Data Transfer Technology to Enable Communication between Displays and Smart Devices

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Recently, the chance to see videos in various places has increased due to the speed-up of networks and spread of digital signage. However, most of the videos are non-interactively broadcast at viewers, and currently viewers often input keywords related to the videos in a search site after they see the videos when they want to find out some information related to the videos. So that viewers can easily obtain information related to videos, Fujitsu Laboratories Ltd. has developed new data transfer technology that enables communication between videos and smart devices by embedding communication information into the videos invisibly and extracting it using the camera application of smart devices. Viewers are able to acquire information related to videos easily just by capturing them. In this paper, we introduce an outline and the usage scenarios of this data transfer technology via video data.

1. Introduction

Recently, the chance to see videos in various places has increased for reasons including the speed-up of networks and spread of digital signage. However, most of the videos are non-interactively broadcast at viewers and currently viewers often input keywords related to the videos in a search site after they see the videos to find out some information related to the videos.

Meanwhile, many people carry smart devices such as smartphones on a daily basis and are in an environment in which they can use information anytime and anywhere by collecting information on the smart devices.

Accordingly, Fujitsu Laboratories has developed technology to transfer data via video as a new communication technology for linking videos shown on various displays including home TVs and digital signage in the streets with smart devices. By making use of this technology, if viewers use smart devices to capture commercials for their desired products or interesting services shown on TV or in digital signage, they can then obtain coupons related to the commercials on the smart devices based on the information embedded in the videos, and present the coupons at stores to enjoy discounts and other services. Other specific examples include: when a desired product is shown on a shopping show, capturing the screen with a smart device allows the viewer to directly access the Website for purchasing the product; capturing the screen while a video of overseas tourist spots is shown delivers tour reservation-related information; and capturing a guide map of a store in the surrounding area delivers store information.

Furthermore, application of the developed technology allows linking between PCs and smart devices. For example, when a file of presentation materials displayed on a PC screen needs to be copied to a smart device, simply capturing the PC screen with the camera application of the smart device copies the file to the smart device. Conversely, to send photo and video files stored on a smart device, the files can be copied to the PC just by capturing the destination PC screen with the camera application of the smart device.

This paper first describes the technology to transfer data via video and goes on to present two application examples, followed by future developments.

2. Issues with existing technologies

In order to apply communication between video

data and smart devices to TV or digital signage or to link video data with PCs, requirements including the following must be satisfied.

1) Only a minor adverse effect on video image quality
2) Usability with existing TVs, PCs and smart devices
3) Reception of information from distant locations
4) Easy configuration and operation to allow use by anybody

1) is a natural requirement in order to prevent any adverse effect on the original purpose of viewing videos and PC screens. Meeting the requirement of 2) makes the services available to more users by not being device-dependent. For the distance in 3), on the assumption that a smart device is used to receive information while a TV is being watched at home, the distance between the viewer and the TV screen can be estimated to be about three times the height of the TV screen, which is said to be the optimal viewing distance for watching a TV. With TV screen sizes of 40 and 60 inches, for example, it would be convenient to be able to receive information from about 1.5 m and 2.2 m respectively. For 4), connection via a USB cable or Wi-Fi is possible for communication between a TV or PC and a smart device. However, configuration for the connection is complicated, and this may be a reason why people would not use the services. Accordingly, configuration and operation must be made as simple as possible to allow the technology to be used by anybody.

Attempts have already been made for linking displays such as TVs and PCs with smart devices. With the requirements mentioned above taken into consideration, the following lists issues with application of each of the four existing technologies.

1) Visible light communication

This is a technology for transmitting 0 or 1 information by flashing lights. It is capable of transmitting information as far as the light reaches and is characterized by a long communication distance of tens of meters. Because the backlight of a display is used for flashing, the light is flashed at a rate of a few kHz to a few MHz so that the flashing is unrecognizable to the human eye. Special devices are required for generating high-speed flashing and reading the flashes.

2) Wireless LAN

Information can be delivered from TVs or digital signage terminals to smart devices via wireless LAN. Setting up an authentication configuration for connecting between terminals that display videos and smart devices is complicated and use of this technology necessitates a certain level of expertise, which poses a problem.

3) QR code

A QR code can be shown in a certain area of the screen to be read with a smart device for transmitting and receiving information. The screen needs to display the QR code in an area that is separate from the area for the video and the code cannot be read without bringing the camera close to the screen.

4) Image recognition

One technique is to use the camera application of a smart device for capturing the PC screen and apply image recognition technology to detect the displayed file.[1)] However, this method requires communication between the PC and the smart device to be established in advance in some way. For that reason, this method cannot be used for delivering information to an unspecified and large number of people.

3. Outline of developed technology

The present technology developed is a type of digital watermarking that is embedded in video signals that change over time. As shown in **Figure 1**, areas with a changing color are embedded in a video, and the number of such areas is increased or decreased to gradually change the overall color of the screen. The wave generated by this change is used as a carrier wave for transmitting information. The color change of

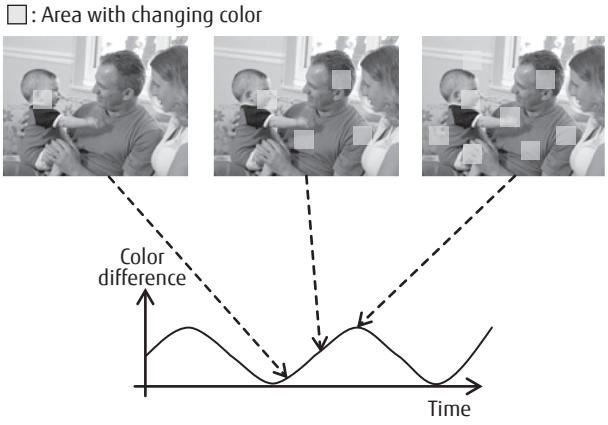

Figure 1
Principle of embedding signals in video.

the respective areas is not large enough for the human eye to recognize, but the accumulated change in a number of these areas leads to an overall color change of an entire screen. However, any rapid color change is suppressed by having a gradual change over time and the change cannot be perceived by the human eye. The reason for this is that humans are sensitive to rapid changes in videos but insensitive to gradual changes. The color change is used to generate a wave, which is modulated according to the information to be transmitted. Two types of wave pattern are defined in advance: One is a wave representing "0" and the other "1." To send binary data of "0110," the technology switches between the two types of wave as they are generated, as shown in **Figure 2**. The smart device extracts the color change of the entire screen from the captured video and judges the order of the two types of wave transmitted, thereby reading the information. The developed technology allows 16-bit information to be embedded in a one-second scene. However, when 16-bit information is transmitted from a display to a smart device, information loss is often generated due to the effect of ambient lighting or camera shaking at the time of capturing the screen. To deal with this problem, the same 16-bit information is embedded iteratively and any loss generated is compensated for by using the information before and after the loss to restore the lost information. This requires a capturing time of 2 to 3 seconds for actual reception with a smart device.

One of the four requirements listed in the previous section is to have a long capturing distance. The color change of an entire screen caused by the developed technology is unlikely to be recognized by humans, which allows the amplitude of the embedded wave to be large. As a result, information can be received from a distant location. An evaluation using a 40-inch display has shown that information can be received from a distance of 3 m. In addition, using a digital zoom feature of the smart device in combination has made it possible to receive data from a fairly distant location of 5 to 6 m.

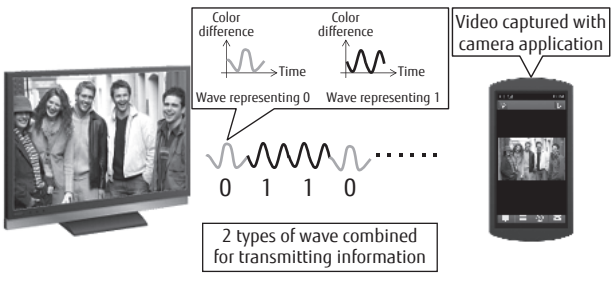

Figure 2
Scheme to send information from display to smart device.

The developed technology uses signals that can be received by camera applications installed in commercially available smart devices for embedding information in videos and no dedicated device for reception is necessary. The signals are pre-embedded in video materials themselves before the videos are broadcast or distributed by general systems, which means that existing display devices such as TVs and digital signage terminals can be used.

In addition, by superimposing on a PC screen the IP address or service set identifier (SSID) of a PC, or an ID as a result of its abbreviation as communication information followed by detecting the communication information with a smart device, the smart device can use the communication information detected to access the PC on the network and establish communication with the PC. This eliminates the need for complicated operation such as inputting information required for wireless connection.

Based on the above, the present technology can be regarded as one that satisfies all of the four requirements mentioned earlier.

4. Application to advertising business

As an application of the developed technology, **Figure 3** shows a model linked with video commercials on TV or digital signage.[2)] Fujitsu provides the advertisers and advertising companies of the commercials with the platform, service, software development kit (SDK) and other software. The advertisers and advertising companies embed IDs of 16 to 32 bits in the commercial materials to identify the commercials and the commercials are broadcast by broadcasting companies or delivery service providers to home TVs and digital signage. Viewers, meanwhile, download the dedicated camera application from a Website to their smart devices and, by using the application to capture commercials of interest, detect the IDs embedded in the commercials. Information relevant to the respective commercial is displayed on smart devices according to the ID detected, where the ID and relevant information

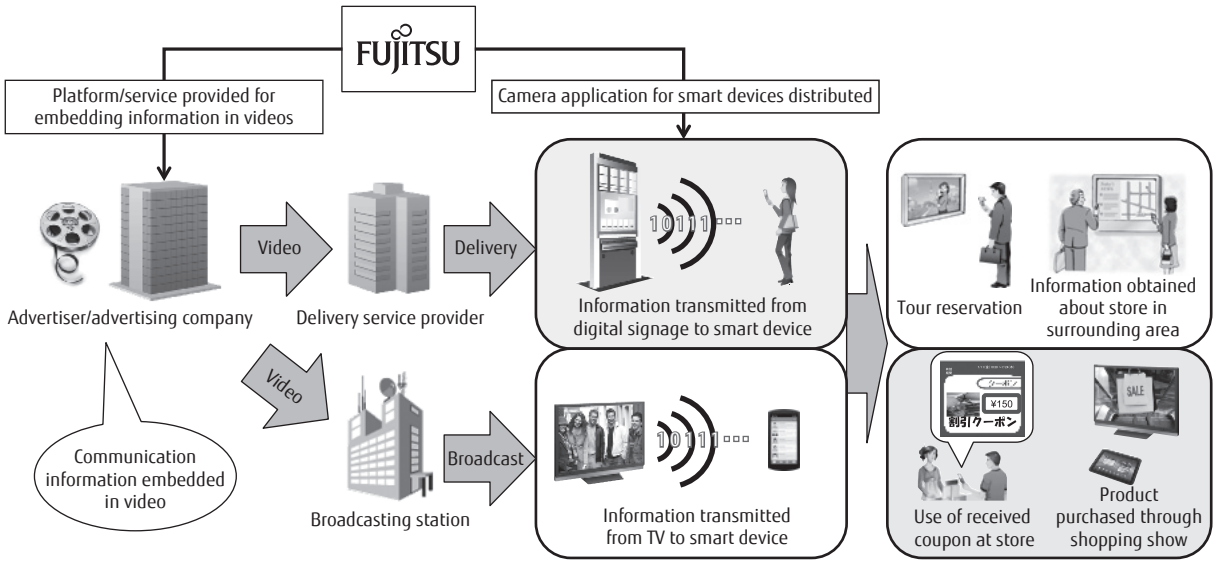

Figure 3
New service making use of developed technology.

are preregistered with a server and the smart devices use the ID as a trigger to download the relevant information from the server. This scheme makes it possible to guide viewers to various services.[3)]

5. Application to linking between PCs and smart devices

This section describes another application: linking between PCs and smart devices.[4)] In the background is the fact that functional enhancement of mobile phones and dissemination of tablets have made it possible to use smart devices for file viewing and editing, which conventionally required PCs, and that in turn has increased the need for transferring files between PCs and smart devices. For example, it is increasingly common for people to copy files that have been created with PCs to smart devices for viewing and editing or, to copy photos and videos that have been captured with smart devices to PCs for viewing. However, linking between PCs and smart devices is still too difficult for general users for reasons such as the need for a complicated configuration, and realization of simpler file transfer between PCs and smart devices is called for.

In order to resolve this issue, we have made use of communication via video data and developed a system in which simply holding up a smart device camera on a PC screen allows the PC being captured to be identified and a file displayed on the PC screen to be automatically transferred to the smart device. The developed system is mainly composed of two technologies:

1) Technology for real-time superimposition of communication information on a PC screen
2) Technology for monitoring a PC screen to transfer a file in response to a request from a smart device

For 1), communication via video data is used to convert communication information such as an IP address and SSID into a signal not visible to the human eye and superimpose it on the PC desktop screen in real time by means of image processing, as shown in **Figure 4**. The superimposed communication information can be detected by capturing the PC screen with the dedicated camera application of the smart device, and the communication information is used to request a file to be sent from the smart device to the PC. To describe 2), files displayed on the PC screen are monitored at all times and the file shown in the foreground when a request for a file arrives at the PC from a smart device is transferred to the smart device.

In addition, use of the communication information detected by the dedicated camera application allows files such as photos and videos stored in the smart device to be copied to the PC.

By making use of the developed system, files can be easily transferred between a PC and a smart device

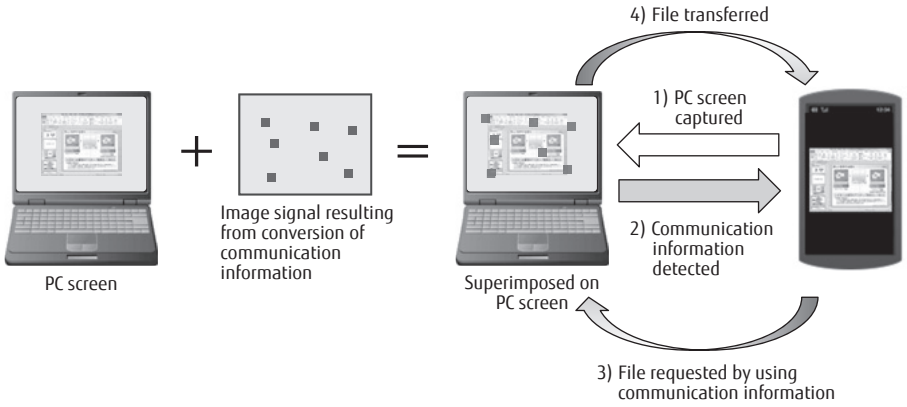

Figure 4
File transfer system.

simply by holding up the smart device camera on the PC screen, and this allows this technology to be applied to various services.

Possible examples include:

- Presentation materials displayed on screens at seminars, conferences and school classes can be made downloadable by the attendees
- Product fliers and catalogs can be made distributable at shows and storefronts

6. Conclusion

This paper has described new technology to enable communication between displays and smart devices that is proposed by Fujitsu Laboratories and its application examples. For the developed technology, we intend to conduct field tests for practical application and plan to invite customers to experience this technology at events and seminars. In addition, we will continue to work on enhancing the core technology so as to make it more convenient. Under the existing conditions, the amount of information that can be sent/received in a capturing time of 2 to 3 seconds, which does not cause stress to users, is 16 bits. We are considering increasing the number of assignable IDs by increasing the amount of information embedded per unit time. Furthermore, we are studying applications such as embedding information in videos on digital signage terminals installed in the streets.

Fujitsu Laboratories has already developed technology to link between analog media including printed matter and ICT[5),6)] and is committed to developing technology that guides every possible thing in the real world to services on a network to allow customers to develop new services.

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