

A SYSTEM, METHOD AND COMPUTER READABLE MEDIUM FOR TRAINING A CONVOLUTIONAL NEURAL NETWORK TO AUTOMATICALLY VERIFY A HOLOGRAM

TECHNICAL FIELD

[0001] The present disclosure relates a system, method and computer readable medium for training a convolutional neural network to detect and verify a hologram on an Identity (ID) document. Embodiments of the present disclosure relate training the convolutional neural network with a first set of training data and a second set of training data obtained by an image differencing technique involving homographically aligning images of original and high printout of Identity (ID) documents containing the holograms and using the trained convolutional neural network to automatically verify the hologram on a test ID document.

BACKGROUND

[0002] Holography is a photographic technique that records the light scattered from an object and presents it in a three-dimensional way. Accordingly, holograms refer to a real world recording of an interference pattern which uses diffraction to reproduce a three-dimensional light field, resulting in an image which still has the depth, parallax, and other properties. While holograms have been used for artistic and aesthetic purposes for decades, the use of holograms on identity (ID) documents such as ID cards is becoming increasingly popular and useful in the present times. Holograms ensure protection and safety by enabling identification of original ID cards by way of embedded images, text, symbols and/ or the like.

[0003] While detection of presence or absence (or tampering) of holograms may be detected by naked eye, the presence of said holograms on a series of images of an ID document or card is difficult to be accurately ascertained. In some camera angles, under different light situations, the hologram may, or may not appear in a captured image. Moreover, the ability of holograms to reflect different light and patterns at different angles can not be accurately captured in images. Given a set of such images, automatic and accurate verification of whether or not the captured images are of an

original ID card, or rather from an image of the card or a tampered/ counterfeit card is difficult. A common problem faced in such scenarios is that the reflected holographic images may or may not show sections of the hologram. With the advent of advanced holographic technologies, verification of the captured images by a human with respect to the presence or absence (or tampering) of holograms is also a challenge at present.

[0004] A conventional technique for detection of holograms is disclosed in “*Mobile hologram verification with deep learning*” by Daniel Soukup and Reinhold Huber-Mork. In this document, a vector representation captures the essential appearance properties of hologram types in only a few values extracted from the photometric hologram stack. The results are based on Euro banknote holograms of genuine and counterfeit Euro banknotes. When compared to a model-based hologram descriptor, the trained convolutional neural network representation enables hologram authentication on the basis of the mobile acquisition method more reliably. However, a disadvantage of this technique is that it requires a specifically developed piece of hardware that is used to illuminate a hologram from specific angles. Another disadvantage of the technique is the requirement of capturing the images at a specified or preset angle for processing the images to identify the hologram present in the ID card. Further, the above technique uses Field Programmable Gate Arrays (FPGA) or specific hardware devices to illuminate a hologram from specific angles. Thus, the solution disclosed in the document cannot be conveniently and widely adopted or be made available as a solution in the industry at large.

[0005] Another conventional technique is disclosed in “*AR-Based Hologram Detection on Security Documents Using a Mobile Phone*” by Andreas Hartl, Clemens Arth, and Dieter Schmalstieg. However, a disadvantage of this technique is that the accuracy of detection and verification of holograms is not optimized using neural networks, thereby resulting in possible errors and lapses of detection.

[0006] Owing to the fact that a plethora of tasks are performed virtually in the present day and age, there is a need for a solution that is capable of overcoming the drawbacks of the conventional techniques and enables automatic and accurate detection and verification of holograms on ID documents or other security documents.

SUMMARY

[0007] The present disclosure relates a system, method and computer readable medium for training a convolutional neural network to detect and verify a hologram on an Identity (ID) document. Embodiments of the present disclosure relate training the convolutional neural network with a first set of training data and a second set of training data obtained by an image differencing technique involving homographically aligning images of original and high printout of Identity (ID) documents containing the holograms and using the trained convolutional neural network to automatically verify the hologram on a test ID document.

[0008] The systems, methods and computer readable medium disclosed in the present application are advantageous in several ways, including but not limited to, automatically and accurately detecting hologram(s) on an ID card or a security document and verifying the authenticity of the ID card or document based on the presence or absence (or tampering) of hologram(s), being capable of being implemented on a device having an imaging unit including but without limitation, a mobile device, a webcam, a surveillance camera, Single Lens Reflex (SLR) camera and/ or the like, reducing consumption of computing power in comparison to techniques implementing a custom hardware, being capable of processing the captured images of ID documents locally on the device, being capable of processing the captured images of ID documents as an application programming interface (API) call to a server, being capable of processing the captured images of ID documents partially on the device and partially as an API call to a server, processing images of an ID card captured without a restriction of any specific angle of view, increasing the efficiency in terms of speed and accuracy of the detection of hologram(s) and the verification of authenticity, optimizing the accuracy of detection of hologram(s) having similar shapes, colors, patterns and/ or the like, overcoming the requirement of human intervention, saving costs, time, manual effort for aligning a large number of ID documents, overcoming requirements of higher hardware specifications as utilized in deep learning models.

[0009] In a first aspect of the present disclosure, a system for training a Convolutional Neural Network (CNN) to automatically verify a hologram of an Identity (ID) document is disclosed. The system may comprise: an imaging unit for capturing: a plurality of first set of images of an original Identity (ID) document at different angles; and a plurality of second set of images of a plurality of high quality printouts of the Identity (ID) document at different angles; an image processing unit for processing: said plurality of first set of images of the original Identity (ID) document to generate at least one first absolute value differencing image; wherein said at least one first absolute value differencing image functions as a first set of training data, and said plurality of second set of images of said plurality of high quality printouts to generate at least one second absolute value differencing image; wherein said at least one second absolute value differencing image functions as a second set of training data, wherein the Convolutional Neural Network (CNN) is trained using the first set of training data and the second set of training data, and wherein the Convolutional Neural Network (CNN) after training is used for verifying the hologram of the Identity (ID) document.

[0010] According to an embodiment in conjunction to the first aspect of the present disclosure, the image processing unit processes said plurality of first set of images to obtain the first set of training data by: aligning said plurality of first set of images to a first image by vertically stacking said plurality of first set of images, wherein the first image is a front image of said plurality of first set of images; converting said plurality of first set of images into a first single channel image; and performing a background differencing of the first single channel image.

[0011] According to an embodiment in conjunction to the first aspect of the present disclosure, the image processing unit aligns said plurality of first set of images to the first image by: vertically stacking all said plurality of first set of images to the first image of said plurality of first set of images; identifying a first foreground content of the original Identity (ID) document; and homographically aligning the first foreground content of said plurality of first set of images.

[0012] According to an embodiment in conjunction to the first aspect of the present disclosure, the image processing unit performs the background differencing of the first

single channel image by: obtaining a pixel value in at least two images in said plurality of first set of images; subtracting the pixel values of the two images; and obtaining the first absolute value differencing image.

[0013] According to an embodiment in conjunction to the first aspect of the present disclosure, the image processing unit processes the second set of images to obtain the second set of training data by: aligning said plurality of second set of images to a second image by vertically stacking said plurality of second set of images, wherein the second image is a front image of said plurality of second set of images; converting said plurality of second set of images into a second single channel image; and performing a background differencing of the second single channel image.

[0014] According to an embodiment in conjunction to the first aspect of the present disclosure, the image processing unit aligns said plurality of second set of images to a second image by: vertically stacking all said plurality of second set of images to the second image of said plurality of second set of images; identifying a second foreground content of said plurality of high quality printouts; and homographically aligning the second foreground content of said plurality of second set of images.

[0015] According to an embodiment in conjunction to the first aspect of the present disclosure, the image processing unit performs the background differencing of the second single channel image by: obtaining a pixel value in at least two images in said plurality of second set of images; subtracting the pixel values of the two images; and obtaining the second absolute value differencing image.

[0016] According to an embodiment in conjunction to the first aspect of the present disclosure, the Convolutional Neural Network (CNN) after training with using the first set of training data and the second set of training data is used for verifying the hologram present in a test Identity (ID) document.

[0017] According to an embodiment in conjunction to the first aspect of the present disclosure, the Identity (ID) document is the test Identity (ID) document used for

verifying the hologram.

[0018] According to an embodiment in conjunction to the first aspect of the present disclosure, the Convolutional Neural Network (CNN) is used for verifying the hologram on the test Identity (ID) document by: capturing, by the imaging unit, a plurality of third set of images of the test Identity (ID) document at different angles; vertically stacking, by the processing unit, all said plurality of third set of images to the third image of said plurality of third set of images; identifying, by the processing unit, a third foreground content of the test Identity (ID) document; homographically aligning, by the processing unit, the third foreground content of said plurality of third set of images; converting, by the processing unit, said plurality of third set of images into a third single channel image; obtaining, by the processing unit, a pixel value in at least two images in the third single channel image; subtracting, by the processing unit, the pixel values of the two images; obtaining, by the processing unit, the third absolute value differencing image; inputting, by the processing unit, the third absolute value differencing image to the Convolutional Neural Network (CNN); verifying, by the Convolutional Neural Network (CNN), the hologram present in the test Identity (ID) document; and providing, by the Convolutional Neural Network (CNN), a validation result to a user.

[0019] In a second aspect of the present disclosure, a method for training a Convolutional Neural Network (CNN) to automatically verify a hologram of an Identity (ID) document is disclosed. The method may comprise: capturing, by an imaging unit, a plurality of first set of images of an original Identity (ID) document at different angles; processing, by an image processing unit, the first set of images of the original Identity (ID) document to generate at least one first absolute value differencing image; obtaining, by the image processing unit, a first set of training data from the first absolute value differencing image; capturing, by the imaging unit, a plurality of second set of images of a plurality of high quality printouts of the Identity (ID) document at different angles; processing, by the image processing unit, said plurality of second set of images of said plurality of high quality printouts to generate at least one second absolute value differencing image; obtaining, by the image processing unit, a second set of training data from the second absolute value differencing image; training the Convolutional Neural Network (CNN) based on the first set of training data and the

second set of training data; and using the Convolutional Neural Network (CNN) after training for verifying the hologram of the Identity (ID) document.

[0020] According to an embodiment in conjunction to the second aspect of the present disclosure, the image processing unit processes said plurality of first set of images to obtain the first set of training data by: aligning said plurality of first set of images to a first image by vertically stacking said plurality of first set of images; converting said plurality of first set of images into a first single channel image; and performing a background differencing of the first single channel image.

[0021] According to an embodiment in conjunction to the second aspect of the present disclosure, the image processing unit aligns said plurality of first set of images to the first image by: vertically stacking all said plurality of first set of images to the first image of said plurality of first set of images; identifying a first foreground content of the original ID document; and homographically aligning the first foreground content of said plurality of first set of images.

[0022] According to an embodiment in conjunction to the second aspect of the present disclosure, the image processing unit performs the background differencing of the first single channel image by: obtaining a pixel value in at least two images in the first single channel image; subtracting the pixel values of the two images; and obtaining the first absolute value differencing image.

[0023] According to an embodiment in conjunction to the second aspect of the present disclosure, the image processing unit processes said plurality of second set of images to obtain the second set of training data by: aligning said plurality of second set of images to a second image by vertically stacking said plurality of second set of images; converting said plurality of second set of images into a second single channel image; and performing a background differencing of the second single channel image.

[0024] According to an embodiment in conjunction to the second aspect of the present disclosure, the image processing unit aligns said plurality of second set of images to a second image by: vertically stacking all said plurality of second set of

images to the second image of said plurality of second set of images; identifying a second foreground content of said plurality of high quality printouts; and homographically aligning the second foreground content of said plurality of second set of images.

[0025] According to an embodiment in conjunction to the second aspect of the present disclosure, the image processing unit performs the background differencing of the second single channel image by: obtaining a pixel value in at least two images in the second single channel image; subtracting the pixel values of the two images; and obtaining the second absolute value differencing image.

[0026] According to an embodiment in conjunction to the second aspect of the present disclosure, the Convolutional Neural Network (CNN) after training with using the first set of training data and the second set of training data is used for verifying the hologram on a test Identity (ID) document.

[0027] According to an embodiment in conjunction to the second aspect of the present disclosure, the Convolutional Neural Network (CNN) verifies whether the valid hologram is present in the test Identity (ID) document by: taking, by the imaging unit, a plurality of third set of images of the test Identity (ID) document at different angles; vertically stacking, by the processing unit, all said plurality of third set of images to the third image of said plurality of third set of images; identifying, by the processing unit, a third foreground content of the test Identity (ID) document; homographically aligning, by the processing unit, the third foreground content of said plurality of third set of images; converting, by the processing unit, said plurality of third set of images into a third single channel image; obtaining, by the processing unit, a pixel value in at least two images in the third single channel image; subtracting, by the processing unit, the pixel values of the two images; obtaining, by the processing unit, the third absolute value differencing image; inputting, by the processing unit, the third absolute value differencing image to the Convolutional Neural Network (CNN); verifying, by the Convolutional Neural Network (CNN), the hologram present in the test Identity (ID) document; and providing, by the Convolutional Neural Network (CNN), a validation result to a user, wherein the Identity (ID) document is the test Identity (ID) document

used for verifying the hologram.

[0028] In a third aspect of the present disclosure, computer readable medium storing a program comprising instructions that, when executed by a system, cause the system to perform the method for training a Convolutional Neural Network (CNN) to automatically verify a hologram of an Identity (ID) document, of any of claims 11-19 is disclosed.

[0029] The following description is provided to facilitate an understanding of some of the innovative features unique to the disclosed embodiment and is not intended to be a full description. A full appreciation of the various aspects of the embodiments disclosed herein may be gained by taking into consideration the entire specification, claims, drawings, and abstract as a whole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] **FIG. 1** is a block diagram depicting an example system **100** for training a convolutional neural network to automatically verify a hologram on an ID document, in accordance with the disclosed embodiments.

[0031] **FIG. 2** is a block diagram depicting an example system **200** for automatically verifying a hologram on a test ID document **202** using a trained convolutional neural network **208**, in accordance with the disclosed embodiments.

[0032] **FIG. 3** is a flow diagram that illustrates an example method **300** for obtaining a trained convolutional neural network for automatically verifying the authenticity of a hologram on an ID document, in accordance with the disclosed embodiments.

[0033] **FIG. 4** is a flow diagram that illustrates an example method **400** for obtaining a first set of training data from a first set of images of an original ID document captured at one or more angles using an imaging unit, in accordance with the disclosed embodiments.

[0034] FIG. 5 is a flow diagram that illustrates an example method **500** for processing the first set of images of an original ID document using an image processing unit, in accordance with the disclosed embodiments.

[0035] FIG. 6 is a flow diagram that illustrates an example method **600** for preparing a first absolute value difference image using an image processing unit, in accordance with the disclosed embodiments.

[0036] FIG. 7 is a flow diagram that illustrates an example method **700** for obtaining a second set of training data from a second set of images of a high quality printout of an original ID document captured at one or more angles using an imaging unit, in accordance with the disclosed embodiments.

[0037] FIG. 8 is a flow diagram that illustrates an example method **800** for processing the second set of images of high quality printouts of an original ID document using an image processing unit, in accordance with the disclosed embodiments.

[0038] FIG. 9 is a flow diagram that illustrates an example method **900** for preparing a second absolute value difference image using an image processing unit, in accordance with the disclosed embodiments.

[0039] FIG. 10 is a flow diagram that illustrates an example method **1000** for automatically verifying the authenticity of a hologram on an ID document by a trained convolutional neural network, in accordance with the disclosed embodiments.

[0040] FIG. 11 is a flow diagram that illustrates an example method **1100** for automatically detecting and verifying a hologram on a test ID document using a trained convolutional neural network, in accordance with the disclosed embodiments.

[0041] The summary above, as well as the following detailed description of illustrative embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the present disclosure, exemplary

constructions of the disclosure are shown in the drawings. However, the disclosure is not limited to specific methods and instrumentalities disclosed herein. Moreover, those in the art will understand that the drawings are not to scale. Wherever possible, like elements have been indicated by identical numbers.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0042] The particular configurations discussed in the following description are non-limiting examples that may be varied and are cited merely to illustrate at least one embodiment and are not intended to limit the scope thereof.

[0043] A system, method and computer readable medium for training a convolutional neural network to automatically verify a hologram of an ID document is disclosed. In an embodiment of the present invention, the system may be implemented on a device, such as a mobile device, and two or more images of an ID document or a high quality printout thereof are captured at two or more angles using the imaging unit of the mobile device or an external imaging unit such as a webcam, a surveillance camera, SLR camera and/ or the like that is either connected locally to the mobile device or wirelessly such as via the internet, Bluetooth, Near-Field-Communication and/ or the like. In an embodiment of the present invention, an image processing unit is used for processing a first set of images of the original ID document to prepare a first absolute value differencing image, which forms a first set of training data or a positive set of training data. A second set of images of the high quality printout of an original ID document is used to prepare a second absolute value differencing image, which forms a second set of training data or a negative set of training data. A convolutional neural network is trained using the first set of training data and the second set of training data. After training, the convolutional neural network is capable of verifying whether a valid hologram is present in a test ID card or not.

[0044] The proposed system, method and computer readable medium of the present invention are capable of being applied generally for the authentication of hologram(s) present on any documents, cards, lenses, bank notes, passports, credit and bank cards or any other physical products, items or goods wherein authenticity of said

products, items or goods is verified by the hologram(s).

[0045] Embodiments of the present invention are capable of accurately verifying the holograms present on an ID document as the lighting changes from imaging the ID document from different angles that result in the holographic elements appearing differently in the resulting images are taken into account. By aligning the images of an ID document captured at different angles and computing an absolute value differencing image, the present invention is capable of training a convolutional neural network to detect the contents of a holographic element, and detect if that pattern is present. Embodiments of the present invention train the convolutional neural network with a second set of training data, being a negative training data, the trained convolutional neural network is capable of identifying images of counterfeit ID documents that are a high quality copy of an original ID document, as a holographic element will be absent on such counterfeit ID documents, and consequently the pattern(s) present in the holographic element will not appear in the corresponding absolute value differencing image, even if said pattern(s) are visible in the high quality image, that is, the counterfeit ID document itself.

[0046] The present invention overcomes the requirement of custom hardware of the conventional techniques and does not need images captured at specific angles to detect the hologram. The trained convolutional neural network can accurately detect the hologram present in the ID document and provide the verification result, that is, whether the hologram on the ID document is a valid one or not.

[0047] The present invention uses absolute image differencing on aligned images. A homographic transformation is used by aligning features in the first image of a first set of images or a second set of images to that of the subsequent images in said set of images. By way of the above, Harris corners, Scale-Invariant Feature Transform (SIFT) feature, Speeded Up Robust Features (SURF), accelerated KAZE features, and/ or the like, which are present in the foreground segment of the image corresponding to the ID document such as ID card in the image are used to homographically align the subsequent images in the set of images. If two images of an ID card are analyzed wherein the ID card is visible in both images, said ID card

may appear to be different in said images on account of the movement of the camera resulting in differences in the location of the card, rotation of the card, and perspective skew in the images. Thus, without homographic transformation, if the first image is placed directly on top of the second image, the cards in both of said images would not align. It is understood that movement of an imaging unit, which can be usually expected while capturing multiple images, may result in images that display the location of the card in different parts of the image, or with rotational differences, scale differences, or different perspective skews. After performing a homographic transformation on the second image of a set of images, the second image will be warped such that the card present in the two images will “be exactly on top of each other” if the two images were put on top of each other. This transformation, followed by image differencing, leads to input images that are ideal for classification by the convolutional neural network, as disclosed in the present invention.

[0048] The present invention combines the computational vision techniques along with the convolutional neural network to determine a score for the confidence of a known hologram in the collection of images taken by the imaging unit. In some embodiments of the present invention, the confidence score may be generated as a percentage of confidence, fractions, true/false score, floating score based on predetermined binary allocation indicating presence or absence of the hologram, and/or the like.

[0049] **FIG. 1** is a block diagram depicting an example system **100** for training a convolutional neural network to automatically verify a hologram on an ID document, in accordance with the disclosed embodiments. The system **100** comprises at least one imaging unit **106**, at least one image processing unit **108** and the convolutional neural network **110**. The imaging unit **106** is used for capturing at least one first set of images of an original ID document **102** at different angles and at least one second set of images of a high quality printout **104** of the original ID document **102** at different angles. In an embodiment of the present invention, the first set of images comprises two or more images of the original ID document captured at two or more angles by the imaging unit. In an embodiment of the present invention, the second set of images comprises two or more images of the high quality printout of the original the ID document captured at two or more angles by the imaging unit. In an embodiment of

the present invention, the third set of images comprises two or more images of the test ID document captured at two or more angles by the imaging unit. Some examples of the imaging unit **106** may be a camera on a mobile phone, webcam, surveillance camera, Single Lens Reflex (SLR) camera and so on.

[0050] The image processing unit **108** is used for processing the first set of images of the original ID document **102** to generate at least one first absolute value differencing image and the second set of images of the high quality printouts **104** to generate at least one second absolute value differencing image. The first absolute value differencing image obtained from the image processing unit **108** comprise a first set of training data used in training of the convolutional neural network **110** while the second absolute value differencing image comprise a second set of training data used in training of the convolutional neural network **110**. The convolutional neural network is trained using the first set of training data and the second set of training data. In some embodiments of the present invention, the first set of training data may be used as a positive set of training data and the second set of training data may be used as a negative set of training data for a convolutional neural network.

[0051] The invention uses a set of images taken from different angles of "training documents". The training documents include without any limitation, real ID documents such as ID cards and high quality printouts of the original ID documents, being real samples of actual Identity documents with holograms or holographic overlays present on the document.

[0052] The image processing unit **108** vertically stacks all the images subsequent to the first image in the first set of images corresponding to the first image of said set, such that said images of the first set of images are homographically aligned. Accordingly, in an embodiment of the present invention, the image processing unit **108** identifies a first foreground content of the ID card in a first image captured at an angle, and homographically aligns said first foreground content with the foreground content of the other images captured at other angles in the first set of images. The image processing unit **108** reduces the first set of images into a first single channel image. In an embodiment of the present invention, the first set of images having a first single

channel are greyscale images. The image processing unit **108** obtains a pixel value in at least two images from the first single channel images. The image processing unit **108** also subtracts the pixel values of the two images to prepare the first absolute value differencing image. The first absolute value differencing image comprises the first set of training data to train the convolutional neural network **110**.

[0053] The image processing unit **108** vertically stacks all the images subsequent to the first image in the second set of images corresponding to the first image of said set, such that said images of the second set of images are homographically aligned. Accordingly, in an embodiment of the present invention, the image processing unit **108** identifies a second foreground content of the ID card in a first image captured at an angle, and homographically aligns said second foreground content with the foreground content of the other images captured at other angles in the second set of images. The image processing unit **108** reduces the second set of images into a second single channel image. In an embodiment of the present invention, the second set of images having a second single channel are greyscale images. The image processing unit **108** obtains a pixel value in at least two images from the second single channel images of the second set of images. The image processing unit **108** also subtracts the pixel values of the two images to prepare the second absolute value differencing image. The second absolute value differencing image comprises the second set of training data to train the convolutional neural network **110**.

[0054] The convolutional neural network **110** is trained using the first and second absolute value differencing images (also referred to as a positive and negative set of training data) of original and high quality printouts of ID documents and are used for authenticating or verifying the ID documents in real-life scenarios.

[0055] The present invention combines the computational vision techniques along with the convolutional neural network to determine a score for the confidence of a known hologram in the collection of images taken by the imaging unit. The process performed in the image processing unit uses the computational vision techniques to convert the images of original ID card and high quality printouts of actual ID documents with holograms into the first and second set of training data. The convolutional neural

network is trained with the first and second set of training data obtained using the computational vision techniques in the image processing unit. The process performed using computation vision technique are not limited to homographically aligning the cards to the first image in the image set, identifying the foreground content of the image, converting the aligned images to a single channel image (greyscale image), performing the process of background differencing and so on. The present invention does not use a field-programmable gate array (FPGA) or specific/ custom hardware for capturing images of the ID cards at specific angles.

[0056] FIG. 2 is a block diagram depicting an example system **200** for automatically verifying a hologram on a test ID document **202** using a trained convolutional neural network **208**, in accordance with the disclosed embodiments. The test ID document **202** is input into the convolutional neural network **208** for verifying whether the hologram present on the test ID document **202** is a valid one or not. The imaging unit **204** is used to capture at least one third set of images of the test ID document **202** at different angles. In an embodiment of the present invention, the third set of images comprises two or more images of the test ID document captured at two or more angles by the imaging unit. The image processing unit **206** is used for processing the third set of images of the test ID document **202** to generate at least one third absolute value differencing image. The image processing unit **206** vertically stacks all the images subsequent to the first image in the third set of images corresponding to the first image of said set, such that said images of the third set of images are homographically aligned. Accordingly, in an embodiment of the present invention, the image processing unit identifies the third foreground content of the ID card in a first image captured at an angle, and homographically aligns said third foreground content with the foreground content of the other images captured at other angles in the third set of images. The image processing unit **206** reduces the third set of images into a third single channel image. In an embodiment of the present invention, the third set of images having a third single channel are greyscale images. The image processing unit **206** obtains a pixel value in at least two images from the third single channel images of the third set of images. The image processing unit **206** also subtracts the pixel values of the two images to prepare the third absolute value differencing image.

[0057] The third absolute value differencing image obtained from the image

processing unit **206** is sent to the trained convolutional neural network **208** for verification. The trained convolutional neural network **208** determines and verifies whether the hologram present on the test ID document **202** is valid or not. The trained convolutional neural network **208** provides a validation result **210** to a user. The validation result **210** is based on a confidence score, determined by similarity to the training documents. In an embodiment of the present invention, the test ID card **202** is the ID document, such as an ID card, that is used for hologram verification in a real-life scenario. The convolutional neural network **208** is trained to detect the contents of a holographic element, and detect if that pattern is present while performing verification processes, using a confidence score determined by the convolutional neural network **208**.

[0058] In some embodiments of the present invention, the images input to train the convolutional neural network may be automatically labelled in a binary allocation, for example '0' for an image representing a second set of training data being a negative set, '1' for an image representing a first set of training data being a positive set. When the trained convolutional neural network is applied to a third absolute value differencing image for testing, the output of the neural net may be a confidence score between the values 0 and 1 (floating point number). In some embodiments of the present invention, a threshold may be predefined, such as a median value, (for example 0.5) to the output of the convolutional neural network, and the output may be deemed as a "positive sample" if the confidence score is greater than the threshold value (for example more than 0.5), and a "negative sample" if the confidence score is below the threshold value (for example less than 0.5).

[0059] **FIG. 3** is a flow diagram that illustrates an example method **300** for obtaining a trained convolutional neural network for automatically verifying the authenticity of a hologram on an ID document, in accordance with the disclosed embodiments. The method **300** may be implemented by capturing a first set of images of an original ID document at one or more angles using an imaging unit, as at block **302**. In an embodiment of the present invention, the first set of images comprises two or more images of the ID document captured at two or more angles by the imaging unit. Then, as at block **304**, the first set of images is processed by an image processing unit to

generate one or more first absolute value differencing images. Thereafter, as at block **306**, a first set of training data is obtained from the one or more first absolute value differencing images. The method **300** may be implemented by obtaining a high quality printout of the original ID document and capturing a second set of images of the printout at one or more angles using an imaging unit, as at block **308**. Then, as at block **310**, the second set of images is processed by the image processing unit to generate one or more second absolute value differencing images. Thereafter, as at block **312**, a second set of training data is obtained from the one or more second absolute value differencing images. The method **300** may be thereafter implemented by training a convolutional neural network as at block **314** using the first set of training data and the second set of training data. In some embodiments of the present invention, the first set of training data may be used as a positive set of training data and the second set of training data may be used as a negative set of training data for a convolutional neural network. Since the first set of images are images of an original ID document captured using the imaging unit at different angles, a holographic element of the original ID document is captured by the imaging unit at different angles and accordingly, the same is detected by the image processing unit. Thus, the first set of training data is capable of training the convolutional neural network to detect and verify images of ID documents, wherein the hologram is present to validate the authenticity of the ID document.

[0060] FIG. 4 is a flow diagram that illustrates an example method **400** for obtaining a first set of training data from a first set of images of an original ID document captured at one or more angles using an imaging unit, in accordance with the disclosed embodiments. The method **400** may be implemented, by aligning the first set of images of the original ID document by an image processing unit, as at block **410**. Usually, captured images of an ID card in a frame have extraneous content, such as the background, or content behind the card. Accordingly, in an embodiment of the present invention, the image processing unit identifies the first foreground content of the ID card in an image captured at an angle, and homographically aligns said first foreground content with the foreground content of the other images captured at other angles. In an embodiment of the present invention, the alignment of the first set of images may be done by vertically stacking said images. In an embodiment of the present invention, vertically stacking the first set of images entails homographically

aligning said images captured at one or more angles to a first image captured at an angle in the first set of images. Once aligned the actual captured images would stack on top of each other such that the content of the ID document, for example the rectangular content or image of a rectangular ID card, would be perfectly aligned as being vertically stacked. In some embodiments of the present invention, the image processing unit comprises one or more algorithms to use homographic techniques to align the images. Then, as at block **420**, the captured first set of images are reduced to a first single channel. In an embodiment of the present invention, the first set of images having the first single channel are greyscale images. In some embodiments of the present invention, the first set of images of the original ID document may be reduced to the first single channel as at block **420** and thereafter aligned by the image processing unit as at block **410**. Thereafter, as at block **430** a first absolute value difference image is prepared using background differencing and as at block **440**, the first set of training data for training a convolutional neural network is obtained. In some embodiments of the present invention, the first set of training data may be used as a positive set of training data for a convolutional neural network.

[0061] FIG. 5 is a flow diagram that illustrates an example method **500** for processing the first set of images of an original ID document using an image processing unit, in accordance with the disclosed embodiments. The method **500** may be implemented by aligning the first set of images to the first image by the image processing unit. Initially, all the first set of images are vertically stacked to the first image of the first set of images, as at block **502**. Then, as at block **504**, a first foreground content of the original ID document is identified. As at block **506**, the first foreground content of the first set of images are homographically aligned.

[0062] FIG. 6 is a flow diagram that illustrates an example method **600** for preparing a first absolute value difference image using an image processing unit, in accordance with the disclosed embodiments. The first absolute value difference image of an original ID card comprises a first set of training data or a positive training data to train a convolutional neural network. In an embodiment of the present invention, a first absolute value difference image may be obtained by performing background differencing of a first single channel image using the image processing unit. The method **600** may be implemented by obtaining a pixel value in at least two images in

a first set of aligned images, as at block **602**. In an embodiment of the present invention, alignment of the first set of images may be implemented using the example method **400** as described in **FIG. 4** of the present disclosure. Then, as at blocks **604** and **606**, the pixel values of the two images are subtracted and the first absolute value differencing image is prepared. In an embodiment of the present invention, absolute value differencing is done by taking the pixel values in the two images and subtracting said pixel values to obtain an absolute value. For example, for two input images I_1 and I_2 , and a resulting absolute value differencing image R , the two-dimensional pixel locations in the x and y axes may be represented as $W(x, y)$. If the image is m pixels in width, and n pixels in height, then let the coordinate system be such that $I_1(0, 0)$ represents the first pixel in the top-leftmost corner in the first input image, and $I_1(m-1, n-1)$ represents the pixel in the bottom right-most corner. Since the first set of images are aligned, all images in the absolute image differencing are assumed to have identical dimensions. As described in the present disclosure, in an embodiment of the present invention, the alignment of the first set of images may be done by vertically stacking said images. In an embodiment of the present invention, vertically stacking the first set of images entails homographically aligning said images captured at one or more angles to a first image captured at an angle in the first set of images. Thus, in the above example, $I_2(0, n-1)$ may represent the bottom leftmost pixel in input image I_2 , $R(m, 0)$ may represent the top rightmost pixel in the resultant image R . The $R(m/2, n/2)$ may represent a pixel in the center of the resultant image R . In an embodiment of the present invention, the resultant image R can be obtained by computing each pixel for the resultant image R using the below equation based on the corresponding pixels of two input images, wherein I_1 and I_2 represent input images.

$$R(x_i, y_j) = ||I_1(x_i, y_j) - I_2(x_i, y_j)|| \text{ ----- Equation (1)}$$

[0063] FIG. 7 is a flow diagram that illustrates an example method **700** for obtaining a second set of training data from a second set of images of a high quality printout of an original ID document captured at one or more angles using an imaging unit, in accordance with the disclosed embodiments. The method **700** may be implemented by aligning the second set of images of the printout of the original ID document by an image processing unit, as at block **710**. Usually, captured images in a frame have

extraneous content, such as the background, or content behind the ID document, such as an ID card. Accordingly, in an embodiment of the present invention, the image processing unit identifies the second foreground content of the ID card in an image of the printout of the ID card captured at an angle, and homographically aligns said second foreground content with the foreground content of the other images of the printout of the ID card captured at other angles. In an embodiment of the present invention, the alignment of the second set of images may be done by vertically stacking said images. In an embodiment of the present invention, vertically stacking the second set of images entails homographically aligning said images captured at one or more angles to a first image captured at an angle in the second set of images. Once aligned the actual captured images would stack on top of each other such that the content of the ID document, for example the rectangular content or image of a rectangular ID card, would be perfectly aligned as being vertically stacked. In some embodiments of the present invention, the image processing unit comprises one or more algorithms to use homographic techniques to align the images. Then, as at block **720**, the captured second set of images are reduced to a second single channel. In an embodiment of the present invention, the second set of images having the second single channel are greyscale images. In some embodiments of the present invention, the second set of images of the original ID document may be reduced to the second single channel as at block **720** and thereafter aligned by the image processing unit as at block **710**. Thereafter, as at block **730** a second absolute value difference image is prepared using background differencing and as at block **740**, the second set of training data for training a convolutional neural network is obtained. In some embodiments of the present invention, the second set of training data may be used as a negative set of training data for a convolutional neural network. Since the second set of images are images of a high quality printout of an original ID document captured using the imaging unit, a holographic element of the original ID document does not exist on the printout and therefore is not captured by the imaging unit and accordingly, the same is detected by the image processing unit. Thus, the second set of training data is capable of training the convolutional neural network to detect and verify images of ID documents, wherein the hologram is absent or tampered with.

[0064] FIG. 8 is a flow diagram that illustrates an example method **800** for processing

the second set of images of high quality printouts of an original ID document using an image processing unit, in accordance with the disclosed embodiments. The method **800** may be implemented by aligning the second set of images to the first image of said second set of images, by the image processing unit. Initially, all the second set of images are vertically stacked to the first image of the second set of images, as at block **802**. Then, as at block **804**, a second foreground content of the ID document is identified. As at block **806**, the second foreground content of the second set of images are homographically aligned.

[0065] FIG. 9 is a flow diagram that illustrates an example method **900** for preparing a second absolute value difference image using an image processing unit, in accordance with the disclosed embodiments. The second absolute value difference image of a high quality printout of an original ID card comprises a second set of training data or a negative training data to train a convolutional neural network. In an embodiment of the present invention, a second absolute value difference image may be obtained by performing background differencing of a second single channel image using the image processing unit. The method **900** may be implemented by obtaining a pixel value in at least two images in a second set of aligned images, as at block **902**. In an embodiment of the present invention, alignment of the second set of images may be implemented using the example method **700** as described in **FIG. 7** of the present description. Then, as at blocks **904** and **906**, the pixel values of the two images are subtracted and the second absolute value differencing image is prepared. In an embodiment of the present invention, absolute value differencing is done by taking the pixel values in the two images and subtracting said pixel values to obtain an absolute value. For example, for two input images I_3 and I_4 , and a resulting absolute value differencing image R' , the two-dimensional pixel locations in the x and y axes may be represented as $W(x, y)$. If the image is m pixels in width, and n pixels in height, then let the coordinate system be such that $I_3(0, 0)$ represents the first pixel in the top-leftmost corner in the first input image, and $I_3(m-1, n-1)$ represents the pixel in the bottom right-most corner. Since the second set of images are aligned, all images in the absolute image differencing are assumed to have identical dimensions. As described in the present disclosure, in an embodiment of the present invention, the alignment of the second set of images may be done by vertically stacking said images. In an embodiment of the present invention, vertically stacking the second set of images

entails homographically aligning said images captured at one or more angles to a first image captured at an angle in the second set of images. Thus, in the above example, $I_4(0, n-1)$ may represent the bottom leftmost pixel in input image I_4 , $R'(m, 0)$ may represent the top rightmost pixel in the resultant image R' . The $R'(m/2, n/2)$ may represent a pixel in the center of the resultant image R' . In an embodiment of the present invention, the resultant image R' can be obtained by computing each pixel for the resultant image R' using the below equation based on the corresponding pixels of two input images, wherein I_3 and I_4 represent input images.

$$R'(x_i, y_j) = ||I_3(x_i, y_j) - I_4(x_i, y_j)|| \text{ ----- Equation (2)}$$

[0066] For the process step of performing absolute image differencing of aligned images, a homographic transformation is used by aligning features in the first image of a first set of images or a second set of images to that of the subsequent images in said set of images. By way of such alignment, Harris corners, Scale-Invariant Feature Transform (SIFT) feature, Speeded Up Robust Features (SURF), accelerated KAZE features, and/ or the like, which are present in the foreground segment of the image corresponding to an ID document such as an ID card in the image are used to homographically align the subsequent images in the respective set of images. If two images of an ID card are analyzed wherein the ID card is visible in both images, said ID card may appear to be different in said images on account of the movement of the camera resulting in differences in the location of the card, rotation of the card, and perspective skew in the images. Thus, without homographic transformation, if the first image is placed directly on top of the second image, the cards in both of said images would not align. After performing a homographic transformation on the second image of a respective set of images, the second image will be warped such that the card present in the two images of the respective set of images will “be exactly on top of each other” if the two images were vertically stacked, that is, put on top of each other. This transformation, followed by image differencing, leads to input images that are ideal for classification by the convolutional neural network, as disclosed in the present invention.

[0067] FIG. 10 is a flow diagram that illustrates an example method **1000** for automatically verifying the authenticity of a hologram on an ID document by a trained convolutional neural network, in accordance with the disclosed embodiments. The method **1000** may be implemented by capturing a third set of images of an ID document at one or more angles using an imaging unit, as at block **1002**. Then, as at block **1004**, the third set of images is processed by an image processing unit to generate one or more third absolute value differencing images. Thereafter, as at block **1006**, the one or more third absolute value differencing images are input to the trained convolutional neural network. Then, as at block **1008**, the trained convolutional neural network generates a confidence score and at block **1010** verifying the authenticity of the hologram on the ID document based on the confidence score. In some embodiments of the present invention, the confidence score generated by the convolutional neural network may be based on a binary allocation, for example, '0' for an image representing a second set of training data being a negative set, '1' for an image representing a first set of training data being a positive set and the confidence score may be a floating decimal number in the range of '0' to '1'. In some embodiments of the present invention, the confidence score may be generated as a percentage of confidence, fractions, true/false score and/ or the like.

[0068] FIG. 11 is a flow diagram that illustrates an example method **1100** for automatically detecting and verifying a hologram on a test ID document using a trained convolutional neural network, in accordance with the disclosed embodiments. The method **1100** can be implemented by capturing, by an imaging unit, a third set of images of the test ID document, such as a test ID card, at different angles, as at block **1110**. In an embodiment of the present invention, the third set of images comprises two or more images of the test ID document captured at two or more angles by the imaging unit. Then, as at block **1120**, vertically stacking, by an image processing unit, the third set of images to a first image of said third set of images. Then, as at block **1130**, identifying, by the image processing unit, a third foreground content of the test ID document. The third foreground content of the third set of images are homographically aligned using the image processing unit, as at block **1140**. Then, the image processing unit converts the third set of images into a third single channel, as at block **1150**. In an embodiment of the present invention, the third set of images having the third single channel are greyscale images. In some embodiments of the

present invention, the third set of images of the test ID document may be reduced to the third single channel as at block **1150** and thereafter aligned by the image processing unit as at block **1140**. As at block **1160**, the image processing unit obtains a pixel value in at least two images in the third single channel image of the third set of images. Then, as at block **1170**, the image processing unit subtracts the pixel values of the two images to obtain the third absolute value differencing image at block **1180**. As at block **1190**, the image processing unit inputs the third absolute value differencing image to the trained convolutional neural network. The trained convolutional neural network verifies whether the hologram present on the test ID document is valid or not, as at block **1195**. The trained convolutional neural network provides a validation result to a user. In an embodiment of the present invention, the test ID card used in the method **1100** is the ID document, such as an ID card, that is used for hologram verification in a real-life scenario.

[0069] As disclosed in the present description, a convolutional neural network in an embodiment of the present invention, is trained to detect positive and negative samples of ID documents. In an embodiment of the present invention, small convolutional neural nets, for example three convolutional layers, followed by three fully connected layers may be trained to automatically detect and verify holograms.

[0070] An advantage of the present invention is that embodiments of the present invention are capable of accurately verifying the holograms present on an ID document as it takes into account the lighting changes from imaging the ID document from different angles that result in the holographic elements appearing differently in the resulting images. By aligning the images of an ID document captured at different angles and computing an absolute value differencing image, the present invention is capable of training a convolutional neural network to detect the contents of a holographic element, and detect if that pattern is present. Another advantage of the present invention is that by training the convolutional neural network with a second set of training data, being a negative training data, the trained convolutional neural network is capable of identifying images of counterfeit ID documents that are a high quality copy of an original ID document, as a holographic element will be absent on such counterfeit ID documents, and consequently the pattern(s) present in the

holographic element will not appear in the corresponding absolute value differencing image, even if said pattern(s) are visible in the high quality image, that is, the counterfeit ID document itself.

[0071] In an embodiment of the present invention, the system may be implemented on a device, for example a mobile device, where the user is instructed to take images from two or more angles using the imaging unit of the mobile device or an external imaging unit such as a webcam, a surveillance camera, SLR camera and/ or the like that is either connected locally to the mobile device or wirelessly such as via the internet, Bluetooth, Near-Field-Communication and/ or the like. In some embodiments of the present invention, the images may be captured from a video recording captured by the imaging unit. In some embodiments of the present invention, the images may be captured automatically by the imaging unit on detection of presence of an ID document. The processing of the image (for example image differencing, and inferencing using a trained convolutional network) may be done either locally on the device of a user, or as an API call to a server, or may be split partially between the device and the server. For example, the creation of a single-channel difference image may be done on the device, and that resulting image may be sent to a server, through an API call for inferencing with a model present on the server.

[0072] An advantage of the present invention is that the convolutional neural network is trained using a first set and a second set of training data, thereby optimizing accuracy of the trained neural network. Additionally, the image differencing techniques implemented in the present invention lead to the production of training data for a convolutional neural network resulting in an increased efficiency in terms of speed and accuracy of the detection of hologram(s) and the verification thereof, optimizing the accuracy of detection of hologram(s) having similar shapes, colors, patterns and/ or the like.

[0073] The convolutional neural network can learn the contents of a holographic element present on an ID document, and detect if that pattern is present while performing verification process, using confidence score determined by the convolutional neural network. In some embodiments of the present invention, the

confidence score generated by the convolutional neural network may be based on a binary allocation, for example, '0' for an image representing a second set of training data being a negative set, '1' for an image representing a first set of training data being a positive set and the confidence score may be a floating decimal number in the range of '0' to '1'. In some embodiments of the present invention, the confidence score may be generated as a percentage of confidence, fractions, true/false score and/ or the like.

[0074] The present invention also discloses a computer readable medium storing a program comprising instructions that, when executed by a system, cause the system to perform the method for training a Convolutional Neural Network (CNN) to automatically verify a hologram of an Identity ID document.

[0075] The proposed system, method and computer readable medium of the present invention are capable of being applied generally for the authentication of hologram(s) present on any documents, cards, lenses, bank notes, passports, credit and bank cards or any other physical products, items or goods wherein authenticity of said products, items or goods is verified by the hologram(s).

[0076] It will be appreciated that variations of the above disclosed and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Also, various presently unforeseen or unanticipated alternatives, modifications, variations or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

[0077] Although embodiments of the current disclosure have been described comprehensively in considerable detail to cover the possible aspects, those skilled in the art would recognize that other versions of the disclosure are also possible.

CLAIMS

What is claimed is:

1. A system for training a Convolutional Neural Network (CNN) to automatically verify a hologram of an Identity (ID) document comprising:
 - an imaging unit for capturing:
 - a plurality of first set of images of an original Identity (ID) document at different angles; and
 - a plurality of second set of images of a plurality of high quality printouts of the Identity (ID) document at different angles;
 - an image processing unit for processing:
 - said plurality of first set of images of the original Identity (ID) document to generate at least one first absolute value differencing image; wherein said at least one first absolute value differencing image functions as a first set of training data, and
 - said plurality of second set of images of said plurality of high quality printouts to generate at least one second absolute value differencing image; wherein said at least one second absolute value differencing image functions as a second set of training data,
 - wherein the Convolutional Neural Network (CNN) is trained using the first set of training data and the second set of training data, and
 - wherein the Convolutional Neural Network (CNN) after training is used for verifying the hologram of the Identity (ID) document.

2. The system of claim 1, wherein the image processing unit processes said plurality of first set of images to obtain the first set of training data by:
 - aligning said plurality of first set of images to a first image by vertically stacking said plurality of first set of images, wherein the first image is a front image of said plurality of first set of images;
 - converting said plurality of first set of images into a first single channel image; and
 - performing a background differencing of the first single channel image.

3. The system of claim 2, wherein the image processing unit aligns said plurality of first set of images to the first image by:

vertically stacking all said plurality of first set of images to the first image of said plurality of first set of images;

identifying a first foreground content of the original Identity (ID) document; and

homographically aligning the first foreground content of said plurality of first set of images.

4. The system of claim 2, wherein the image processing unit performs the background differencing of the first single channel image by:

obtaining a pixel value in at least two images in said plurality of first set of images;

subtracting the pixel values of the two images; and

obtaining the first absolute value differencing image.

5. The system of claim 1, wherein the image processing unit processes the second set of images to obtain the second set of training data by:

aligning said plurality of second set of images to a second image by vertically stacking said plurality of second set of images, wherein the second image is a front image of said plurality of second set of images;

converting said plurality of second set of images into a second single channel image; and

performing a background differencing of the second single channel image.

6. The system of claim 5, wherein the image processing unit aligns said plurality of second set of images to a second image by:

vertically stacking all said plurality of second set of images to the second image of said plurality of second set of images;

identifying a second foreground content of said plurality of high quality printouts; and

homographically aligning the second foreground content of said plurality of second set of images.

7. The system of claim 5, wherein the image processing unit performs the background differencing of the second single channel image by:

obtaining a pixel value in at least two images in said plurality of second set of images;

subtracting the pixel values of the two images; and

obtaining the second absolute value differencing image.

8. The system of claim 1, wherein the Convolutional Neural Network (CNN) after training with using the first set of training data and the second set of training data is used for verifying the hologram present in a test Identity (ID) document.

9. The system of claim 1, wherein the Identity (ID) document is the test Identity (ID) document used for verifying the hologram.

10. The system of claim 9, wherein the Convolutional Neural Network (CNN) is used for verifying the hologram on the test Identity (ID) document by:

capturing, by the imaging unit, a plurality of third set of images of the test Identity (ID) document at different angles;

vertically stacking, by the processing unit, all said plurality of third set of images to the third image of said plurality of third set of images;

identifying, by the processing unit, a third foreground content of the test Identity (ID) document;

homographically aligning, by the processing unit, the third foreground content of said plurality of third set of images;

converting, by the processing unit, said plurality of third set of images into a third single channel image;

obtaining, by the processing unit, a pixel value in at least two images in the third single channel image;

subtracting, by the processing unit, the pixel values of the two images;

obtaining, by the processing unit, the third absolute value differencing image;

inputting, by the processing unit, the third absolute value differencing image to the Convolutional Neural Network (CNN);

verifying, by the Convolutional Neural Network (CNN), the hologram present in the test Identity (ID) document; and

providing, by the Convolutional Neural Network (CNN), a validation result to a user.

11. A method for training a Convolutional Neural Network (CNN) to automatically verify a hologram of an Identity (ID) document comprising:

capturing, by an imaging unit, a plurality of first set of images of an original Identity (ID) document at different angles;

processing, by an image processing unit, the first set of images of the original Identity (ID) document to generate at least one first absolute value differencing image;

obtaining, by the image processing unit, a first set of training data from the first absolute value differencing image;

capturing, by the imaging unit, a plurality of second set of images of a plurality of high quality printouts of the Identity (ID) document at different angles;

processing, by the image processing unit, said plurality of second set of images of said plurality of high quality printouts to generate at least one second absolute value differencing image;

obtaining, by the image processing unit, a second set of training data from the second absolute value differencing image;

training the Convolutional Neural Network (CNN) based on the first set of training data and the second set of training data; and

using the Convolutional Neural Network (CNN) after training for verifying the hologram of the Identity (ID) document.

12. The method of claim 11, wherein the image processing unit processes said plurality of first set of images to obtain the first set of training data by:

aligning said plurality of first set of images to a first image by vertically stacking said plurality of first set of images;

converting said plurality of first set of images into a first single channel image; and

performing a background differencing of the first single channel image.

13. The method of claim 12, wherein the image processing unit aligns said plurality of first set of images to the first image by:

vertically stacking all said plurality of first set of images to the first image of said plurality of first set of images;

identifying a first foreground content of the original Identity (ID) document; and

homographically aligning the first foreground content of said plurality of first set of images.

14. The method of claim 12, wherein the image processing unit performs the background differencing of the first single channel image by:

obtaining a pixel value in at least two images in the first single channel image;

subtracting the pixel values of the two images; and

obtaining the first absolute value differencing image.

15. The method of claim 14, wherein the image processing unit processes said plurality of second set of images to obtain the second set of training data by:

aligning said plurality of second set of images to a second image by vertically stacking said plurality of second set of images;

converting said plurality of second set of images into a second single channel image; and

performing a background differencing of the second single channel image.

16. The method of claim 15, wherein the image processing unit aligns said plurality of second set of images to a second image by:

vertically stacking all said plurality of second set of images to the second image of said plurality of second set of images;

identifying a second foreground content of said plurality of high quality printouts; and

homographically aligning the second foreground content of said plurality of second set of images.

17. The method of claim 15, wherein the image processing unit performs the background differencing of the second single channel image by:

obtaining a pixel value in at least two images in the second single channel image;

subtracting the pixel values of the two images; and

obtaining the second absolute value differencing image.

18. The method of claim 11, wherein the Convolutional Neural Network (CNN) after training with using the first set of training data and the second set of training data is used for verifying the hologram on a test Identity (ID) document.

19. The method of claim 18, wherein the Convolutional Neural Network (CNN) verifies whether the valid hologram is present in the test Identity (ID) document by:

taking, by the imaging unit, a plurality of third set of images of the test Identity (ID) document at different angles;

vertically stacking, by the processing unit, all said plurality of third set of images to the third image of said plurality of third set of images;

identifying, by the processing unit, a third foreground content of the test Identity (ID) document;

homographically aligning, by the processing unit, the third foreground content of said plurality of third set of images;

converting, by the processing unit, said plurality of third set of images into a third single channel image;

obtaining, by the processing unit, a pixel value in at least two images in the third single channel image;

subtracting, by the processing unit, the pixel values of the two images;

obtaining, by the processing unit, the third absolute value differencing image;

inputting, by the processing unit, the third absolute value differencing image to the Convolutional Neural Network (CNN);

verifying, by the Convolutional Neural Network (CNN), the hologram present in the test Identity (ID) document; and

providing, by the Convolutional Neural Network (CNN), a validation result to a user,

wherein the Identity (ID) document is the test Identity (ID) document used for verifying the hologram.

20. A computer readable medium storing a program comprising instructions that, when executed by a system, cause the system to perform the method for training a Convolutional Neural Network (CNN) to automatically verify a hologram of an Identity (ID) document, of any of claims 11-19.