MULTI-INFORMATION SYSTEM USING FIBER OPTICS

Hirokazu Yoshino, Tsutomu Asabe, Kiyoshi Kubo,
Kenzo Ohno and Tashuo Fujita

Matsushita Electric Industrial Co., Ltd.

I. Introduction

With the complication of the society and economy and with the higher standard of civilization, it is expected that necessary information should be provided to meet various requirements in many fields of individual life. It is desirable to develop new information systems such as two-way communication CATV system in order to meet such requirements. Several experimental two-way CATV systems are now developed in many countries.(1)

Progress in the field of optical fiber transmission has been accelerated since a low-loss fiber of 20 dB/Km was achieved in 1970.(2) Because of the notable advantages such as long distance transmission capability, enlargement of capacity, and construction flexibility etc., optical fiber transmission systems are expected to be applied in many fields. For a two-way CATV system application, the HI-OVIS system has been developed and experimented in Japan.(3)

The technology of two-way CATV system is classified into three major categories: various kinds of information filing, transmission of audio video, facsimile and data signals and information processing and control. For an optical transmission system, we have been developed optical transmitter, receiver and connector. Utilizing a new type of low reflection directional coupler, bidirectional video transmission through a single optical fiber has been experimented using same wavelength light sources at each end.(4) A still picture storage to use interactive information retreaval is one of fundamental file of system. For this purpose, a new optical video disk which is capable of instantaneous add-on recording and playback has been developed. Utilizing these newly-developed technologies, a new interactive information system using optical fiber has been experimented. This system is able to supply more advanced services, and has a more performance characteristics. In this paper, the configuration of the system is presented.

II. Discussion of Optical Fiber Information System

If an optical fiber cable is used as a transmission line, the structure of a signal distribution network becomes different from that of coaxial cable. Because of a linearity range of optical transmitter and receiver, it is difficult for a practical use to multiplex many video signals as in the coaxial cable by present technology. Therefore individual distribution line is necessary from signal source to terminal. A typical signal distribution network of optical fiber system consists of multiplexed trunk lines from center to demultiplexing points i.e. subcenters, and individual distribution lines from subcenter to terminals.

Generally, several signals are transmitted from center to terminals such as video signal with sound, data signal, facsimile signal and stereo sound. For transmission line, these signals are multiplexed as shown in Fig. 1. A frequency assignment should be selected so as to minimize the interference or beat of signals. Baseband TV signal transmission is used for simplicity of terminal equipment.

III. Feature of System

The optical fiber information system developed are composed of following technology, the computer control and communication, optical fiber transmission, storage of audio visual information, and home terminal. Several features of the system is as follows.

(1) Optical transmission: The development of directional coupler with low reflection accomplishes a bidirectional transmission through a single fiber. Using low loss connector and high efficiency optical transmitter and receiver, transmission of wide-band signal, for a long distance is made possible.

(2) Information processing: The distributed data processing network is accomplished by introducing a micro-computer at terminal and subcenter. Under the control of microprocessor, each center file is possible to operate as an individual subsystem.

(3) Information file: For still picture storage, large capacity and high access optical video disk is developed. Other equipment such as random access VCR and high S/N frame memory are also realized.

(4) Home terminal: Using a capacity sensitive touch keyboard, subscriber can request various information such as still picture, moving picture and facsimile. Combining terminal with equipment such as TV, FAX, FM, VTR and TV camera, home terminal can receive many services presented below.

Basic concept for program service development is as follows.

(1) New community development: Because of increasing complexity of social structure, the traditional local community has been destroyed. There are, however, still strong needs for the development of the new community. The system offers local community news by

video and hardcopy, mutual communication method by TV camera, microphone and facsimile.

(2) Information retreaval: Complexity of the society, progress of technology and cultual changes have caused individual to get his own subjective information more frequently. The system satisfies these needs instantaneously with audio-visual information and hardcopy.

(3) Home education: The system supports a various kinds of educational program in order for individual to catch up and well adapt ever-changing social environment.

The service of the system is shown in Table 1.

TABLE 1
Service of System

Service	Contents
Retransmission	Retransmission of broadcast channel
Local news	Local Origination Local Community news Living information
Video	Arranged video program (News, Sports, Show time)
Reservation	Rental video Reservation for cooking, shopping etc.
Education	Simple CAI problem and answer
Communication	Communication between terminals (camera, microphone, FAX)
Facsimile	Hardcopy (Memocopy) Document retreaval service
Home control	Control of home equipment
Home security	Fire sensor Burglar alarm

IV. System Configuration

The block diagram of the system is shown in Fig. 2. The system consists of center, subcenters, transmission lines and home terminals. Each terminal is connected to subcenter by single optical fiber.

In Fig. 2, request data from touch keyboard at a terminal is sent to subcenter controller. Collected data from terminals are transmitted to center communication controller. Processing the request data, center controller selects one of information files and send requested information to subcenter through frequency multiplexed trunk line. Each output signal of information files is multiplexed as shown in Fig. 1. At subcenter, trunk line signals are demultiplexed and enter each corresponding switcher. According to the control data from the center, switcher distributes trunk line signals to individual line. Still picture is stored in frame memory at subcenter, and the video signal is transmitted to terminal.

(1) Center: Center consists of system controller and information files. System controller is a minicomputer with disks and ICU (interface control unit). For an information file of still picture, optical video disk is developed. The disk is able to record 20,000 frame pictures and access randomly within a half mili-second. There are several ordinary video cassette players for use of video service and local origination In addition to these, random access VCR which is able to access any position of a cassette video tape is used for video retreaval and transmission reservation service. Audio and facsimile information is stored in a digital disk after being processed and compressed.

(2) Subcenter: Subcenter consists of frame memory, switcher and controller. Using a high S/N magnetic sheet frame memory, high quality still picture reception is accomplished. To make an effective use of frame memory, it is installed in subcenter instead of terminals. Data transmission between center-subcenter and subcenter-terminal each of 48 K bps and 9600 bps respectively, is controlled by subcenter microcomputer. Control of switchers for signal distribution and assignment of frame memory to terminals is also controlled by the subcenter processor. Outline of center and subcenter equipment is listed in Table 2.

TABLE 2
Outline of System

Item	Outline
System configuration	Center and Subcenters
Number of terminals	300 Terminals/Subcenter 20 Subcenters/Center
Data transmission	48 K bps (Center to Subcenter) 9600 bps (Subcenter to Terminal)
Network	Trunk line (to Subcenter) Distribution line (to terminal)
Optical Video Disk	Capacity 20,000 frames Access time 0.5 ms
Random Access VCR	Numb. of material 1 ∿ 30
Audio File	ADPCM, 3 ch TDM
Frame Memory	Magnetic Sheet, S/N 50 dB
System Controller	Minicomputer PFU-300 Microcomputer L-16A

(3) Optical transmission line: As mentioned in Chap III, bidirectional transmission through a single fiber is achieved by use of

directional coupler. Schematic configuration of the transmission system is shown in Fig.3. Characteristics of trunk and distribution line are listed in Table 3 and characteristics of optical elements are shown in Table 4.

TABLE 3
Characteristics of Optical Transmission Line

Transmission system	Characteristics	
Bidirectional transmission	Bidirectional transmission	Same wavelength and frequency
	Transmitter	LED
	Receiver	PIN
	Optical fiber	Step index
Long-distance transmission	Modulation	FM-IM
	Frequency	22MHz ± 6MHz
	Transmitter	LD
	Receiver	APD
	Optical fiber	Graded index
Wideband transmission	Modulation	Analog-IM (30.8MHz)
	Bandwidth	45MHz (-3 dB)
	Transmitter	LED
	Receiver	PIN
	Optical fiber	Step index

TABLE 4
Characteristics of Optical Component

Component	Loss	Reflection(%)
Connector	< 0.7	< 0.05
Directional Coupler	3.7	< 0.0025
Splice	0.1	< 0.02
PIN	—	< 0.02
LED	12	< 0.5

(4) Home terminal. Home terminal consists of keyboard, terminal controller, TV, FM, FAX receivers, VTR, camera and microphone. The picture is shown in Fig. 4. Touch key and display of entry data are controlled by 4 bit microcomputer. Terminal controller has also a processer and the terminal can be easily expanded to have a home computer capability. Connecting a video RAM to the terminal, BASIC program can be developed independently. Developed programs can be transferred to center digital files for individual person.

V. Conclusion

In this paper, visual information system which offers still picture, moving picture, stereo sound, hardcopy and TV or facsimile communication services has been presented. Utilizing advanced technique such as optical fiber transmission, large information files, communication and control, the system has achieved higher performance characteristics and higher grade of service than ever. This system has been experimented for verification of hardware and evaluation of services in our laboratory.

Acknowledgement

The authors wish to thank Dr. K. Iga, Dr. M. Fukai, Mr. K. Tatematsu, Mr. I. Senbokuya for their encouragements. Thanks are also due to Mr. T. Tsutsumi and Mr. T. Yoshida for their developments of relevant equipment.

References

(1) W. Kaiser, H. Marko, E. Wite, "Two-way Cable Television", Proceeding of Symposium, Springer-Verlag, April, 1977.

(2) F. P. Kapron, D. B. Keck and R. D. Mauer, "Radiation Losses in Glass Optical Waveguides", App. Phys. Lett., Vol. 17, pp. 423, Nov. 1970.

(3) M. Kawahata and K. Kohnushi, "Visual Information System - HI-OVIS -", J. of Ins. of TV Eng., Vol. 32, No. 4, 1978.

(4) T. Ichida et al., "Bidirectional Video Transmission System using a Single Optical Fiber", IOOC Tech. Digest.

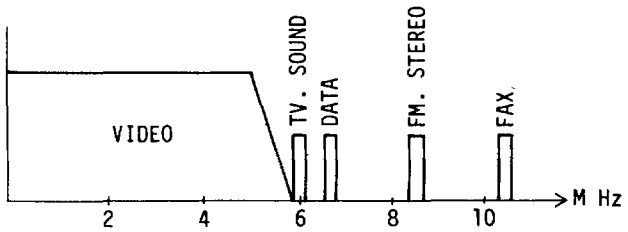

Fig.1. Frequency Allocation.

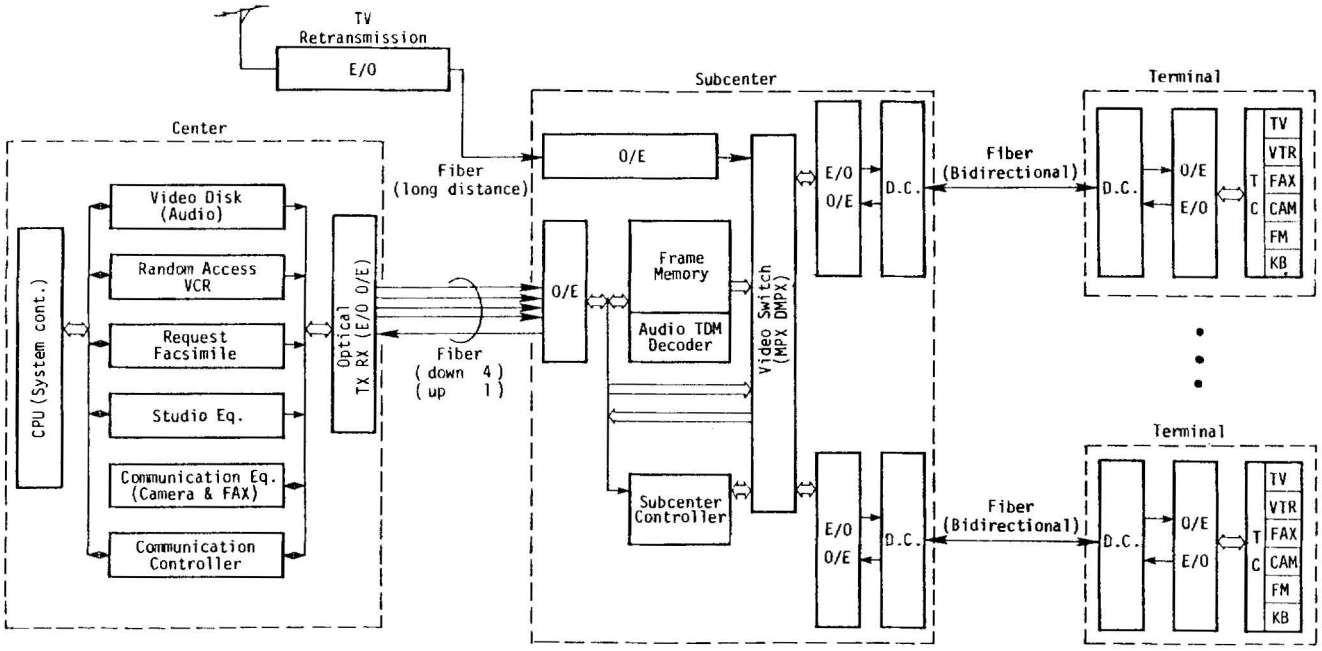

Fig.2. Block diagram of system.

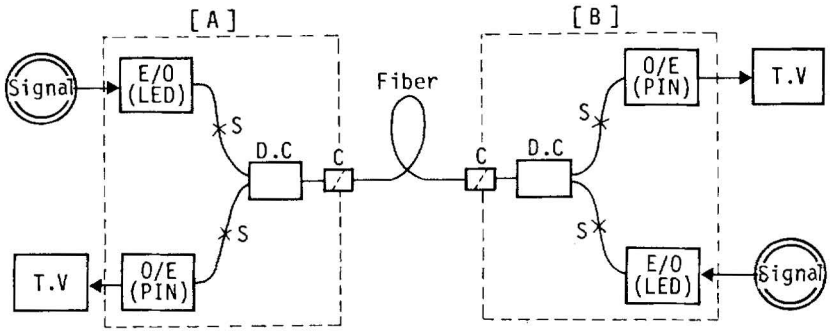

Fig.3. Block diagram of bidirectional transmission system.

Fig.4. Picture of terminal