CCITT SGXV
Working Party XV/1
Specialists Group on Coding for Visual Telephony

Document #363

September 1988

SOURCE: NTT, KDD, NEC and FUJITSU
TITLE : STATISTICS OF CODED ELEMETNS IN FLEXIBLE HARDWARE

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1. Introduction

Statistics of the following coded elements in Flexible Hardware were obtained for several videoconferencing scenes;

1) Block Address (BA)
2) Block Type (TYPE3)
3) Classification Index (CLASS)
4) Motion Vector Information (DMV)
5) Transform Coefficient Data (TCOEFF) and End of Block (EOB)

Entropy and ideal Huffman codes are calculated for each element and compared with the current coding efficiency when initial compatibility check parameters are applied.

2. Measuring method and coding parameters

A statistics measuring equipment is prepared which accumulates the number of counts for each of 8 bit words at a clock frequency of 6.75 MHz. This equipment picks up necessary coded elements with a gate circuit operating at proper timing.

Coding parameters are those of the initial compatibility check which are specified in Doc. #249. Our Flexible Hardware uses a picture basis quantizer control so that the stepsize is kept constant throughout a coded picture. The loop filter on/off is controlled by the motion vector, thus some block types never appear. Calculation of the differential motion vector is in the first mode, or the motion vector to be encoded is predicted from the motion vector of the previous contiguous block.

3. Measured pictures

The following seven scenes were measured;

Scene A : Continuous videoconferencing session consisting of typical scenes, 8 minutes.
Scene B1: Three persons seated side by side ('Checked Jacket' type), 25 seconds.
Scene B2: Three persons standing up at the end of meeting, 25 seconds.
Scene B3: One person presenting before a flip chart, 25 seconds.
Scene B4: One person zoomed in from a three person view, 25 seconds.
Scene B5: Six persons seated in a split-screen arrangement, 25 seconds.
Scene B6: One person close up, 25 seconds.

Average stepsizes of these scenes are given in Table 1. Average coded picture rates were controlled around 15 Hz.

Table 1 Average stepsize

Scene	Average Stepsize
A (Whole session)	7.65
B1 (Three persons seated)	10.54
B2 (Three persons standing up)	8.07
B3 (One person presenting)	10.74
B4 (One person zoomed in)	11.38
B5 (Split-screen)	9.94
B6 (Close up)	11.85

4. Statistics and VLC codeset evaluation

4.1 Statistics

Measured statistics are given in Figures 1 - 5, Scene A on the upper and Scene B1-6 on the lower. Computer printouts are available for interested members.

1) Block Address Fig. 1
2) Blcok Type Fig. 2
3) Classification Index Fig. 3
4) Motion Vector Information Fig. 4 (DMVx, DMVy)
5) Transform Coefficient Data and EOB Fig. 5
   Note: Intra/inter AC coefficients, inter DC coefficients and EOB were measured.

4.2 VLC code set evaluation

Using the measured statistics, entropy is calculated for each coded element. Huffman coding is also applied to the statistics to obtain ideal code length. These values are compared with the bit numbers consumed in the Flexible Hardware.

Comparison for Scene A (Whole session) is shown in Table 2. For Scenes B1-6, see the following Tables.

1) Block Address Table 3
2) Blcok Type Table 4
3) Classification Index Table 5
4) Motion Vector Information Table 6
5) Transform Coefficient Data and EOB Table 7 (Note: 'Last non-zero' is not taken into account)

For coded blocks, the following average number of transmitted DCT coefficients are obtained;

Scene	A	B1	B2	B3	B4	B5	B6
Number of zeroes	12.28	12.79	10.71	10.49	9.10	10.85	12.74
Number of non-zeroes	5.29	7.10	5.06	8.47	6.75	8.21	8.28
Total	17.57	19.89	15.77	18.96	15.85	19.06	21.02

Table 2 Coding efficiency comparison for Scene A

Coded Elements	Entropy	Huffman Coding	Flexible Hardware
Block Address (BA)	2.641	2.671	3.179
Blcok Type (TYPE3)	0.884	1.267	2.251
Classification Index (CLASS)	1.981	2.000	2.530
Motion Vector Information (DMVx)	3.628	3.664	3.679
Motion Vector Information (DMVy)	3.992	4.018	4.030
Transform Coefficient (TCOEFF) and EOB	1.793	1.896	1.924

5. Conclusion

We can conclude as follows on how optimum the initial compatibility check VLC code sets are.

1) As far as one-dimensional VLC is used for transform coefficients, the code set in Doc. #249 is near optimum including the EOB coding.

2) For differential motion vector coding, the code set in Doc. #249 is near optimum.

3) For block address coding, there is a possibility to save 0.5 bits per coded block if a dedicated code set other than that for transform coefficients is designed.

4) If motion vector control of the loop filter is agreed, the following code set is appropriate using a part of the transform coefficient code set;

Block Type	Bit Length	Code
Inter coded	1	1
MC coded (DMV≠0)	3	001
MC fixed (DMV≠0)	3	010
MC coded (DMV=0)	3	011
MC fixed (DMV=0)	5	00010
Intra	5	00011

Coding efficiency is expected to improve by 0.9 bit per transmitted block.

5) Since the four classes are chosen almost equally frequently, 2 bit fixed length coding is more appropriate. If all zeroes should be avoided to protect the picture/GOB start codes, the following code set is suggested;

Zigzag	01
Horizontal	10
Vertical	11
Fourth	001

END

Table 3 Block Address (BA) coding

Scene	Entropy	Huffman Coding	Flexible Hardware
A (Whole session)	2.641	2.671	3.179
B1 (Three persons seated)	2.220	2.326	2.778
B2 (Three persons standing up)	2.436	2.486	2.889
B3 (One person presenting)	2.128	2.261	2.784
B4 (One person zoomed in)	2.197	2.282	2.599
B5 (Split-screen)	2.550	2.597	3.187
B6 (Close up)	1.946	2.132	2.971

Table 4 Block Type (TYPE3) coding

Scene	Entropy	Huffman Coding	Flexible Hardware
A (Whole session)	0.884	1.267	2.251
B1 (Three persons seated)	0.993	1.298	2.318
B2 (Three persons standing up)	1.020	1.316	2.320
B3 (One person presenting)	1.508	1.611	2.595
B4 (One person zoomed in)	1.579	1.640	2.610
B5 (Split-screen)	0.921	1.265	2.277
B6 (Close up)	1.619	1.720	2.736

Table 5 Classifcation Index (CLASS) Coding

Scene	Entropy	Huffman Coding	Flexible Hardware
A (Whole session)	1.981	2.000	2.530
B1 (Three persons seated)	1.998	2.000	2.488
B2 (Three persons standing up)	1.989	2.000	2.405
B3 (One person presenting)	1.970	2.000	2.381
B4 (One person zoomed in)	1.991	2.000	2.415
B5 (Split-screen)	1.986	2.000	2.527
B6 (Close up)	1.983	2.000	2.417

Table 6(a) Motion Vector Information (DMV-x) coding

Scene	Entropy	Huffman Coding	Flexible Hardware
A (Whole session)	3.628	3.664	3.679
B1 (Three persons seated)	2.886	2.910	3.116
B2 (Three persons standing up)	4.002	4.031	4.066
B3 (One person presenting)	4.082	4.106	4.150
B4 (One person zoomed in)	3.669	3.692	3.728
B5 (Split-screen)	2.871	2.910	3.103
B6 (Close up)	3.217	3.271	3.340

Table 6(b) Motion Vector Information (DMV-y) coding

Scene	Entropy	Huffman Coding	Flexible Hardware
A (Whole session)	3.992	4.018	4.030
B1 (Three persons seated)	3.678	3.719	3.813
B2 (Three persons standing up)	4.348	4.381	4.469
B3 (One person presenting)	3.673	3.720	3.727
B4 (One person zoomed in)	4.084	4.111	4.136
B5 (Split-screen)	3.667	3.713	3.788
B6 (Close up)	4.020	4.066	4.126

Table 7 Transform Coeficient (TCOEFF) and EOB coding

Scene	Entropy	Huffman Coding	Flexible Hardware
A (Whole session)	1.793	1.896	1.924
B1 (Three persons seated)	2.000	2.069	2.110
B2 (Three persons standing up)	1.882	1.961	1.990
B3 (One person presenting)	2.168	2.211	2.272
B4 (One person zoomed in)	1.996	2.050	2.075
B5 (Split-screen)	1.967	2.034	2.061
B6 (Close up)	1.973	2.039	2.067

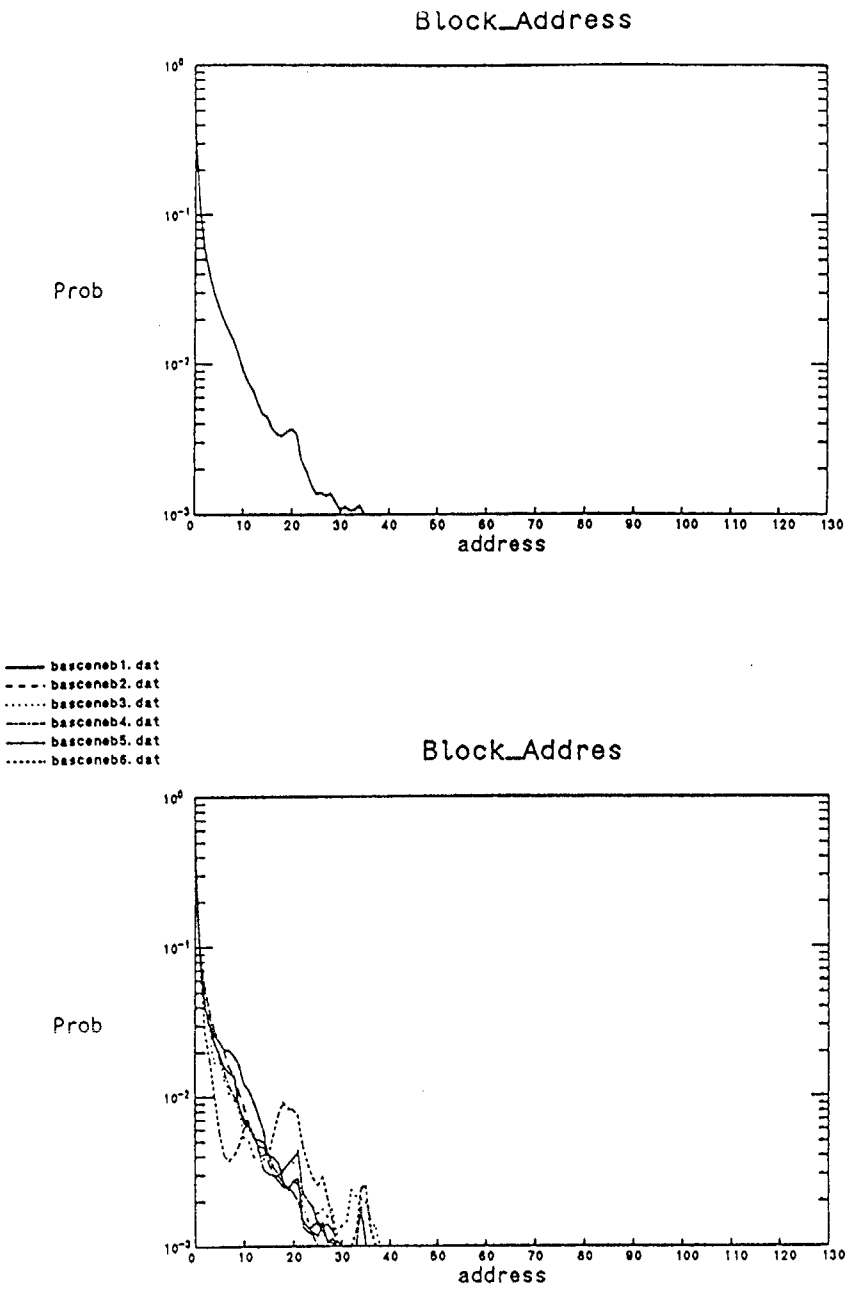

Figure 1

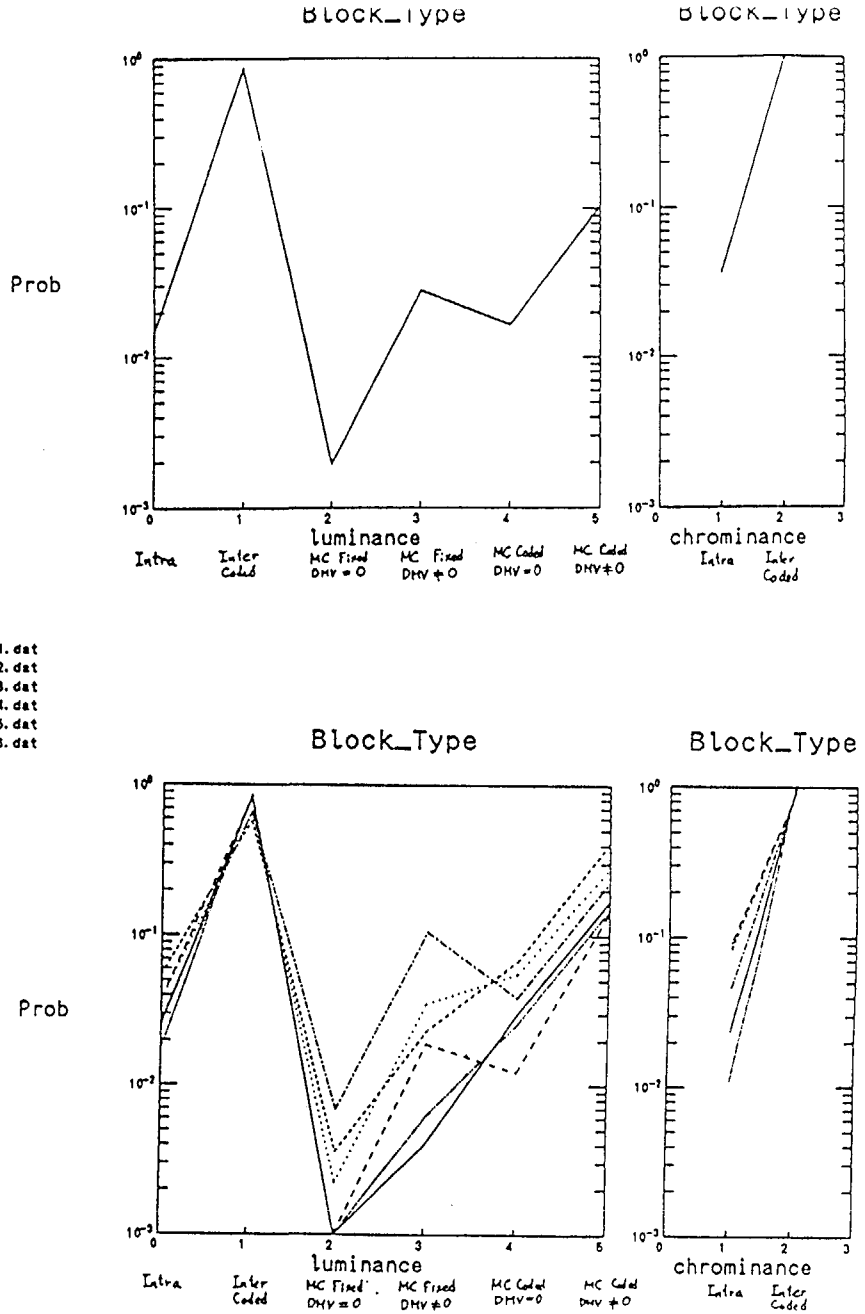

Figure 2

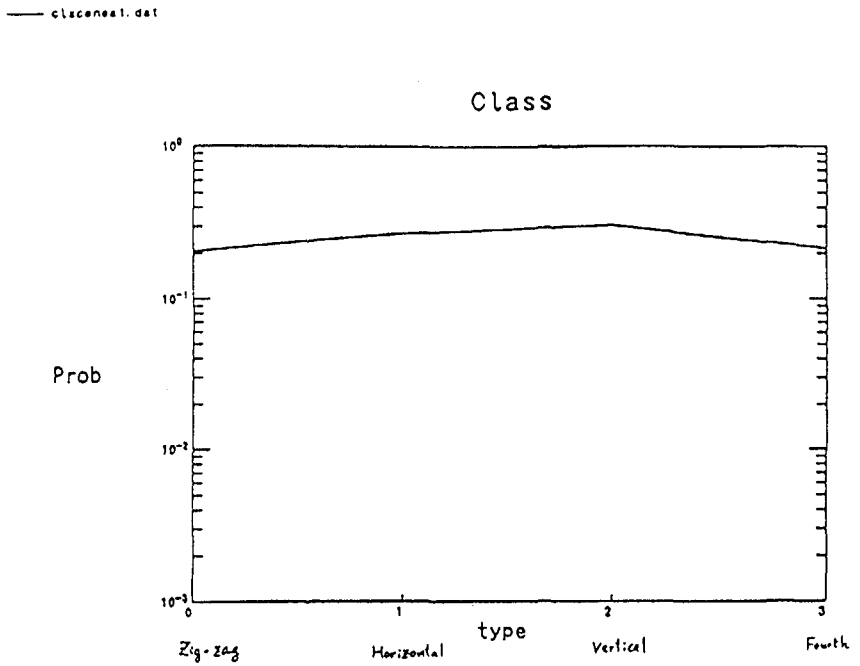

Figure 3

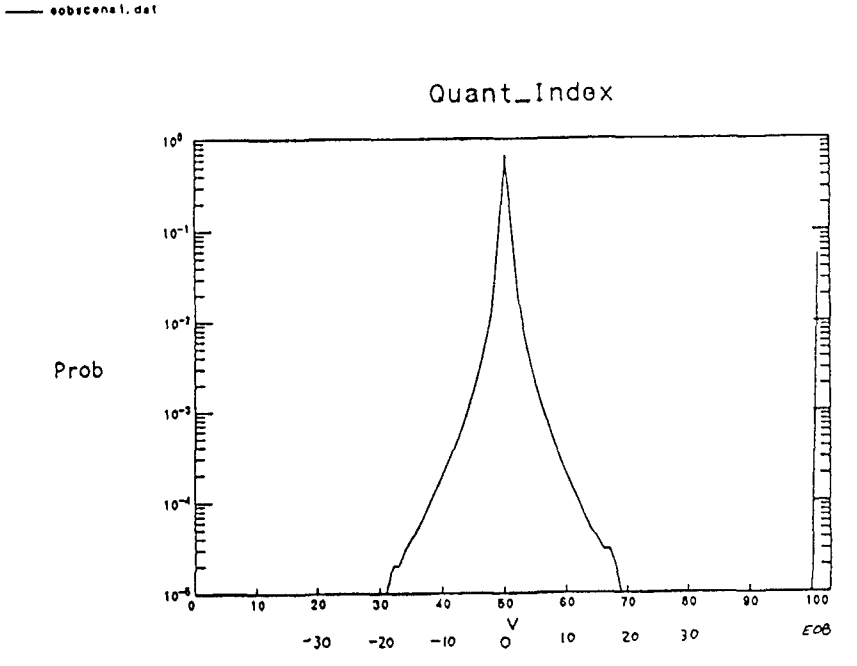

Figure 5

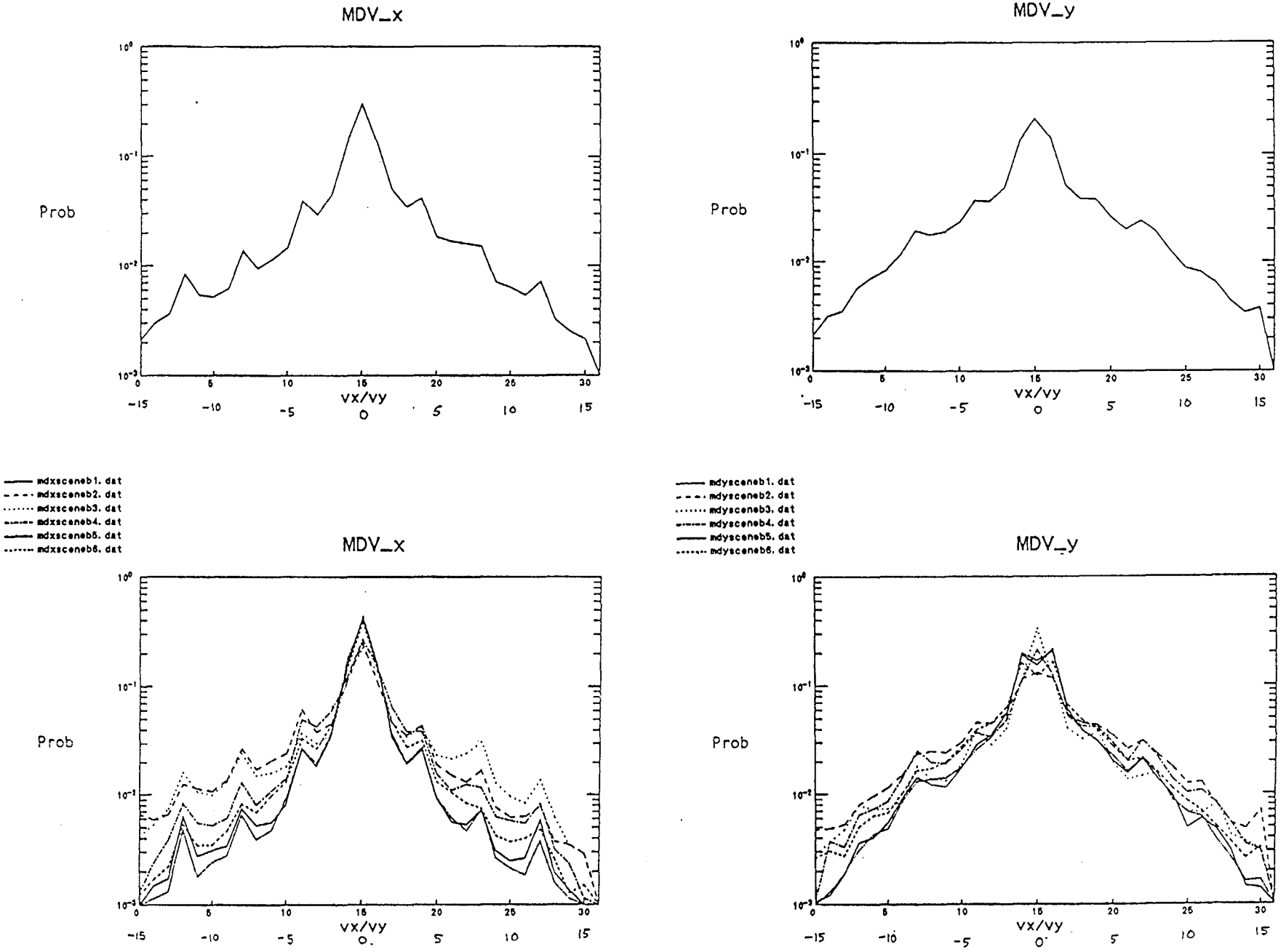
MDV_x
Prob
vx/vy
MDV_y
Prob
vx/vy
mdxsceneb1. dat
mdxsceneb2. dat
mdxsceneb3. dat
mdxsceneb4. dat
mdxsceneb5. dat
mdxsceneb6. dat
MDV_x
Prob
vx/vy
mdysceneb1. dat
mdysceneb2. dat
mdysceneb3. dat
mdysceneb4. dat
mdysceneb5. dat
mdysceneb6. dat
MDV_y
Prob
vx/vy

Figure 4