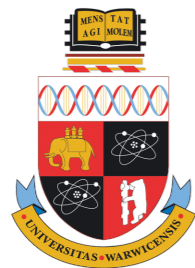


# Reversible Data Hiding in JPEG Images Based on Adjustable Padding

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**WARWICK**



Charles Sturt  
University

International Workshop on Biometrics and Forensics  
4-5 April 2017  
Coventry, UK

# Trustworthy Camera



camera



image



marked image



digital signature



# Trustworthy Camera



marked image



image



digital signature

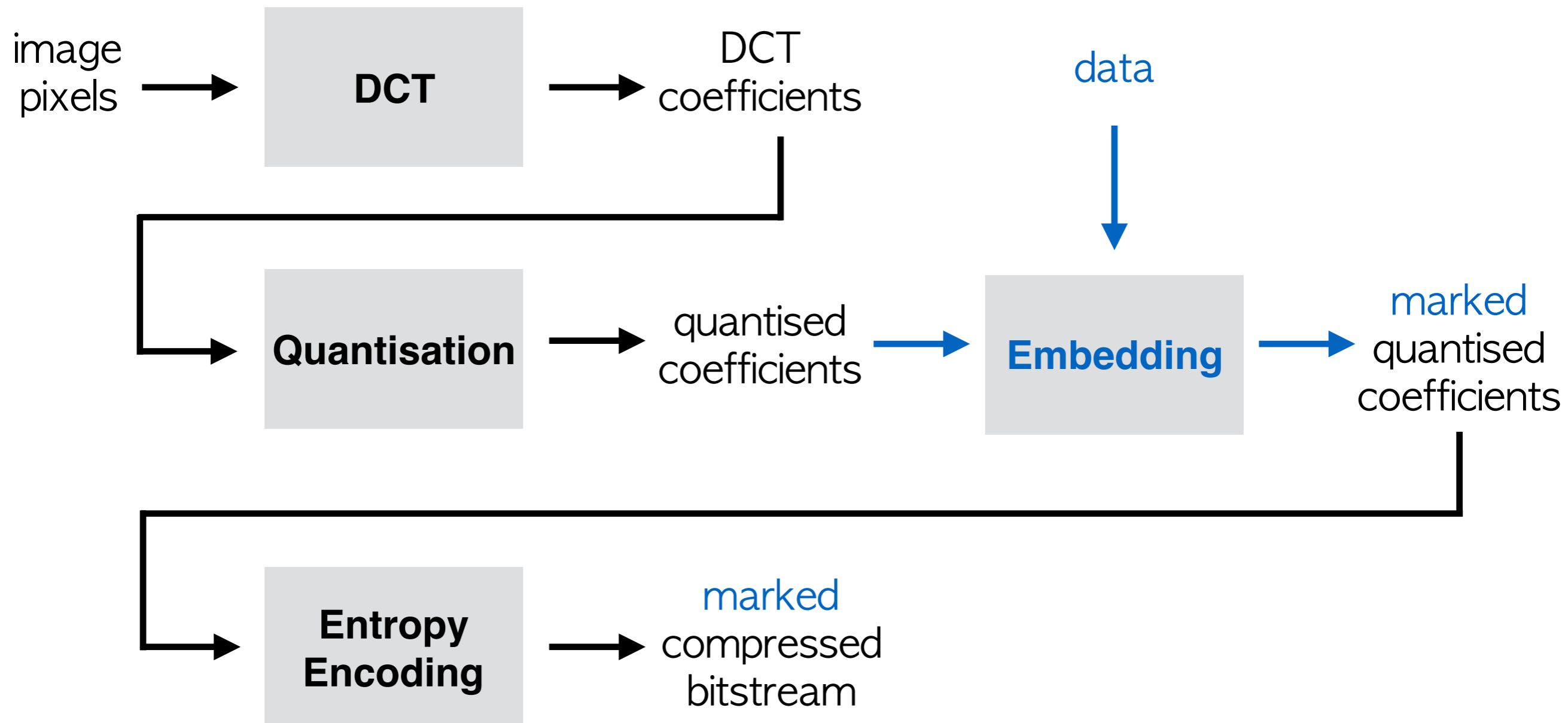


verification



digital signature

# Reversible Data Hiding in JPEG



# Reversible Data Hiding in JPEG

quantised coefficients

-26	-3	-6	2	2	-1	0	0
0	-2	-4	1	1	0	0	0
-3	1	5	-1	-1	0	0	0
-4	1	2	-1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

quantisation table

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

# Histogram Shifting Based Scheme

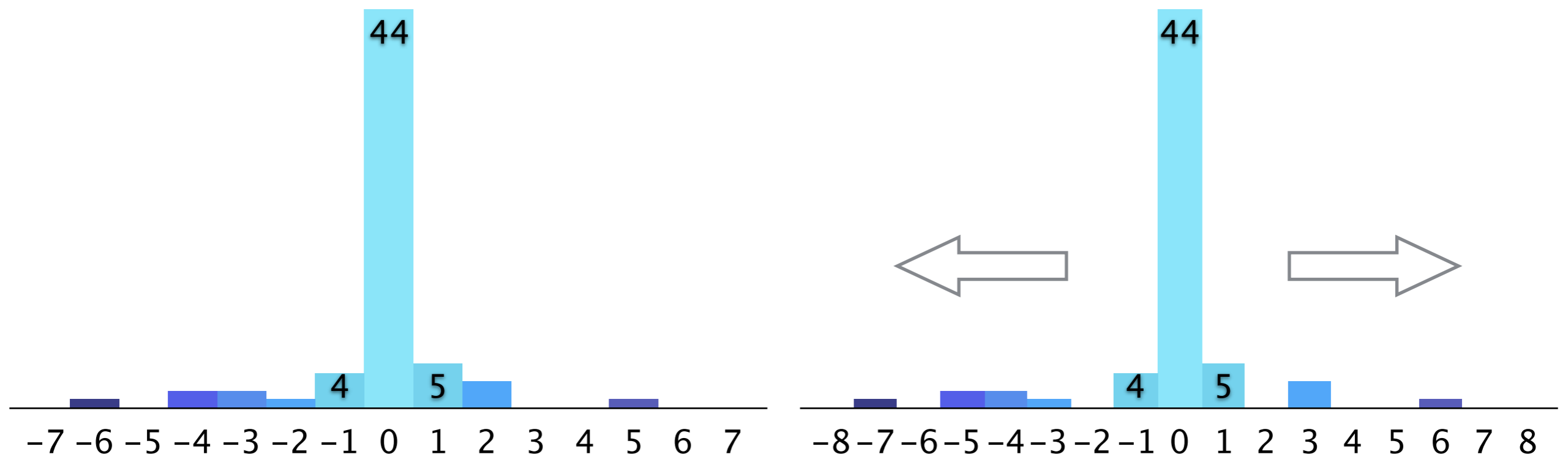
F. Huang, X. Qu, H. J. Kim, and J. Huang, "Reversible data hiding in JPEG images,"  
IEEE Trans. Circuits Syst. Video Technol., vol. 26, no. 9, pp. 1610-1621, Sep. 2016.

-26	-3	-6	2	2	-1	0	0
0	-2	-4	1	1	0	0	0
-3	1	5	-1	-1	0	0	0
-4	1	2	-1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

-26	-4	-7	3	3	-1	0	0
0	-3	-5	1	1	0	0	0
-4	1	6	-1	-1	0	0	0
-5	1	3	-1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

# Histogram Shifting Based Scheme

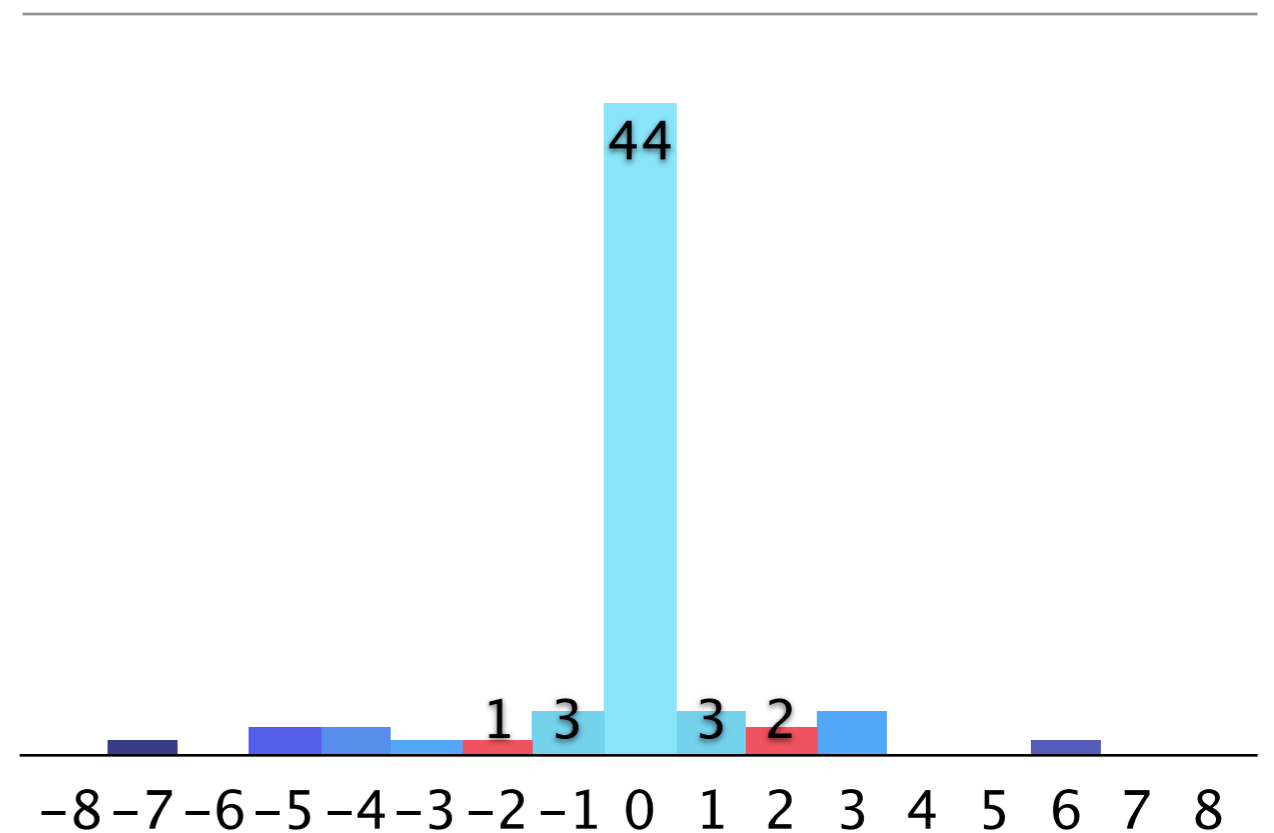
F. Huang, X. Qu, H. J. Kim, and J. Huang, "Reversible data hiding in JPEG images,"  
IEEE Trans. Circuits Syst. Video Technol., vol. 26, no. 9, pp. 1610-1621, Sep. 2016.



# Histogram Shifting Based Scheme

F. Huang, X. Qu, H. J. Kim, and J. Huang, "Reversible data hiding in JPEG images,"  
 IEEE Trans. Circuits Syst. Video Technol., vol. 26, no. 9, pp. 1610-1621, Sep. 2016.

-26	-4	-7	3	3	1	0	0
0	3	-5	1	1	0	0	0
-4	2	6	-1	2	0	0	0
-5	1	3	-1	0	0	0	0
2	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0





# Adjustable Padding Based Scheme

$$n = 38$$

$$m = 4$$

$$k = \left\lfloor \frac{n}{m} \right\rfloor = \left\lfloor \frac{38}{4} \right\rfloor = 9$$

balanced ternary digits    binary digit

$$(1, -1, 0, 0, 1, 0, 0, 0, \mathbf{0})_3 \quad || \quad (\mathbf{0})_2$$

$$(1, -1, 0, 0, 1, 0, 0, 0, \mathbf{2})$$

-26	-3	-6	2	2	-1	0	0
0	-2	-4	1	1	0	0	0
-3	1	5	-1	-1	0	0	0
-4	1	2	-1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

-26	-3	-6	2	2	-1	-1	0
0	-2	-4	1	1	1	0	0
-3	1	5	-1	-1	1	0	0
-4	1	2	-1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	2	0	0	0	0	0	0
0	0	0	0	0	0	0	0

# Adjustable Padding Based Scheme

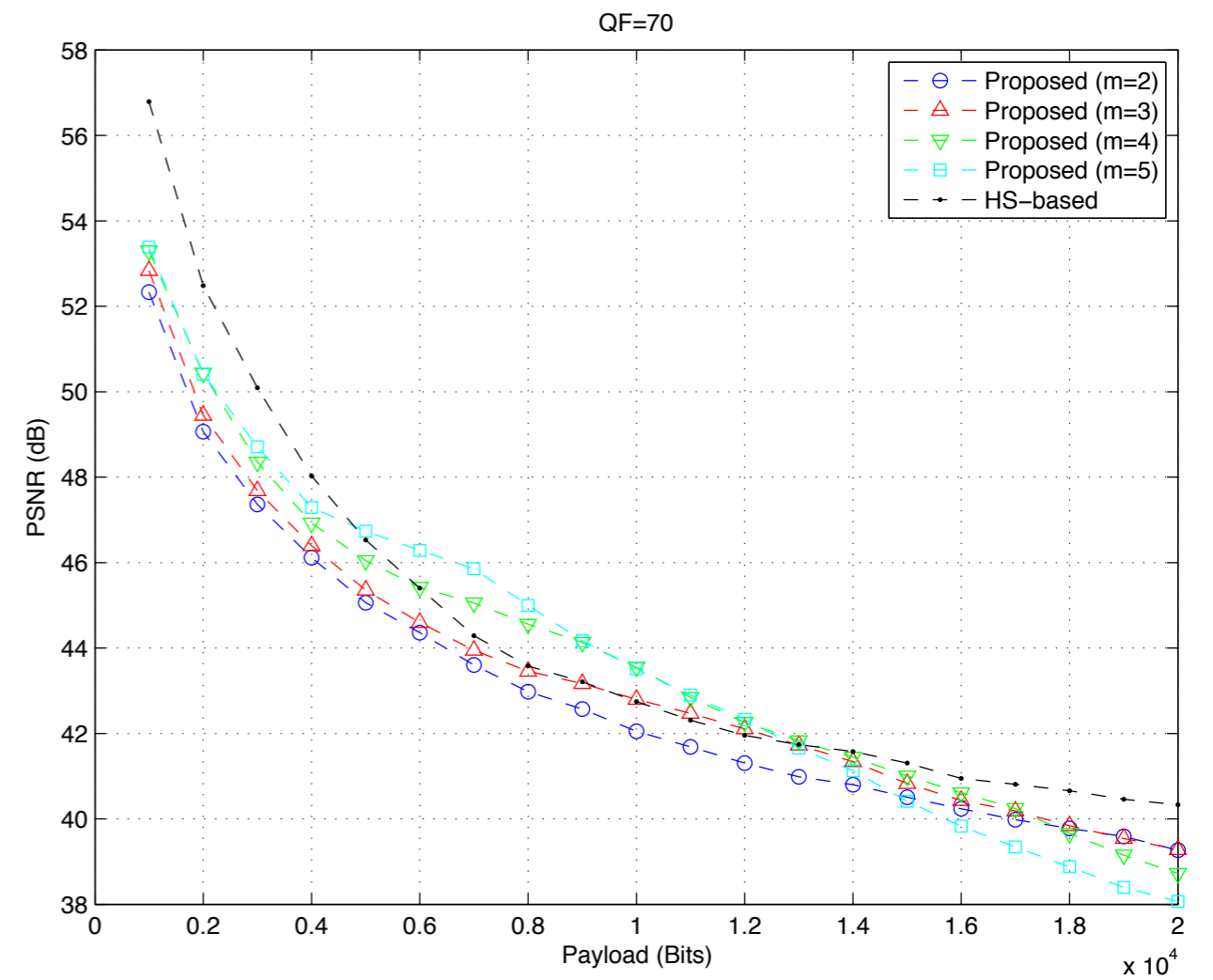
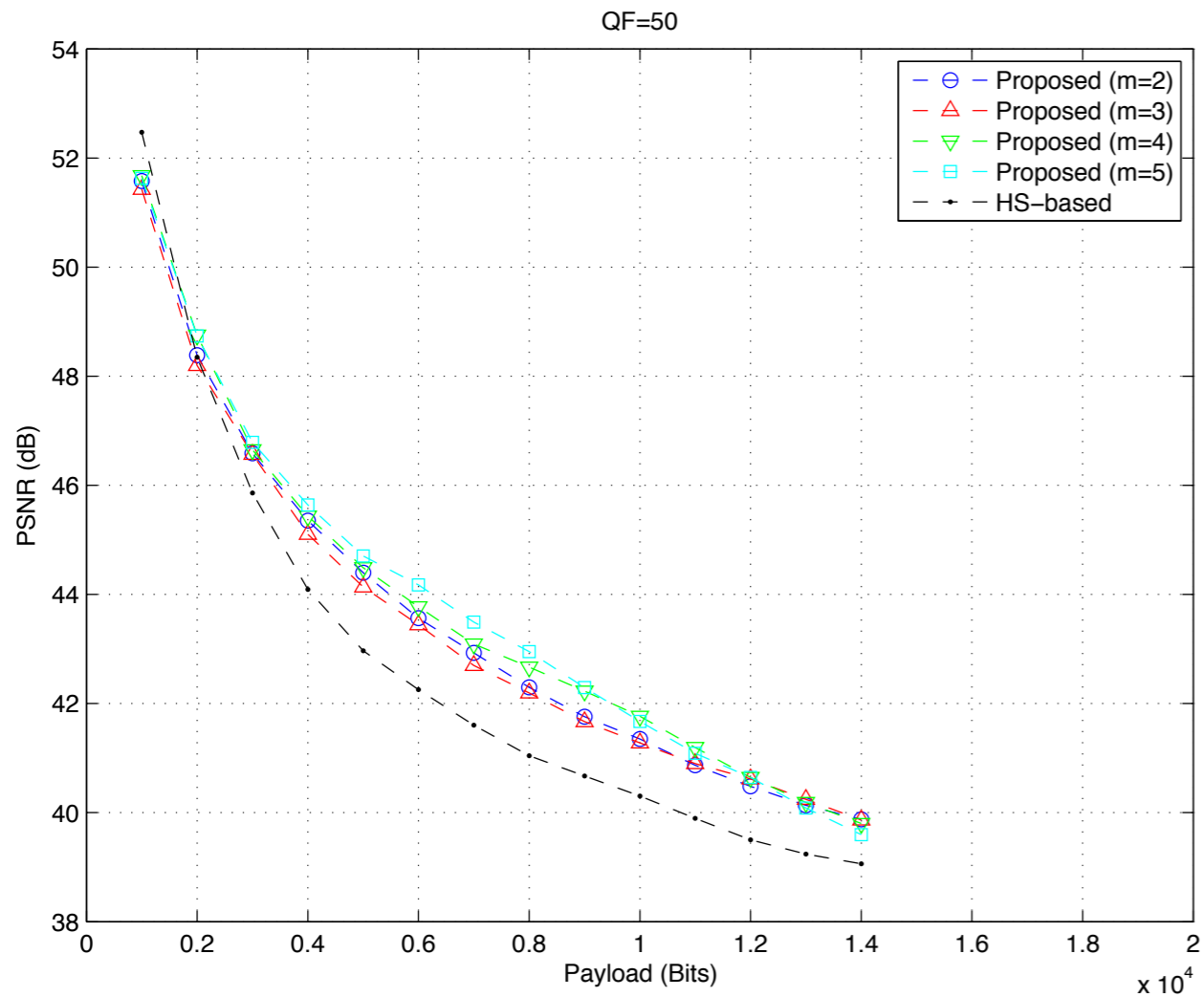
$$n' = n - k = 38 - 9 = 29$$

$$k = \left\lfloor \frac{n}{m} \right\rfloor = \left\lfloor \frac{n' + k}{m} \right\rfloor$$

$$k = \left\lfloor \frac{n'}{m - 1} \right\rfloor = \left\lfloor \frac{29}{3} \right\rfloor = 9$$

-26	-3	-6	2	2	-1	-1	0
0	-2	-4	1	1	1	0	0
-3	1	5	-1	-1	1	0	0
-4	1	2	-1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	2	0	0	0	0	0	0
0	0	0	0	0	0	0	0

# Experimental Results

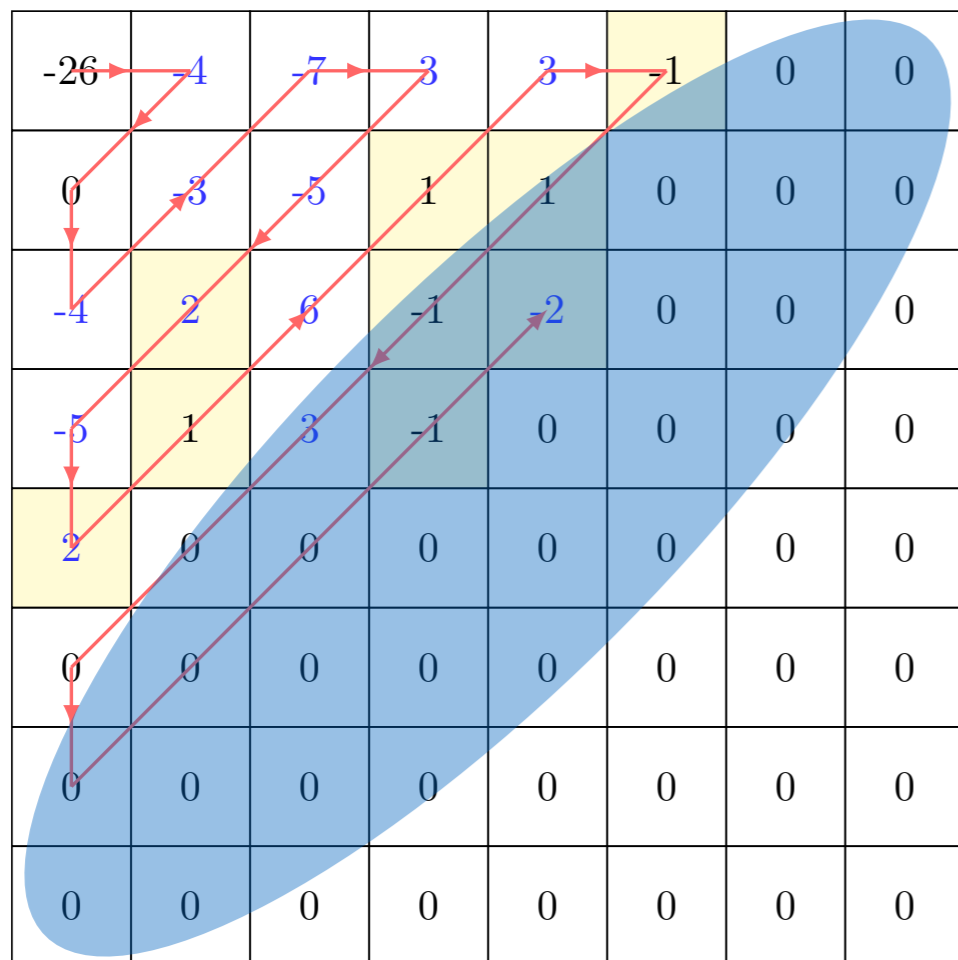


Visual Quality vs Data Payload  
on Lower Quality JPEG

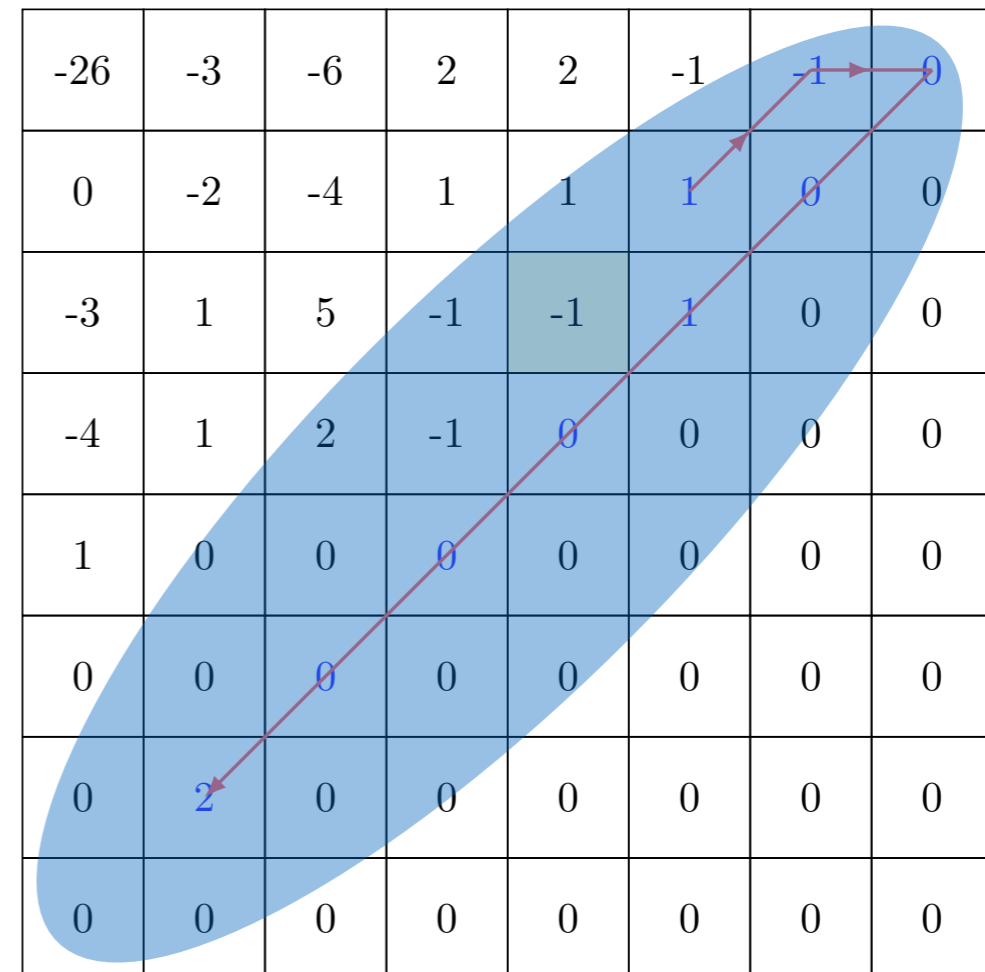
Visual Quality vs Data Payload  
on Higher Quality JPEG

# Experimental Results

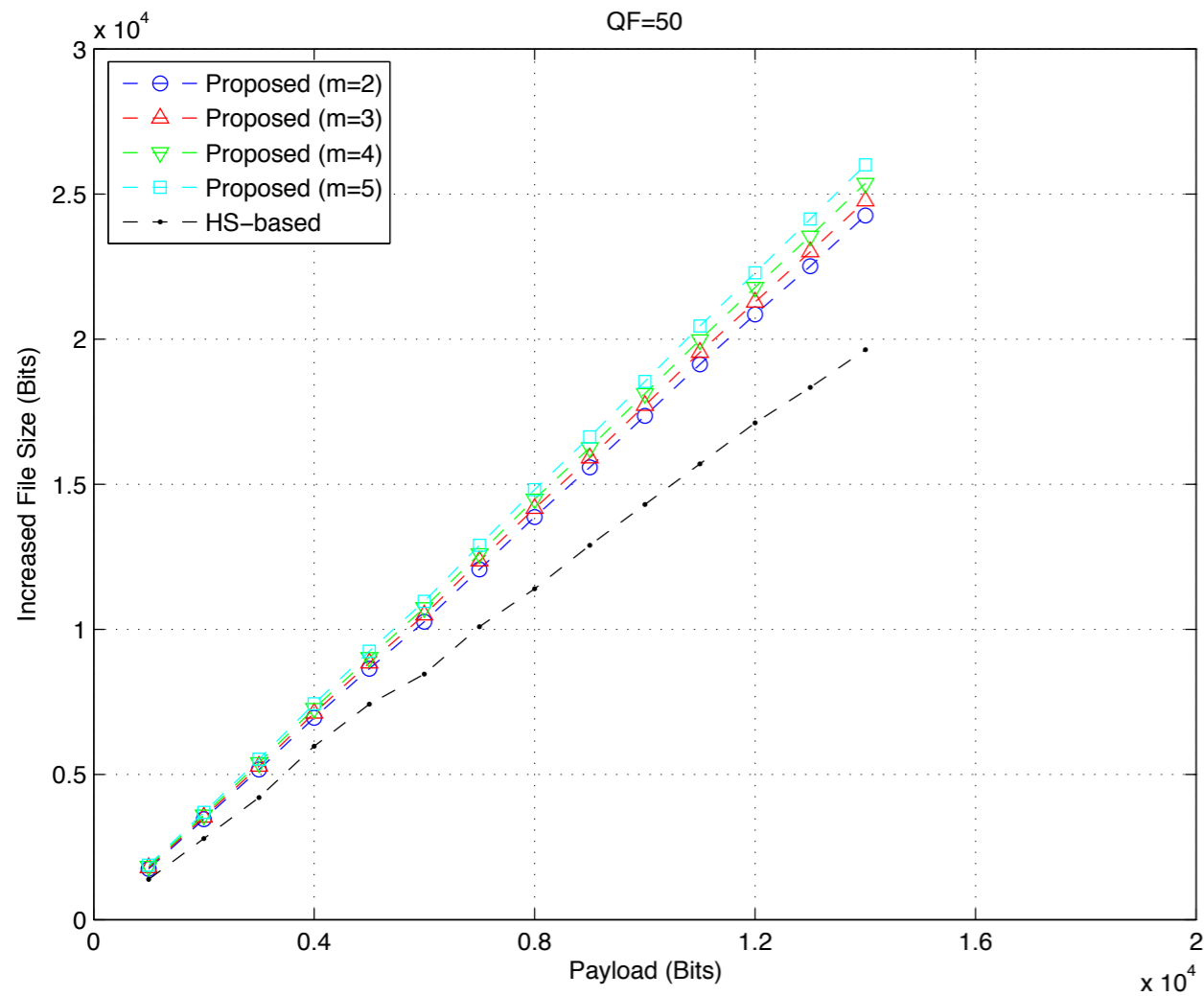
HS based scheme



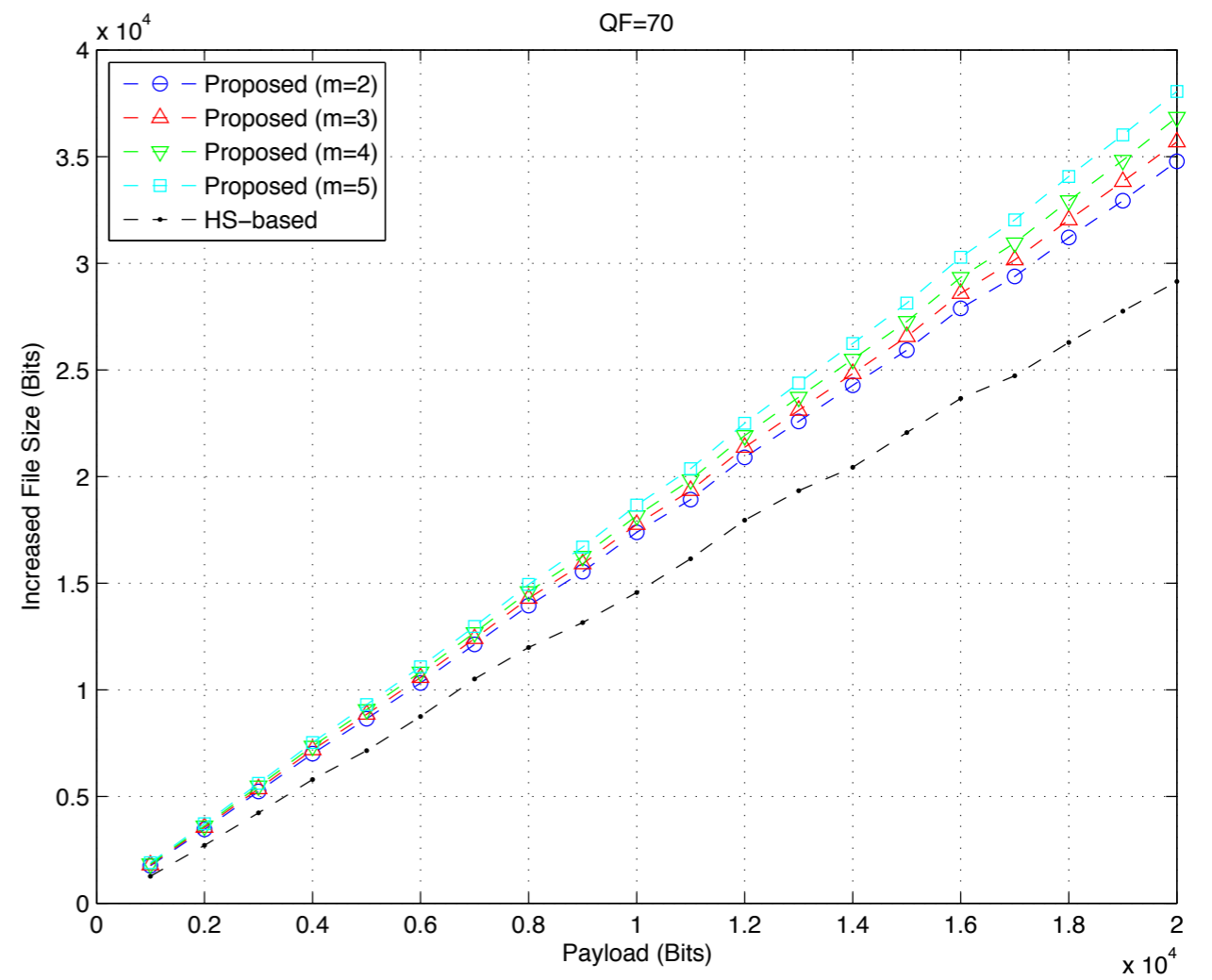
proposed scheme



# Experimental Results



File Size vs Data Payload  
on Lower Quality JPEG



File Size vs Data Payload  
on Higher Quality JPEG

# Experimental Results

## HS based scheme

-26	-4	-7	3	3	-1	0	0
0	3	-5	1	1	0	0	0
-4	2	6	-1	-2	0	0	0
-5	1	3	-1	0	0	0	0
2	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

## proposed scheme

-26	-3	-6	2	2	-1	-1	0
0	-2	-4	1	1	1	0	0
-3	1	5	-1	-1	1	0	0
-4	1	2	-1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	2	0	0	0	0	0	0
0	0	0	0	0	0	0	0

# Conclusion

- Strength

Novel strategy (embedding in zero coefficients)

Adjustable message length

Good visual quality

- Weakness

Increased file size (due to change in zero coefficients)