Document Tampering Detection (Find-it Challenge Analysis)

Fig1. Tampered image with the tampered region highlighted

Overview

1. Challenge (Classification & Detection)
2. Methods for detection
    a. Yashas Method
    b. Fusion(Jpeg Artifacts using DCT)
    c. CMFD(Copy Move Forgery Detection)
    d. Splicebuster(Steganalysis)
    e. Noiseprint(Deep learning based steganalysis)
3. Results
    a. Confusion Matrix
    b. F1 score
4. PaySlip Dataset

Challenge Description

For classification we have around 1240 images out of which 240 images are forged

The dataset was divided into 2 parts. Training and Testing.

	Training	Testing
Forged	130	110
Not Forged	500	500

For training & testing distribution of dataset

Challenge Description

A forger can create various types of forgery. They are described as follows:

- CPI (copy and paste inside the document)
- CPO (copy and paste from another document)
- IMI (creation of a text box imitating the font)
- CUT (deletion of one or more characters/words)
- Other: drawing, copy and paste from web...

TABLE I
NUMBER OF DOCUMENTS PER TYPES OF ALTERATION IN EACH CORPUS

	T1Train	T2Train	T1Test	T2Test	Total
CPI	9	34	13	27	83
CPI CPO	1	5		4	10
CPI CPO CUT	1	1		1	3
CPI CPO IMI		1		1	2
CPI CUT	9	18	6	17	50
CPI CUT IMI		4		6	10
CPI IMI	2	6	1	4	13
CPO		7	3	2	12
CPO CUT		1	1	2	4
CUT	3	9	2	8	22
CUT CPI CPO IMI	1				1
IMI	3	11	3	7	24
IMI CUT		1	1		2
Other	1	2		1	4
Total	30	100	30	80	240

The distribution of forgeries across the dataset

Methods proposed

Different techniques provide solutions to different types of tampering.

Yashas' Method[1]: Augment and Adapt, Yashas Anandani & C.V. Jawahar, ICPR 2018

Fusion[2]: Improved dct coefficient analysis for forgery localization in jpeg images, A. Piva, ICASSP, 2011

CMFD[3] : Copy Move Forgery detection Cozzolino, Davide & Verdoliva, Luisa, ICIP 2014

Splicebuster[4]: D. Cozzolino & L. Verdoliva, WIFS 2015

Noiseprint[5]: a CNN-based camera model fingerprint. Cozzolino, Davide & Verdoliva, Luisa. Submitted, Uploaded: Aug 2018.

Augment and Adapt: A Simple Approach to Image Tampering Detection

Yashas Annadani, C.V. Jawahar, ICPR [1]

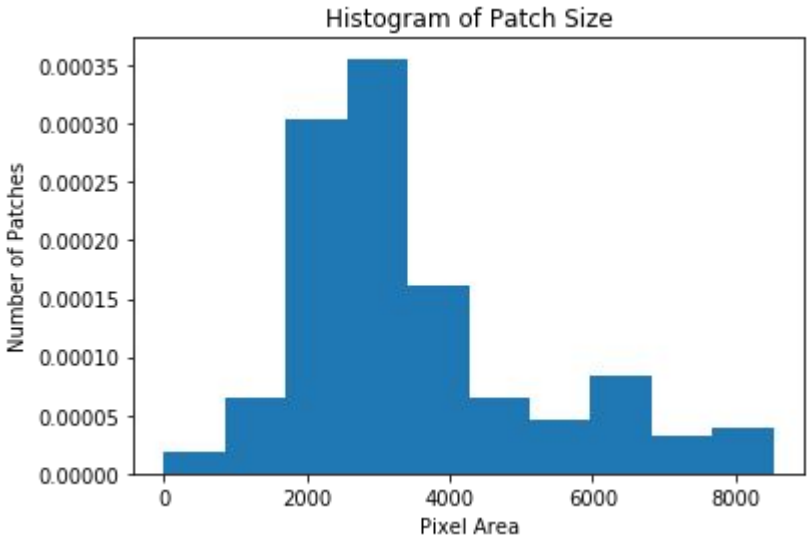
Divide an image into 64x64

If the more than image is 10% of the patch is tampered. We label the patch as tampered.

If k patches are tampered in an image. The image is classified as tampered

K was brought to reduce false positives. Here K can can take values from 1 to 8.

Using only 7 layer CNN doesn't learn a feasible representation of tampering

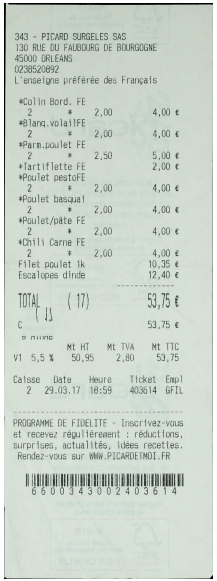


The distribution of tampered patch size.

Augment and Adapt: A Simple Approach to Image Tampering Detection

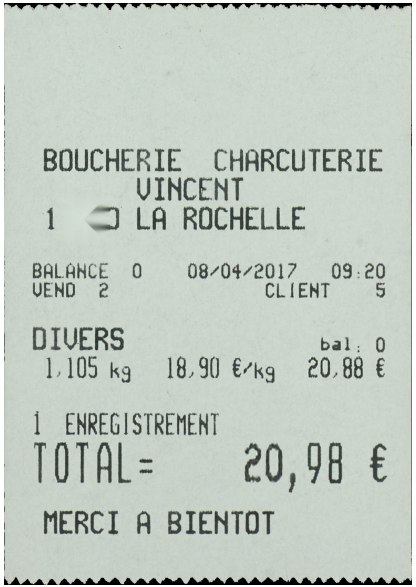
Yashas Annadani, C.V. Jawahar, ICPR [1]

White region Composted



Copy-paste(Below TOTAL)

Inpainting



Inpainting

Augmented Images

Augment and Adapt: A Simple Approach to Image Tampering Detection

Yashas Annadani, C.V. Jawahar, ICPR [1]

Accuracy on patches

Good training accuracy but poor test results.
Distribution of patches selected for training not appropriate

Test results

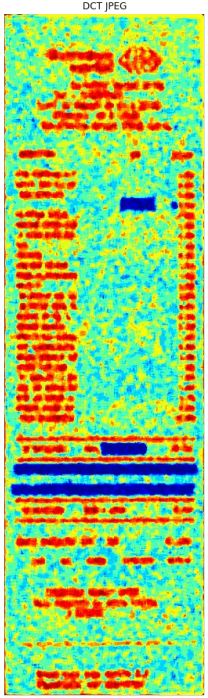
Very high false positive rate, most likely model overfitted on training patches.
It learned how to detect edges instead of tampering

Improved dct coefficient analysis for forgery localization in jpeg images

T. Bianchi, A. D. Rosa, and A. Piva, IEEE International Conference on Acoustics, Speech and Signal Processing, 2011[1]

Original Image 1

DCT JPEG



The method tries to detect forgery double jpeg artifacts in an image.

Findit dataset has Jpeg images, hence this method is used to find CPO(copy paste from other document) and imitation based on forgery.

Results

Acc: 0.959
Precision: 0.804
Recall: 0.994
F1: 0.889

Forgeries missed were CPI(copy paste from Same document)

	Pred True	Pred False
Gr True	193	47
Gr False	1	938

Confusion Matrix

How it works

Let Q_1 and Q_2 quantization steps used in the first and second compression.

To estimate Q_1 , they minimize the difference between 2 histogram of DCT coefficients, one of the image h(x) and one predicted by using Q_1 and Q_2 , p(x).

They have discovered that double jpeg artifacts cause a periodic shift in the DCT coefficient of the doubled quantized region with a period Q_1 / gcd(Q_1, Q_2). Let that function be n(x).

They estimate the histogram as a mixture model of single compressed region (H_1) and double compressed regions (H_0). Let it be

$p(x; Q_1 , \alpha) = \alpha \cdot n(x; Q_1) \cdot \tilde{n}(x \mid H_1) + (1 - \alpha) \cdot \tilde{n}(x \mid H_1)$

$\tilde{n}(x|H_1)$ is histogram calculated by using only Q_2 , $\tilde{n}(x|H_0)$ is calculated as $\tilde{n}(x|H_0) = n(x, Q_1) \cdot \tilde{n}(x|H_1)$

Estimation of Q_1 using L_2 loss : $\hat{Q}_1$ = argmin sum($[h(x) - p(x; Q_1 , \alpha)]$)^2

After estimating Q_1 the probability of a 8x8 block

$$p = p(\mathcal{H}_0|x_0, \ldots, x_{63}) = \frac{\prod_i p(x_i|\mathcal{H}_0)}{\prod_i p(x_i|\mathcal{H}_0) + \prod_i p(x_i|\mathcal{H}_1)}$$

being double compressed (p) is given by joint distribution over all coefficients

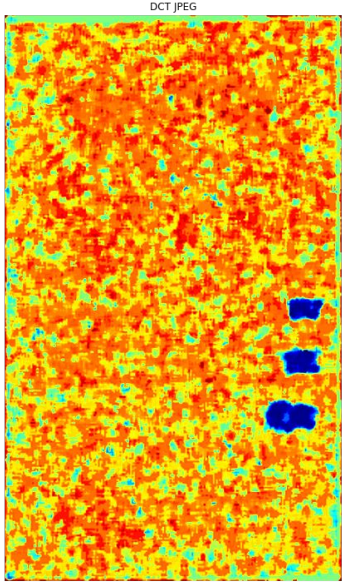
Analysis on Fusion

A very basic but highly effective approach, it is able to beat many of the current methods. But works only on JPEG

Correctly predicted

Original Image 1

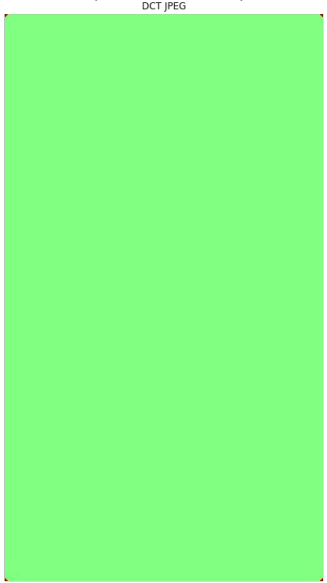
DCT JPEG



Failure Case.(Q1 == Q2)

Original Image 1

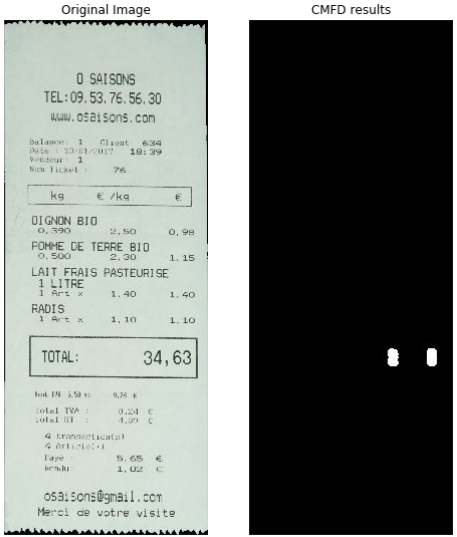
DCT JPEG



CMFD(Copy Move Forgery detection)
Cozzolino, Davide & Poggi, Giovanni & Verdoliva, Luisa, ICIP 2014[4]

The paper proposes using Patch Match algorithm for detecting tampering.

Used to detect copy-paste from same document(CPI)



Example of CMFD.
"3" is copied from 1 location to another

Results

Acc: 0.84
Precision: 0.220
Recall: 0.981
F1: 0.360

Forgeries CPO & Imitation Misclassified

	Pred True	Pred False
Gr True	53	187
Gr False	1	938

CMFD(Copy Move Forgery detection)
Cozzolino, Davide & Poggi, Giovanni & Verdoliva, Luisa, ICIP 2014[4]

Used to detect copy-paste from same document

Patch Match algorithm quickly finds correspondences between small square regions (or patches) of an image. It is extremely robust to rotation. Also it is faster than other methods(due to the random nature of the algorithm).

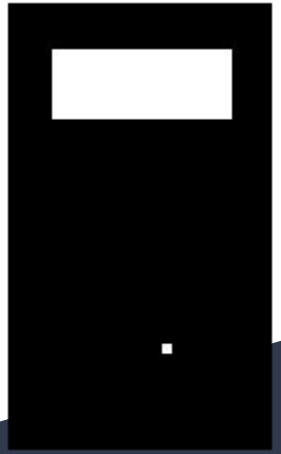
Patch Match works by defining a NNF(nearest neighbour field) f: R^2 -> R^2 for pixel to an offset. Two regions in image with high correspondence can be concluded to be originated from the same patch. (one patch is copied to another location)

Analysis on CMFD

CMFD is very useful in the challenge. Large number of tampered cased were CPI.

Original Image

GT MASK



CMFD results

Top region of the image was pasted just below it. CMFD was able to detect the forgery and also give the original location of the copied patch

Original Image

GT MASK

CMFD results

Multiple forgies were attempted. Some at character level, while others were used to hide information. CMFD is able to detect these

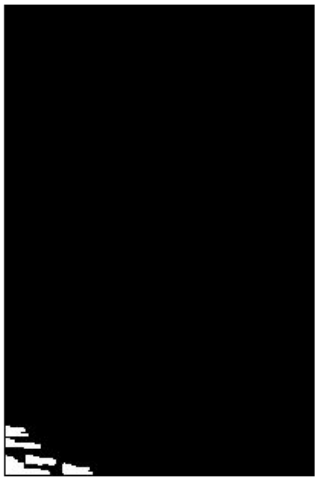
Analysis on CMFD

False positive

Large smooth regions such as the black background. Lead to false positives.

Original Image Not Tampered

CMFD results

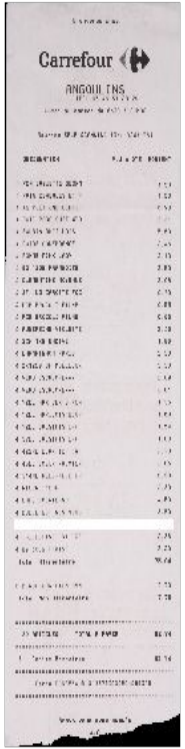


False Negatives

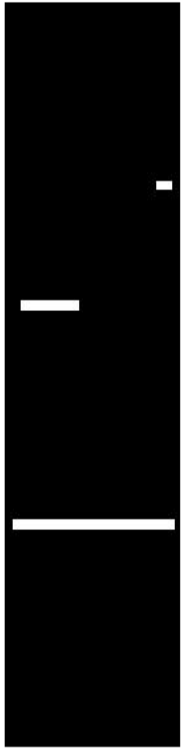
Different camera: Patch Match will not work on CPO. Hence we move to splice buster and noiseprint to detect these

Small forgeries: While experimentation we noticed CMFD is unable to catch very small patches. We have look further into patch match to get better results

Original Image



GT MASK



CMFD results

CMFD was able to detect CPI but not CPO

Original Image

GT MASK

CMFD results

CMFD was unable to detect small patches

Splicebuster & Steganalysis

D. Cozzolino, G. Poggi and L. Verdoliva, 2015 IEEE International Workshop on Information Forensics and Security (WIFS), 2015 [2]

Feature-based algorithm to detect image splicings without any prior information.

Splicing and host images are assumed to be characterized by different parameters

For splice detection, the high level noise is more important than the image content.

Linear high pass filters is used to create “residue”.

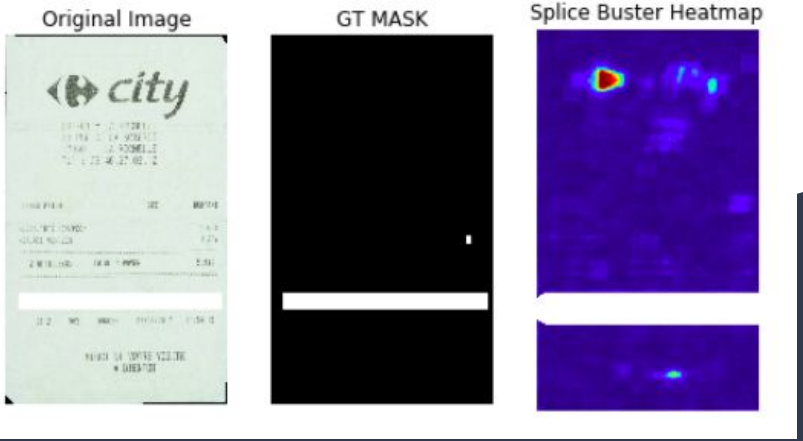
Co-occurrence matrix is calculated for residue. This matrix is used as features for the gaussian mixture model/SVM.

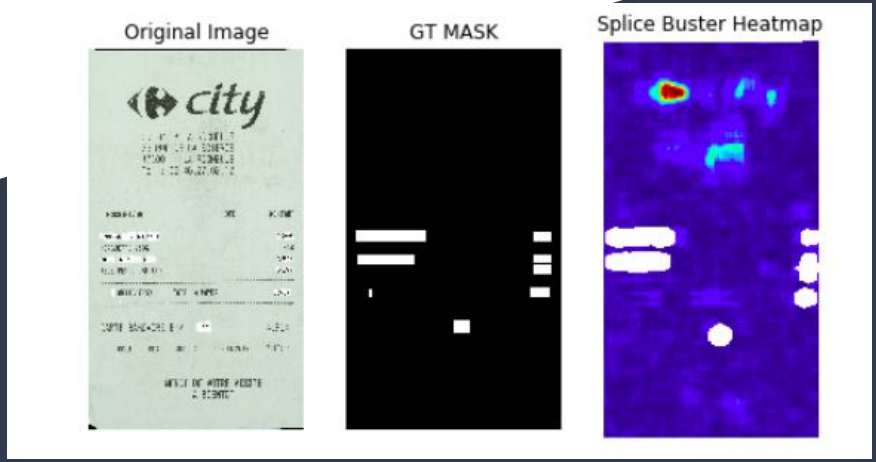
This co-occurrence matrix is then used as a feature for GMM.

Using expectation-maximization we can cluster pixels into 2 classes, forged or background.

Analysis of Splice Buster

Splicebuster is good at finding CPO.





Noiseprint: a CNN-based camera model fingerprint

Cozzolino, Davide & Verdoliva, Luisa. (2018).[3]

This approach tries to find the tampered regions by extracting the 'noiseprint'(fingerprint of the camera model used).

One of these high frequency noise is PRNU(Photo Response Non Uniformity) caused by the output of the sensors. This noise is not only camera dependant but also depends on the location of the sensor in the camera.

A siamese network is trained using different camera models.

The paper proposed a 17 layer FCNN. Given an image, the output is the noiseprint.

Results

Acc: 0.932
Precision: 0.675
Recall: 0.993
F1: 0.803

Forgeries CPI & Imitation Misclassified

	Pred True	Pred False
Gr True	162	78
Gr False	1	938

Results(Classification)

Different methods specialize in different types of methods

We apply all above methods on a tampered image. If any of the above images detect forgery. We classify the image as forged.

T1 Train

Acc: 0.993
Precision: 0.933
Recall: 0.933
F1: 0.933

	Pred True	Pred False
Gr True	28	2
Gr False	2	468

T1+T2 Train

Acc: 0.991
Precision: 0.984
Recall: 0.969
F1: 0.976

	Pred True	Pred False
Gr True	126	4
Gr False	2	468

T1 Test

Acc: 0.983
Precision: 0.966
Recall: 0.805
F1: 0.878

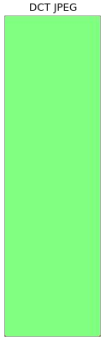
	Pred True	Pred False
Gr True	29	1
Gr False	7	462

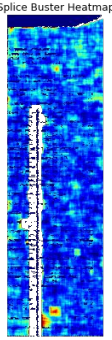
T1+T2 Test

Acc: 0.982
Precision:0.972
Recall: 0.938
F1: 0.954

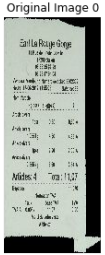
	Pred True	Pred False
Gr True	107	3
Gr False	7	462

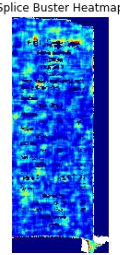
Failure Cases(False Positive)

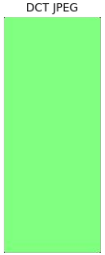




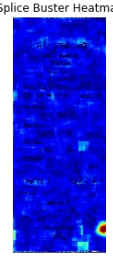
Splicebuster Triggered by torn region

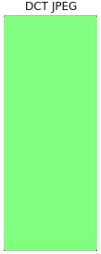






Splicebuster Triggered by torn region



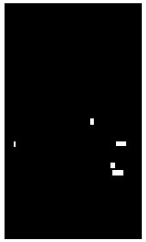


CMFD predicted white space as copied

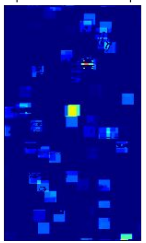
Failure Cases(False Negative)

Original Image 1

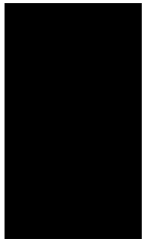
GT Mask



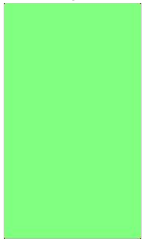
Splice Buster Heatmap



CMFD results



DCT JPEG

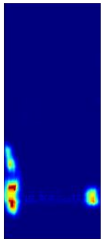


Whole image was given as tampered

Original Image 1

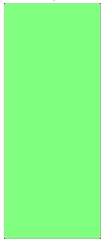
GT Mask

Splice Buster Heatmap



CMFD results

DCT JPEG



Whole image was given as tampered

Conclusion

They have achieved reasonable accuracy on find-it challenge from ICPR 2017.

Payslip Dataset

A Dataset for Forgery Detection and Spotting in Document Images

Nicolas Sidere, Francisco Cruz, Mickal Coustaty and Jean-Marc OgierL3i Laboratory, University of La Rochelle

2017 Seventh International Conference on Emerging Security Technologies (EST)

Payslip Dataset

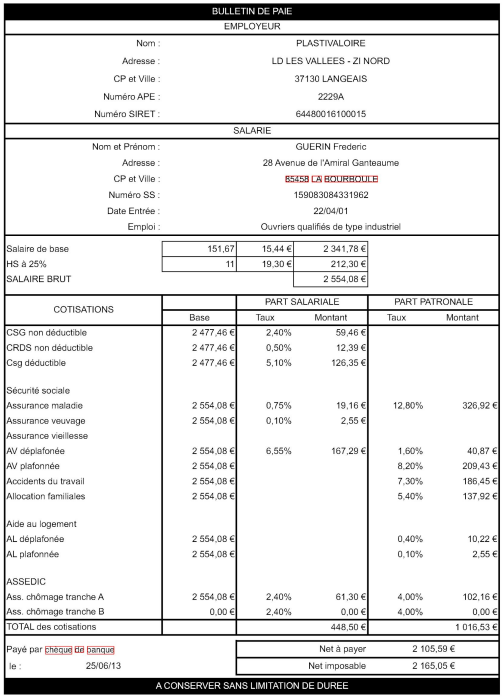
Dataset of Genuine Documents : Synthetic real-like Payslips

- 200 documents
- 5 fonts, 4 text sizes
- 477 Forged Documents
- 241 Genuine Documents

		# documents	# forgeries
Imitation	Case 1	22	298
	Case 2	37	493
C/P intra		224	1627
C/P Inter	Case 1	50	931
	Case 2	44	811
	Case 3	100	1798
Total		**477**	**5958**

Types of forgeries

Payslip Dataset(Examples)



BULLETIN DE PAIE

EMPLOYEUR

Nom :	PLASTIVALOIRE
Adresse :	LD LES VALLEES - ZI NORD
CP et Ville :	37130 LANGEAIS
Numéro APE :	2229A
Numéro SIRET :	64480016100015

SALARIE

Nom et Prénom :	GUERIN Frederic
Adresse :	28 Avenue de l'Amiral Ganteaume
CP et Ville :	65458 LA BOURBOULE
Numéro SS :	1590830843319 62
Date Entrée :	22/04/01
Emploi :	Ouvriers qualifiés de type industriel

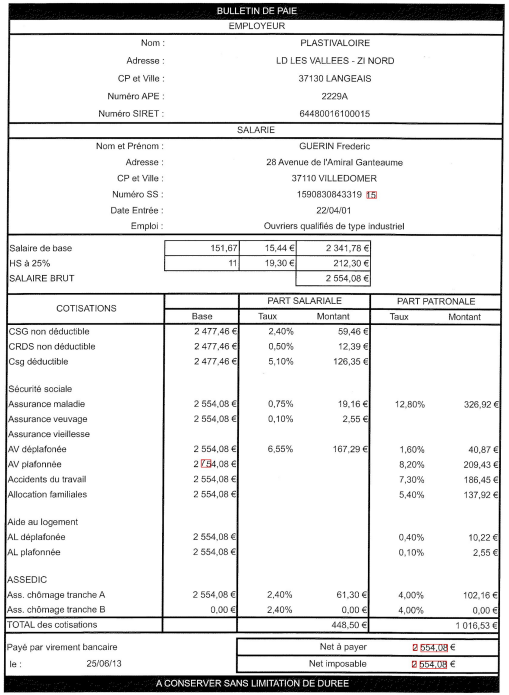
Salaire de base	151,67	15,44 €	2 341,78 €
HS à 25%	11	19,30 €	212,30 €
SALAIRE BRUT			2 554,08 €

COTISATIONS		PART SALARIALE		PART PATRONALE	
	Base	Taux	Montant	Taux	Montant
CSG non déductible	2 477,46 €	2,40%	59,46 €		
CRDS non déductible	2 477,46 €	0,50%	12,39 €		
Csg déductible	2 477,46 €	5,10%	126,35 €		
Sécurité sociale					
Assurance maladie	2 554,08 €	0,75%	19,16 €	12,80%	326,92 €
Assurance veuvage	2 554,08 €	0,10%	2,55 €		
Assurance vieillesse					
AV déplafonée	2 554,08 €	6,55%	167,29 €	1,60%	40,87 €
AV plafonnée	2 554,08 €			8,20%	209,43 €
Accidents du travail	2 554,08 €			7,30%	186,45 €
Allocation familiales	2 554,08 €			5,40%	137,92 €
Aide au logement					
AL déplafonée	2 554,08 €			0,40%	10,22 €
AL plafonnée	2 554,08 €			0,10%	2,55 €
ASSEDIC					
Ass. chômage tranche A	2 554,08 €	2,40%	61,30 €	4,00%	102,16 €
Ass. chômage tranche B	0,00 €	2,40%	0,00 €	4,00%	0,00 €
TOTAL des cotisations			448,50 €		1 016,53 €

Payé par chèque de banque		Net à payer	2 105,59 €
le :	25/06/13	Net imposable	2 165,05 €

A CONSERVER SANS LIMITATION DE DUREE

Imitation



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Numéro APE :	2229A
Numéro SIRET :	64480016100015

SALARIE

Nom et Prénom :	GUERIN Frederic
Adresse :	28 Avenue de l'Amiral Ganteaume
CP et Ville :	37110 VILLEDOMER
Numéro SS :	1590830843319 15
Date Entrée :	22/04/01
Emploi :	Ouvriers qualifiés de type industriel

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Csg déductible	2 477,46 €	5,10%	126,35 €		
Sécurité sociale					
Assurance maladie	2 554,08 €	0,75%	19,16 €	12,80%	326,92 €
Assurance veuvage	2 554,08 €	0,10%	2,55 €		
Assurance vieillesse					
AV déplafonée	2 554,08 €	6,55%	167,29 €	1,60%	40,87 €
AV plafonnée	2 554,08 €			8,20%	209,43 €
Accidents du travail	2 554,08 €			7,30%	186,45 €
Allocation familiales	2 554,08 €			5,40%	137,92 €
Aide au logement					
AL déplafonée	2 554,08 €			0,40%	10,22 €
AL plafonnée	2 554,08 €			0,10%	2,55 €
ASSEDIC					
Ass. chômage tranche A	2 554,08 €	2,40%	61,30 €	4,00%	102,16 €
Ass. chômage tranche B	0,00 €	2,40%	0,00 €	4,00%	0,00 €
TOTAL des cotisations			448,50 €		1 016,53 €

Payé par virement bancaire		Net à payer	2 554,08 €
le :	25/06/13	Net imposable	2 554,08 €

A CONSERVER SANS LIMITATION DE DUREE

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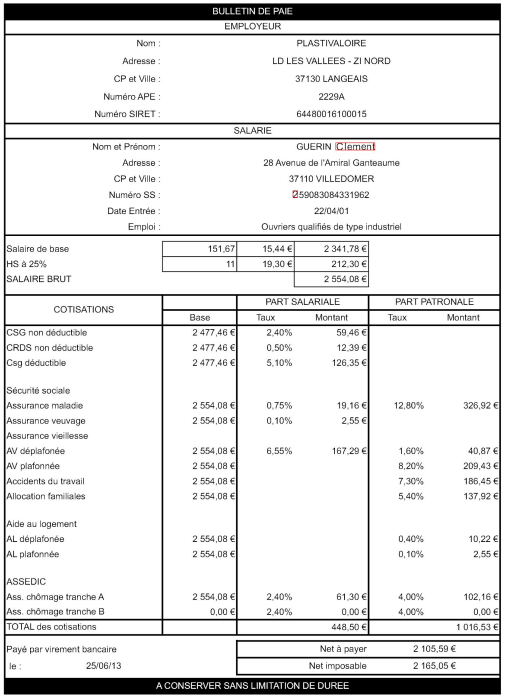

BULLETIN DE PAIE

EMPLOYEUR

Nom :	PLASTIVALOIRE
Adresse :	LD LES VALLEES - ZI NORD
CP et Ville :	37130 LANGEAIS
Numéro APE :	2229A
Numéro SIRET :	64480016100015

SALARIE

Nom et Prénom :	GUERIN Clement
Adresse :	28 Avenue de l'Amiral Ganteaume
CP et Ville :	37110 VILLEDOMER
Numéro SS :	2590830843319 62
Date Entrée :	22/04/01
Emploi :	Ouvriers qualifiés de type industriel

Salaire de base	151,67	15,44 €	2 341,78 €
HS à 25%	11	19,30 €	212,30 €
SALAIRE BRUT			2 554,08 €

COTISATIONS		PART SALARIALE		PART PATRONALE	
	Base	Taux	Montant	Taux	Montant
CSG non déductible	2 477,46 €	2,40%	59,46 €		
CRDS non déductible	2 477,46 €	0,50%	12,39 €		
Csg déductible	2 477,46 €	5,10%	126,35 €		
Sécurité sociale					
Assurance maladie	2 554,08 €	0,75%	19,16 €	12,80%	326,92 €
Assurance veuvage	2 554,08 €	0,10%	2,55 €		
Assurance vieillesse					
AV déplafonée	2 554,08 €	6,55%	167,29 €	1,60%	40,87 €
AV plafonnée	2 554,08 €			8,20%	209,43 €
Accidents du travail	2 554,08 €			7,30%	186,45 €
Allocation familiales	2 554,08 €			5,40%	137,92 €
Aide au logement					
AL déplafonée	2 554,08 €			0,40%	10,22 €
AL plafonnée	2 554,08 €			0,10%	2,55 €
ASSEDIC					
Ass. chômage tranche A	2 554,08 €	2,40%	61,30 €	4,00%	102,16 €
Ass. chômage tranche B	0,00 €	2,40%	0,00 €	4,00%	0,00 €
TOTAL des cotisations			448,50 €		1 016,53 €

Payé par virement bancaire		Net à payer	2 105,59 €
le :	25/06/13	Net imposable	2 165,05 €

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   Cozzolino, Davide & Verdoliva, Luisa. (2018). Noiseprint: a CNN-based camera model fingerprint.
   Url: https://arxiv.org/abs/1808.08396

Github(Code): https://github.com/shubhMaheshwari/document_image_tampering
Website: http://preon.iiit.ac.in:9090