Paper ID-1808:Chebyshev-Harmonic-Fourier-Moments and Deep CNNs for Detecting Forged Handwriting

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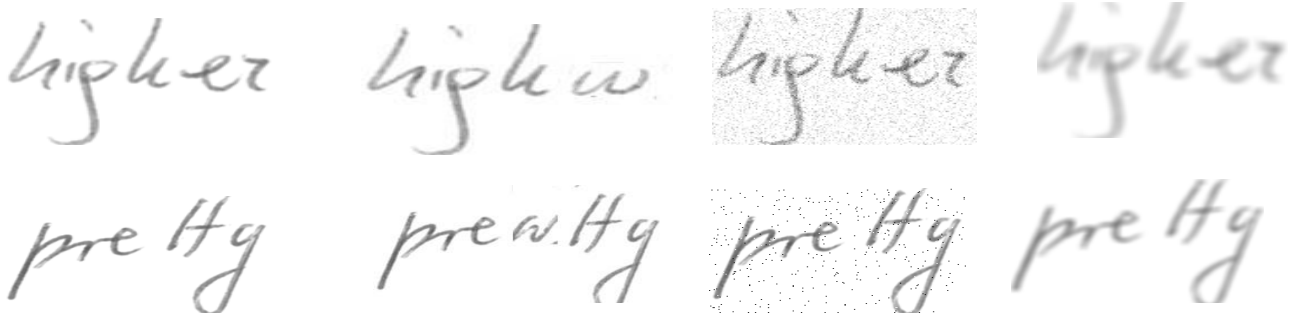
Motivation: Classification of Forged handwriting text in noise and blur environment

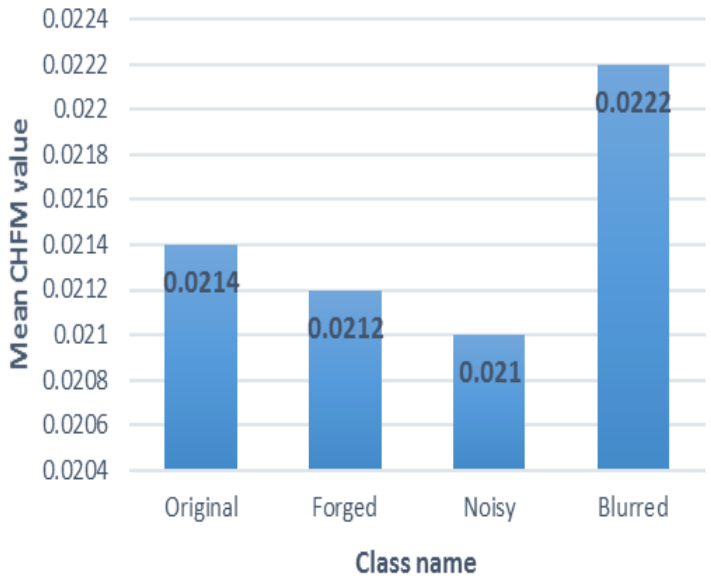
Original Forged Noisy Blurred



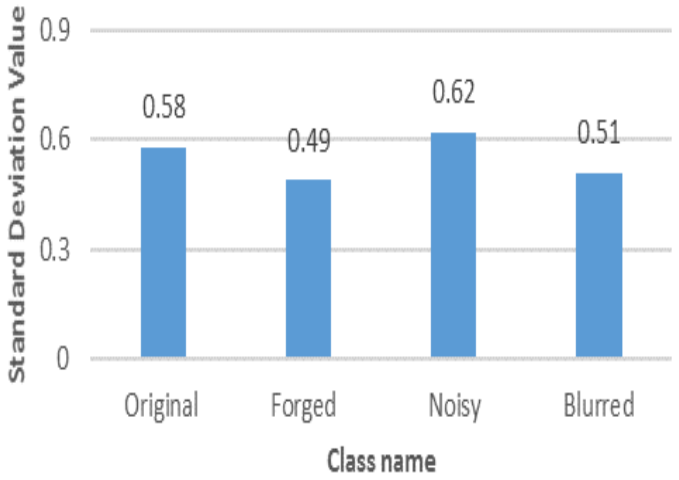
Sample images of Original, Forged, Noisy and Blurred classes

The Proposed Method

- Motivation for CHFM



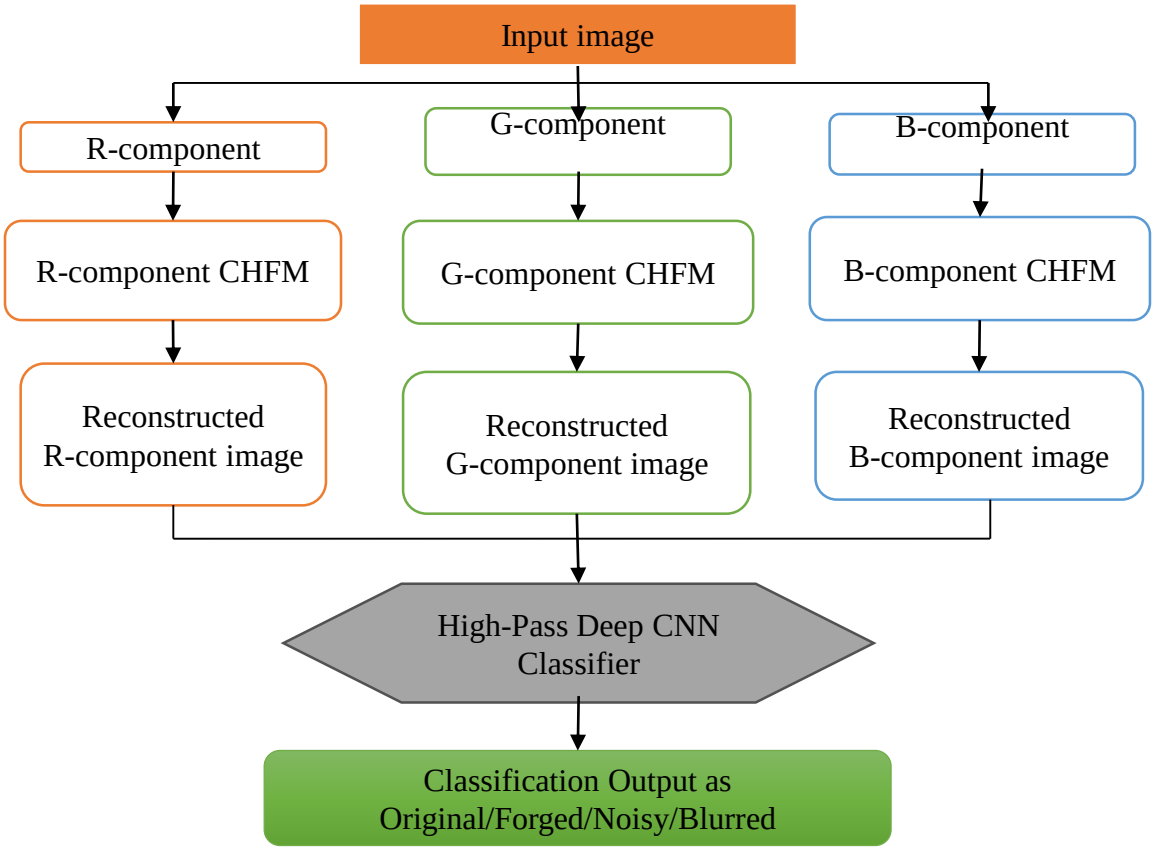
Mean of CHFM for inter images of different classes



Normalized Standard deviation of few CHFMs for intra images of different classes

The Proposed Method

- Block diagram of the proposed method



Block diagram of the proposed method

The Proposed Method

- Chebyshev-Harmonic-Fourier-Moments(CHFM) for Image Reconstruction

Original Forged Noisy Blurred

R images

G images

B images

Input images

The Proposed Method

- Chebyshev-Harmonic-Fourier-Moments(CHFM) for Image Reconstruction

Original Forged Noisy Blurred

R images

G images

B images

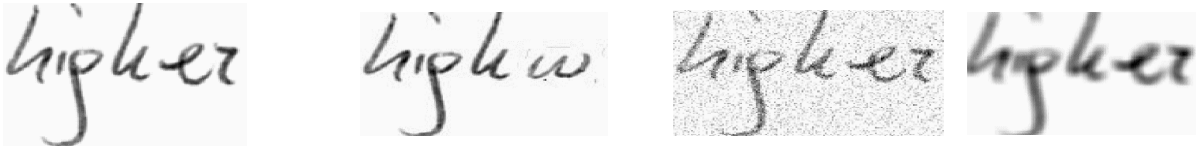
Reconstruction using Chebyshev Moments without Fourier transform

The Proposed Method

- Chebyshev-Harmonic-Fourier-Moments(CHFM) for Image Reconstruction

Original Forged Noisy Blurred

R images



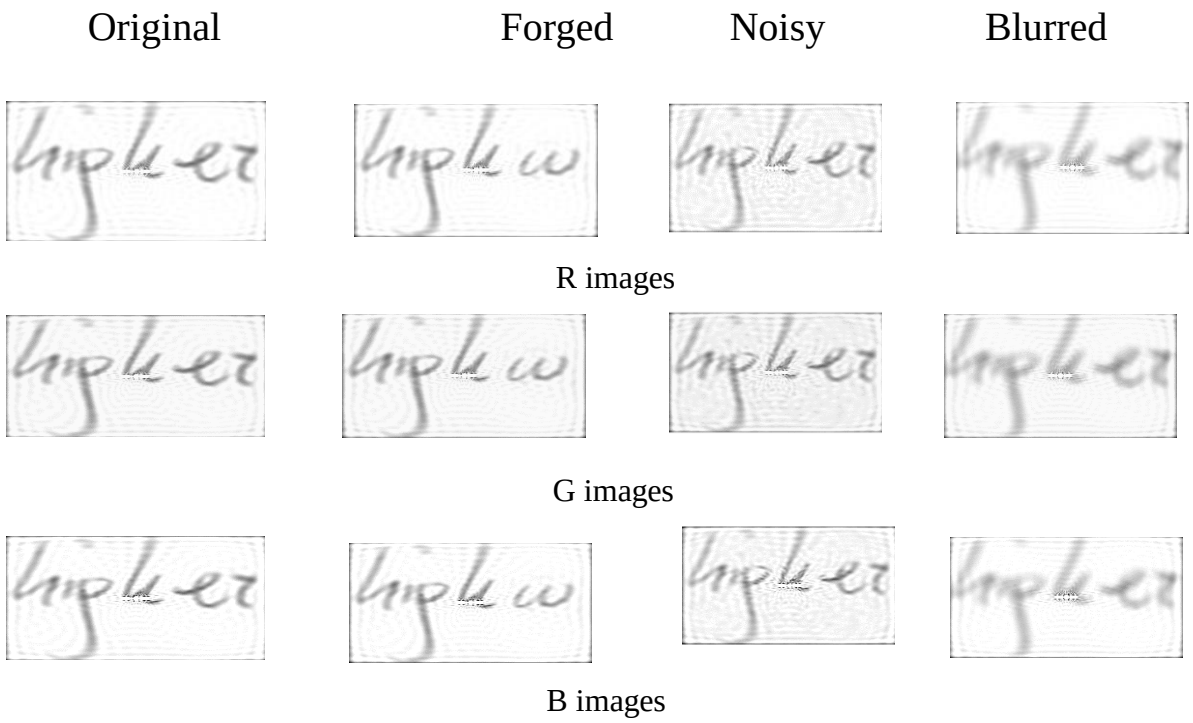
G images

B images

Reconstruction images using only Fourier transform without Chebyshev moments

The Proposed Method

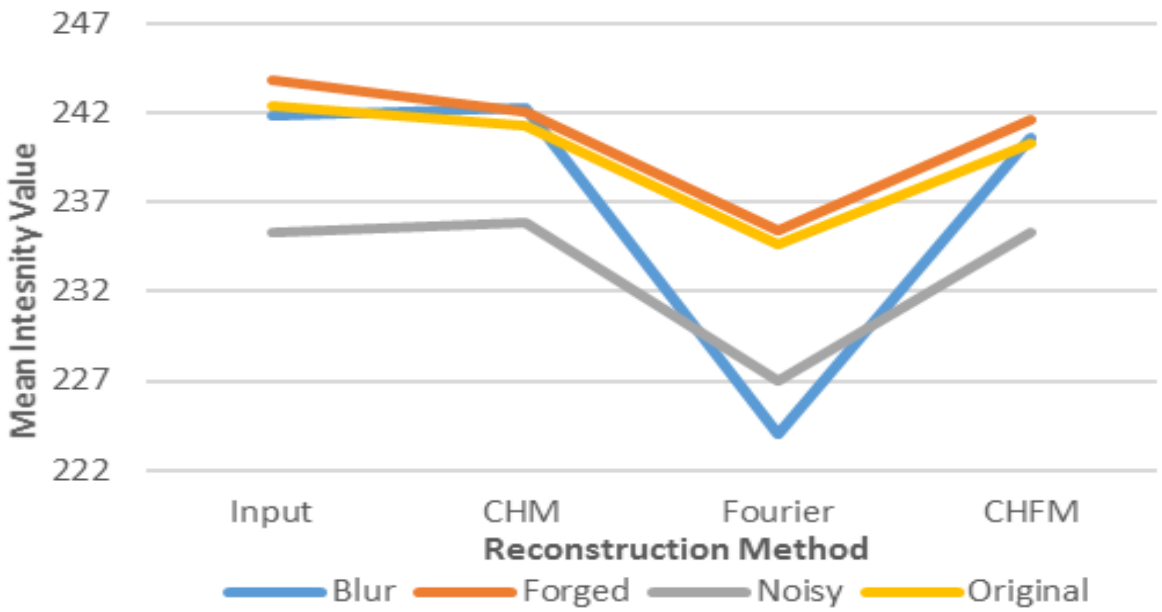
- Chebyshev-Harmonic-Fourier-Moments(CHFM) for Image Reconstruction



Reconstruction images of the proposed CHFM

The Proposed Method

- Chebyshev-Harmonic-Fourier-Moments(CHFM) for Image Reconstruction



Mean of reconstructed images of color components of respective images

The Proposed Method

- H-D-CNN for Classification of Forged Handwriting Images
- For each reconstructed image, we employ High Pass Filter-Deep Convolutional Neural Network (H-D-CNN).
- The first layer of this CNN is the Gaussian High pass filter to extract the hidden features
- Then these features are passed through the Xception Net without the top classifier, which acts as a Backbone feature extractor for our task.
- Then these extracted features are passed through Global Average Pooling Layer and four fully connected Layers (FC) to get the classification output.

The Proposed Method

- H-D-CNN for Classification of Forged Handwriting Images

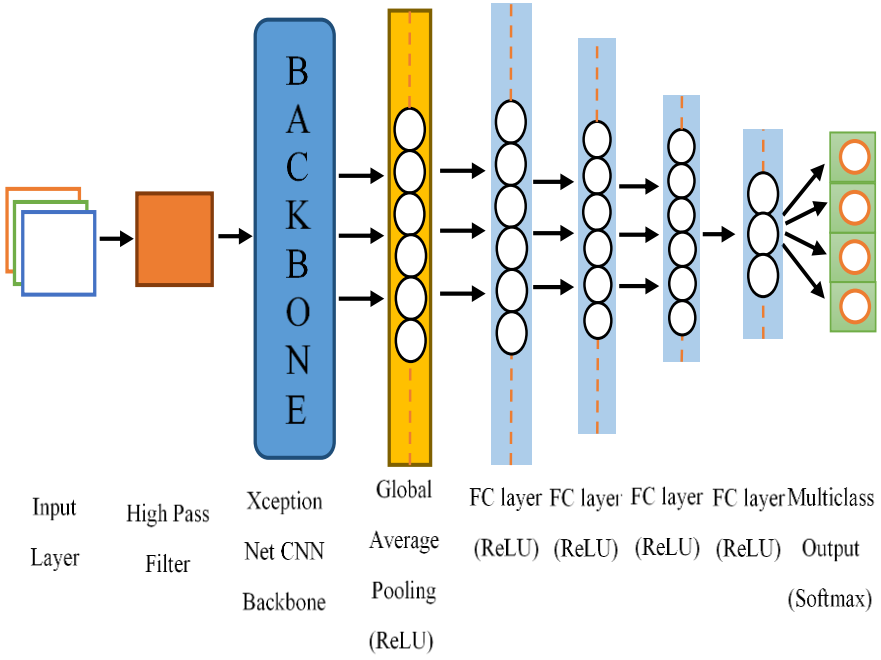
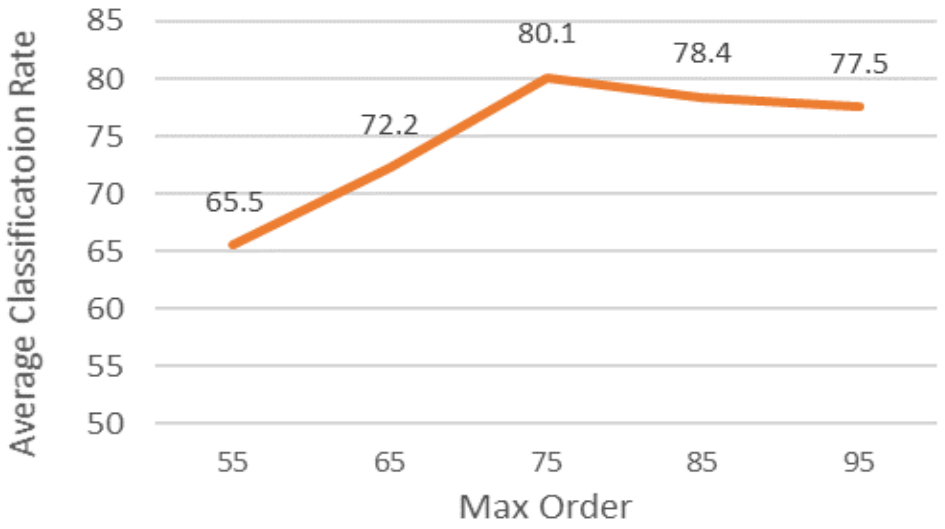


Fig. 7.High pass filter deep CNN Architecture.

Experimental Results

- Optimal value determination for the order of CHFM to obtain reconstructed images.



Optimal value determination for the order of CHFM to obtain reconstructed images.

Experimental Results

Ablation Study

Table: Confusion matrix and average classification rate of the only CHM without Fourier transform (in %) (F: Forged, O: Original, B: Blurred and N: Noisy indicates classes, C: Classes, CR: Average classification rate).

C	Our				ACPR 2019				ICPR 2018		IMEI	
	F	O	B	N	F	O	B	N	F	O	F	O
F	60.0	36.8	3.2	0.0	84.0	6.0	10.0	0.0	43.0	57.0	39.0	61.0
O	32.8	63.2	0.0	0.0	2.0	94.0	4.0	0.0	5.0	95.0	12.0	88.0
B	3.2	0.0	96.0	0.8	38.0	0.0	72.0	0.0	-	-	-	-
N	2.4	0.0	2.4	95.2	0.0	2.0	0.0	98.0	-	-	-	-
CR	78.6				87.0				69.0		63.5	

Table: Confusion matrix and average classification rate of the only Fourier transform without CHM (in %)

C	Our				ACPR 2019				ICPR 2018		IMEI	
	F	O	B	N	F	O	B	N	F	O	F	O
F	64.0	36.0	0.0	0.0	76.0	10.0	14.0	0.0	76.0	24.0	58.0	42.0
O	28.0	68.8	3.2	0.0	6.0	86.0	8.0	0.0	11.0	89.0	4.0	96.0
B	0.0	0.8	96	3.2	0.0	4.0	92.0	4.0	-	-	-	-
N	0.0	0.0	4.8	95.2	0.0	0.0	4.0	96.0	-	-	-	-
CR	81.90				87.5				82.5		77.0	

Experimental Results

Ablation Study

Table: Confusion matrix and average classification rate of the proposed CHFM (in %)

C	Our				ACPR 2019				ICPR 2018		IMEI	
	F	O	B	N	F	O	B	N	F	O	F	O
F	67.2	32.8	0.0	0.0	74.0	26.0	0.0	0.0	88.3	11.7	79.0	21.0
O	27.2	69.6	3.2	0.0	4.0	96.0	0.0	0.0	6.7	93.3	14.0	86.0
B	0.0	0.0	99.2	0.8	2.0	2.0	96.0	0.0	-	-	-	-
N	0.0	0.0	1.6	98.4	0.0	0.0	0.0	100	-	-	-	-
CR	83.6				91.5				90.8		82.5	

Experimental Results

Experiments on Forged Handwriting Detection

Table: Confusion matrix and average classification rate of the proposed and existing methods on our dataset (in %).

C	Proposed method				Kundu et. al.				Wang et al.				Shivakumara et. al			
	F	O	B	N	F	O	B	N	F	O	B	N	F	O	B	N
F	67.2	22.8	0	0	48.0	48.0	2.0	2.0	39.2	35.2	30.4	0	60.0	4.0	0.8	35.2
O	27.2	69.6	3.2	0	46.0	52.0	2.0	0.0	21	51	28	0	0.0	64.0	20.0	16.0
B	0	0	99.2	0.8	0	2.0	94.0	4.0	9.6	0	90.4	0	8.0	0	56.0	36.0
N	0	0	1.6	98.4	2.0	0.0	0.0	98.0	0	3.6	0	96.4	0.0	0	16.0	84.0
CR	83.6				73.0				69.25				66.0			

Experimental Results

Experiments on Forged Handwriting Detection

Table: Confusion matrix and average classification rate of the proposed and existing methods on ACPR2019 dataset (in %).

C	Proposed method				Kundu et. al.				Wang et al.				Shivakumara et. al			
	F	O	B	N	F	O	B	N	F	O	B	N	F	O	B	N
F	74.0	26.0	0	0	85.7	4.8	9.5	0.0	71.4	25.0	1.8	1.8	50.0	40.0	0.0	10.0
O	4.0	96.0	0	0	20.0	70.0	10.0	0.0	25.0	57.8	7.8	9.4	23.0	77.0	0.0	0.0
B	2.0	2.0	96.0	0	15.8	15.8	63.2	5.2	1.8	9.0	78.2	11.0	0.0	22.0	78.0	0.0
N	0.0	0.0	0	100.0	0.0	0.0	10.0	90.0	8.0	14.3	1.5	76.2	0.0	0.0	10.0	90.0
CR	91.5				77.5				70.1				73.75			

Experimental Results

Experiments on Forged Handwriting Detection

Table: Confusion matrix and average classification rate of the proposed and existing methods on ICPR 2018 FCD dataset (in %).

Methods	Proposed method		Kundu et. al.		Wang et al.		Shivakumara et. al	
Classes	Original	Forged	Original	Forged	Original	Forged	Original	Forged
Original	93.3	6.7	90	10	84.6	15.4	92	8
Forged	11.7	88.3	72.5	27.5	10.7	89.3	49.4	50.6
Average	90.8		78.3		86.9		71.3	

Table: Confusion matrix and average classification rate of the proposed and existing methods on IMEI dataset

Methods	Proposed method		Kundu et. al.		Wang et al.		Shivakumara et. al	
Classes	Original	Forged	Original	Forged	Original	Forged	Original	Forged
Original	86.0	14.0	57.8	42.2	83.2	16.8	82.2	17.8
Forged	21.0	79.0	41.8	58.2	25.6	74.4	18	82
Average	82.5		58.0		78.8		82.1	

Conclusion and Future Work

- We have proposed a novel method for forged handwriting detection by exploring the concept of Chebyshev-Harmonic-Fourier-Moments (CHFM) and a high pass deep convolutional neural network (D-CNN).
- Our method works based on exploiting irregularities and inconsistencies in the tampered information in the images, unlike existing methods which depend on distortions introduced by the forgery operation.
- However, the proposed method sometimes misclassifies an authentic image as forged, and vice versa.
- This is due to natural handwriting variations overwhelming the effects of forgery.
- The possible solution is to incorporate contextual features with the help of natural language processing.

Thank you for your patience

Questions and Suggestions