

DIGITAL BROADCASTING and INTERACTIVE TELEVISION in DISTANCE EDUCATION: Digital And Interactive Television Infrastructure Proposal for Anadolu University Open Education Faculty

Assoc. Prof. Dr. Reha Recep ERGUL
Anadolu University
Faculty of Open Education
Eskisehir, TURKEY

ABSTRACT

Rapid changes and improvements in the communication and information technologies which emerged in the mid 20th Century and which are still being developed today require new methods, constructions, and arrangements in the production and distribution of information. We can easily say that Television has experienced the dexterity of presenting complex and difficult processes to comprehend concepts, subjects, and experimental studies to learners from different points of view. This is a result of 2D or 3D graphics and animations using audio visual stimulators and in doing so, it has replaced its technology from analog to digital leading to a digital-interactive.

As such, it has also begun to convert the broadcasting technology in Turkey by adopting this direction. In the light of this approach, we can argue that television broadcast the infrastructure of Anadolu University Open Education Faculty needs to be replaced with a digital and interactive one. This study contains basic concepts of digital and interactive broadcasting and the new improvements. Furthermore, it incorporates the approaches of the fundamental groundwork to introduce a digital television broadcasting infrastructure.

Keywords: Distance Education, Digital Broadcasting,
Digital and Interactive Television.

INTRODUCTION

Under the influence of insufficiencies and deficiencies in its social, political, and economical constructions, Turkey has to find radical solutions to its growing population, unemployment, the deterioration in income distribution, the degeneration of moral values, and its shortcomings in health care, human rights and most importantly its education system. Solutions can be found by people who are aware of alternative views to address these problems by referring to their field of studies. Other internal and external factors which are the concern of some people may also highlight these feelings. Indeed, a caring society composed of this type of individuals should be one of the main purposes of a healthy education system.

Rapid changes and improvements in the communication and information technologies came to light in the mid 20th Century and, are still evolving at the present time. As a result, new methods, new constructions or new arrangements in the production and distribution of information are highly desirable features. Television has become one of the main education tools of distance education system for Anadolu University Open Education Faculty which was first planned theoretically in 1970's and established fully in 1982.

The appeal of this mass-communication device suits the needs of the large number of registered students at this institution and its affordable feature has helped in the process. Distance education system has also been backed up by teleconferencing, computer aided or web based education, in line with the developments in printed materials, academic counseling, and technological developments.

Television has shown its dexterity of presenting complex and difficult process to comprehend concepts, subjects, and experimental studies to learners from different points of view. This is supported by photographs, 2 D or 3 D graphics and animations with audio visual stimulators. As a result TV technology has evolved from an analog to digital one, resulting into a digital-interactive medium. By embracing this application, Turkey has witnessed an advancement towards this direction. The Turkish private television company, Digiturk, has begun broadcasting digitally and it is now transmitting its broadcasts to receivers through satellites. During the "European Broadcasting Union (EBU) Technical Committee Annual Meeting" in 2004, the state television broadcast channel TRT announced that it would change its television broadcast system to digital within a transition period of 10 years (Tew, 2006). Since Anadolu University Open Education Faculty television programs are broadcast through TRT, educative television program production studios of Anadolu University are expected to develop their current technological infrastructure to be fully prepared for digital broadcasting.

Establishing the infrastructure required for digital television broadcasting in distance education is the first step. This would hopefully make interactive broadcast easier. For such an innovative infrastructure to be rewarding, preparations of the sole Anadolu University television program production center are not enough. That is to say that since this institution is not legally the main provider Anadolu University has to cooperate with broadcaster and service provider organizations and institutions like TRT and Turk Telekom.

WHY DIGITAL?

The first binary number which is the origin of modern digital systems and composed of "0"s and "1"s was devised by philosopher and mathematician Gottfried Wilhelm von Leibnitz on March 15, 1679 (Pohlmann, 1995:7). However, digital encoding language is based on the Morse code. Every letter and symbol in the Morse code has a code similar to the binary number system. Radio and television have developed through the years with similar technological infrastructures until 1990's when computer technology had reached an acceptable scale capable of processing audio and video. After, these technological developments began to plan a common language or system. The basis of digital systems is formed by data encoding systems which are based on "0's and 1's" pronoun as "bits" and used by computer technologies. These are accepted as the common language. In this way, television entered into the digital communication world.

When the initial low data processing rates and limited data storage capacities, not forgetting the huge size of data required for images are take into consideration, the difficulties of digital systems in providing necessary bandwidths for broadcast can be better understood. Naturally, improving data processing rates, the capacities of computers, plus software have accelerated the digital technologies appearance into every aspect of life as well as in broadcasting. When digital broadcasting technology is compared with analog technology, its advantages can be summarized as follows:

- Better quality audio and video broadcast
- More channels and higher capacity
- Capability to correct data errors which may happen during broadcast
- Decrease in generation loss due to data copying
- Compatible and cooperative with other transmitting environments like the Internet

- Easy access to audio and video data, editing and archiving
- Provision of mutual data transfer or briefly interactivity

The most important benefit of digital television broadcasting is in its power to steer away television from being a unidirectional passive watching device and lead it into the interactive communication world of bidirectional data transfers. Digital television broadcast, namely Digital Video Broadcasting (DVB) is seen as the future of broadcasting and its standards are determined as being statutory, and legal by International Telecommunication Union and European Broadcasting Union.

DIGITAL TELEVISION (DTV) or DIGITAL VIDEO BROADCASTING (DVB)

During the development process of mass-communication technologies beginning from 1990's up to now, there have been many changes. The Internet and mobile communications technologies have provided users with the interactive digital services. Television has followed this trend through a digitizing process. Digital television is a "hybrid" platform combining classical analog TV and Internet or similar platforms with data provided by multimedia services. Digital television is a revolutionary technology in broadcasting and can be considered as a gate way to an interactive media world.

The first technical stage of digital broadcasting is to convert video signal that changes between 25 and 30 frames per second according to broadcasting standards into digital signal encoded as 1 and 0 bits. In other words, images like the ones as shown in Figure 1, are divided into the smallest parts or points called "pixels". Color and brightness of each of these pixels are defined to achieve a digitizing process.

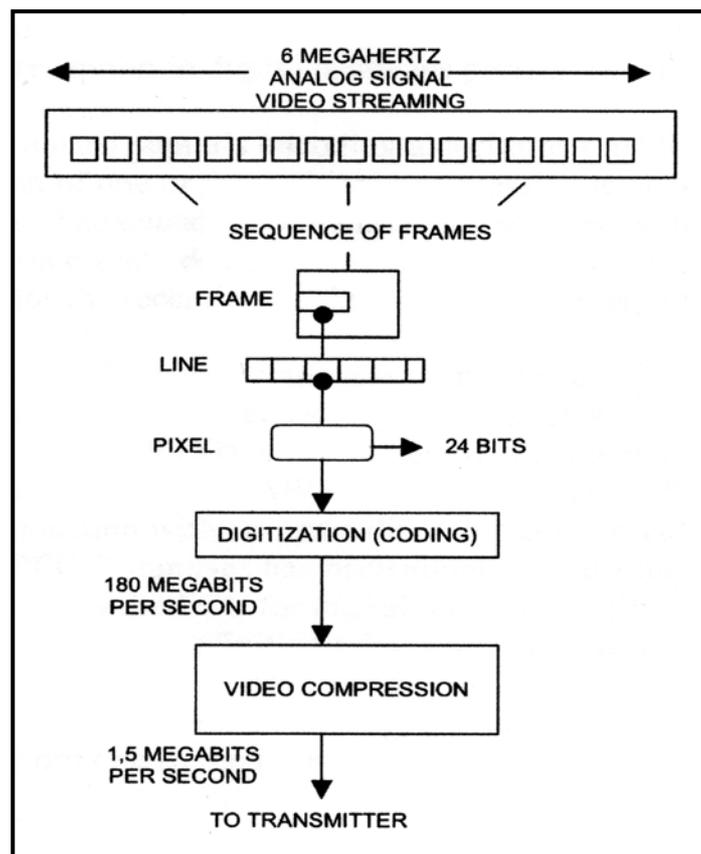


Figure: 1
Digital video compression (Pagani, 2003:55)

For example, in an image frame with broadcast quality, there are 720 points horizontally and 576 points vertically that total 414,720. If a broadcast quality of 25 frames per second is assumed, point number defined by 1 byte reaches to 10,368,000. In short, a digital video image of 1 second contains information of 10 million points (Durmaz, 1999:3). In order to broadcast digital audio and video carrying such a large amount of information, a very large bandwidth is required. This is a significant point for transmission lines with limited bandwidth. Therefore, in order to solve this problem, compression techniques are used.

DIGITAL COMPRESSION

Because of limited data storage and transmitting capacity in the main production and transmission processes like digital signal or processing, storing, archiving and broadcasting of data, digital compression methods are needed.

Large amounts of bandwidth may be required for example 64 Kbps for audio and 12 Mbps for video. Compressing of digitized signal allows transmitting more channels within narrower bandwidths. However, broadcasting compressed data and then restoring them to their original condition in receiver devices requires the above standard.

The basic technology for realizing digitalization in broadcast services is the MPEG-2 (Moving Picture Experts Group) standard. MPEG-2 defines the basic concepts for the provision of digital A/V services in all the digital television standardization efforts. MPEG-2 defines a signal compression, packetization and multiplexing standard for digital audio and video, as well as rudimentary mechanisms for conveying other data in a digital A/V stream. Transport stream (TS) and program stream (PS) definitions have a specific set of application areas. The most important application area of the TS is digital television. The basic packet-oriented multiplexing approach for video, audio and other data defined in MPEG-2 is illustrated in Figure 2. Digital video and audio data is encoded into compressed MPEG-2 video and audio elementary streams. These elementary streams are packetized to produce video and audio packetized elementary streams (PES) packets. Private data is fed directly to the PES packetizer. PES packet streams are multiplexed to single transport or program streams depending on the application. The program stream is designed for use in relatively error-free environments such as DVDs (Lugmayr & other, 2004.11).

MPEG-2 standard is used successfully at bit rates exceeding 1 Mbps but this would not suffice in the future. Although MPEG-4 format conceptually has common properties with MPEG-2, it has optimized video and audio compression algorithms. There is no incompatibility between MPEG-2 and MPEG-4: MPEG-2 decoders installed in receivers and PC's are also used decoding MPEG-4 streams.

The ability of MPEG-4 to dissect the image, or even synthesise a part of it electronically into different constituent planes, lies in its hard. It will allow non-real cartoon like images to be merged with normal real-world image, and at the decoder several planes can be combined, either under direct control of programme maker, or by the viewer, or both. The artistic potential for new kinds of programmes is immense. In order for the system to support the new complexities, one of the essential parts of MPEG-4 is a labelling scheme whereby the image planes and contents, especially the objects in each plane, can be identified to machine processes as well as by the viewers.

This implies some kind of description language and data formats that serve to define the image content. This so-called Metadata is what MPEG-7 emphasises with the intent of providing tools for the system and operators to describe the content and its properties (Drury, 2000.37).

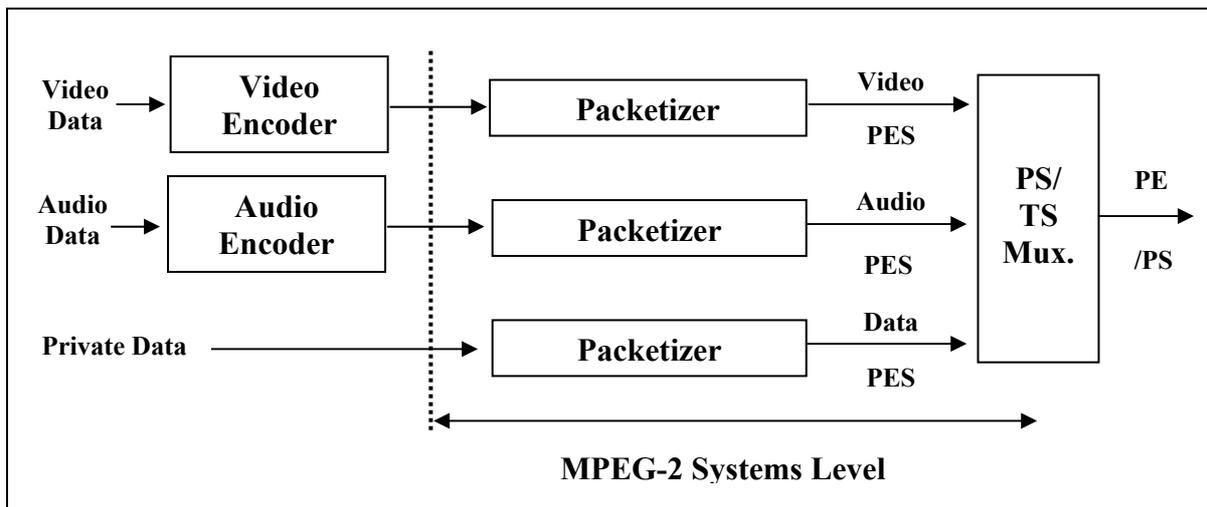


Figure: 2
MPEG-2 video, audio and data multiplex (Lugmayr & other, 2004:11).

MPEG-4 format allows possibilities for new applications and services on the Internet rather than digital television broadcasting. Applications with MPEG-21 format are rather new and works on compatibility with other formats are still in progress. Video, audio and other data digitalized during the first stage of digital television process are compressed and packetized with reduced bandwidth and then sent via transmission lines using one of the three methods: Terrestrial (DVB-T), Satellite (DVB-S), and Cable (DVB-C). In addition to these, digital television signal can be transmitted via other transmission media such as Multipoint Microwave Distribution System (MMDS) and Asymmetric Digital Subscriber Line (ADSL).

DIGITAL TRANSMISSION SYSTEMS

In DVB-T, DVB-S, DVB-C and other transmission systems data are transmitted in two ways. The first is via cable using traditional copper coaxial or optic fiber cables; and the second is wireless via airwaves or satellite. Data transmitting rates, capacities, coverage, service lives and costs are different from each other. Transmission systems can be used for transmitting digital television data together or separately. Digital transmission is the transmission of analog or digital data in the form of digital signals. Digital transmission speed is usually measured in bits per seconds or symbols per second, either one referred to as data rate. The data rate can be either in bits per seconds (bps) or in bauds (or simply baud rate). Baud rate is defined as the number of symbols per second. Data rate in bits per second is also called the bit rate (Ahmad, 2002: 65).

Table: 1
Digital television and transmission lines bit rates.

Digital TV	6-10 Mbps	5.1 Audio
Digital HDTV	40-60 Mbps	5.1 Audio uncompressed
ADSL (High speed modem)	1-2 Mbps	
Telephone modem	14-56 Kbps	
ISDN	64-128 Kbps	
Internet2 (US)	9.6 Gbps	

Bit rates of data to be transferred through digital transmission systems determine the capacity of a system. Examples of bit rates used in digital television or transmission lines are shown with Table: 1. DVB-T (Terrestrial) has 7-8 MHz bandwidth and uses MPEG-2 format. It enables broadcasting more channels via low powered terrestrial transmitters using VHF and UHF bands. DVB-S (Satellite) transmits data directly or indirectly through satellite using MPEG-2 compression format on 11-12 GHz Ku band. DVB-C (Cable) transmits a multitude of channels to viewers through satellite compatible cable and its most important feature is that it has interactive broadcasting infrastructure. Asymmetric Digital Subscriber Line (ADSL) technique is a readily available solution for the supply of interactive multimedia services because it makes use of the pre-existing telephone network.

This technology will be used in the medium term to extend the supply of multimedia services to those areas not yet included in the new broadband infrastructure still under construction. In some areas, where territorial morphology and population density make neither cabling nor the implementation of a radio system economically viable, ADSL becomes the first choice. It is difficult, however, for ADSL to be used on a vast scale because of its limited growth potential in performance terms and the high number of apparatus necessary for each user connected to the service. ADSL is a selective system: it allows for the use of one or two quality video programs at a time chosen from much broader bouquet, therefore limiting the possibility of contemporary use from two or more terminals connected to the same line (Pagani, 2003:79).

When assessed according to different configurations, capacities, data transmitting rates and costs, each digital system defines a convenient transmission line for itself. Depending on the data transmitting purpose of the digital system, they can be used together or separately. When Anadolu University Open Education and its considerable student population together with geographic conditions are taken into account, it would be very desirable that DVB-S and DVB-T transmission systems should be used together for digital and interactive television broadcasting. DVB-C and ADSL transmission systems are economical for densely populated areas like cities, but they are not suitable transmission systems for less populated areas like the countryside.

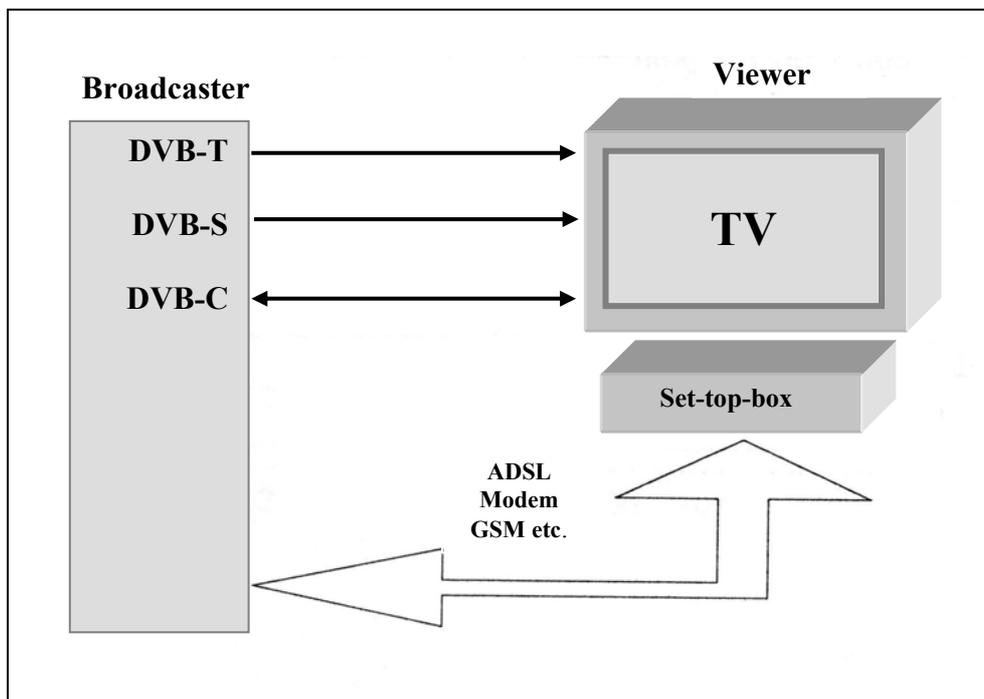


Figure 3
Internet protocol TV (IPTV) transmissions channels (Orava & Perttula, 2004: 7)

INTERACTIVE TELEVISION (ITV)

The term interactivity is usually taken to mean the chance for interactive communication among subjects. Technically, interactivity implies the presence of a return channel in communication system, going from the user to the source of information. The channel is a vehicle for the data bytes that represent the choices or reaction of the user. This definition classifies systems according to whether they are diffusive or interactive. Diffusive systems are those where only one channel runs from the information source to the user (referred to as downstream). Interactive systems have a return channel from the user to the information source (referred to as upstream).

There are two fundamental factors determining performance in terms of system interactivity. These are response time and return channel band (Pagani, 2003: 97). The greatest advantage of digital video broadcasting (DVB) is interactivity. The convergence of broadcasting and internet technology brought about two way communications. Interactivity can be provided by return channel and a passive user becomes an active user. Return channel (as a back channel) is a kind of feedback from viewer to broadcaster. In this way, digital television system becomes a powerful medium for communication (Kesim, 2005: 3). In the interactive television system shown in Figure 4, transport streams containing the video-audio content prepared by Anadolu University Open Education Faculty in standard MPEG-2 format are transmitted to service provider via satellite. Service provider transmits these data streams to students through terrestrial and cable lines. If the lecture is broadcasted live, students can transmit their responses to the studio via feedback channel through multimedia home platform (MHP), set-top box, and PC etc. Here, the central components are the DVB broadcasting service provider and the interactive service provider.

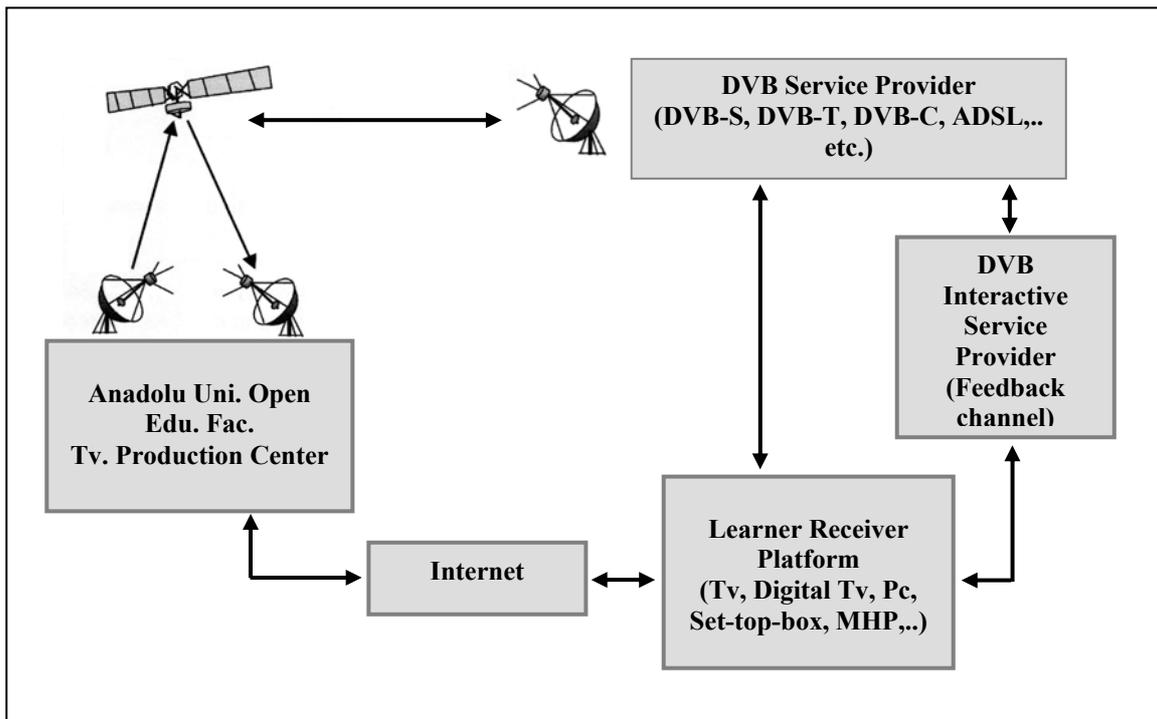


Figure 4
Interactive television (ITV) system architecture.

Digital video broadcasting is an extension of MPEG-2 based DVB transmission standards. This extension provides ways to transport data other than standard MPEG-2 A/V data in DVB broadcast systems. Examples of data broadcasting include the download of software or the delivery of Internet services over broadcast link.

The DVB feedback channel allows the upstream flow of data from the user to the interactive service provider. The network independent protocols accessible in the feedback channel are either IP-based, MPEG-2 DSM-CC based or service specific. Network independent protocols in a broadcast channel for interactive services rely on the DVB data broadcasting standards (Lugmayr & other, 2004:15). Bit rates of MPEG-2 format transmitted to students are between 4-9 Mbps.

This indicates that digital television can transmit better quality video, audio, and 2D or 3D graphics than the traditional television format. When bidirectional communication is also added to the above quality, it is seen that digital and interactive television is an important communication device that should be utilized in distance education system.

CONCLUSION

Television programs are defined as being one of the essential components of Anadolu University Open Education system (Bozkaya, 2006:146), and in order to enhance their viewability and student achievement an interactive structure is needed. Because of the great student number, television as a mass communication device plays an important role in this process. Therefore, the first and the easiest phase in establishing an interactive television system for distance education is migrating to digital television.

Digital television is not just compressed video-audio and optimized image quality. Distance education offers the opportunity for repeating television programs and receiving student feedback whenever and wherever needed. With the aid of increased audio visual quality, digital and interactive television can help presenting subjects intelligibly and more in detail by removing the restrictions of traditional television system that has a unidirectional communication.

In e-learning distance education system, television programs can be transmitted interactively via high-speed Internet and ADSL. If e-learning teaching materials consist of high resolution 2 and 3 dimensional graphics, pictures or video, using data communication on the Internet will not be adequate. Establishing an ADSL infrastructure in the countryside is also costly and difficult. It is getting harder for many users utilizing the Internet environment simultaneously for the purpose of learning because of the narrow bandwidth. For this reason, a convergence can be obtained between the two systems by using the digital video broadcast or digital transmission lines and high-speed Internet simultaneously. Compression methods, transmission systems and feedback channel play an important role within digital process. MPEG-2 format and its even more extended standards are applied by the interactive service providers successfully. However, the important issue here is that Anadolu University Open Education system has not the right to broadcast television programs legally. Hence, establishing a digital and interactive television infrastructure for distance education requires at first to establish a technical work group to liaise with the broadcasting organization TRT.

BIODATA AND CONTACT ADDRESSES OF AUTHOR



Dr. Reha Recep Ergül is an Assoc. Prof. in Anadolu University OEF-TV Production Center, Turkey. He received his PhD from Anadolu University Institute of Social Sciences Cinema and Television Department in 1994. He has been teaching digital and analog recording techniques of film and television sound in Anadolu University Communication Sciences Faculty since 1994. The author is currently a faculty member of Anadolu University OEF. His research fields are new communication technologies.

Assoc. Prof. Dr. Reha Recep ERGUL
Anadolu Üniversitesi, Açıköğretim Fakültesi
Yunussemre Kampusü, 26470, Eskişehir
Phone: +90 0222 335 05 80 (ext. 2437)
E-mail: rrergul@anadolu.edu.tr

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