THE COFDM TECHNOLOGY BRINGS NEW DIMENSIONS INTO ELECTRONIC NEWS GATHERING

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ABSTRACT

Electronic News Gathering involves small camera crews working on the location. Small portable cameras with compact cassette systems allow the crew to grab the news and carry the information back to the studio. For some particular event like golf tournaments, wireless cameras, which can transmit the video and sound information back to a base station by means of a small transmitter, are frequently used.

INTRODUCTION

For news programs it is very important to add video clips from outside, but other programs would also require the camera to be moved outside the studio. Earlier OB Vans equipped with a number of cameras cabled to van was the only method used to gather TV information outside the studio whereby the signals were either recoded in the OB van or transmitted back to the studio via microwave links.

A few transmissions require for the quality reasons the traditional set-up, as just described. Else the set-up would be mobilized with smaller cameras used by a crew of 2 to 3 persons.

Where live transmissions are required the cameras would be cabled to a small OB Van parked near the location of event. If there is time to go back to the studio e.g. for the evenings news, the camera would be equipped with ENG Tape recorder.

There are very proposals for use in the live situation to minimize use for cabling, but they have their drawbacks and limitation. First to benefit from the development in Digital Broadcasting, the wireless camera found its solution in using the COFDM modulation system.

THE COFDM PRINCIPLE

In wireless camera applications the video signal (either component or composite) is fed the MPEG2 encoder module and converted to MPEG 4:2:0 or MPEG 4:2:2 (ref.1). The strong compression system reduces the required Bit rate for carrying the camera signal to typically 4-6 MBit/sec.

The MPEG encoded signal is then fed to the modulator. The modulator makes use of the Coded Orthogonal Frequency Division Multiplex system (COFDM, ref. 2). This modulation system has successfully been proven in TV broadcasting, as one of the best methods to carry video and audio programs off air.

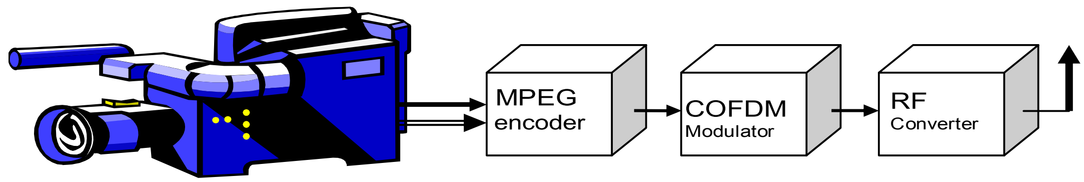

Fig. 1, the wireless camera.

The COFDM system carries its data information on a high number of carriers. The DVB-T norm gives a choice between two modes (1705 carriers and 6817 carriers respectively). The two modes are often referred to as the 2k and 8k mode, the description refers to length of the Inverse Fast Fourier Transformation used to generate the signal. Though a number of carriers are used for receiver synchronization and receiver control, quite a high number are available for data. The signal carrying data can be either QPSK modulated, 16 QAM modulated or 64 QAM modulated.

Before transmission the data is heavily interleaved in time (within the frame) and in frequency. A frame refers to a full set of carriers. Thanks to the interleaving system together with a Viterby/Trellis– and a Reed Solomon (shorten form) error corrections system, the transmission will be experienced as very robust. The preprocessing in transmitter and post correction in the receiver the system will typical appear as error free even with a BER of $2*10^{-4}$ after the Viterby/Trellis

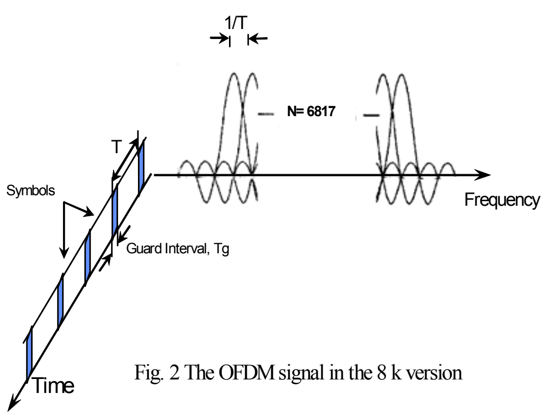

Fig. 2 The OFDM signal in the 8 k version

The Guard interval is another important parameter for the robustness of the COFDM modulation. The Guard interval is inserted between two successive symbols. The guard interval prevents symbol interference caused by echoes, at least as long as the echoes falls within the guard interval. The longest guard interval in the 8k mode is 224 µsec and in 2k: 56 µsec. 224 µsec equals an echo traveling at approximately 65 km longer than the main signal. The DVB-T standard gives the options of guard intervals of ¼, 1/8, 1/16 and 1/32 of the duration of the symbol part.

In the DVB-T standard the broadcaster has the options of selecting between 2k and 8k mode, between protection degree of the Viterby/Trellis error protection and the guard interval. The ability to choose between these parameters becomes very handy in a camera application.

With reference to fig. 1, whereby the signal is fed from the COFDM modulator to the RF converter and output amplifier giving an output level at maximum 1W, it could be beneficial to sacrifice covering range in order to improve battery time. The output frequency should be selectable, as various countries have various regulations. The general acceptable range for wireless system would be between 1.99 to 2.7 GHz.

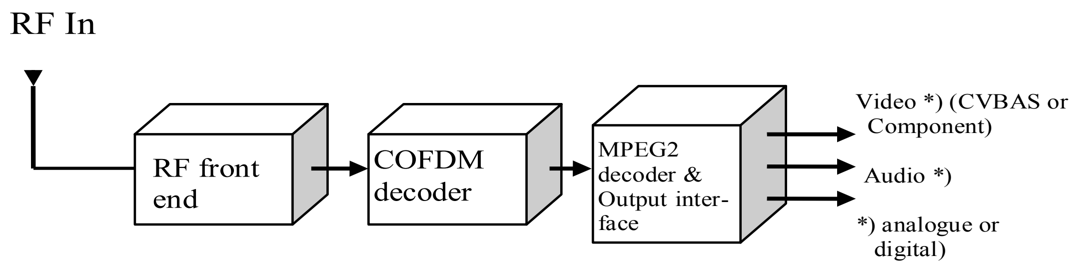

Fig.3 The receiver unit for the wireless camera

MODES FOR WIRELESS CAMERA

In a wireless cable application 'far away' echoes are normally insignificant in level. Sometimes it can be of interest to use the camera from a moving vehicle. Tests in Singapore using QPSK mode has shown that the 8k mode is operational up to 80 km/h, while 2k mode operates at a considerable higher speed, in principle it should be 4 times higher. The maximum speed would be limited by the Doppler effects on the orthogonality of the carriers and the phase noise in the system. However, new receiver technology will positively push the speed limits upwards.

The wireless camera will normally be using the 2 k mode, since the larger space between the carriers makes the mode more tolerant to phase noise in the up and down converter in the transmitter and receiver.

The protection by the Viterby/Trellis error correction is described by the Code rate with ½ representing the maximum protection and 7/8 the lowest. The DVB-T options are ½, 2/3, 3/4., 5/6 and 7/8.

Selection of code rate modulations characteristics and guard interval will depend of the application.

1. For stationary application, it is recommended to select 64 QAM, 2/3 code rate and 1/8 guard interval - this gives a max bit rate of 22.12 Mbit/s. The camera-operator can then set the MPEG encoding in the camera for minimum compression and benefit from the lower delay in the MPEG encoding and decoding.

2. For mobile application, where the camera is carried around to follow a moving event, it would be best to select 16QAM, code rate ½ and guard interval ¼. This equals a bit rate of 9.95 Mbit/sec.

3. For applications where the camera is used on a moving vehicle at some speed, the QPSK mode is the only option. With code rate ½ and guard interval ¼ the bit rate is 4.98 Mbit/sec. Although an acceptable bit rate for transmission of quality pictures, there would be, however, a delay caused by the MPEG processing of up to 2 secs.

TYPICAL EXAMLES

The transmitter module for the camera can be made very compact and at low weight. Fig.4 shows an example of the transmitter attached to the camera.
The receiver equipment will normally be installed in the OB van or in some building near the operational place of the camera crew.

Fig. 4 ENG Camera with the TX attached

The distance between the camera and the base station depends very much of the surroundings, Even if COFDM does not require line of sight buildings and trees will attenuate the RF signals. In the table below is shown some typical figures for the wireless camera used in an urban area.

Modulation	Code rate	Power	Typical range
QPSK	1/2	1 W	2 km
16 QAM	1/4	1 W	1 km
64 QAM	2/3	1 W	450 m

The antenna in the OB van was a omni-directional type (2dB gain). By using an antenna with a higher reception gain, the coverage of the wireless camera can easily be increased.

TYPICAL APPLICATIONS

One of the most common applications would be for events such as national parades, festivals and sport games like the Olympic game shown in fig. 5. The wireless camera allows the camera crew to move around and follow the event while still in contact with the studio via the OB van. Viewers will get to enjoy live coverage of the show just.

Another interesting application makes use of the COFDM systems capability to support mobile application. The wireless camera is used to transmit pictures from a helicopter to a base station. Such an application is not just useful in for an ENG service, but can be of interest in surveillance situation.

Fig, 5, Off air transmission from a sport game.

In a helicopter the range of the wireless system can easily be extended by adding an RF power amplifier to the transmitter set-up. By just a 10 W amplifier the range can easily come to 6 to 10 km.

Fig. 6, Wireless camera mounted at a helicopter

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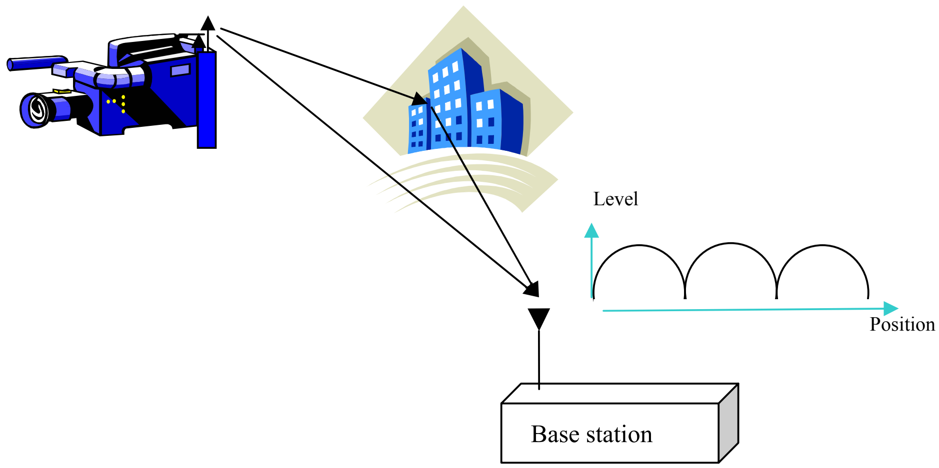

There are occasionally some problems in COFDM reception as illustrated above. It can occur in situations, where a signal and a reflected signal are close in level and time. The two signals might ‘add’ together, but they can also ‘subtract, and generate a local spot with very low signal strength..

The latest development in COFDM is receivers with a diversity function using a dual set of antennas and two COFDM demodulation chips. The two antennas are typically just spaced 1/2 λ from each other. By minimizing the out-phasing, these receivers add to the robustness of the COFDM system.

CONCLUSION

The robustness of COFDM brings a new level of technology into the wireless camera application. Electronic News Gathering will very likely benefit from a lively and more direct communication between the main studio and the camera crew. Other applications such as surveillance of certain areas for security or environment reasons would also likely benefit from the COFDM version of the wireless system.

REFERENCES

Ref.1: ETR 154, Digital broadcasting systems for television; Implementation guidelines for the use of MPEG-2 systems; Video and audio in satellite and cable broadcasting applications, 1997.
Ref. 2: ETS 300 744, Digital Video Broadcasting; Framing structure, channel coding and modulation for digital Terrestrial television.

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