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Research Article

A New Wireless Generation Technology for Video Streaming

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With the exponential rise in the volumes of video traffic in cellular networks, there is an urgent need for improving the quality of video delivery. This research proposes a mobile generation model based on the updated technologies of the fourth- and fifth-generation mobile systems, which is called Proposed Generation (Pro-G). This model uses wider bandwidth and advanced adaptive modulation and coding. It also incorporates the method of the adaptive video streaming of multiple video data rates by using the transcoding technique, which is called H.265 proposed (H.265 pro). Thus, both methods are tested to provide a large number of users of video/data application with more speed and best quality. A comparison with 4G technology is done to assign the development regarding number of users with data rate. The suggested video coding shows how much the overall system is more reliable over the congested channel than conventional video coding technologies such as high-efficiency video coding (HEVC/H.265) and advanced video coding (AVC/H.264). The results showed that the proposed method of transmitting wireless data is better than the LTE-ADV method. In this method, the rate of data transfer increases by 29% compared with LTE-ADV, while the bit rate saving was increased to 13% in the proposed video coding compared with that in the H.265.

1. Introduction

Currently, there are many mobile and wireless systems such as fourth-generation (4G) systems, which include Long-Term Evolution (LTE), Wi-Fi, and WiMAX. Wireless networks depend on the IP protocol, which means that this protocol in the network layer expresses all data transmission.

4G technology is mainly the extension of the third-generation (3G) technology, with additional information measure and services. 4G technology can provide several advancements to the wireless market, together with downlink information rates [1].

The 5G systems offer many distinct characteristics which make them stronger and more demanding in the future [2].

The main objective of the 5G systems is the transfer of data to mobile devices with high quality and efficiency [3]. These services have already been provided, but the provision of high-definition video, multimedia services, and interactive presentation that leads to degradation in service quality may be a significant challenge. Among the services, the video streaming service is preferred, and with the high flow of data and information, the response to users is essential to maintain the quality of service and performance.

There must be improvements to 4G systems to accommodate the need for video services, which will be 72% in 2019 [4].

One of the characteristics of video transmission over wireless networks is the availability of large amounts of data for transmission in a short time. The popular video encoding technology is H.264, which provides a useful service yet is impractical in the transmission of high-resolution data.

This paper proposes a new wireless technology, and it has been compared with 4G system technology. This paper also designs a new multi-video coding, and it has been evaluated with previous video coding methods.

The advanced wireless technology and video coding have been studied in literature as follows: Pandiaraj [5] improved the throughput of coverage area by using relay techniques, compared their power adoption with WiMAX. The architectural evolution of wireless mobile network technology

from 4G to 5G was discussed by Sule and Joshi [1]; Nissel and Rupp [6] proposed a new modulation scheme which combines the advantages of Filter Bank Multicarrier (FBMC) and Single-Carrier-Frequency-Division Multiple Access (SC-FDMA). The proposed technique did not require a cyclic prefix and had much lower out-of-band emissions.

For video coding, Nightingale et al. [7] evaluated the performance of the HEVC regular in loss-prone networks. Zeng et al. presented a comparison between the coding gains predicted by the target models of video quality assessment for the two standards [8]. Bojkovic examined the general performance of HEVC and implementation [9].

This paper proposes a new MCS, which is called a modulation coding scheme proposed (MCS pro). The MCS pro has more throughput than the MCS standard. Then, the MCS pro is combined with FBMC. In terms of the video coding, this paper also proposes a new video coding which is called H.265 proposed (H.265 pro). The H.265 pro with optimum H.265 is used to find the best video coding.

2. Overview of the LTE-Advanced

3GPP defines three channels of control, a random-access channel (RACH), a physical channel (PCH), and a shared data channel (SDCH), and reference signals for the LTE downlink. The control channels are transmitted in the control region at the beginning of each subframe, that is, in the 1st, 2nd, or 3rd orthogonal frequency-division multiplexing (OFDM) symbols [10], and the physical broadcast channel (PBCH) is plotted on the 72 central subcarriers (6 resource blocks (RB)) of the available bandwidth [11]. Figure 1 illustrates how the aforementioned logical channels are mapped on physical channels in a 20 MHz transfer scenario (100 RB) [12, 13]. 3GPP describes two synchronization messages: the primary synchronization (P-SS) and secondary synchronization (S-SS), which are used for the search and synchronization procedures of the UE cells. Note that, in LTE, the time is divided into "10" ms frames, each frame is divided into "10" subframes, and each subframe is divided into two time slots [14]. At last, a slot is partitioned into 7 OFDM symbol images (or six slots in the situation of amplified OFDM cyclic prefix).

3. Digital Video Coding Standard

The core of this paper is on transcoding for bit rate saving. The different types of video coding standards H.265 and H.264 are described in the following sections.

3.1. Advanced Video Coding (AVC/H.264). The H.264 is the common coding method [15]. It aimed for a good variety of video applications from mobile phones to web applications to the TV (HDTV). A variety of the practicality enhancements inside the H.264 commonplace compared to previous codecs of video are the discrete cosine transformation works at 4×4 pixels rather than 8×8. However, it additionally supports 8×8, color sampling is compatible with $4:2:2$ and $4:4:4$, up to twelve bits per pixel are possible. The H.264 has features such as the motion compensation (MC) blocks are of various sizes, coding is Arithmetic of Variable length (VLC), De-blocking filter and built-in reference mechanism, frequency distortion optimizer, weighted duplex forecast, redundant pictures (RD), versatile layout of the macroblocks, direct mode for frame B, multiple reference frames, and MC for subpixel [15].

3.2. High-Efficiency Video Coding (HEVC/H.265). The H.265 procedure outlines the configurations to denote the coded data of video. Its encoder produces structures that are captured inside units of data referred to as NAL (Network Abstraction Layer) [16].

H.265 has a structure similar to H.264. H.265 has many enhancements such as flexible division partitions, transforming block sizes, and high interpolation with a complicated and unblocking filter and supports multiprocessing [16–18]. The different options concerned in hybrid video coding using H.265/HEVC are as follows:

(i) A different form of structure coding like coding tree units (CTU), coding tree block (CTB), coding units (CUs), coding blocks (CBs), prediction units (PUs) and prediction blocks (PBs) [19, 20]

(ii) Transform units (TUs) and transform blocks (TBs)

(iii) Different MV signaling

(iv) Quantization control

(v) In-loop de-blocking filtering

(vi) Sample adaptive offset (SAO) [15]

4. Implementation of the Proposed System in Physical Layer

This paper proposes a new communication system as shown in Figure 2, which is called Pro-G. Figure 2 illustrates the steps of the proposed system, some of which are components of the 4G system with the addition of proposals including a new modulation-coding scheme (MCS) that is more efficient and replacement of OFDM with FBMC. The new system and LTE-ADV features are presented in Table 1.

This paper proposes a new modulation coding scheme (MCS pro) (Algorithm 1) and compares the proposed scheme with the traditional MCS (Table 2).

5. Implementation of the Proposed Video Coding

This paper also explains a new multicoding with controller transcoding video method, which is called H.265 pro. The method has been designed by using two HEVC structures, as shown in Figure 3. The figure shows the proposed multicoding step, which has same steps of traditional H.265 coding, which contains transformation (T), quantization (Q), motion composition (MC), buffer, and sample adaptive offset (SAO), but these have a multicoding with different

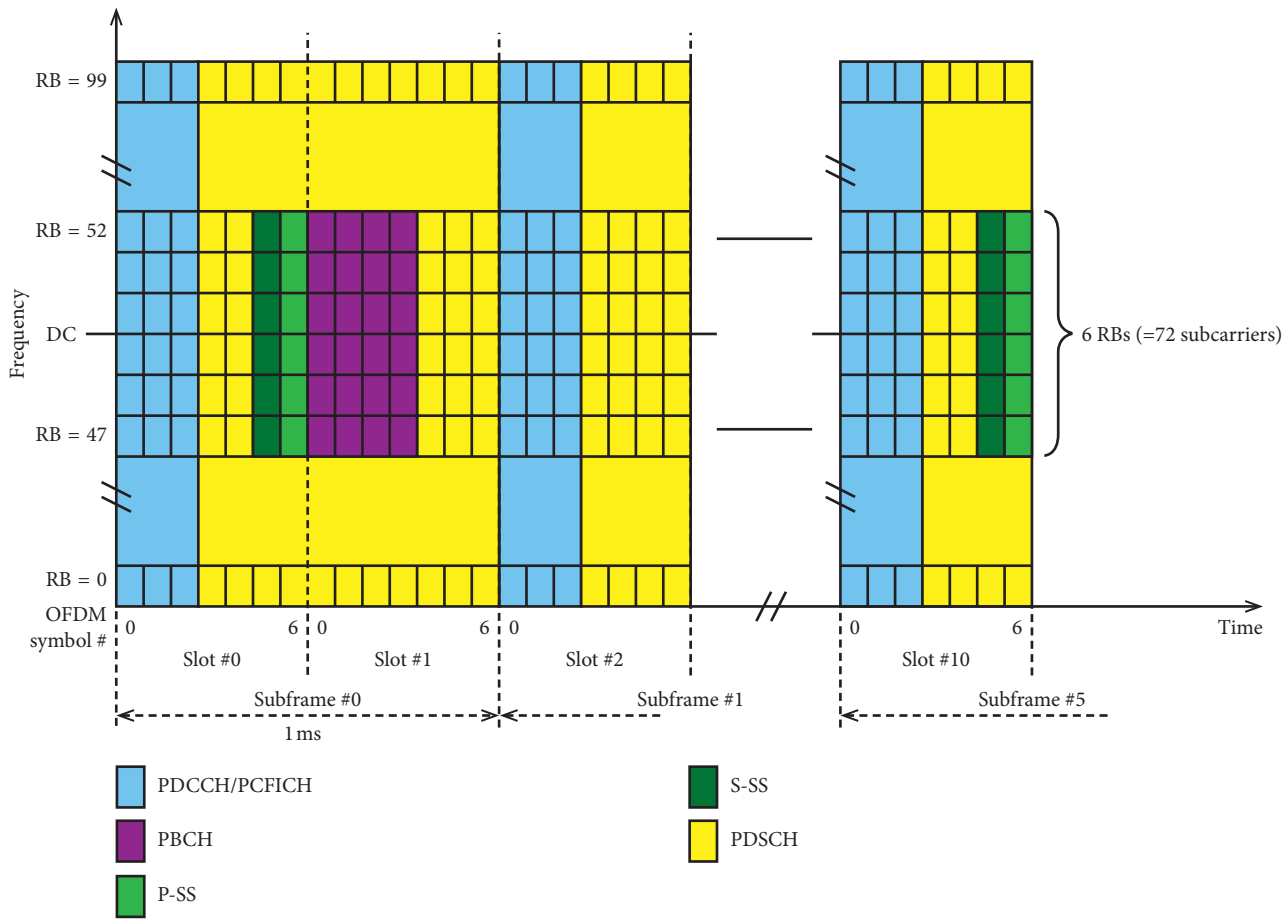

Figure 1: Mapping of LTE downlink channels.

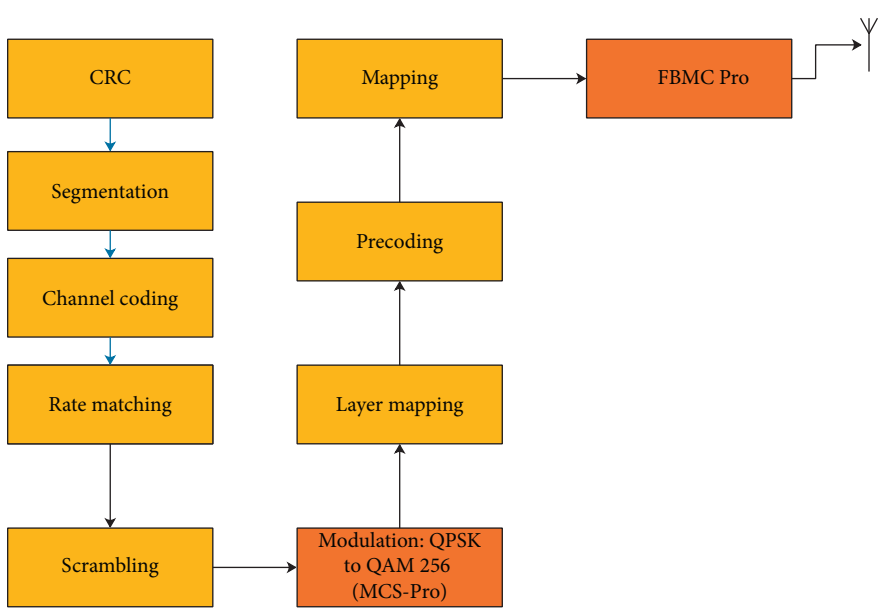

Figure 2: Block diagram of the proposed system.

parameter codings such as rate factor and dimension. First, the raw data video enters the first pass of H.265. The raw video data are analyzed and saved as a log file; then, the second pass collects the data from the first pass and achieves the best encoding quality. The second pass is controlled by bit rate ranging.

Table 1: Comparison of the features of the system.

System	LTE-ADV	Pro-G
Bandwidth	1.4–20 MHz	1.4–40 MHz
Channel modulation	QPSK to QAM 256	QPSK to QAM 256 (MCS pro)
Waveform modulation	OFDM	OFDM and FBMC

Table 2: A parameter of the MCS pro and MCS standard.

CQI index	MCS standard			MCS pro		
	Modulation	Code rate	Efficiency	Modulation	Code rate	Efficiency
1	QPSK	78	0.1523	QPSK	449	0.877
2	QPSK	193	0.3770	QPSK	602	1.1758
3	QPSK	449	0.8770	16 QAM	490	1.9141
4	16 QAM	378	1.4766	16 QAM	553	2.1602
5	16 QAM	490	1.9141	64 QAM	466	2.7305
6	16 QAM	616	2.4063	64 QAM	517	3.0293
7	64 QAM	466	2.7305	64 QAM	567	3.3223
8	64 QAM	567	3.3223	64 QAM	616	3.6094
9	64 QAM	666	3.9023	64 QAM	666	3.9023
10	64 QAM	772	4.5234	256 QAM	682	5.332
11	64 QAM	873	5.1152	256 QAM	711	5.5547
12	256 QAM	711	5.5547	256 QAM	754	5.8906
13	256 QAM	797	6.2266	256 QAM	797	6.2266
14	256 QAM	885	6.9141	256 QAM	885	6.9141
15	256 QAM	948	7.4063	256 QAM	916	7.1602

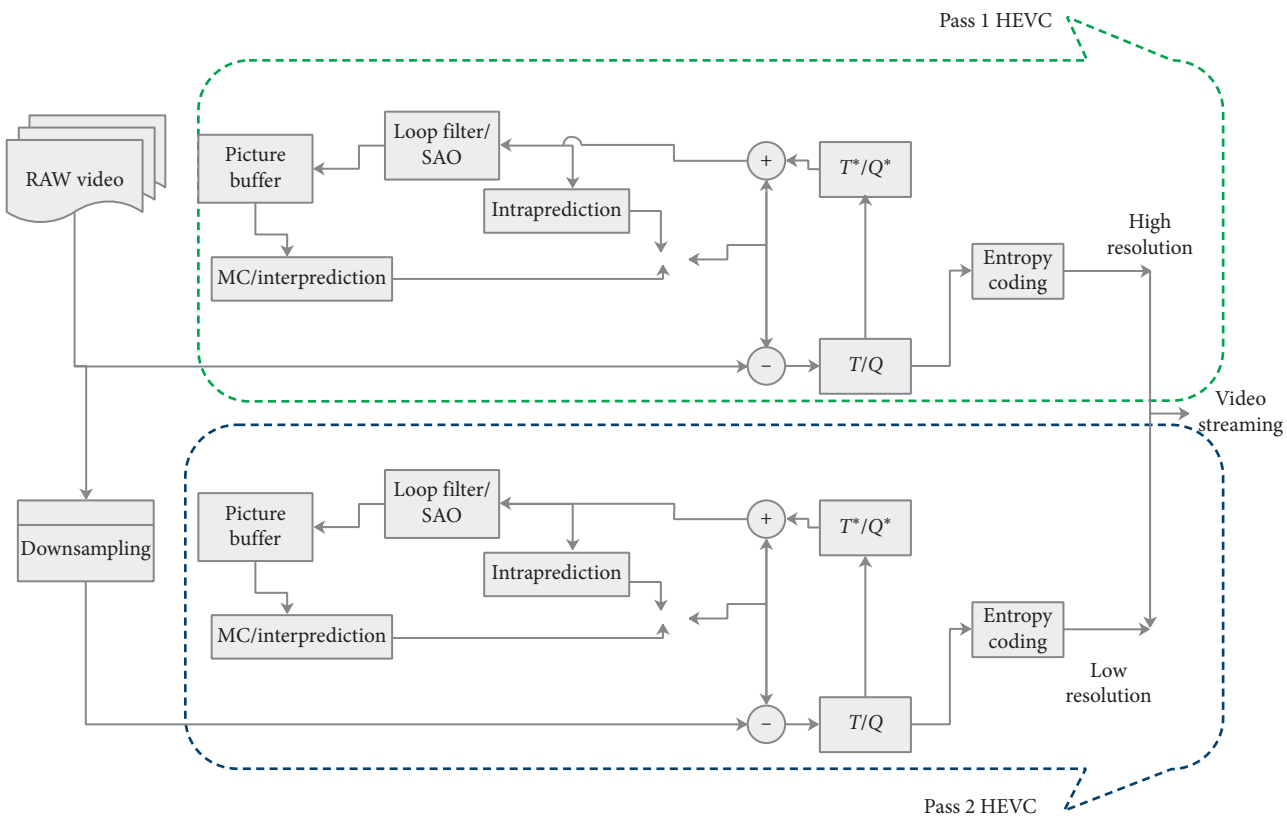

Figure 3: Block diagram of H.265 pro.

```
input code rate old;
start;
nsymbol = 7;
ncarrier = 12;
while CQI ≤ 15 do
   Read modulation order;
   i = 1;
   while i ≤ N do
      code rate new(i) = TBS/nsymbol ∗ ncarrier ∗ 2 ∗ modulation order;
      if code rate new ≥ code rate old then
         code rate old = code rate new;
      else
         code rate old = code rate old;
      end
      i = i + 1;
   end
   CQI = CQI + 1;
end
```

Algorithm 1: The proposed modulation coding scheme.

The H.265 pro is compared with H.265. H265 is implemented with some of the video controller methods. The methods are as follows:

(i) Constant QP: It is the amount of compression for every macroblock in a frame.

(ii) Average bit rate (ABR): the amount of data transferred per unit of time.

(iii) Video buffering verifier (VBV): It ensures that an encoded video stream can be correctly buffered.

An FFmpeg tool has been used to apply the controller types, and H.265 pro with the video sequence dimension $1920 * 1080$ and 120 fps has been used in this paper.

6. Implementation Results

The simulation evaluates and compares the Pro-G and LTE-ADV system to determine the best performance; the parameters of simulation are presented in Table 3. The MATLAB 2018 is used to implement the proposed system by using parameters in Table 3. The bandwidth is from 1.4 to 20 MHz (i.e., 6 RB to 100 RB), while the MCS is from QPSK to QAM 256; three channel types are used in the evaluation (AWGN, Flat, and Pedestrian); FBMC is used in Pro-G while OFDM in the LTE-ADV; and minimum mean squared error (MMSE) is used in the equalizer while the antenna number is from single input single output (SISO) to multiple input multiple output (MIMO). Figure 4 provides information about the simulation steps: first, it enters the number of base stations and users; second, it enters the system configuration such as the power of nodes, frequency, number of antennas, and number of RB, and the modulation type index.

Figure 5 shows the throughput of transmitted data versus SNR in the AWGN channel; the parameters used in evaluation are FBMC, SISO, and 20 MHz. The throughput in MCS pro is about 128 Mb/s while that of MCS is about 116 Mb/s; the best performance is shown by the MCS pro.

Table 3: Parameters of simulation.

Parameter	Value
Center frequency (GHz)	2.5
Subcarrier spacing (kHz)	30
Bandwidth (MHz)	1.4–20
FFT size	72 to 2048
Number of subcarriers	72 to 1200
Channel modulation	QPSK to QAM 64 and advance QAM 256
Waveform modulation	OFDM, FBMC
Channel coding	Turbo coding, $R = 1/3$
Number of antennas	1×1, 2×2, 4×4, 8×8
Number of frames	100
Channel type	AWGN, Flat, Ped A
Equalizer type	MMSE
Power of BS and UE (dB)	30 dB

Figure 6 shows the BER of the data versus SNR in the AWGN channel; the MCS pro shows the best performance because the BER in MCS pro is about $1 * 10^{-6}$ while that of MCS is about $3 * 10^{-6}$.

Figure 7 presents the throughput versus SNR between two types of modulation schemes (MCS and MCS pro) in the flat channel with different numbers of antennas.

The throughput of MCS pro is more than that of MCS; two video coding methods consumed the most throughput after 27 db. The MCS pro offers significant gains regarding the number of data rates compared to MCS. In terms of the antenna 8×8, the throughput in the MCS pro is around 965 Mb/s as opposed to around 888 Mb/s in the MCS.

Figure 8 presents the BER versus SNR between two types of modulation schemes (MCS and MCS pro) with different numbers of antenna. The BER of MCS pro is lower than that of MCS. In terms of the antenna 8×8, the BER in the MCS pro is around $3.6 * 10^{-5}$ as opposed to around $5.7 * 10^{-5}$ in the MCS.

Figure 9 illustrates the throughput versus SNR between two types of modulation schemes (MCS and MCS pro) in the

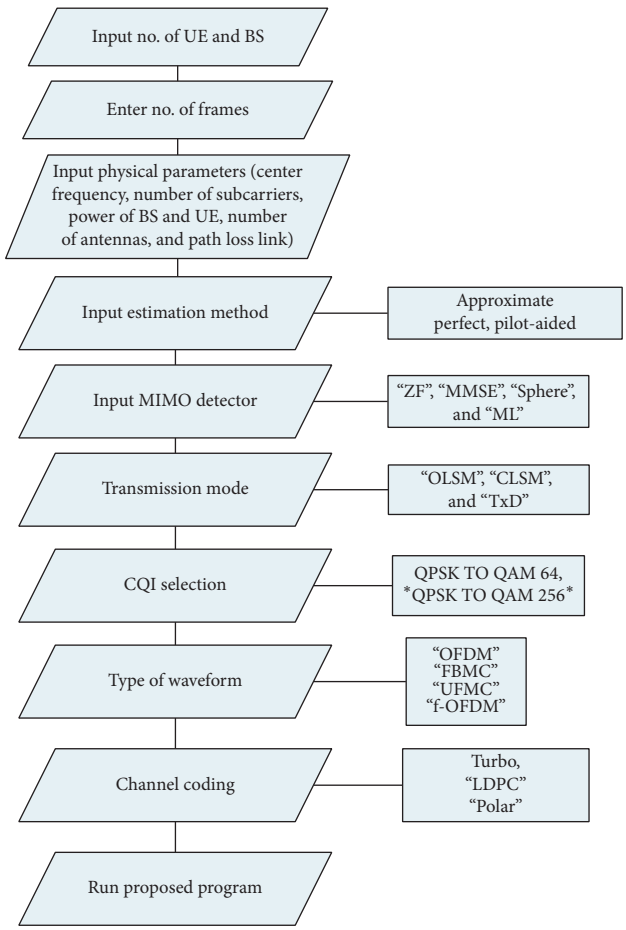

Figure 4: Simulation steps.

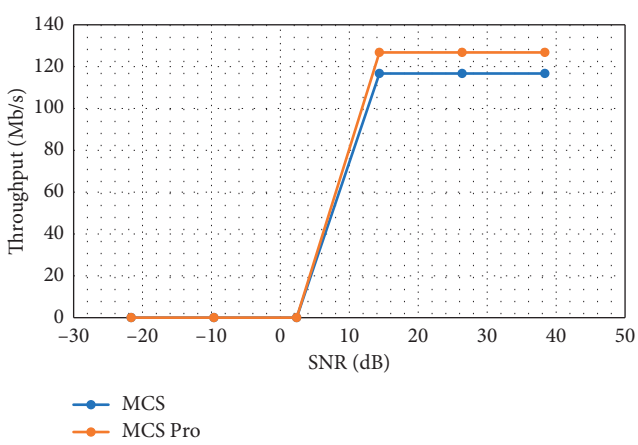

Figure 5: SNR versus throughput in the AWGN channel.

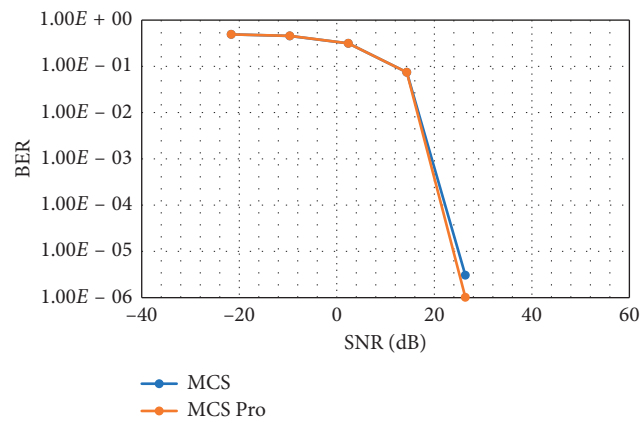

Figure 6: SNR versus BER in the AWGN channel.

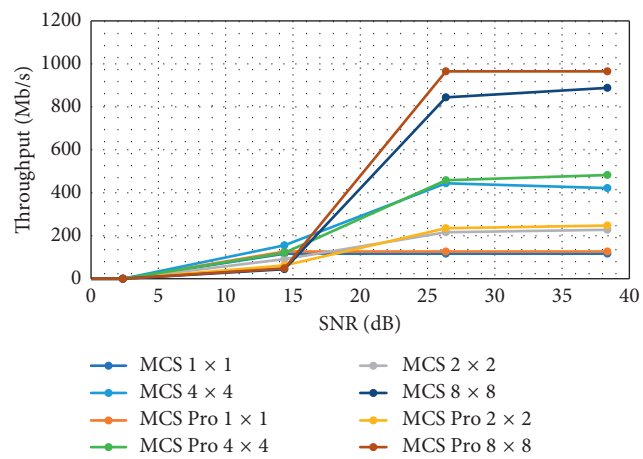

Figure 7: SNR versus throughput in the flat channel.

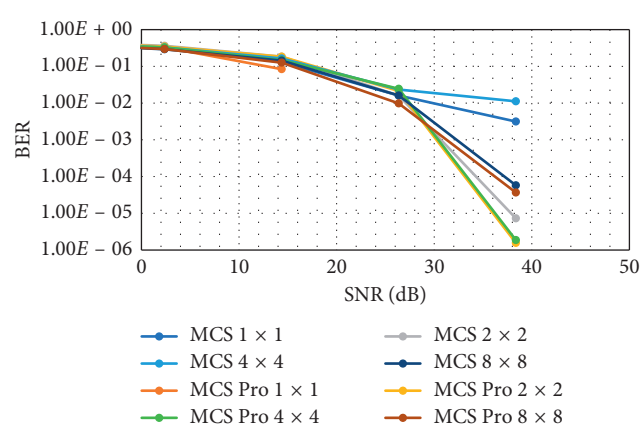

Figure 8: SNR versus BER in the flat channel.

pedestrian channel with different numbers of antenna. The throughput is the same as that in the flat channel.

Figure 10 shows that the BER of MCS pro is lower than that of MCS. In terms of the antenna 8×8, the BER in the MCS pro is around $3 * 10^{-4}$ as opposed to around $4 * 10^{-3}$ in the MCS.

Figure 11 shows the throughput with different numbers of antenna. The parameters used in the evaluation are OFDM (LTE), FBMC (Pro-G), SISO, MIMO, 20 MHz, and LTE-ADV. When the number of antennas is eight, the throughput in the Pro-G is the highest, that is, around 965 Mb/s, as opposed to that of LTE-MCS pro and LTE-ADV, which was about 900 and 746 Mb/s, respectively.

Figure 12 illustrates a level of bit rate with high resolution (720, 1080, 4K, and 8K) between two video coding

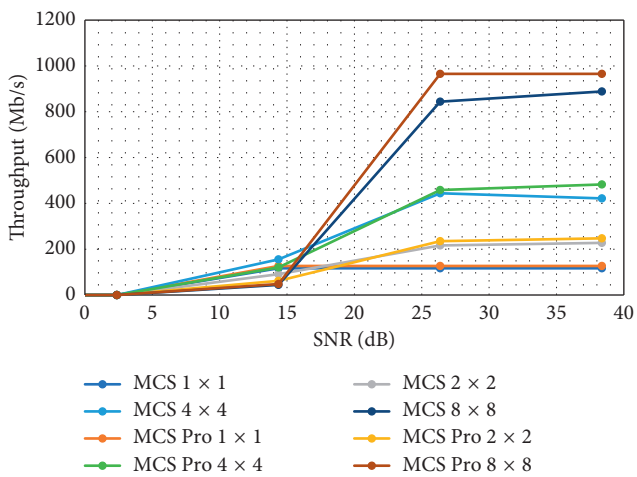

Figure 9: SNR versus throughput in the pedestrian channel.

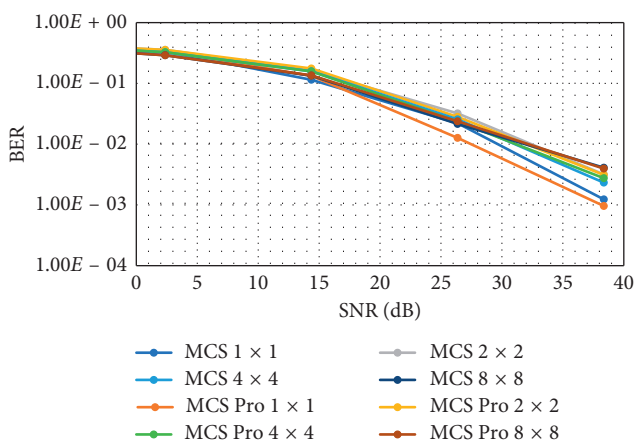

Figure 10: SNR versus BER in the pedestrian channel.

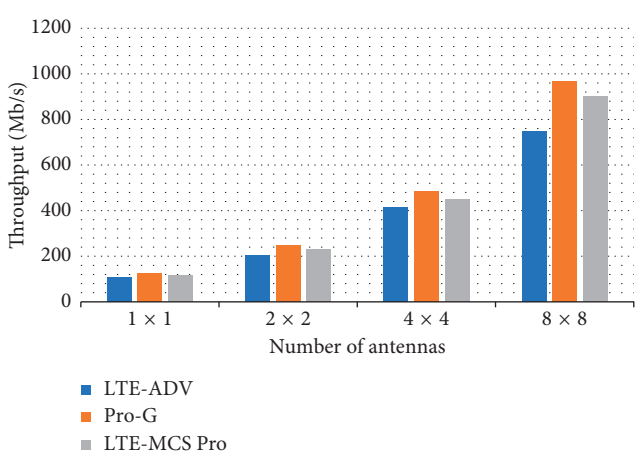

Figure 11: Comparison of the throughput with different numbers of antenna.

methods (H.265 and H.265 pro). The parameters used in the evaluation are shown in Table 4.

The bit rate of H.265 pro is lower than that of H.265; both video coding methods consumed most data on 8K. The H.265 pro offers significant gains regarding coding efficiency

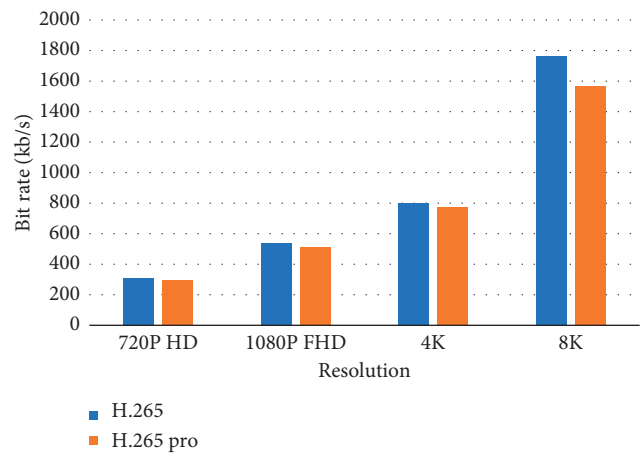

Figure 12: Comparison of the bit rate between the H.265 and the H.265 pro in high-resolution video.

Table 4: Parameters of the video sequences.

Resolution	Resolution dimension	Frame rate	Frame number
720 HD	1280 ∗ 720		
1080 HD	1920 ∗ 1080	120	100
4K	3840 ∗ 2160		
8K	7680 ∗ 4320		

compared to the H.265. When the resolution is 8K, the bit rate of H.265 pro in 8K is lower than that of H.265 (i.e., about 1567 kbps and 1763 kbps, respectively). Table 5 presents the evaluation parameters of the H.265 pro and H.265.

Figure 13 presents that the bit rate performance in H.265 pro is the lowest (the best performance), the resolution 1080 is used in the evaluation, and the ABR rate is the largest. ABR has a higher bit rate than H.265pro about double rate, while the bit rate in constant rate also higher than in H.265pro (about 525 and 424, respectively). The VBV is considered the best and closest to the h265 pro.

Figure 14 shows the number of users of the two video coding methods from 720 to 8K. The number of users was highest for H.265 pro in 720; 720 has the most number of users for both the wireless systems while the lowest number of users is in 8K.

In terms of 720 in the Pro-G, the H.265 pro has the highest number of users around 3286 users as opposed to that of H.265, which was about 3116 users. In LTE-ADV, the number of users was 2541 for H.265 pro compared to 2410 for H.265.

7. Conclusions

This paper proposes a method of wireless transmission and video encoding method where the two proposed methods are compared with the traditional method. The evaluation parameters used are the data transfer rate, the compression ratio, and the bit error rate. Both proposed systems are combined to calculate the number of users, which is compared with the traditional systems.

The results showed that the proposed method for transmitting wireless data is better than the LTE-ADV

Table 5: Comparison results of the two video coding methods.

Resolution	Parameter	H.265 pro	H.265
8K	Data rate (kb/s)	1567.14	1763.66
	Time (sec)	75.23	171.46
	CR	30486	27089
4K	Data rate (kb/s)	772.66	799.63
	Time (sec)	30.01	40.86
	CR	15458	14937
1080	Data rate (kb/s)	511.14	538.58
	Time (sec)	10.16	12.47
	CR	5842	5544
720	Data rate (kb/s)	293.75	309.72
	Time (sec)	5.14	6.69
	CR	4518	4285

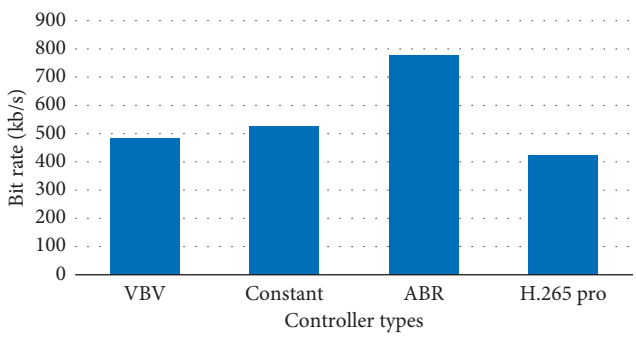

Figure 13: Comparison of bit rate video coding with the control.

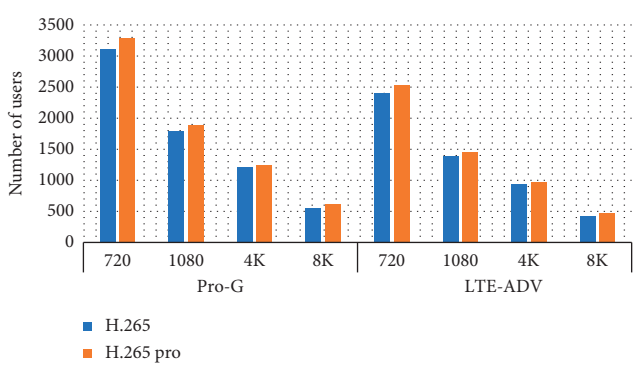

Figure 14: Comparison of the number of users between video coding methods and the wireless systems in a high-resolution video.

method where the throughput increased the data transfer by 29% because the proposed system uses a more efficient MCS compared to the traditional system. The proposed system uses the FBMC for waveform modulation. On the contrary, OFDM is used in the LTE-ADV. The improvement goes back to FBMC, which has less processing time and more spectral efficiency than LTE-ADV.

The bit rate has been gained in H.265 pro about 13% as compared to H.265.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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