The scaling affected the quality of the decoded video as shown in Figure 8c. For example, Figure 9 illustrates the visual quality difference between the unscaled and scaled frame number 216. The quality degradation in 9b can be observed in the blurry grass and the writing on the back of player number 82.

(a) Unscaled
(b) Scaled

Figure 9: Visual quality difference between the unscaled and scaled frame 216 when 4-QAM is used

The performance of the streaming system when 16-QAM is used is shown in Figures 8d, 8e, and 8f. The performance when 64-QAM is used is shown in Figures 8g, 8h, and 8i. Figures 8j, 8k, and 8l show the performance when 256-QAM is used while Figures 8m, 8n, and 8o show the performance when adaptive modulation is used. It can be seen that adaptive modulation system outperforms the fixed modulation streaming systems. Adaptive modulation managed to eliminate starvation and reduced the amount of required scaling, hence, enhancing the temporal and spatial quality of the decoded video. Compared to the next best fixed modulation video streaming system, adaptive modulation reduces the average frame scaling from 10.26% to 3.90% and improves the average PSNR by 0.47 dB.

Additional simulations were carried out under the same channel realization but with different random seeds. Figure 10 shows that the adaptive modulation video streaming system outperforms fixed modulation systems in terms of average frame scaling, number of starvation instants, average skip length (SL), and average inter-starvation distance (ISD) for the different simulation runs.