REDUCED-REFERENCE QUALITY METRIC FOR 3D DEPTH MAP TRANSMISSION

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Outline

- Introduction
- 3D Video quality
- Objectives
- Feature extraction
- Proposed method
- Results
- Conclusion

Introduction

- User expectation is high for upcoming 3D video services (e.g. superior quality)
- Rendered 3D video quality is affected by channel errors, resource limitations, etc.
- For adaptive transmission over time-varying channels/network, 3-D video transmission parameters need to be updated “on the fly”
- 3D video quality measured at the receiver can be used as feedback information

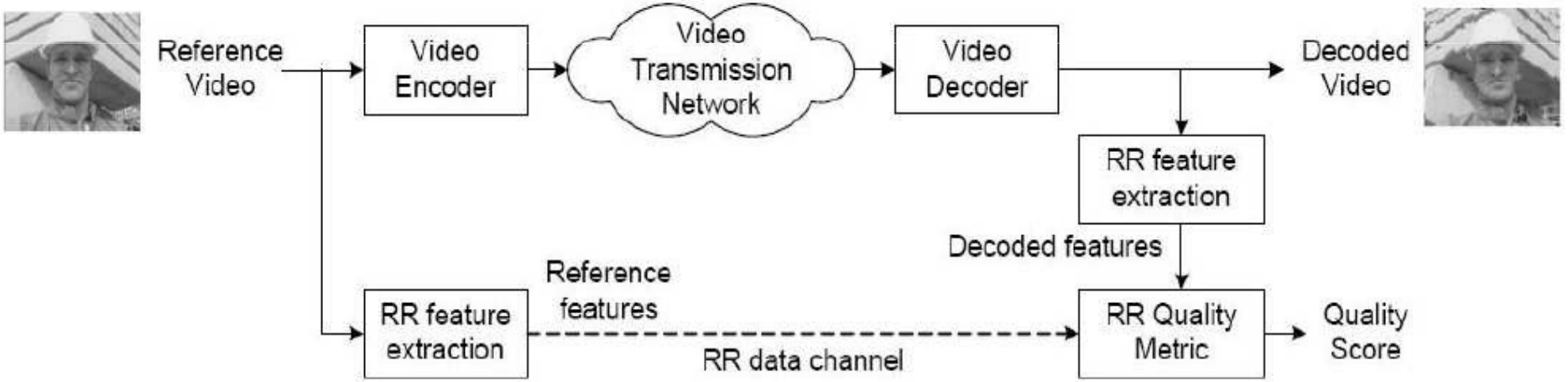
3D Video Quality

- Measuring 3D video quality at the receiver is a challenge due to:
  - The complex nature of 3D video quality
  - The lack of an accurate objective metric for 3D video
  - Operational difficulties of using *Full-Reference (FR)* quality metrics

  - Solution
    - *No-Reference (NR)* quality metrics
    - *Reduced-Reference (RR)* quality metrics

Reduced-Reference (RR) objective metrics

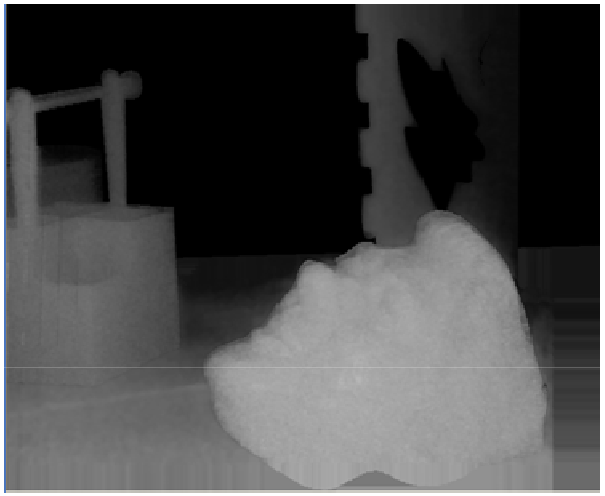
- Feature extraction from the original image



Objectives

- Propose a *Reduced-Reference* quality metric for depth maps associated with colour plus depth 3D video
- Identify image features that can be extracted from 3D depth maps to implement an RR metric
- Evaluate the performance of the proposed method under
  - Different compression levels
  - Different packet Loss Rates

Feature extraction from 3D depth maps

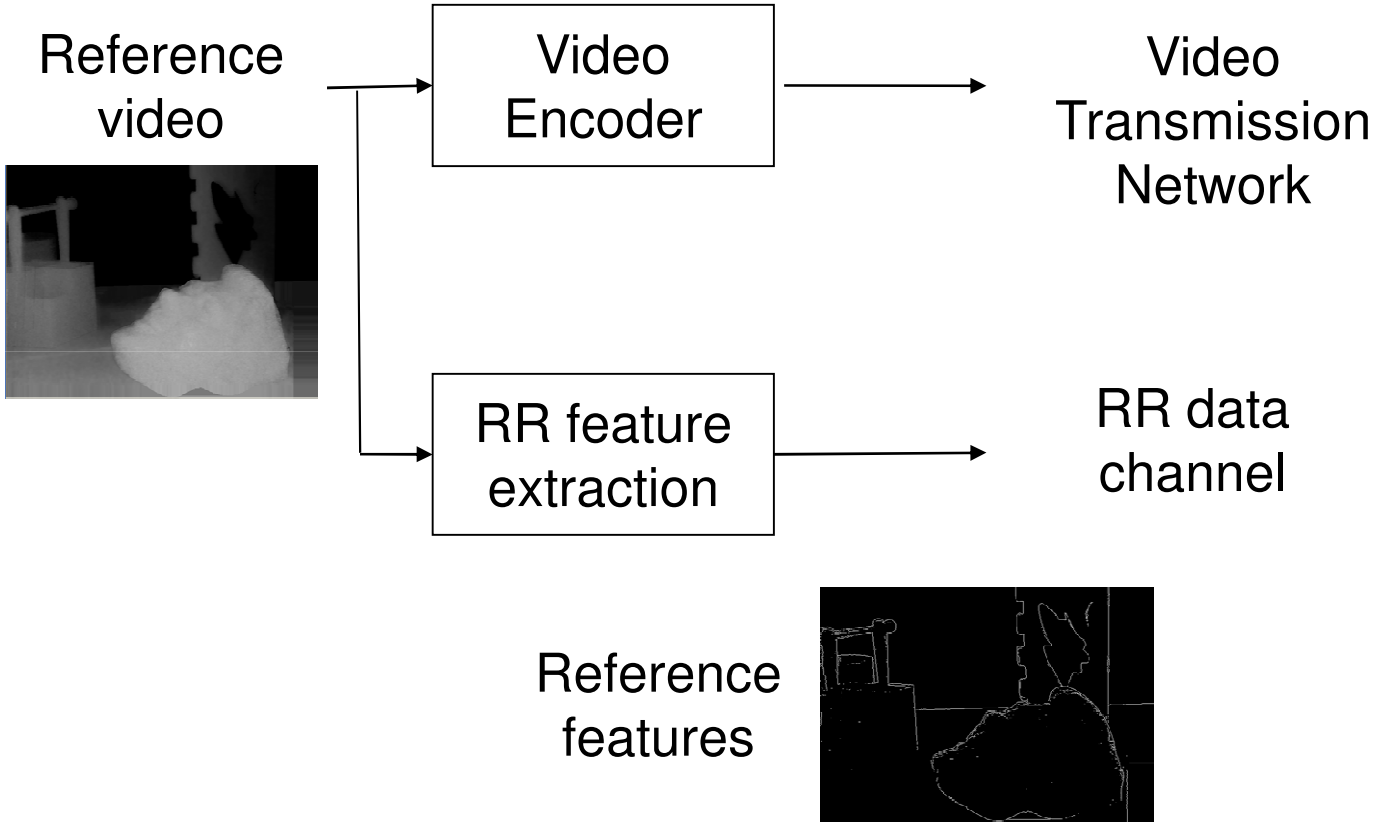


(a)

(b)

- The edges of the depth image represent different depth levels
- Hence, the extracted edge map can be used to evaluate the quality

Proposed RR Method



Proposed RR Method contd.

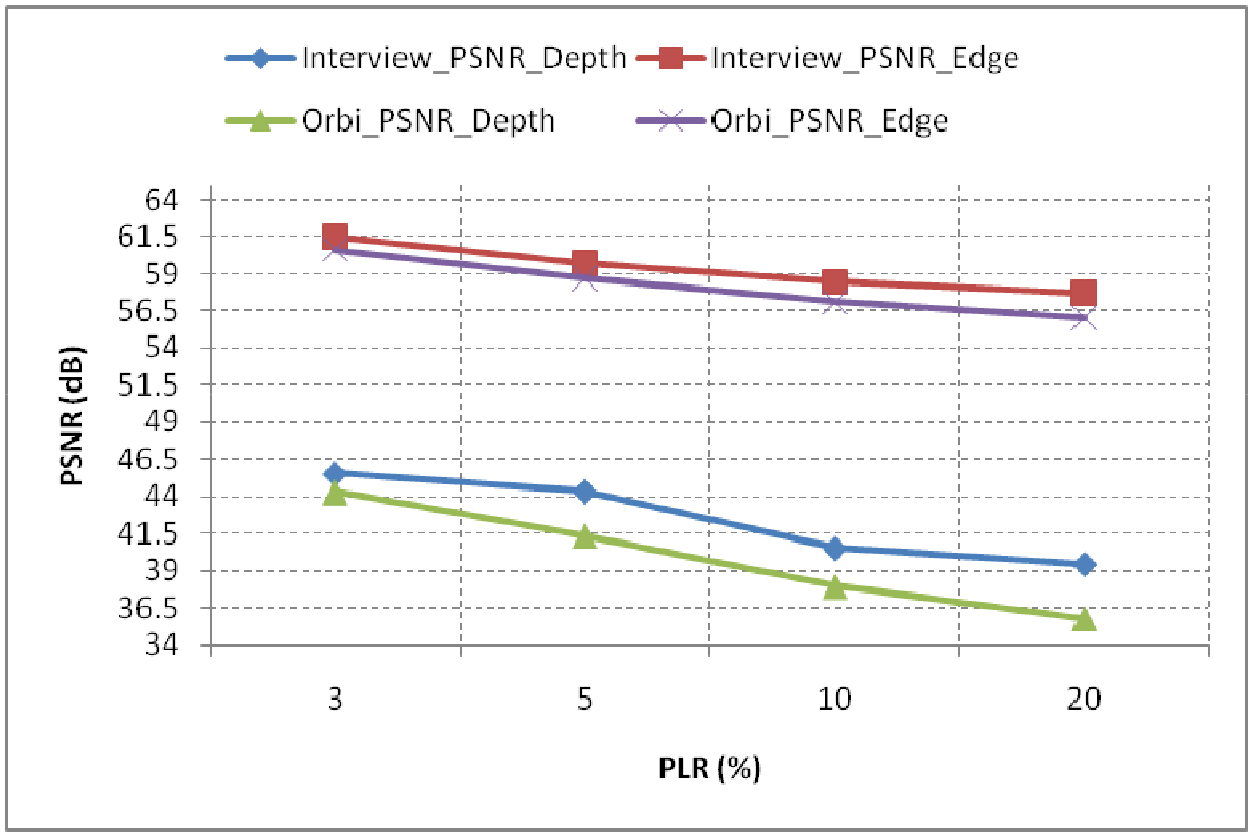
$$PSNR_{Depth\_Map} = f(PSNR_{Binary\_Edge\_Mask})$$

- Different image scenes have different edge densities
- The compression level has an effect on the amount of edge information that can be extracted.
- Solution: Lookup tables?

Overhead Analysis

- FR Method (8 bits/pixel)
  - E.g. For 720x576 depth map: 3.31776 Mbits per image
- Proposed RR method (1 bit/pixel)
  - E.g. For 720x576 depth map: 414.720 Kbits per image
- The overhead can be further reduced
  - run-length encoding can be used to compress the binary edge mask
  - a selected number of blocks from the binary edge mask can be considered

Performance evaluation



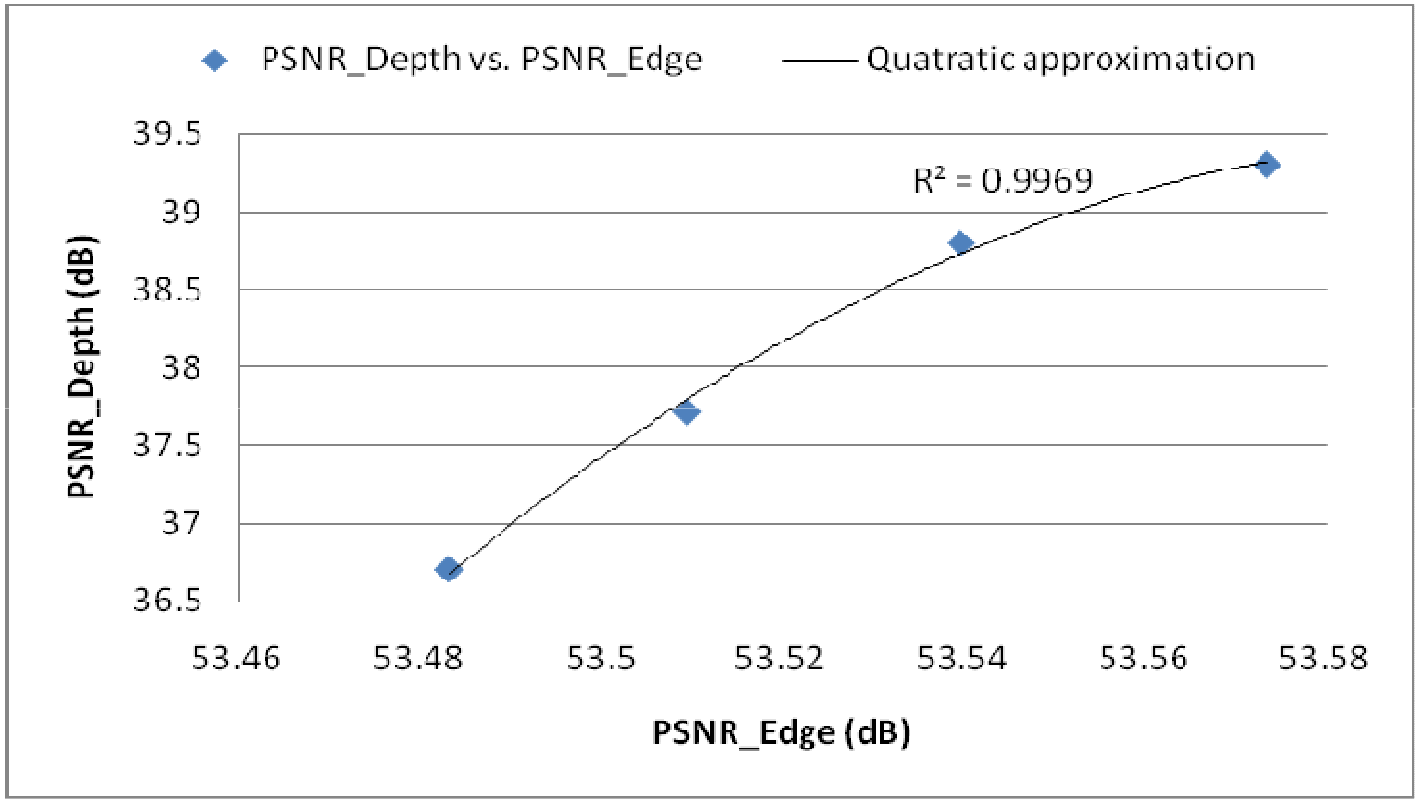
Measured quality using $PSNR_{depth}$ and $PSNR_{edge}$ at QP=1

Correlation Analysis

$$PSNR_{Depth\_Map} = f(PSNR_{Binary\_Edge\_Mask})$$

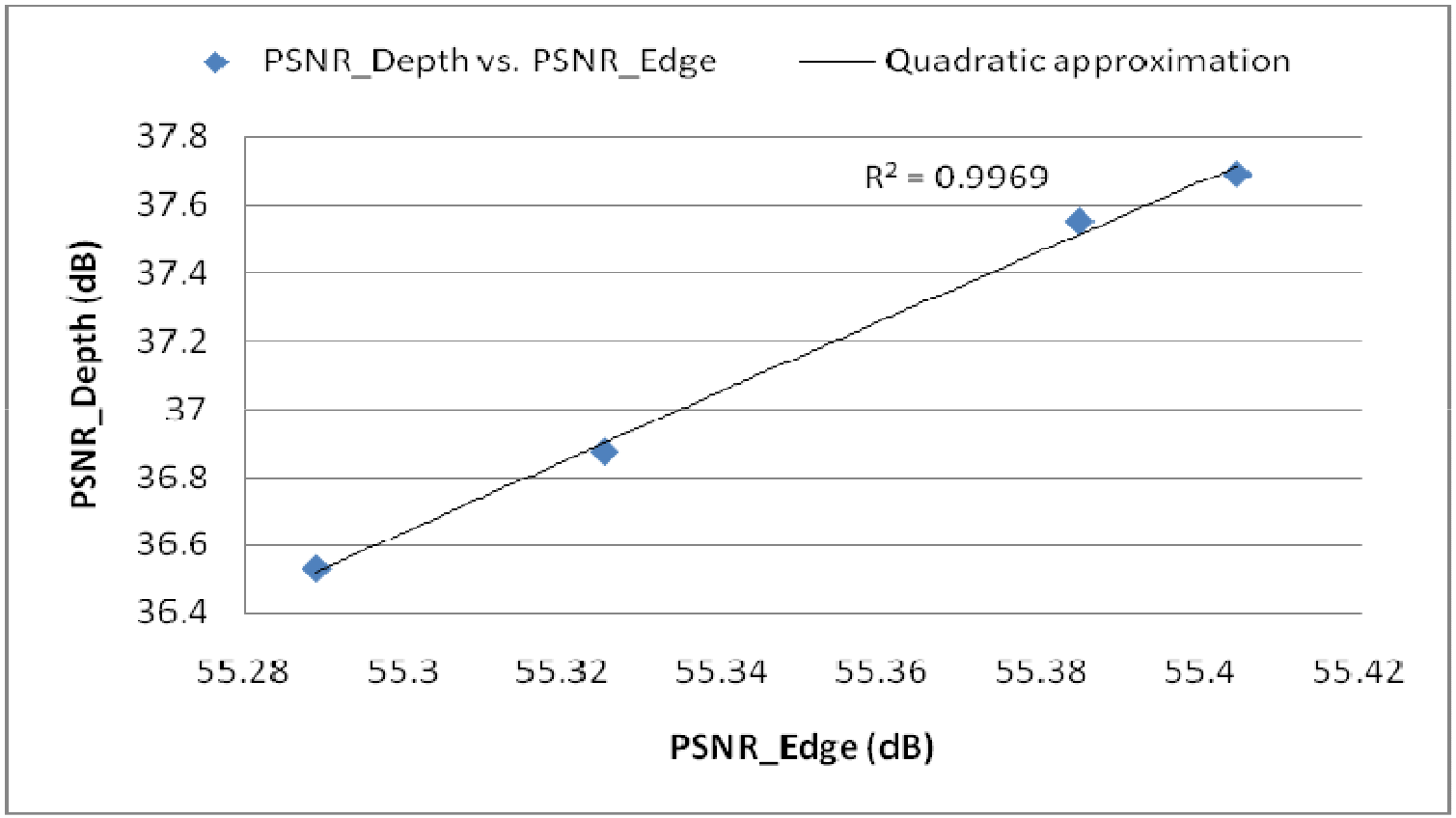
$$PSNR_{Depth\_Map} = \alpha.PSNR_{Binary\_Depth\_Mask}^{2} + \beta.PSNR_{Binary\_Depth\_Mask} + \gamma$$

Correlation Analysis contd.



Scatter plot showing the correlation between the proposed *Reduced-reference* method and the reference method (*Orbi*, QP=35).

Correlation Analysis contd.



Plot showing the correlation between the proposed *Reduced-reference* and the reference method (*Interview*, QP=45).

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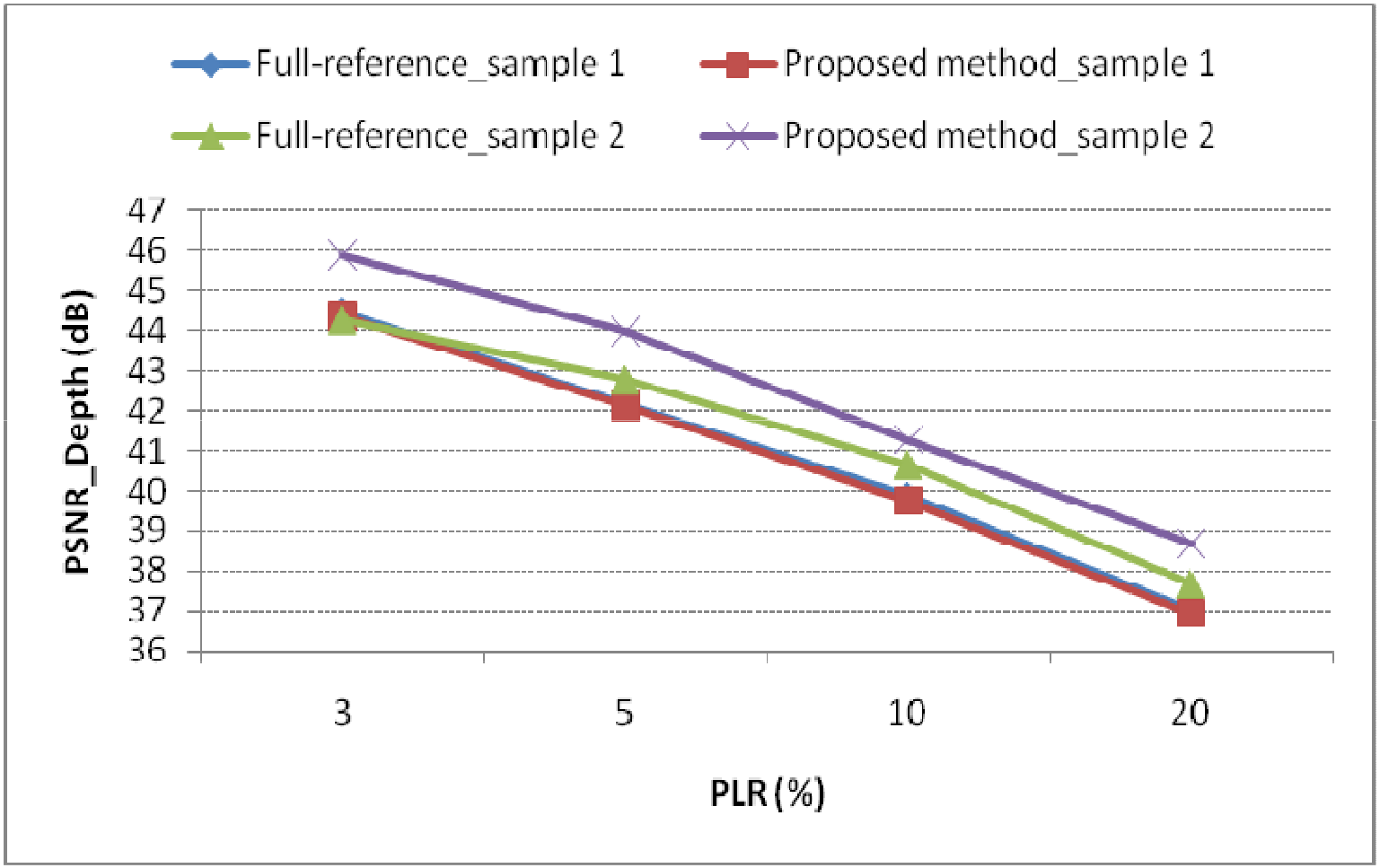
Correlation Analysis contd.

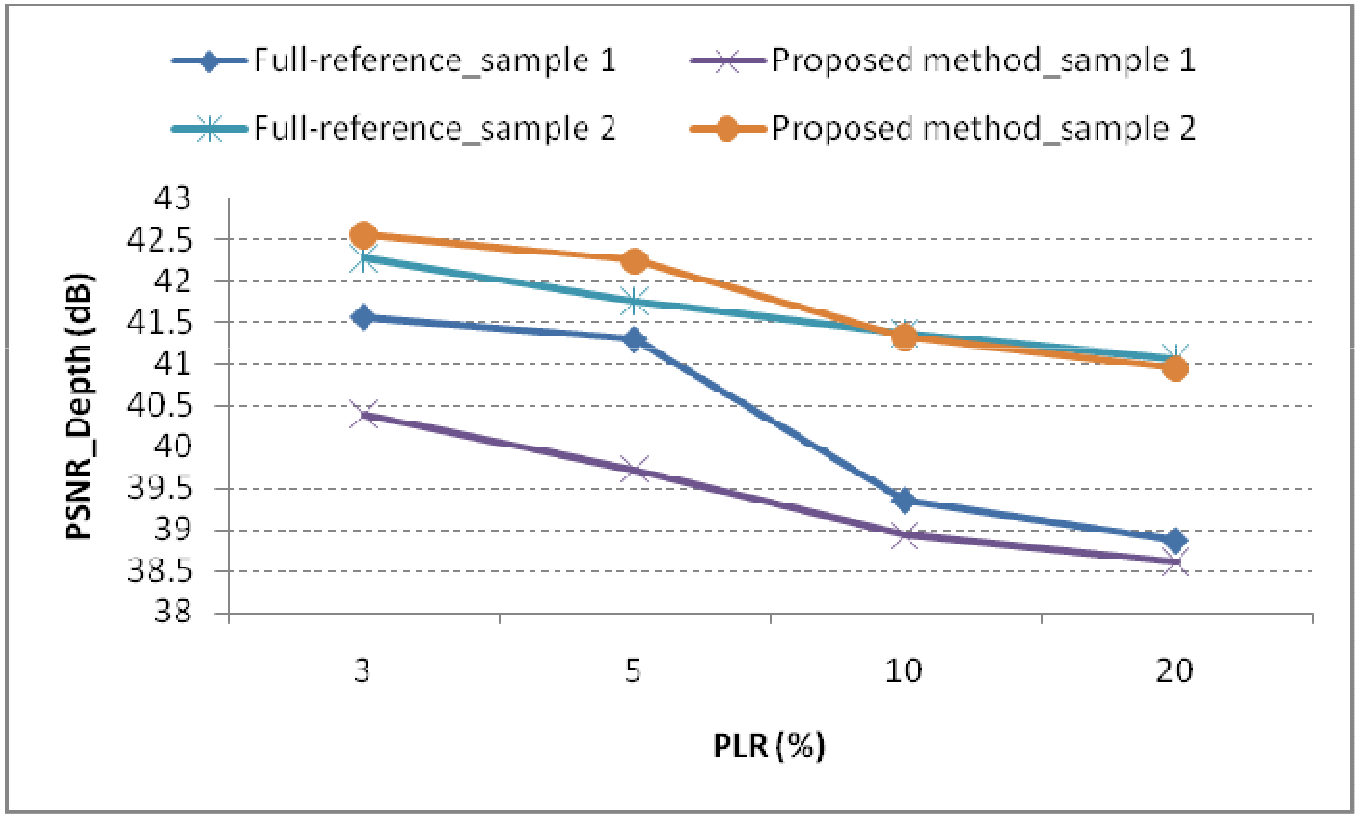
QP	R-square		QP	R-square	
	Orbi	Interview		Orbi	Interview
1	0.9993	0.9678	30	0.9870	0.9977
5	0.9822	0.9860	35	0.9969	0.9901
10	0.9928	0.9937	40	0.9978	0.9539
15	0.9995	0.9998	45	0.9969	0.9969
20	0.9999	0.9158	50	0.8415	0.9524
25	0.9711	0.9770	-	-	-

Results for video transmission



Measured quality for the *Orbi* at different PLRs (QP=20, Equation (2): α=4.864, β=-503.77 and γ=130.65)

Results contd.



Measured quality for the *Interview* at different PLRs (QP=35, Equation (2): α=30.727, β=-3376.3 and γ=92786).

Conclusions

- Efficient 3D video services can be delivered by using measured video quality at the receiver side as feedback information
- Due to operational difficulties, *NR* and *RR* quality metrics are the most feasible methods
- Hence this work proposed a *RR* metric for 3D depth maps associated with colour plus depth 3D video
- Edge information as the side information
- Analysis shows high correlation between the *RR* and *FR* quality methods
- Results show better approximation in place of *FR* quality metrics with a reduced overhead.

Questions?

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Thank you!

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