Deep Learning For Fraud Detection

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ICPR Fraud Detection Contest

- Identify which **receipt** is frauded.
- Small dataset of **600 Images** (470 genuine, 130 frauded).

Idea

- **Dividing** the image into smaller frames to increase the dataset.
- We used **linear methods for data augmentation** (rotation,flip).
- Detecting important information using **Image Manipulation**.
- Feed those important information to a **Deep Learning Network**.
- **Train** the network to detect if the image is **tampered** or **genuine**.

Local Binary Patterns

$$\begin{pmatrix} 15 & 200 & 115 \\ 27 & 70 & 24 \\ 213 & 5 & 60 \end{pmatrix} \longrightarrow \begin{pmatrix} 1 & 0 & 0 \\ 1 & x & 1 \\ 0 & 1 & 1 \end{pmatrix} \mathcal{P} \begin{pmatrix} 2^0 & 2^1 & 2^2 \\ 2^3 & x & 2^4 \\ 2^5 & 2^6 & 2^7 \end{pmatrix} \longrightarrow \begin{pmatrix} 15 & 200 & 115 \\ 27 & 217 & 24 \\ 213 & 5 & 60 \end{pmatrix}$$

We first compare the reference pixel (here the pixel with the value 70) to each of his neighbour, if the neighbour is greater we replace it by a 0 and if it is lower or equal we replace it by a 1. We use $\mathcal{P}$ for the ponderation operator, to transform the matrix into a binary number, $(\mathbf{11011001})_2 = \mathbf{217}$.

Discrete Wavelet Transform

$$x_{n,i} = \{\mathbf{70\ 56\ 61\ 49}\} \rightarrow \{x_{n-1,i}, d - 1_{n,i}\} = \{\mathbf{63\ 55\ 7\ 6}\}$$

The transformation replaces the sequence with its pairwise average $x_{n-1,i}$ and difference $d_{n-1,i}$ defined as:

$$x_{n-1,i} = \frac{x_{n,2i} + x_{n,2i+1}}{2}, d_{n-1,i} = \frac{x_{n,2i} - x_{n,2i+1}}{2}$$

We extend the one-dimensional Wavelet transform in two dimensions.

$$\begin{bmatrix} 70 & 56 & 61 & 49 \\ 52 & 46 & 39 & 43 \\ 63 & 45 & 46 & 54 \\ 53 & 39 & 40 & 44 \end{bmatrix} \rightarrow \begin{bmatrix} 63 & 55 & 7 & 6 \\ 49 & 41 & 3 & -2 \\ 54 & 50 & 9 & -4 \\ 46 & 42 & 7 & -2 \end{bmatrix} \rightarrow \begin{bmatrix} 56 & 48 & 5 & 2 \\ 50 & 46 & 8 & -3 \\ 7 & 7 & 2 & 4 \\ 4 & 4 & 1 & -1 \end{bmatrix}$$

We first apply one dimensional Haar-wavelet in each row and then on each column.

Error Level Analysis

To find the tampered parts, we first apply **JPEG compression** with the quality loss of **90%**, then we calculate the difference between the first image and the compressed one.

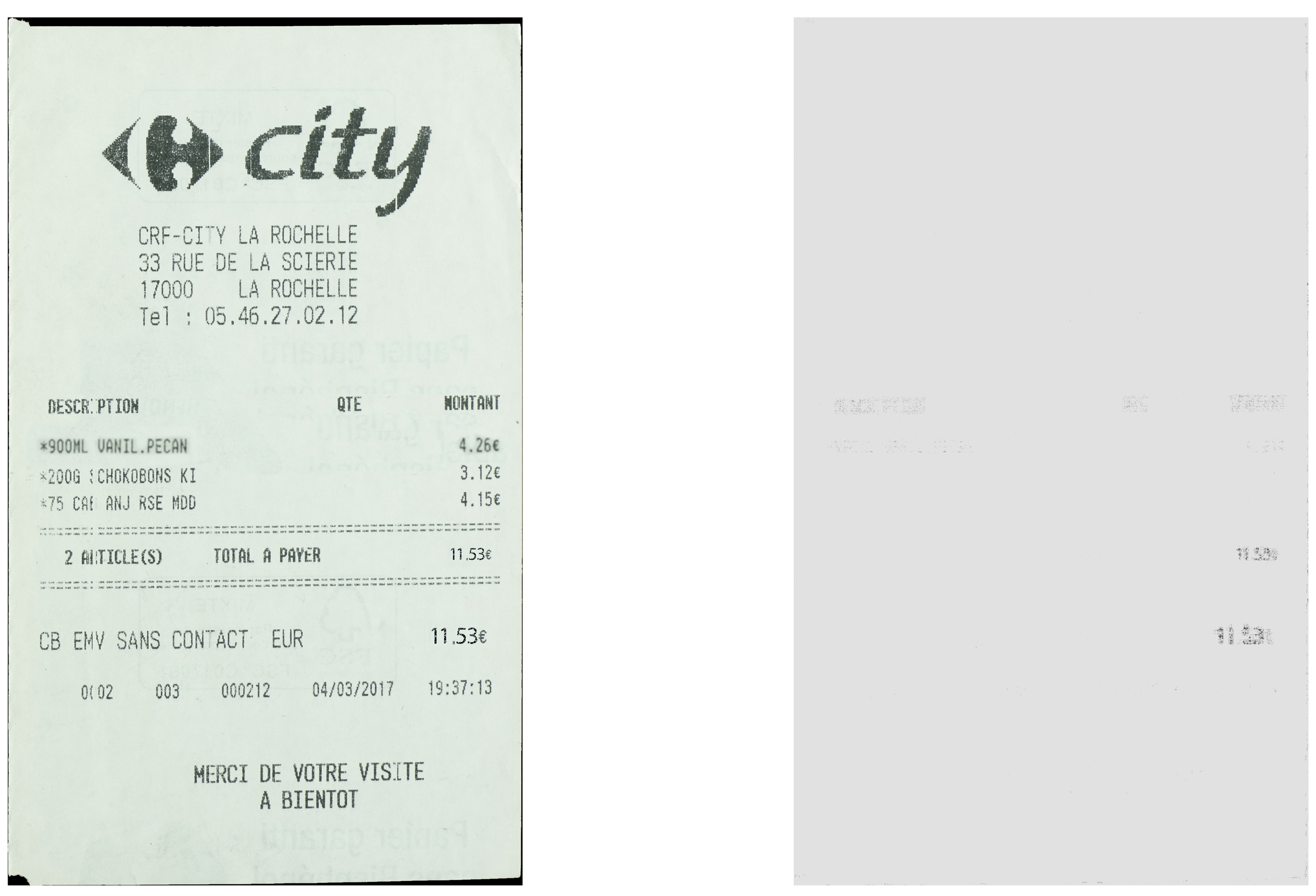
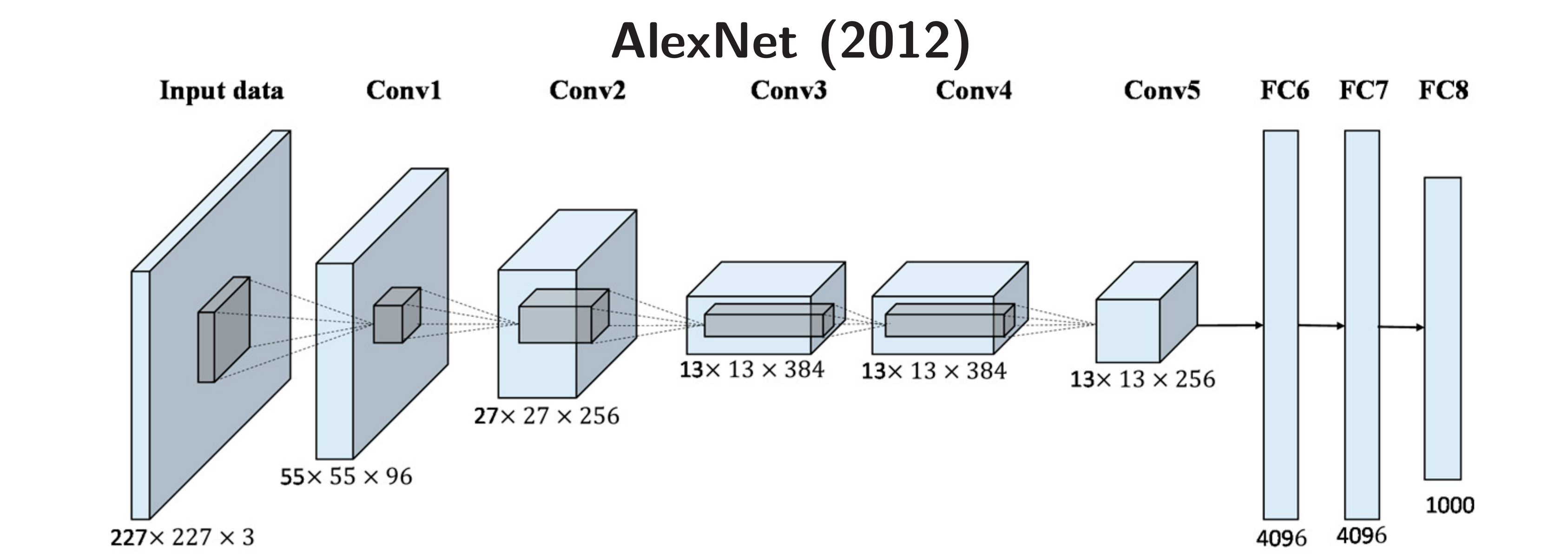
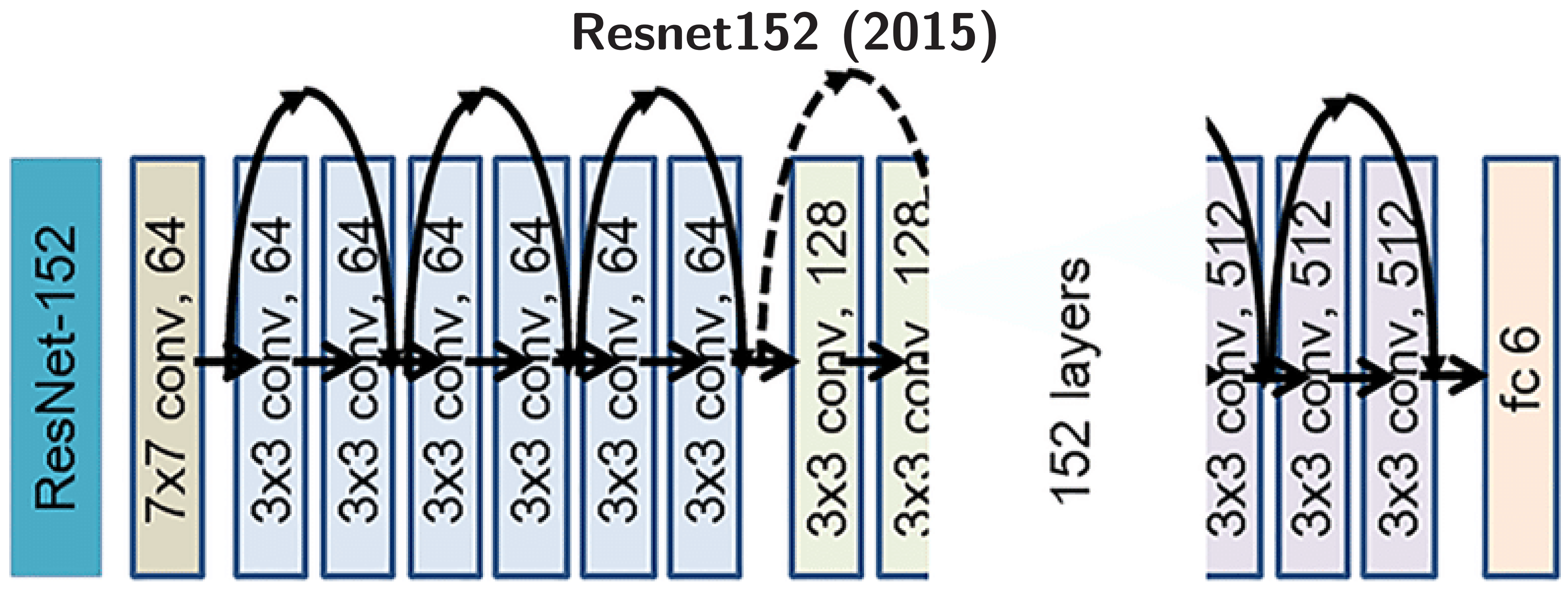


Figure 1:Left: Frauded image. Right: Manipulated areas found with ELA

This technique is based on the idea that tampered areas can act differently to JPEG compression than the rest of the image.

Finetune Deep Learning Models





Results

All learning were done with a graphic card **Titan X Pascal** on the framework **Tensorflow**, 24 hours were needed to fully train our best network.

Network	Combined Methods	Accuracy
AlexNet	RGB	62%
AlexNet	ELA+PCA+LBP	65%
AlexNet	ELA+Wavelet+LBP	74%
AlexNet	ELA+Wavelet+GrayScale	76%
AlexNet	ELA+Wavelet+GrayScale+Fraud Creation	85%
ResNet152	RGB	63%
ResNet152	ELA+PCA+LBP	65%
ResNet152	ELA+Wavelet+LBP	75%
ResNet152	ELA+Wavelet+GrayScale	80%
ResNet152	ELA+Wavelet+GrayScale+Fraud Creation	91%

Conclusion

- Achieved more than **90 %** accuracy.
- Easily **adaptable** to any types of images (bills, document).
- Creating different types of image manipulation might improve our model's **reliability**.

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