Documents Counterfeit Detection Through a Deep Learning Approach

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Introduction

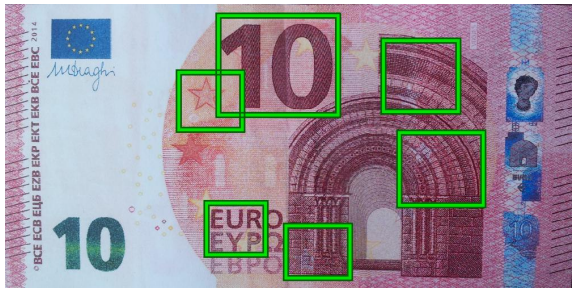
Money is an exchange for goods and services

A common threat to any economy is the amount of counterfeit money circulating in the market.

In the first half year of 2015, 454K counterfeit Euro banknotes were withdrawn from circulation [1]

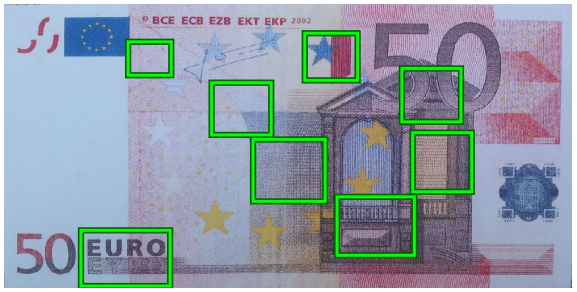
State-of-the-art

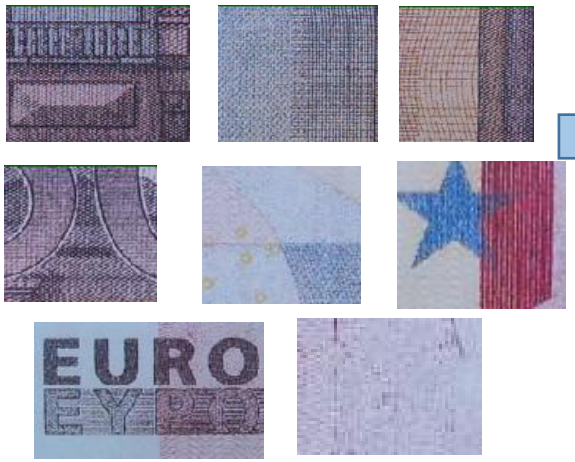
ROI/patches



Model ML

Real o counterfeit?





Model ML

Real o counterfeit?

Methodology

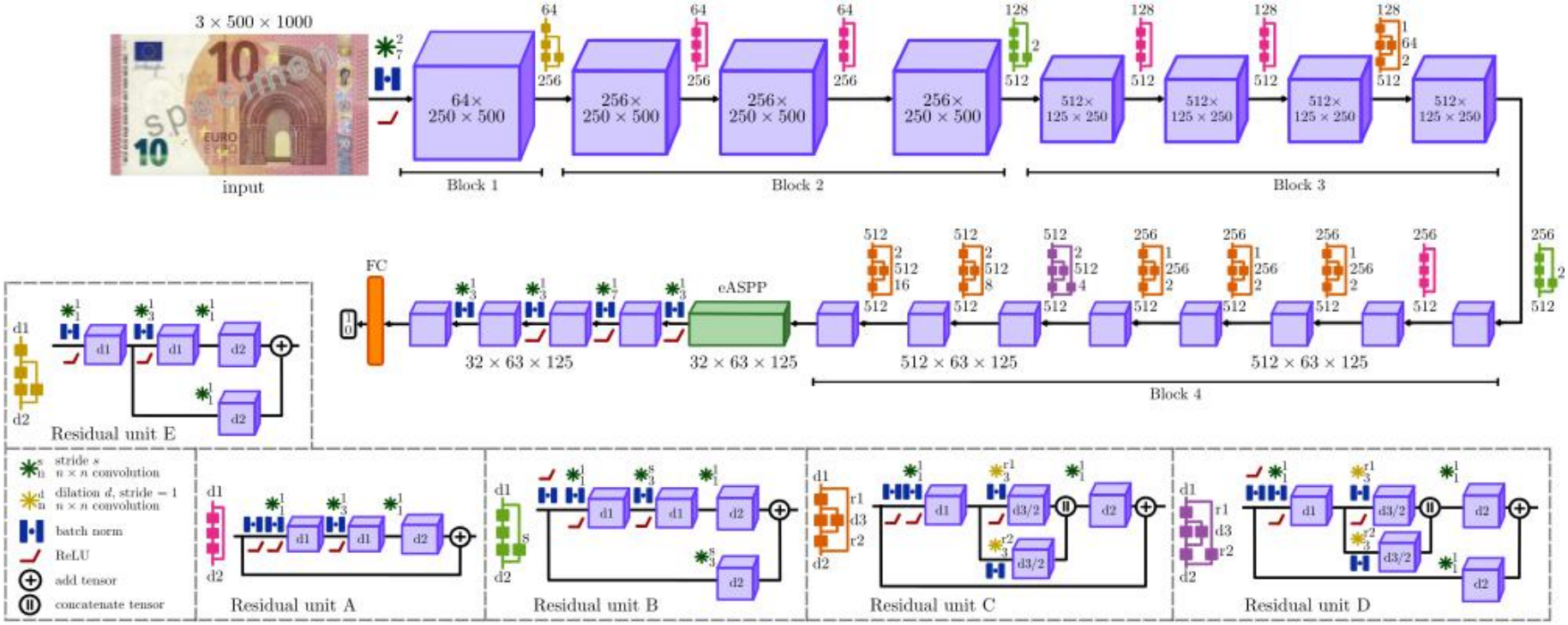
Preprocessing for our model of banknotes counterfeit detection

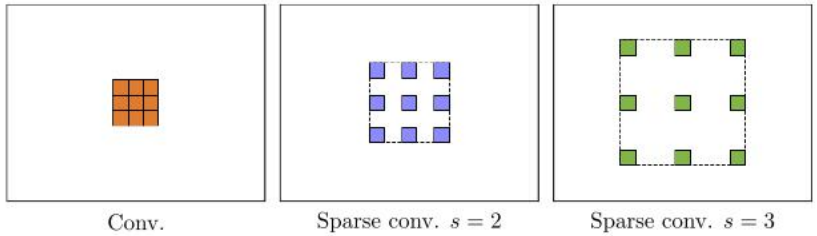
Model ML

Real o counterfeit?

Methodology

Our deep learning model based in AdapNet++ [2]





Methodology

Training, weighted binary cross-entropy

$$\mathcal{L}_{binary} = -\frac{1}{N}\sum_{c}^{C}\sum_{i}^{N}\tau_c \log P(y_i = c|X;\theta),$$

$$P\left(y_i|X;\theta\right) = \sigma(y_i) \in [0,1].$$

Experiments

Euro dataset (banknote photographed) taken from [3]. The * symbol denotes the combination of data types

Alias	Banknote	Side	Patch	Ok	False
$B1$	10 €	O	6	346	256
$B2$	10 €	R	6	348	242
$C1$	20 €	O	8	392	212
$C2$	20 €	R	5	373	216
$D1$	50 €	O	8	350	309
$D2$	50 €	R	5	351	321
$*B3 = B1 + B2$	10 €	$O + R$	–	694	498
$*C3 = C1 + C2$	20 €	$O + R$	–	765	428
$*D3 = D1 + D2$	50 €	$O + R$	–	701	630
$*BCD3 = B3 + C3 + D3$	10€ + 20€ +50€	O+R	–	2160	1556

Experiments

Benchmark results, using the AUC (under the receiver operating characteristic curve) metric on the test set

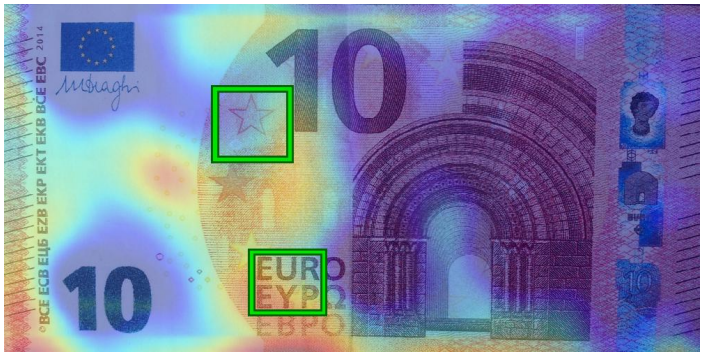
	SIFT-BoW	K-SVD	SCSPM	FSIM	2D-SIWPT	17Quality	Our Net
$B1$	0.9646	0.9892	0.9996	0.6718	0.7656	0.8829	0.9964
$B2$	0.9606	0.9865	0.9989	0.7766	0.7448	0.8638	0.9676
$C1$	0.9859	0.9949	1.0000	0.6664	0.7552	0.8860	0.9762
$C2$	0.9822	0.9943	1.0000	0.7105	0.7510	0.8422	0.9111
$D1$	0.9799	0.9913	0.9997	0.6399	0.6843	0.8554	0.9968
$D2$	0.9643	0.9938	1.0000	0.6477	0.6734	0.8333	0.9774
$*B3$	–	–	–	–	–	–	0.9466
$*C3$	–	–	–	–	–	–	0.8561
$*D3$	–	–	–	–	–	–	0.9975
$*BCD3$	–	–	–	–	–	–	0.9612

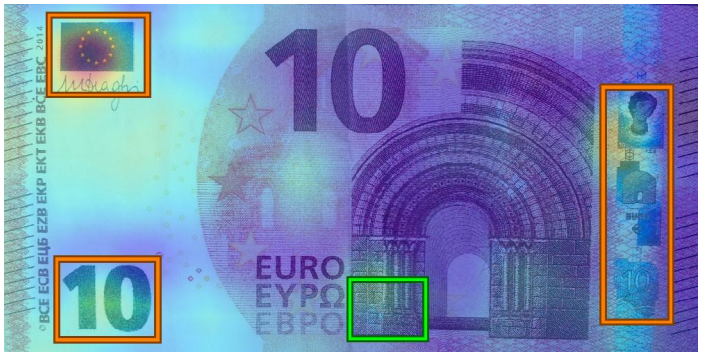
Time comparison in seconds on the test set

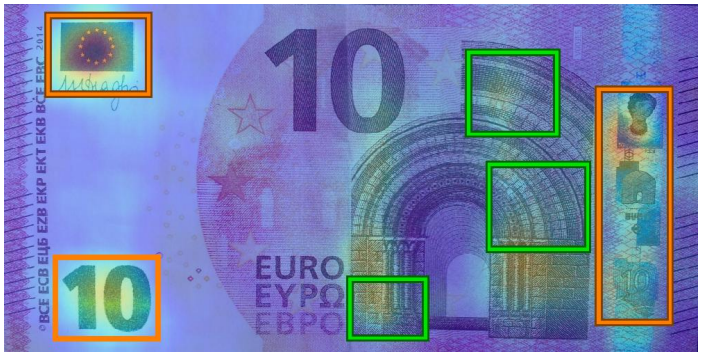
	SIFT-BoW	K-SVD	SCSPM	FSIM	2D-SIWPT	17Quality	Our Net
256×256	0.1063	1.2408	2.0997	0.2005	0.1895	0.9072	–
512×512	0.5265	3.5376	9.4853	0.2317	0.4985	3.5376	–
500×1000	–	–	–	–	–	–	0.1159

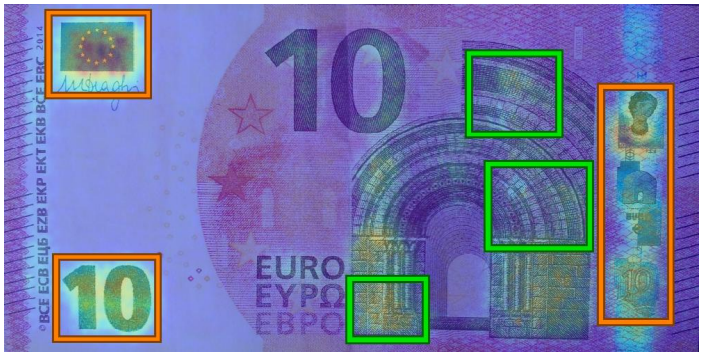
Experiments

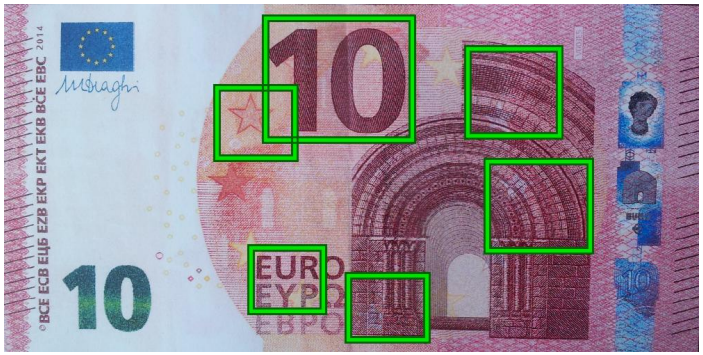
Regions activated to perform the prediction, on different scales











Experiments

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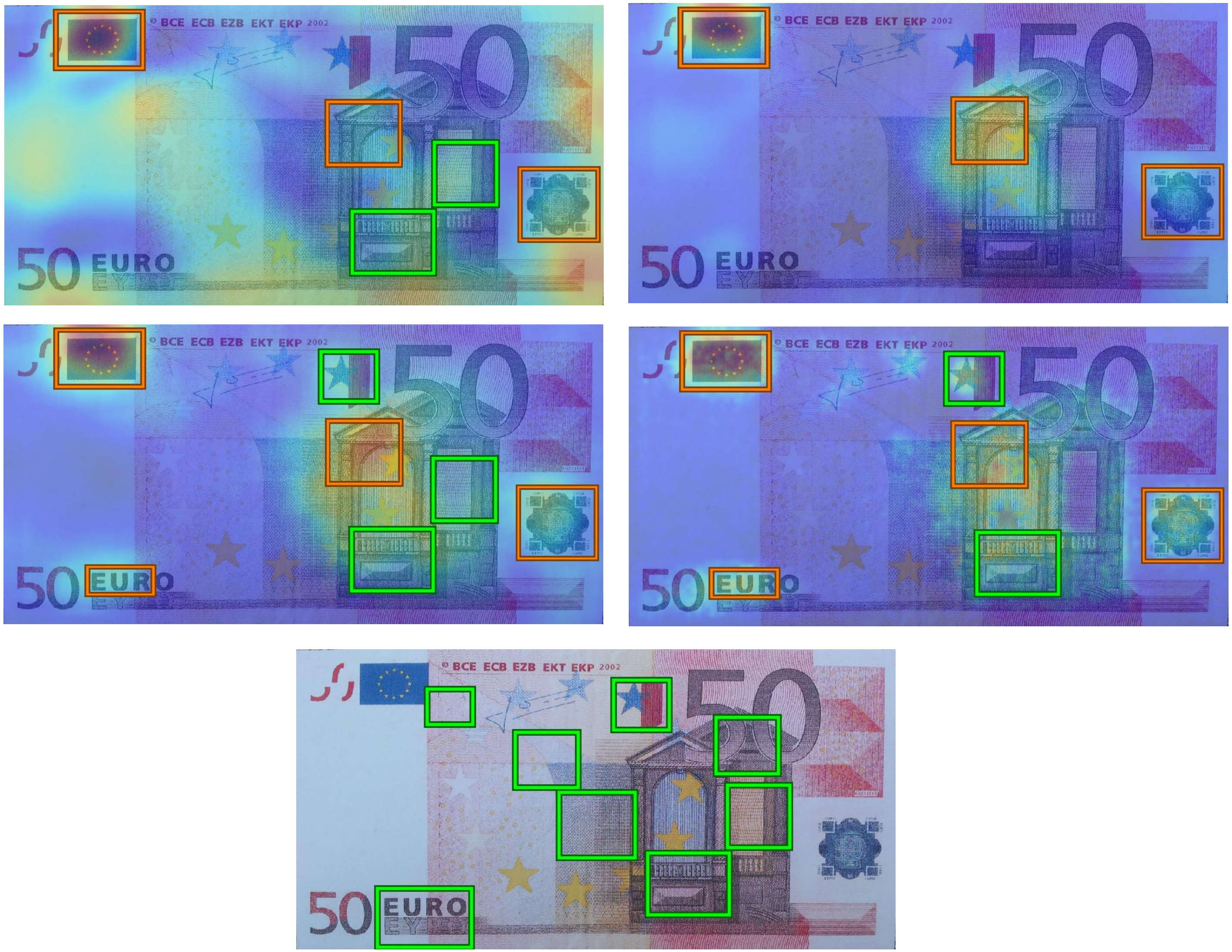

References

[1] E. C. Bank, "Biannual information on euro banknote counterfeiting," 2015. [Online]. Available: https://www.ecb.europa.eu/press/pr/date/2015/html/pr150717.en.html

[2] A. Valada, R. Mohan, and W. Burgard, "Self-supervised model adaptation for multimodal semantic segmentation," International Journal of Computer Vision, pp. 1–47, 2019.

[3] A. Berenguel, O. R. Terrades, J. Lladós, and C. Cañero, "Banknote counterfeit detection through background texture printing analysis," in 2016 12th IAPR Workshop on Document Analysis Systems (DAS). IEEE, 2016, pp. 66–71

Thank You