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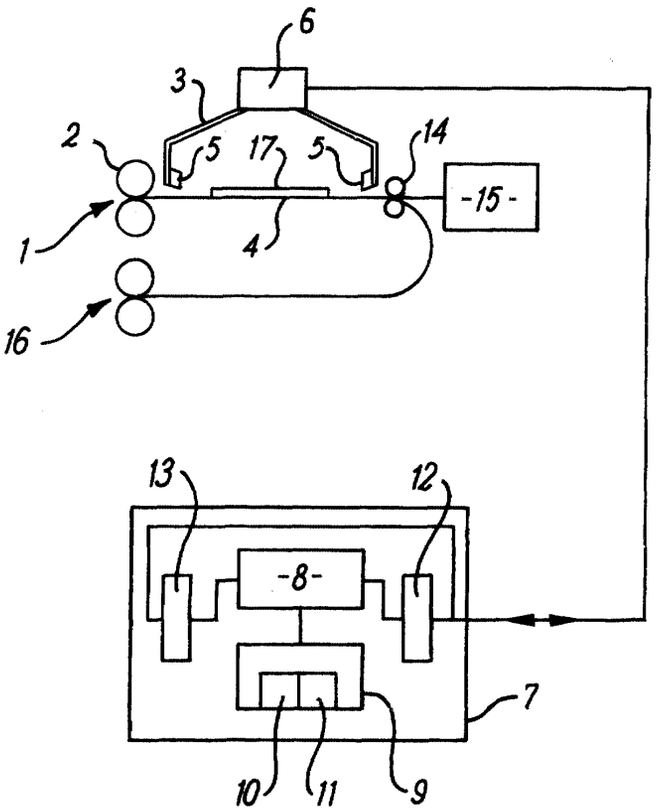
(54) Authentication of banknotes

(57) A method for authentication of bank notes involves analysing light received from a surface of the bank note and comparing properties of the light with reference properties pertaining to a genuine such surface. The properties are compared with reference to transitions at edges of design material on the surface. The bank note is advanced through a chamber (3) on a support belt (4) where it is illuminated by monochromatic light sources (5). Reflected light is received by a scanner (6).



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Description

[0001] This invention relates to authentication of design material applied to surfaces, particularly bank notes.

[0002] Machines which accept bank notes, such as automatic vending machines, change machines and the like, require authentication apparatus which is capable of distinguishing between genuine notes and counterfeit copies.

[0003] One example of authentication apparatus is described in GB 2122743B. This apparatus receives light at different wavelengths from the entire surface of the bank note. The received light is analysed in an integrated manner throughout the surface so that reliable authentication can be achieved irrespective of the orientation or positioning of the bank note.

[0004] Whilst this known technique is advantageous and effective, problems can arise due to the colour accuracy of modern photocopiers and other readily available relatively low cost copying equipment such as personal computers with scanners and colour printers.

[0005] The rapid development which has taken place in relation to equipment of this nature has led to an increase in bank note forgery. The quality of the counterfeit bank notes is not usually good enough to deceive the human eye and fingers, but the position is different with conventional electronic bank note readers. Present day bank notes incorporate security features, such as magnetic printing, intaglio printing, holograms, internal threads, fluorescence, micro-printing, etc., which are mostly intended for the human eye. However, conventional bank note readers tend to use techniques based on low-resolution pattern and colour recognition using broad band light emitting diodes and standard photo diodes. Conventional electronic bank note readers can be deceived by counterfeit notes produced with laser or inkjet colour printers, and many of the above mentioned security features can be readily counterfeited to the extent necessary to deceive the reader.

[0006] An object of the present invention is to provide an improved authentication technique, and apparatus using the technique, which is capable of distinguishing effectively between original design material, such as is applied to the surface of a bank note, and counterfeit copies of such material, in particular by relying on a characteristic of the genuine material which is difficult or expensive to counterfeit yet which is fast, easy and cheap to verify with an automatic reader.

[0007] According to one aspect of the invention therefore there is provided a method of authenticating design material applied to a surface wherein light received from an examined such surface is analysed and properties thereof are compared with reference properties pertaining to a genuine such surface, characterised in that the properties are compared with reference to transitions at edges of the design material whereby such material is established as authenticated when the sharpness of such transitions exceeds a predetermined level.

[0008] With this arrangement, reliable and effective authentication can be readily achieved in so far as the technique is utilised to detect counterfeit surfaces which bear design material of a lower level of sharpness than the genuine surface. This is the case in relation to machine copies, such as photocopies or scanned computer printed copies, of high quality printed surfaces such as banknotes. Banknotes are printed such that the edges of design material are very sharp, whereas photocopies or computer printed copies are of much lower resolution and give edges which are imprecise or blurred.

[0009] In particular, one characteristic that separates a genuine bank note from a counterfeit note printed with a computer colour printer is the sharp edges of the ink that the offset and intaglio presses produce. Computer colour printers create colours by mixing a limited number of base colours. This technique creates blurred edges when viewed in high resolution. The intaglio and offset presses are very expensive and therefore not readily accessible to the ordinary counterfeiter. Thus, it can be difficult to deceive the technique of the invention without incurring high expense. On the other hand in so far as the invention can be performed with readily available relatively inexpensive high resolution scanners and fast micro-controllers, the invention can be put into practice conveniently and inexpensively.

[0010] The invention can therefore meet two principal criteria of bank note authentication, namely, reliance on a characteristic which is expensive to reproduce exactly in its genuine form, and use of an authentication method which can be convenient and inexpensive to put into practice.

[0011] The method of the invention may be utilised alone or in combination with any other authentication technique e.g. the technique of GB 2122743B.

[0012] Most preferably, the method of the invention involves analysis of changes in properties between adjacent discrete areas of the surface.

[0013] The discrete areas may comprise small quadrants or pixels which may have an area no larger than $0.02mm^2$ and preferably which are much smaller, say down to $0.002mm^2$. The invention is however not necessarily restricted to this range of $0.002mm^2$-$0.02mm^2$ and areas outside this range may be used. The use of very small areas gives high accuracy of contrast, but requires very high speed measuring equipment which may be more costly.

[0014] The areas may be analysed by measuring received light intensity (signal amplitude) and this may be effected sequentially from area to adjacent area. The analysed changes in properties may constitute rate of change of amplitude from area to adjacent area.

[0015] The analysis may be performed over part or all of the surface, preferably over the entire surface. The rate of change of signal amplitude may be measured from area to area over part of the surface or the entire surface and a mean or averaged value may be derived

and used for comparison purposes to establish authentication.

[0016] The analysis may be effected by sequentially receiving light from the different areas using any suitable static or moving examination or scanning technique. Alternatively, the analysis may be effected by receiving light from the surface and properties derived therefrom for the respective areas.

[0017] The received light may be of any suitable nature and may be monochromatic, or multi-colour, or white light, including light within and/or close to the visual spectrum. Monochromatic light may be suitable for determination of sharpness. Multi-colour or white light may be advantageous if other properties of the surface are additionally examined for authentication.

[0018] The light may be received after transmission through or reflection from the surface.

[0019] There may be one source of light and one kind of light receiver, this being suitable for use in the case of monochromatic light.

[0020] Alternatively there may be any suitable combination of one or more sources and one or more receivers and/or one or more filters or the like.

[0021] Thus, in the case of multi-colour or white light, there may be multiple different monochromatic sources with respective multiple different monochromatic receivers, or there may be a single, e.g. white light, source with multiple different monochromatic receivers. Other arrangements are also possible.

[0022] Most preferably the surface is provided by a bank note and the method may be applied to one or both surfaces.

[0023] The invention also provides apparatus for use in performing the above method comprising means for receiving a surface having thereon design material to be authenticated relative to predetermined genuine such material, at least one light source for illuminating the surface, at least one receiver for receiving light from the surface, and an analyser for analysing data representing received light from the surface, said analyser including a comparator to compare this data with corresponding data pertaining to the genuine material, characterised in that the comparator is arranged to compare the data with reference to transitions at edges of the design material so as to produce an indication of authentication when the sharpness of such transitions is greater than a predetermined level.

[0024] The light source may comprise one or more LED's or photo diodes or any other suitable devices.

[0025] The light receiver may comprise a scanner of any suitable construction.

[0026] The analyser may be provided by a micro-computer system.

[0027] The invention will now be described further by way of example only and with reference to the accompanying drawing which is a schematic representation of one form of authentication apparatus according to the invention.

[0028] Bank note authentication apparatus, as shown in the drawing, has an inlet slot 1 with driven rollers 2 in communication with an illumination chamber 3.

[0029] Within the chamber 3 there is a bank note support bed 4, monochromatic light sources 5 arranged to illuminate the support bed (e.g. at c.570nm wavelength), and a scanner 6 arranged to scan the region of the support bed.

[0030] The scanner 6 is connected to electronic control equipment 7 including a microprocessor control unit 8, an analyser 9 including a comparator 10 and a reference data store 11, and input and output devices 12, 13.

[0031] The chamber 3 has an outlet slot 14 which is selectively in communication with a bank note receiving device 15, and a bank note return slot 16.

[0032] In use a bank note 17 is inserted through the slot 1 and is advanced into the chamber 3 by means of the driven rollers 2.

[0033] Within the chamber 3 the top surface of the bank note 17 on the support bed 4 is illuminated by the light sources 5.

[0034] The scanner 6 operates to scan the illuminated top surface of the bank note 17 and receive an analogue signal of varying amplitude representing reflected light intensity correlated with the scanned position on the surface of the note 17.

[0035] This continuous analogue output is converted to discrete signals corresponding to the light intensity (signal amplitude) at each successive pixel area of the surface having a defined area in the range 0.002-0.02mm^2 An 8-bit digital output of signal strength say 1.55 to 3.62 VDC is derived.

[0036] The analyser 9 computes a rate of change of amplitude between successive adjacent areas i.e. between successive derived digital signals.

[0037] This rate of change is averaged over the entire top surface of the bank note and a final average rate of change is derived.

[0038] The note is identified e.g. using the technique of GB 2122743B, or otherwise, and the derived average rate of change is compared with a predetermined reference value in the data store 11 for that bank note.

[0039] If the derived average rate of change is the same as the reference value, or falls below the reference value by no more than a predetermined margin, the note is accepted and is advanced to the note receiver 15 of the apparatus.

[0040] If the derived rate of change falls below the limit of acceptable margin the note is rejected and may be returned through the reject slot 16.

[0041] In effect the apparatus measures the sharpness of transitions at edges of design material on the top surface of the note.

[0042] In the case of a genuine bank note, design material is typically printed with edges of great sharpness and the rate of change of intensity of reflected light is high. In the case of counterfeit copies using photocopiers or computer printers the edges are much less sharp

and appear blurred at high resolution whereby the rate of change of intensity of reflected light is low.

[0043] With this arrangement, counterfeit copies can be readily detected in a particularly effective and reliable manner.

[0044] A characteristic of the bank note, namely the sharpness of the printing edges, which is very expensive to copy accurately is used for authentication purposes, and the technique of authentication can be performed using convenient and inexpensive apparatus. The arrangement described above therefore meets principal criteria of bank note authentication and is particularly advantageous.

[0045] It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiment which are described by way of example only.

Claims

1. A method of authenticating design material applied to a surface wherein light received from an examined such surface is analysed and properties thereof are compared with reference properties pertaining to a genuine such surface, characterised in that the properties are compared with reference to transitions at edges of the design material whereby such material is established as authenticated when the sharpness of such transitions exceeds a predetermined level. A method of authenticating design material applied to a surface wherein light received from an examined such surface is analysed and properties thereof are compared with reference properties pertaining to a genuine such surface, characterised in that the properties are compared with reference to transitions at edges of the design material whereby such material is established as authenticated when the sharpness of such transitions exceeds a predetermined level.

2. A method according to claim 1 characterised in that adjacent discrete areas of the surface are analysed for changes in properties.

3. A method according to claim 2 characterised in that the discrete areas may comprise small quadrants or pixels which have an area no larger than 0.02 mm^2.

4. A method according to claim 3 characterised in that small quadrants or pixels have an area in the range 0.002 mm^2 to 0.02 mm^2.

5. A method according to any one of claims 2-4 characterised in that areas may be analysed by measuring received light intensity.

6. A method according to claim 5 characterised in that the areas are analysed sequentially from area to adjacent area.

7. A method according to claim 6 characterised in that the analysed changes in properties constitute rate of change of amplitude from area to adjacent area.

8. A method according to claim 6 or 7 characterised in that the areas are analysed over the entire surface.

9. A method according to claim 7 characterised in that a mean or averaged value of signal amplitude is derived for the analysed areas.

10. A method according to any one of claims 2 to 9 characterised in that the light is received sequentially from the different areas.

11. A method according to any one of claims 2-9 characterised in that the light is received from the surface and properties derived therefrom are subdivided logically for the respective areas.

12. A method according to any one of claims 1 to 11 characterised in that the received light is from a monochromatic source.

13. A method according to any one of claims 1 to 12 characterised in that the light is received after reflection from the surface.

14. A method according to any one of claims 1 to 13 wherein the surface is the surface of a bank note.

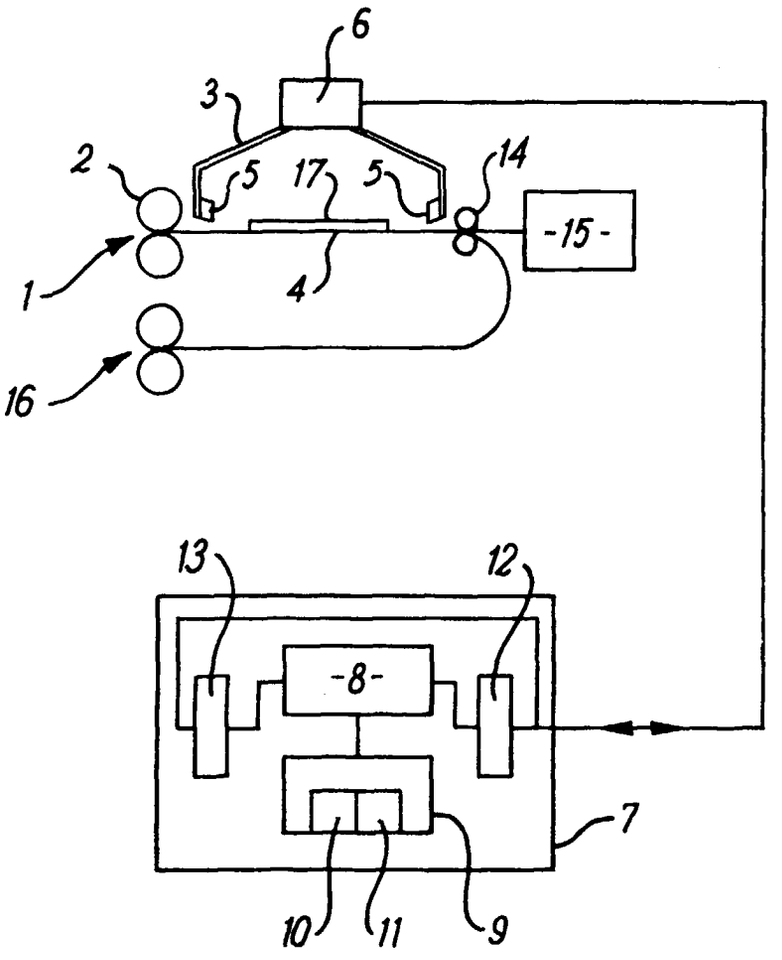
15. A method according to claim 14 applied to both surfaces of the bank note.

16. Apparatus for use in performing the method according to claim 1 comprising means for receiving a surface having thereon design material to be authenticated relative to predetermined genuine such material, at least one light source (5) for illuminating the surface, at least one receiver (6) for receiving light from the surface, and an analyser (9) for analysing data representing received light from the surface, said analyser (9) including a comparator (10) to compare this data with corresponding data pertaining to the genuine material, characterised in that the comparator (10) is arranged to compare the data with reference to transitions at edges of the design material so as to produce an indication of authentication when the sharpness of such transitions is greater than a predetermined level.

17. Apparatus according to claim 16 characterised in that the light source may comprise one or more LED's.

18. Apparatus according to claim 16 or 17 characterised in that the light receiver comprises a scanner (6).

19. Apparatus according to any one of claim 16 to 18 characterised in that the analyser (9) be provided by a micro-computer system (7).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