document. The method comprises the steps selecting an image background colour and intensity; filling a background region of the watermark image with the colour and an average intensity equalling the selected intensity, and with intensities of individual pixels falling within a background intensity range.

An indicator region is filled with the selected colour and with an average intensity equalling the selected intensity, but with the intensity of individual pixels falling within a range substantially greater than the first range such that the resolution of the image, the dithered arrangement, and the two or more intensities are selected
5 such that the colour and intensity of the image background and the indicator region appear uniform to the naked eye but the indicator region becomes apparent to the naked eye after processing the printed image with a copying device operating as a low pass filter.

10 The step of filling the background may comprise applying a dithered pattern of two intensities having a first difference. The step of filling the indicator region may include applying a dithered pattern of two intensities having a second difference substantially greater than said first difference. The selected intensity may be less than RGB(239,239,239).

15 There may be included the steps of receiving a base image; and identifying a background region and an indicator region within the base image according to a colour or intensity differentiation between the background region and the indicator region.

20 ~~There may be also be included the steps of identifying a visible marking region within the base image; and filling said visible marking region with a second colour and intensity different to the first colour and intensity.~~

25 There may be further included the steps of receiving a visible mark base image and an indicator base image; identifying the indicator region and the background region within the indicator base image and filling it. A visible marking region may be identified as may be a background region within the visible mark base image. The visible mark base image and the filled and processed indicator base image
30 may be combined, such that for each corresponding pixel the colour and intensity of that pixel in one image takes precedence over the colour and intensity of that pixel in the other image. Pixels in the background region of the visible mark image may have lower precedence than pixels in the processed indicator base image. Pixels in the visible marking region in the visible mark base image may have higher
35 precedence than pixels in the processed indicator base image.

In a further preferred aspect of the present invention, there is provided a system of generating a printable watermark image for combining into a printable document the system comprises means for selecting an image background colour and intensity; means for filling a background region of the watermark image with the colour and an average intensity equalling the selected intensity, and with intensities of individual pixels falling within a background intensity range; and means for filling an indicator region with the selected colour and with an average intensity equalling the selected intensity, but with the intensity of individual pixels falling within a range substantially greater than the first range such that the resolution of the image, the dithered arrangement, and the two or more intensities are selected such that the colour and intensity of the image background and the indicator region appear uniform to the naked eye but the indicator region becomes apparent to the naked eye after processing the printed image with a copying device operating as a low pass filter.

The means for filling the background may comprise means for applying a dithered pattern of two intensities having a first difference. The means for filling said indicator region may include means for applying a dithered pattern of two intensities having a second difference substantially greater than the first difference. The selected intensity may be not less than RGB(239,239,239).

There may be included a means for receiving a base image; and means for identifying a background region and an indicator region within the base image according to a colour or intensity differentiation between the background region and the indicator region.

There may be finally included means for identifying a visible marking region within the base image; and means for filling the visible marking region with a second colour and intensity different to the first colour and intensity

There may be finally included means for receiving a visible mark base image and an indicator base image; means for identifying the indicator region and the background region within the indicator base image and filling same; means for identifying a visible marking region and a background region within the visible mark base image; and means for combining the visible mark base image and the filled and processed indicator base image, such that for each corresponding pixel the colour and intensity of that pixel in one image takes precedence over the colour

and intensity of that pixel in the other image, with pixels in the background region of the visible mark image having lower precedence than pixels in the processed indicator base image, and pixels in said visible marking region in the visible mark base image having higher precedence than pixels in the processed indicator base image.

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In a penultimate aspect of the present invention there is provided a watermark image generated by the above method; and a document incorporating a watermark image produced by above method.

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In a final aspect of the present invention there is provided a computer usable medium comprising a computer program code that is configured to cause a processor to execute one or more functions to enable the method described above to be performed.

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Brief Description of the Drawings

In order that the invention may be readily understood and put into practical effect there shall now be described by way of non-limitative example only preferred embodiments of the present invention, the description being with reference to the accompanying illustrative drawings in which:

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- Figure 1 is an original pattern of a grey-level watermark;
- 25 Figure 2 is an original companyword image for a colour watermark;
- Figure 3 is a copyword image for a colour watermark;
- Figure 4 is a pattern image for shaping a watermark;
- Figure 5 shows the initial patterns for the dots of a copy indicia;
- Figure 6 shows the initial watermark image;
- 30 Figure 7 shows the initial watermark image after extending;
- Figure 8 shows the watermark after controlling the strength;
- Figure 9 shows the watermark after noise has been applied to the overall background;
- Figure 10 is a block diagram of a watermark generation of a preferred process of
- 35 the present invention;
- Figure 11 is a diagram showing pixel extension of the present invention;
- Figure 12 is a flow chart of the watermark generation process of Figure 10;

Figure 13 is a flow chart of the water embedding process of Figure 10;

Figure 14 shows a document with a watermark;

Figure 15 shows a photocopy of the document of Figure 14 when the density of the copier is too light; and

- 5 Figure 16 shows the document of Figure 14 when the density of the copier is too dark.

Detailed Description of the Present Invention

- 10 The invention relates to copy protected printed or digital documents. The invention enables the embedding of an image or indicia in a printed document such that, when the document is printed, the image or indicia is not visible. When the document is photocopied or scanned, the image or indicia becomes visible.

- 15 Watermarking on digital or printed documents is a system for controlling copies of printed documents based on an optical watermarking method. The system includes an anti-copy optical watermark and anti-copy background. Two types of watermarks may be used: a grey-level watermark, and a colour watermark.

- 20 The system consists of a watermark generator and a watermark embedded for controlling copies of a printed document based on an optical watermark.

- 25 In a copy control process, the owner or authorized user of the digital documents uses a logo (pattern image) that combines with some copyright words to indicate ownership of the document. After photocopying the watermarked document, the copied document will show the salient words (e.g., copy) which indicate that the document has been copied, modified or tampered with. When combined with controlled printing of the original watermarked document, a robust system for authenticating digital and paper documents can be established.

- 30 As shown in Figure 12, to create a grey-level watermark the watermark generator receives an image as input 1201. The watermark generator will extract features from the pattern image seen in Figure 1 at 1202. The features that the watermark generator extracts include the original background 103, the companyword 101, and copyword 102. The colour of the companyword 101 should be selected such that, after photocopying, it will completely or partially disappear. To achieve this it is preferable that the companyword is white. It is preferable that inside the pattern
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image, the companyword 101 and copyword 102 are of the same colour (white colour). The initial watermark pattern for the copyword is generated and consists of dots and a background that interlace with each other. The dots 107 are in all of the same size and distance between the dots of the watermark pattern remains the same. This can be seen in Figure 5.

The size and colour of the dots for both for gray-level watermark and colour watermark are controlled in such a way that, after photocopying, the dots can be clearly reproduced and differentiated. The controlling of the watermark is by modulation, and this is explained in detail below. The dots should not be so small that, after photocopying, they cannot be reproduced; but should not be so large such that they are visible to the human eye when in the watermark.

The size (width x height) of the original pattern watermark image in proportion to the document image is an important factor in the visibility of the dots after photocopying. The size of the original pattern image is selected such that after the watermark extending and embedding into the document, the dots are sufficiently small but can be reproduced and differentiated after photocopying. For example, if the original pattern image selected is of 560 x 650, then the original document size for embedding is 3000 dots x 3500 dots. Other sizes can also be used provided that the dots are clear and can be reproduced.

The extension factors (times that the watermark is extended in x and y direction respectively) is an important factor in that it controls the spacing between the final dots. If the watermark has been extended 4x4 times the original size, if only one dot is left after controlling the strength, then the spacing between dots will be three times the original dot size. Such spacing is enough to differentiate the dots after photocopying.

The companyword 103 does not change in the generation process 1203 and the copyword part 102 keeps the dot pattern. The watermark background 109 is then selected such that the background will be gray after a copy is taken of the printed image. The copyword background 108 selected by the watermark generator will be lighter than the overall background 109. The watermark generator then extends the initial watermark in 1204. The initial watermark is extended in the x and y directions respectively. As an example if an original pixel is a dot after the watermark is extended by extension factors $m \times n$ the original dot will become $m \times$

n times the original dot size. This can be seen in Figure 11A where only location (0,0) is filled. In 11b the pixel having been extended by an extension factor of four, the locations (0,0), (0,1) (0,2), (0,3), (1,0), (1,1) (1,2) (1,3) (2,0) (2,1) (2,2) (2,3) (3,0) (3,1) (3,2) (3,3) are filled.

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The formula for extending the initial watermark is

$$(n * X_0 + (i - 1), m * Y_0 + (j - 1)).$$

- 10 where (X_0, Y_0) is the initial dot location, m and n are the extension factors for extending, and i and j are loop variables.

How this is applied can be seen in the pseudo code below:

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15 for ( i = 0 ; i < m ; i ++ ) {
    for ( j = 0 ; j < n ; j ++ ) {
        newdotlocation ( n * X0 + ( i - 1 ), m * Y0 + ( j - 1 )) = 1
    }

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- 20 The extended watermark can be seen in Figure 7.

The watermark is then modulated in 1205. Modulation is used to reduce the strength of the watermark such that the visibility of the dots will be minimised. The distance from the original dots to the extended dots are calculated. If the distance exceeds a selected reference value the pixel will be controlled. Modulation is used to obtain a good visual effect. The distance for modulation is calculated using the following equation:

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$$\text{distance} = \sqrt{(x - x_0)^2 + (y - y_0)^2}$$

where (X_0, Y_0) is the original dot location, and (x, y) is the extended location.

If the reference value for controlling a dot is selected as: ref Value ≥ 1 then only one dot will left for each extended big dot. This can be seen in Figure 11C.

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If the dot at location (0, 0) has been extended 4 x 4 times, then the distance value at locations (0,0) (0,1) (0,2) (0,3) (1,0) (1,1) (1,2) (1,3) (2,0) (2,1) (2,2) (2,3) (3,0)

(3,1) (3,2) (3,3) in Figure 11 will be 0,1, 2,3,1,1.414,2.236,3.1623,2.236, 2.828, 3.6056, 3, 3.1623, 3.6056, 4.2426 respectively. If the reference value is selected to be: $3 > \text{reference Value} > 2$, only dots at location (1,2) (2,1) and (2,2) will be left after controlling the strength. Whether the selected reference value will work fine will depend on the visibility of the dot after photocopying. For example, if after photocopying, the dot can not be reproduced, the reference Value will be adjusted to a smaller value (to make the resulting dot much larger). The extended watermark can be seen in Figure 8. The background of the watermark is then randomized in 1206 by selecting a background similar to the overall background and randomly distributing that background within the watermark background as seen in Figure 9. The generated watermark will then be imbedded into high-resolution documents 1207 for a satisfactory visual effect to be obtained.

The overall steps in the process can be seen in block diagram 10. The original pattern image is fed into the watermark generator 120 and initial watermark pattern is generated 121. From the initial watermark pattern an initial watermark is generated 122 and extended 123. The strength of the watermark is controlled 124 and the watermark is randomised 125.

The process of generating a colour watermark is similar to that of a grey-level watermark, but it differs from the grey-level watermark in that for a colour watermark either randomising the background or applying a new set of copyword, copybackground and overall background can be selected. Some white lines will be added for the invisibility of the copywords in the watermark.

To generate a colour watermark the watermark generator receives as input two pattern images. Two pattern images are used, one is used for retrieving the copyword information seen in Figure 3 and the other is used for retrieving the copybackground information seen in Figure 2. Features from the original pattern images will be extracted. The process for extracting the features is the same as that for grey-level watermark.

The initial watermark pattern will be generated. It consists of dots and background that interlace with each other. The overall colour background will be divided into three parts: the leftmost part, middle part and the rightmost part. Correspondingly, the copyword and copybackground will also be divided into three parts. Different colour values will be used for these three parts. The three split parts of each

image will be reassembled and a change pattern generated between the colour values. In a preferred embodiment, the images are split into three vertical parts: the left about 15%, middle about 70% and right about 15%. The left and right parts of the images preferably use the same colour. The change pattern images can
5 also be generated using Adobe PhotoShop gradient tool. This is done so that a change pattern can be generated so that the human eye does not easily detect the hidden word. The initial watermark will be generated with reference to the copyword and companyword images provided. Only the copyword will keep the dots. The companyword word will remain the same colour as that in the pattern
10 image.

In order to serve for the modulation purposes, the initial watermark will be extended in the x and y directions respectively to obtain large dots, as for the grey level watermark. The colour watermark will be modulated to obtain a good visual
15 effect as for grey-level watermark. There is an option for selecting either randomising the watermark background or applying a new set of copyword, overall background and copybackground.

If randomising is selected, a similar colour background will be selected and the
20 colour watermark will then be randomised in order to make it uniformly distributed.

If applying a new set of copyword, overall background and copybackground is selected then the pattern images of copyword, overall background and copybackground will be applied to the colour watermark to achieve good visual
25 effect.

A copybackground is used to make the copyword more prominent after being photocopied. The copybackground used is lighter than the overall background so that, after photocopying, the copybackground will be degraded and the copy word
30 will become more prominent.

For example if pink was used, pink with 8% capacity would be used for the copybackground, pink with 88% capacity would be used for the copyword and pink with 42% capacity for the overall background. Using the same colour makes it
35 harder for the human eye to detect the copyword.

Watermark embedding is performed in spatial domain and is shown in Figure 13. The pixel values of the original document are directly modified to embed the watermark. If the watermark is required to retain a certain shape, a shape image will be used as the reference image in order to shape the watermark to the desired shape.

To embed a grey-level watermark (Figure 13) the original document that needs to be watermarked will be converted into the suitable image format 1301. For example, a gif. file. The location for embedding the watermark will be searched in 1302. An area which has sparse text words is the ideal location for watermarking, as this will achieve better results in terms of visibility after photocopying.

Once the decision on where the watermark will be embedded has been made, the watermark will be embedded in 1303 by pixel modulation as for a grey level watermark. If the original document pixel falls outside the watermark pixel range, the resultant pixel will be the same as the original document pixel value. If the original document pixel is white, the result pixel will be the same as the watermark pixel value. However, if original document pixel is black, the result will be the same as the original document pixel value. Finally, if the original document pixel lies between the white and black pixels, the result will be the same as the original document-pixel-value.

If the watermark needs to be shaped using a shape such as shown in Figure 4, the modulation will differ. If the original document pixel falls outside the watermark pixel range, the result pixel will be the same as original document pixel-value. If the original document pixel is white and falls outside the shape, the result pixel will be a white pixel. However, if the original document pixel is white and falls inside the shape, the resultant pixel will be the same as the watermark pixel. If the original document pixel is black and falls outside the shape, the resultant pixel will be the same as the original document pixel. However, if the original document pixel is black and falls inside the shape, the resultant pixel will be the same as the original document pixel. If the original document pixel is neither white nor black, the resultant pixel will be the same as the original document pixel value.

The process will happen to every pixel of the watermark image. After the watermarked image has been embedded, the document will be saved 1304 to a proper image format. For example, a jpeg or gif file.

For a colour watermark, in step 1303 the watermark will be embed into the whole background of a document. To embed a watermark the original document that needs to be watermarked will be converted into the suitable image format for example a gif format. The location for embedding the watermark will be searched. For colour documents, the whole background will be selected as the embedding area in order to obtain the good visual results.

The colour watermark is embedded by pixel modulation. If the original document pixel falls outside the watermark pixel range, the resulting pixel will be the same as the original document pixel value. If the original document pixel is a white pixel, the resulting pixel will be the same as the watermark pixel value. If the original document pixel is a black pixel, the resulting pixel will be the same as the original document pixel value. If the original document pixel value is greater than the watermark pixel, the resulting pixel will be the same as the watermark pixel value. If the original document pixel is neither white nor black, the resultant pixel will be the same as the original document pixel value.

If a colour watermark needs to be shaped then colour modulation to embed the watermark will take into account the shape. If the original document pixel falls outside the watermark pixel range, the resulting pixel will be the same as the original pixel. If the original document pixel value is white and falls outside the shape, then the resulting pixel will be the same as the original document pixel. If the original document pixel value is white and falls inside the shape, then the resulting will be the same as the watermark pixel value. If the original document pixel value is black and falls outside the shape, then the resulting pixel will be the same as the original document pixel value. If the original document pixel value is black and falls inside the shape, then the resulting pixel will be the same as the original document pixel value. If the original document pixel value is neither black nor white and falls outside the shape, then the resulting pixel will be the same as the original document pixel value. If the original document pixel value is neither black nor white and falls inside the shape, then the resulting pixel will be the same as the original document pixel value.

After the watermarked image has been enabled, the image will be saved to a proper image format. For example, as jpeg or gif files.

It is difficult for the copyword to be differentiated if the density of the photocopier is too light or too dark, or the resolution of the photocopier is similar to that of the printer. The resolution of a printer is typically 600dpi to 1200 dpi, while the resolution of a copier is typically 150 dpi to 600 dpi (the higher end of the range is more typical for copiers at the higher end of the range). To overcome this problem a colour detector is applied. As is shown in Figures 14 to 16, the colour detector consists of a light-grey background and an indication of nature of the copy such as, for example, the word "invalid". The word "invalid" will become obvious when it is copied in very dark density (Figure 16) and will be very faint when the density is very light (Figure 15). The colour detector serves to identify the density of the photocopier. Two types of colour detector are used: light colour detector and dark colour detector. When the density of the photocopier is too light, the light colour detector will become invisible, which implicates that the density is not correctly selected. When the density of the photocopier is too dark, the dark colour detector will become too dark to be seen, which implies that the density is not correctly selected as well.

The background of the watermark is an important factor in the watermarking process. If the background is too dark, then the degradation is not there after photocopying, so that the watermarking effects are not as visible as they should be. If the background is too light, then the original logo will not be clear in the watermark. Therefore, a compromise between the visibility of original logo and the good degradation effect of background must be made.

For grey-level watermark, it is recommended that the background be below RGB value (239,239,239) corresponding to HTML code #EFEFEF. For colour watermark, it is recommended that the background be below this threshold (lighter than this colour), e.g. the capacity of the colour is less than 42% for any colour. The value of copy background should be of the same colour as the copyword, but should be as light as possible.

Photocopying for watermark detection is used. It is well known that for a bandwidth limited image, it is possible to completely reconstruct the original image if the sampling frequency, $f_s > 2f_n$, where f_s is the highest frequency present in the image f_n is the Nyquist frequency. Real word images are not band limited, and therefore aliasing errors occur. Aliasing errors can be reduced by low-pass filtering the image prior to sampling but at the cost of attenuating high spatial frequencies.

This is the so-called "Moire phenomena" in printing industry. Moire effect appears in the form of beat patterns that arise if the image contains periodicities that are close to half the sampling frequencies. This effect occurs when the display spot size is small (compared to the sampling distance) so that the reconstruction filter cut off extends far beyond the ideal low-pass filter cut off. Then a signal at frequency $f < 2f_n$ will interfere with a companion signal at $f_n - f$ to create a beat pattern.

As the frequency of the watermark image is lower than the host image, the watermark can be extracted by photocopying low-pass filtering. Most photocopiers scan at 150dpi-450dpi, while the resolution of good quality Laser printers is around 600dpi, therefore the watermark can easily be extracted by photocopying.

The present invention also includes a computer usable medium having a computer program code. The computer program code is configured to cause at least one processor to execute one or more functions to enable a computer to perform the above method.

To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

CLAIMS:

1. A printable watermark image for embedding into a document for printing, said image comprising:
5 an image background having a average intensity of a first colour; and
an indicator region also having said average intensity of said colour, at least said indicator region intensity being the result of a dithered arrangement of at least two different intensities,
10 wherein the range of said two or more intensities of said indicator region is greater than the range of said two or more intensities of said image background, and wherein the resolution of said image, the dithered arrangement and the two or more intensities are selected such that the colour and intensity of the image background and the indicator region appear uniform to the naked eye but the indicator region becomes apparent to the naked eye
15 after processing the printed image with a copying device operating as a low pass filter.
2. A printable watermark as claimed in claim 1, wherein the average intensity of the image background is also the result of a dithered arrangement of two or
20 more different intensities.
3. A printable watermark as claimed in either claim 1, wherein said image background and said indicator region are a uniform colour.
- 25 4. A printable watermark as claimed in claims 1 to 3, wherein said watermark image includes a visible mark region which is of a different colour than said uniform colour.
5. A printable watermark as claimed in claim 1, wherein said watermark image
30 includes a visible mark region which is of a different area averaged intensity than said image background and said indicator region.
6. A printable watermark as claimed in claims 1 to 5, wherein said watermark
35 comprises at least three regions, each said region having a first colour selected from a set of at least two colours.
7. A printable watermark as claimed in claim 6, wherein a first region is substantially 15% of the surface area of said watermark, a middle region is

substantially 70% of the surface area of said watermark, and a second region is substantially 15% of the surface area of said watermark.

- 5 8. A printable watermark as claimed in claim 7, wherein the first and second regions are of the same colour, said middle region is interposed between the first and second regions and is of a different colour, and the boundaries between the three regions having a change pattern.
- 10 9. A method of generating a printable watermark image for combining into a printable document, said method comprising the steps of:
selecting an image background colour and intensity;
filling a background region of the watermark image with said colour and an average intensity equalling said selected intensity, and with intensities of individual pixels falling within a background intensity range; and
15 filling an indicator region with said selected colour and with an average intensity equalling said selected intensity, but with the intensity of individual pixels falling within a range substantially greater than said first range such that the resolution of said image, the dithered arrangement, and the two or more intensities are selected such that the colour and intensity of the image background and the indicator region appear uniform to the naked
20 eye but the indicator region becomes apparent to the naked eye after processing the printed image with a copying device operating as a low pass filter.
- 25 10. A method as claimed in claim 9, wherein said step of filling said background comprises applying a dithered pattern of two intensities having a first difference, and said step of filling said indicator region includes applying a dithered pattern of two intensities having a second difference substantially greater than said first difference.
- 30 11. A method as claimed in either claim 9 or claim 10, wherein said selected intensity is less than RGB(239,239,239).
- 35 12. A method as claimed in any one of claims 9 to 11, further including the steps of:
receiving a base image; and

identifying a background region and an indicator region within said base image according to a colour or intensity differentiation between said background region and said indicator region.

5 13. A method as claimed in claim 12, further including the steps of identifying a visible marking region within said base image; and filling said visible marking region with a second colour and intensity different to said first colour and intensity.

10 14. A method as claimed in any one of claims 9 to 11, further including the steps of:
receiving a visible mark base image and an indicator base image;
identifying said indicator region and said background region within said indicator base image and filling same,
15 identifying a visible marking region and a background region within said visible mark base image, and
combining said visible mark base image and said filled and processed indicator base image, such that for each corresponding pixel the colour and intensity of that pixel in one said image takes precedence over the
20 colour and intensity of that pixel in the other said image, with pixels in said ~~background region of said visible mark image having lower precedence~~
than pixels in said processed indicator base image, and pixels in said visible marking region in said visible mark base image having higher precedence than pixels in said processed indicator base image.

25 15. A system of generating a printable watermark image for combining into a printable document, said system comprising:
means for selecting an image background colour and intensity;
means for filling a background region of the watermark image with said
30 colour and an average intensity equalling said selected intensity, and with intensities of individual pixels falling within a background intensity range; and
means for filling an indicator region with said selected colour and with an average intensity equalling said selected intensity, but with the intensity of
35 individual pixels falling within a range substantially greater than said first range such that the resolution of said image, the dithered arrangement and the two or more intensities are selected such that the colour and intensity

of the image background and the indicator region appear uniform to the naked eye but the indicator region becomes apparent to the naked eye after processing the printed image with a copying device operating as a low pass filter.

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16. A system as claimed in claim 15, wherein said means for filling said background comprises means for applying a dithered pattern of two intensities having a first difference, and said means for filling said indicator region includes means for applying a dithered pattern of two intensities having a second difference substantially greater than said first difference.

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17. A system as claimed in either claims 15 or claim 16, wherein said selected intensity is not less than RGB(239,239,239).

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18. A system as claimed in any one of claims 15 to 17, further including:
means for receiving a base image; and
means for identifying a background region and an indicator region within said base image according to a colour or intensity differentiation between said background region and said indicator region.

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19. A system as claimed in claim 18, further including:
means for identifying a visible marking region within said base image; and
means for filling said visible marking region with a second colour and intensity different to said first colour and intensity.

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20. A system as claimed in any one of claims 15 to 17, further including:
means for receiving a visible mark base image and an indicator base image;

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means for identifying said indicator region and said background region within said indicator base image and filling same;

means for identifying a visible marking region and a background region within said visible mark base image, and

means for combining said visible mark base image and said filled and processed indicator base image,

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such that for each corresponding pixel the colour and intensity of that pixel in one said image takes precedence over the colour and intensity of that pixel in the other said image, with pixels in said background region of said

visible mark image having lower precedence than pixels in said processed indicator base image, and pixels in said visible marking region in said visible mark base image having higher precedence than pixels in said processed indicator base image. a colour detector is applied.

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21. A system as claimed in any one of claims 15 to 20, further including an colour detector comprising a light-grey background and an indication of nature of the copy.

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22. A system as claimed in claim 21, wherein the indication of the nature of the copy is a word that becomes obvious when copied in a density that is dark and becomes faint when the density is light.

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23. A system as claimed in claim 21 or claim 22, wherein the colour detector serves to identify a density of a photocopier.

24. A system as claimed in any one of claims 21 to 23, wherein the colour detector is selected from the group consisting of: a light colour detector and a dark colour detector.

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~~25. A system as claimed in claim 24, wherein the light colour detector will be invisible when the density of the photocopier is too light, and the dark colour detector will become too dark to be seen when the density of the photocopier is too dark.~~

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26. A method as claimed in any one of claims 9 to 14, further including an colour detector comprising a light-grey background and an indication of nature of the copy.

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27. A method as claimed in claim 26, wherein the indication of the nature of the copy is a word that becomes obvious when copied in a density that is dark and becomes faint when the density is light.

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28. A method as claimed in claim 26 or claim 27, wherein the colour detector serves to identify a density of a photocopier.

29. A method as claimed in any one of claims 26 to 28, wherein the colour detector is selected from the group consisting of: a light colour detector and a dark colour detector.
- 5 30. A method as claimed in claim 29, wherein the light colour detector will be invisible when the density of the photocopier is too light, and the dark colour detector will become too dark to be seen when the density of the photocopier is too dark.
- 10 31. A watermark image generated by the method according to any one of claims 9 to 14 and claims 26 to 30.
32. A document incorporating a watermark image produced by the method of any one of claims 9 to 14 and claims 26 to 30.
- 15 33. Computer usable medium comprising a computer program code that is configured to cause a processor to execute one or more functions to perform the method of any one of claims 9 to 14 and claims 26 to 30.