Wireless LAN-Compatible Projectors

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Abstract

The introduction of wireless LAN environments has advanced rapidly in recent years. The effective rate of wireless LAN is about 4-6Mbps with the IEEE802.11b standard. However, NEC Viewtechnology has succeeded in implementing wireless LAN-compatible projectors that can be used conveniently in the limited bandwidth that is available. This has been achieved by developing a unique compression/decompression algorithm and by optimizing the PC screen in order to enable screen image capturing and data transmission systems. This paper introduces wireless LAN-compatible projectors and some of the innovative applications that are enabled by them.

1. Introduction

Wireless LAN technology as represented by technologies such as those related to the IEEE802.11b and IEEE802.11g standards has recently been disseminating rapidly. NEC Viewtechnology has also been developing wireless, LAN-based projectors that can be connected freely to multiple personal computers (PCs) without the need of complicated signal cable connections. However, the effective communication speed specified by the IEEE802.11b standard, which is the most used of the wireless LAN standards, is only between 4 and 6Mbps. This speed is too slow to achieve a display performance at the practical level when it is required to transmit non-deteriorated XGA images that are of the typical resolutions handled by projectors.

To solve this problem and enable high-speed wireless presentations, we have developed a unique compression/decompression algorithm that features a low load, high compression ratio and high image quality, and also optimizes the PC screen capturing capability and data transmission systems. The superiority of our unique compression/decompression algorithm and the features of the image transmission system are described below. In addition, we will also introduce the new presentations that are possible with wireless LAN-compatible projectors and the application software that provides a framework for "conference."

2. Compression/Decompression Algorithm

2.1 Issues Regarding PC Screen Compression/Decompression

The transmission via wireless LAN of high-resolution PC screen images requires compression of the image because an enormous amount of data is necessary to transmit the uncompressed images. Since the representative image resolution adopted by current projectors is XGA (1,024 × 768), it is necessary to compress the data quantity to about 1/10th that of the original image in order to obtain a practical image transmission speed in the communications of the IEEE802.11b standard bandwidth.

The currently most popular image compression encoding methods are JPEG and PNG. However, they are suitable only for transmission of either natural images or character images, and have difficulty with the efficient high-quality compression of PC screen images in which both natural images and character images are mixed.

For example, JPEG is suitable for the compression of photos and natural images and image quality deterioration is not so noticeable even when such images are compressed to about 1/10th. However, when JPEG is applied to an image containing steep edge components such as characters and graphs, the image obtained after the same degree of compression contains strong noise (**Fig. 1**). For PNG, it is capable of compressing character and graph images with high efficiency (to below
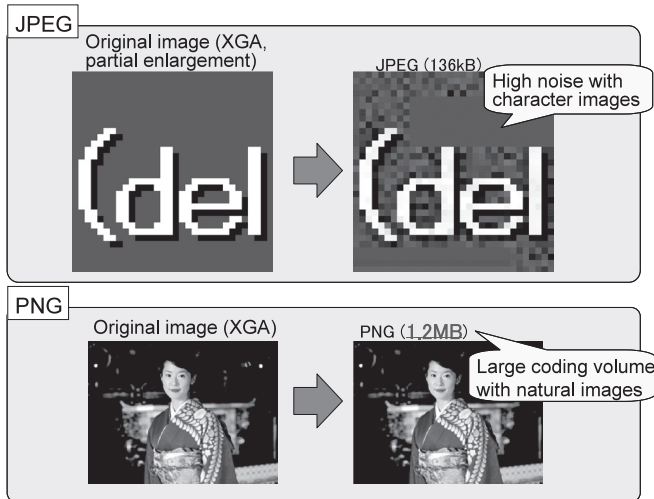
Fig. 1 Problems with previous compression/decompression algorithms.

Comparison of image quality (PSNR) at same data size (same compression rate)

Fig. 2 Comparison of compression/decompression rates.

Fig. 3 Improvement of character image quality.

1/20th in most cases) and without image quality deterioration, but its compression rate for photographs and natural images is poor (about a half in most cases).

JPEG2000 has been proposed as a next-generation image standard to succeed JPEG. It offers excellent performances in both image quality and compression rate, but it imposes very heavy processing loads and its costs are very high because it necessitates the development and incorporation of a dedicated LSI for use in real-time decoding.
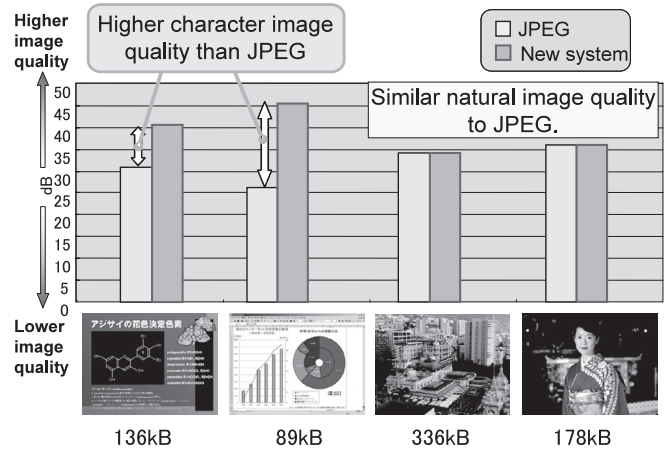
2.2 Features of the Developed System

To solve the above problems, we developed a unique image compression/decompression algorithm that can compress both natural images and character images with high efficiency and high image quality. This algorithm does not impose a heavy load on the computation processing and can decode images quickly using only the CPU incorporated in the projector (without a dedicated LSI). We designed this algorithm aiming at a significant improvement in the processing speed while maintaining the image quality by compromising with an increase of a limited amount of the code volume (a compression rate of about 1/10th can thus be achieved).

The developed system has the following features.

(1) Improved Character and Graph Image Quality
The newly developed uniquely irreversible compression technique does not deteriorate the quality of characters and graph images and provides an even higher image quality than JPEG (the PSNR value is higher by +10 to 20dB at the same

compression rate) (**Fig. 2**, Left). In particular, a great reduction effect is achieved for the noise that accompanies each character (**Fig. 3**).

(2) Maintained Photo and Natural Image Quality
The algorithm is also optimized to maintain image quality of natural images at a practical level, achieving similar image quality and compression rate to JPEG (Fig. 2, Right).

(3) High-Compression/Decompression Speeds
A unique speed increase technique has been developed to improve the compression speed by 2.7 times and the decompression speed by 2.9 times compared to JPEG (**Fig. 4**, Results obtained in a compression/decompression experiment of 20 typical electronic presentation material images).

3. Image Transmission System

The image transmission speed is increased thanks to the optimization of the PC screen capturing and image communicating systems as well as to the reduction of the data amount us-
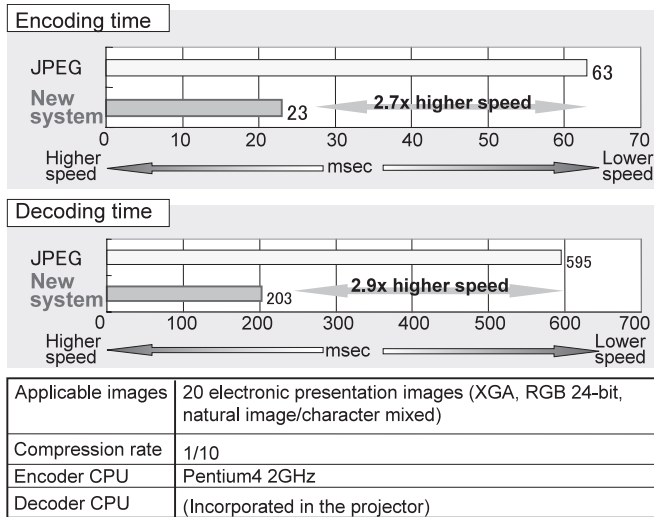
Fig. 4 Comparison of processing speed.

ing the image compression/decompression algorithm described above.

3.1 PC Screen Capturing and Image Communication Systems

Fig. 5 shows the configuration of our image transmission system when it is incorporated with a Windows XP or Windows 2000 system. To enable reception of screen drawing commands issued by the application software, a mirror display driver is included in the same level as the display driver that drives the primary image display. The mirror display driver acquires the image drawing area information from the screen drawing command that it receives from the system and identifies the area in which the screen image has changed. Although the application software draws the screen images one after another in real time, all of the data variations caused by the screen drawing cannot be transmitted because the network bandwidth of the wireless LAN assumed by the image transmission system is as low as 4 to 6Mbps. Consequently, the mirror display driver limits the area with image changes in order to minimize the size of the original image that it passes over to the image compression module.

The image compression module executes or stops the image compression based on the flow control information from the communication module, so that the amount of image compression data does not exceed a level that cannot be transmitted to the network. If the resolution of the PC screen image is larger than the display resolution of the projector, the system reduces
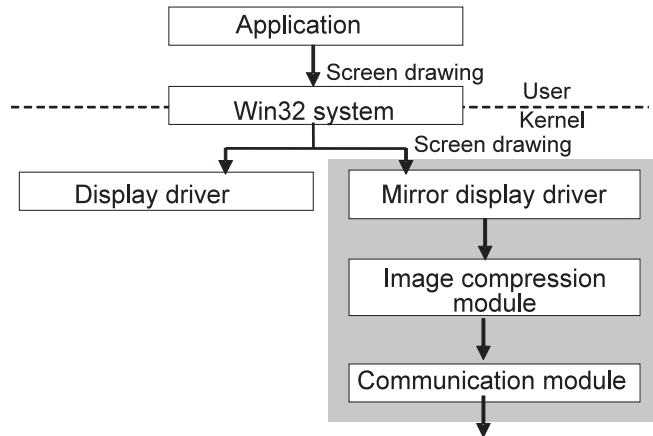

Fig. 5 Configuration of the image transmission system.

the image to the maximum resolution that can be handled by the projector before compressing it.

This system executes the series of image transmissions from the PC screen by capturing them to perform image compression and the data transmission is run on the kernel layer of the Windows OS as described above and image transmissions at a higher speed than hitherto may thus be provided.

3.2 Image Transmission Rate and Transmission Delay Time

Fig. 6 shows the transmission time when the sample images (with XGA resolution) used in the previous section to describe the compression/decompression algorithm are displayed on a PC screen and transmitted to the projector in 1-to-1 transmission in the IEEE802.11b AdHoc mode. The PC screen image is compressed to about 100 to 400kB per image before being transmitted.

Screens 1 and 2 are the samples assuming typical materials used in projector presentations. The present image transmission system can transmit these types of materials in less than 0.5 second. Even when the transmitted image is a natural image as shown in Screen 3, in which the image compression size is relatively high, the system can transmit such an image in about 1 second.

This image transmission system is subjected to transmission control, which inhibits the simultaneous transmission of the data of more than one image in the network path between the PC and projector in order to minimize the image transmission delay time (the period from the display of the desired image on the PC screen until the same image is displayed by the projector). This makes it possible to limit the image transmission de-
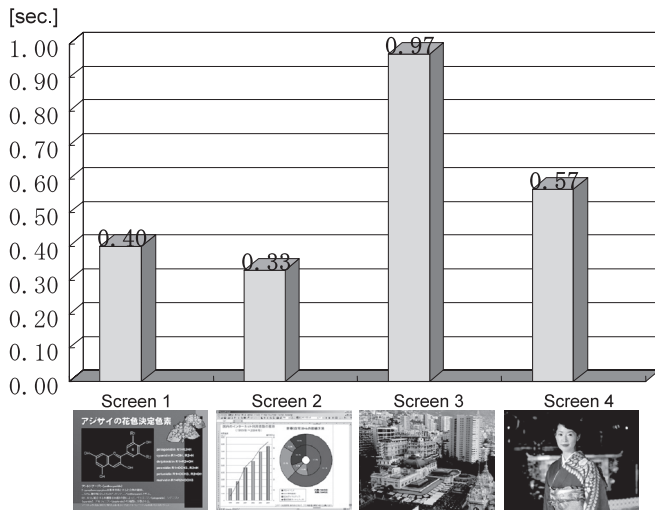
Fig. 6 Screen transmission speeds with IEEE802.11b AdHoc.

Fig. 7 Conference using wireless projectors.

lay to less than about 1 second.

4. Wireless Projectors

Our wireless projector products are provided with the Image Express Utility 2 (IEU) application software, which employs the transmission system described above to support trouble free meetings and paperless "conference." These projectors are compatible with both the AdHoc and Infrastructure wireless LAN modes.

4.1 Paperless "Conference"

When used with wireless LAN, the IEU eliminates the need for a troublesome video cable connection between the PC and projector and makes possible the installation of projectors in remote locations or on a ceiling where it is difficult to distribute video cables, provided of course that these positions are accessible by the radio waves. As the IEU also supports image transmission to a projector installed in a different network segment, it can also transmit images to be projected at remote locations.

The IEU introduces the notion of "conference" in the management of multiple terminals in the network. When the IEU is launched on the PCs of the participants while the presenter's PC is transmitting an image to the projector, the presenter's PC appears as though a "conference" is being held between the participant PCs, which may receive the same images as those transmitted to the projector. **Fig. 7** shows an example in which
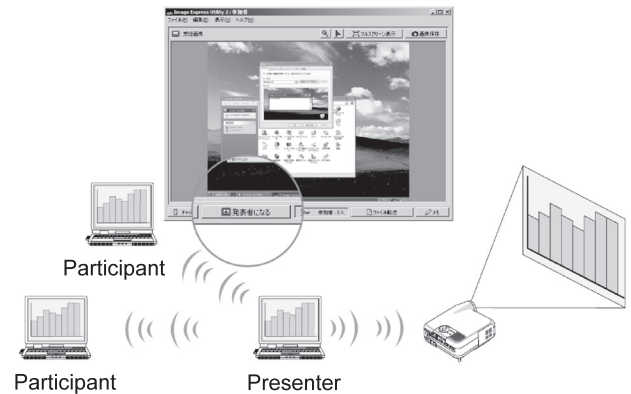
a single PC is transmitting an image to one projector and three other PCs.

Every image received by the participants' PCs can be saved as an HTML file together with an additional memo. When one of the participants' PCs sets a specified folder as a public folder, other PCs participating in the "conference" can freely download the file in the public folder, thereby making it easy to distribute materials between participants. These functions enable effective "conference" without using paper materials.

The IEU allows the presenter to be switched by a simple click of a button displayed on the screen. This procedure eliminates the need for a troublesome reconnection of cables and makes it possible to set a PC in a remote location as the presenter.

In addition, the IEU also has a mode that simulates a school lesson, in which the teacher can name the student who makes a representation. The teacher's PC can check the screens of the students' PCs so that it becomes possible for example to advance the lesson while checking if each student is ready to perform a presentation.

4.2 Simplified Operation

Network setup procedures involve many setup items. This constraint is particularly prominent with a wireless LAN network, where a complicated and often troublesome setup procedure is required, even for simply enabling communications between equipment components. The IEU functions as an automatic networking setup between the projector and PC, thus eliminating the need for a user to set up the network.

The IEU also incorporates a function for saving the network connection status in a file during "conference." When it is required to resume a "conference" in the same environment as

before, the second or later "conference" can be begun by simply opening the setup file saved in the previous "conference." When the setup file is opened, it automatically executes the following procedures; it detects the location of the projector(s) used in the previous "conference" in the network, switches on the projector(s), carries out the series of necessary connection procedures and transmits images.

5. Conclusion

We developed a unique image compression/transmission technology aiming at practical PC screen transfer via wireless LAN, and commercialized wireless projector products that are capable of natural PC presentations involving still and simple animation images.

In the future, we will advance our R&D program, aiming at improving the ease of use of the projectors and at enabling real moving image presentations using wireless LAN.

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