TAP: Touch-And-Play

Duck Gun Park, Jin Kyung Kim, Jin Bong Sung,
Jung Hwan Hwang, Chang Hee Hyung, Sung Weon Kang

Basics Research Laboratory, Electronics and Telecommunications Research Institute
161 Gajeong Dong, Yuseong Gu, Daejeon, Korea
{duck, curl, courtney, jhhwang, hyoung, swkang}@etri.re.kr
+82-42-860-6053

ABSTRACT

An intuitive context aware service between two devices is possible using touch with the intrabody communication. Using this technology, users with multimedia devices may simply touch them to establish network connection, transfer data, and provide the required service; hence the name Touch-And-Play (TAP). Using TAP, users can disclose their context by touching the specific device. For instance, a user carrying a digital camera touches the TV to begin a slide show or a printer to print a photo. TAP is expected to enable the provision of intuitive, context-aware service. This paper discusses the feasibility of TAP and its application in user interface.

Author Keywords

intrabody communication, tap, touch-and-play, context aware service

ACM Classification Keywords

H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces - Interaction styles.

INTRODUCTION

With mobile devices such as PDAs and digital cameras becoming necessities in our lives, consumers need to connect their mobile devices with each other and with various peripherals. Since these devices are mobile products, however, conventional wired methods such as USB OTG inconvenience the users since they must carry connection cables together with their devices. Furthermore, physically connecting and disconnecting two devices require user intervention, not to mention time and effort. This proves to be cumbersome if the task occurs frequently.

To overcome such disadvantages of wired methods, researchers have come up with wireless methods for device connection. While wireless communication method eliminates many of the inconvenient feature of the wired communication method, the use of the wireless communication still requires user interventions to set up and manage network. For example, in case of Bluetooth, a user who wants his/her picture on PDA to be printed has to scan the network, select a printer while navigating through the available devices in the network, connect to the device, select the picture to be printed, select the print menu, and disconnect the network. And the mobile device usually have less means for this kind of input compared to the conventional personal computer, which makes this task more difficult. Although performing these actions takes only a few clicks of the buttons in the device menu, and user preference settings can do away with some of them, learning the device manual still requires the users time and effort.

The user interventions required for these actions convey the information regarding what the user wants, namely context information. In the previous example of printing a photo in PDA, the following context information was required:

- Identity of the user, i.e., authorization of the user to use the printer

- Selection of devices, e.g., printer and PDA

- Selection of the service, i.e., printing

- Data of interest, i.e., specific photo file to be printed

These kinds of information make up the *context*. Anind K. Dey defined *context* as any information that can be used to characterize the circumstances of an entity, which can be a person, a place, or an object that is considered relevant to the interaction between a user and an application including the user himself/herself and the applications themselves [1]. A context-aware system uses the context to provide the relevant information and/or services to the user, whereas relevance depends on the users task. One of the holy grails of context-aware computing is to have the applications do the right thing at the right time for users without their direct manipulation.

Realizing such autonomous, context-aware application requires a method of extracting the context without the manual input of the user. Various works to extract more contexts from the touch action have been performed. What a person touches and when he or she does so can supply useful information for desktop environments [2]. The touch action can also be used to pick and drop data physically from one place to another [3]. Synchronous touch action between two devices has been used to connect two devices wirelessly [4].

These studies have used information on touch itself based on touch sensors. Still, Zimmerman proposed the use of the human body as a transmission medium [5]. This technology enables the data communication through human body. For example, the users can share their business card by simply handshaking. Later, many studies have been conducted to enhance its features such as data rate; ditto for a study to understand its characteristics under various environments [6] [7]. Using this communication method, a simple touch action can have more information. Rekimoto et al studied the use of a wearable key to personalize the environment object [8].

However they usually have focus on the sending the data over the human body but they dont have focus on how the intrabody communication can be used and what will be the merit over the wireless network like bluetooth, Zigbee, UWB. Recently M. Shinagawa et. al [9] succeeded sending data at 10 Mbps rates. But they showed sending multimedia data from the floor to the handheld device. Though it was novel, they couldnt provide the justification over the previous wireless network technology which has 54Mbps data rates and promises more. But intrabody communication has a potential and that its UI applications have not been explored deeply.

In this paper we tried to explore the application of the intrabody communication. intrabody communication has good points and bad points. One of the major bad points is that it has to touch which require the physical movement of user while with the wireless technology, the user can do with a few button click. However our idea is that this disadvantage can be another advantage. As there will be a lot of devices waiting to serve in the same space, the wireless technology cannot provide the specific context the user is, while the touch action can provide the required context to offer services.

This paper presupposes that the touch, a simple and intuitive action, can be enough for a user to convey the necessary context between intelligent appliances. Using intrabody communication, network connection, data transfer, and selection of appropriate service can be realized. For example, a user reviewing pictures from his/her digital camera may simply touch a printer to establish network communication between the printer and his/her digital camera automatically upon seeing a picture that he/she liked. Likewise, based on the context that the user was looking at a particular picture when he/she touched the printer, the photo file in question is transferred to the printer using intrabody communication for printing. The same thing can happen when the user with a digital camera touches a high-definition television set to start a slide show. This technology was named Touch-And-Play or TAP for short. In this paper, the technical feasibility to enable these kinds of service and its application in user interface design are discussed.

IMPLEMENTATION

Physical Signaling

TAP can be implemented using the intrabody communication. The intrabody communication as originally proposed by Zimmerman used on-off keying (OOK), operating at 330 kHz with 2400 bps data rates [5]. Since then, various hard-

Figure 1. Using TAP, which enables the user to print the desired photo in the camera by touching the printer while holding the digital camera

ware devices have been developed using intrabody signaling [6] [9]. We used the direct digital intrabody communication module developed by our colleagues. The module transmits and receives 1 Mbps signal using non-return to zero(NRZ) signal format. The broadband signaling of intrabody communication has one channel of communication. So half duplex communication using the master/slave structure was used in TAP.

Network Management

The network connection for TAP tends to be frequently made. The duration is also relatively short. Furthermore, the network member tends to change constantly. Thus, ad-hoc networking is required. The transceiver of the TAP that does not engage in network connection sends configuration packet twice every seconds. The configuration packet is sent randomly so that the possible collision should be avoided in successive trials. This packet includes the function ID of the device. Once the configuration packet is received, the receiver sends its own configuration packet and searches the context-aware matrix of the devices. The context-aware matrix determines which will be the Master. Table 1 shows the context-aware matrix. The next transmission is initiated by the master device.

Context-aware Service

Once the network connection is established, the Master requests for the function ID of the Slave. The function ID refers to the function of the intelligent device. Once it receives the function ID of the Slave, the master searches the context-aware matrix. If the Master is a digital camera, the context-aware matrix decides the required action, or printing in this case. Thus, the digital camera sends the data file to the printer. The user simply touches the printer to print, i.e., touch-and-play (TAP). The context-aware matrix is built such that the most intuitive interaction between two intelligent appliances can be realized. It can even be expanded when a new device is invented. For the most intuitive interaction set, the context action requires further research.

Demo Application of TAP

Based on this protocol scheme, the demo application was developed. The scenario of the demo application features the user who has a digital camera and touches the high-definition television (HDTV) to see the picture he/she was reviewing using the LCD display of the camera. Once the user touches the printer, the photo file is printed. A digital camera was replaced with the functional equivalent of the microcontroller (ATmega128L, Atmel, USA), with the picture file stored in flash memory. As a functional equivalent of HDTV, the LCD TV with a notebook computer was used. On the other hand, the printer with a notebook computer was used as a functional equivalent of the printer. The microcontroller was connected with the PC using the USB to the serial extension cable. The microcontroller with the picture file sends the picture data continuously. The program in the notebook computer then receives the picture data and provides the right service according to its functions.

DISCUSSION

Context Automation Level

Although there is obvious interaction between devices in case of the digital camera and printer, some interactions are not that intuitive in the case of the MP3 audio and digital camera; thus requiring some kind of interaction level that will prevent any unintended interaction. The context-aware matrix interaction was categorized into two groups: group A, which is intuitive enough for general use, and; group B, which is not intuitive enough but nonetheless helpful. In a context-aware matrix shown at Table 1, a group A interaction is written in bold font. The user can choose from the following context automation levels:

- High: Provide all service (group A and group B).

- Normal: Provide any good enough service (group A only).

- Low: Provide the service approved by the user.

- None: Do not provide any service.

Intentional vs. Unintentional Touch

Since this service is done automatically, there is always the possibility that unwanted service will be provided. This problem is similar to how much responsibility can be given to servant devices. Although this problem can be minimized using the context automation level, so is the benefit of new technology. Thus, some kind of trade-off between automatic service and security is required. The specific trade-off point will require further research. However, there is some method to be used for differentiating unintentional touch and intentional touch.

First method is simple confirmation process required before execution of service. Todays mobile device has one or two mechanism for accepting and canceling maneuver. Using this simple mechanism the user can selectively execute the service. For example when the user viewing the picture touches the printer, after all process of establishing network and deciding context aware service and transferring the required data, the printer may ask the user if he/she wants to print the specific picture. At this stage the user does not need to hold touching. And the user push the button of printer to accept the printing or cancel it. Though this process is simple to build, it is most powerful to prevent unwanted service. However asking everytime when unintentional touch has been established can make the user annoying. So it should be carefully chosen which service to adopt this scheme.

Second method is enabling the TAP service only when the device is activated and in use. For example when the user leaving the office to go home, grasp the PDA and the phone, nothing should happen, for usually these devices will be in sleep status to save battery. This scheme can be effective for the many devices involved in the TAP service are battery sensitive portable devices.

Third method is using only small area of the surface of the device for TAP service. Preferably button type which require intentional pressure by user will make unintentional touching unlikely to happen. For example the user who does handshake are selective at giving his business card. In this case giving his business card only when the user is pushing TAP button of his mobile phone can be solution. This method is most effective but requires additional button hardware. Of course the additional button will cost small. But in the viewpoint of the mobile device design, which is very tight in space requirement, this can be problem.

Multi-function Convergence Device

It is difficult to define the default service in case of a multi-function device. For example, if the connection between the PC is made, one cannot identify the default service since there are many possible services that can be provided by the PC. Furthermore, the trend is toward convergence. The new printer has a scanner, a photocopier, and a fax. Thus, it is hard to make a decision as to which function ID it should have once it is registered for context-aware matrix.

One of the major application devices will be a smart phone. Nowadays, a smart phone usually has an MP3 player function, a digital camera function, and a PDA function with the basic mobile phone function. All of these functions are members of the function ID matrix. Thus, the static permanent function ID for smart phone is impossible.

One solution involves using a dynamic function ID allocation per communication session. Usually for human interface design, the system is designed to have only one focus of interaction at a time. For example the PC can have many windows for task. However usually only one window receives the input focus. Similarly the menu of the smart phone usually has one single focus. So the function ID of the smart phone can be determined with the function with the focus. For example of the smart phone, when the user is watching the pictures he taken, the configuration packet for TAP has the function ID of the camera. When the user is listening to MP3, the function ID in the configuration packet will be MP3. And when the user is reviewing his address book, the function ID in the configuration packet will be mobile phone to enable exchanging the business card. So if the user was looking at the address book of the mobile phone when touching the printer, the address will be printed. Or if the user was looking at the photo when touching the printer, the photo will be printed.

	PC	TV	Printer	Camera	Mobile Phone	MP3 Audio
PC	(F)**Network connection**	(←)**Monitor connection**	(←)**Printer connection**	(←)**Camera connection**	(←)**Sync connection**	(←)**Network connection**
TV	(↑)**Monitor connection**		(←)Print TV schedule	(←)**Slide show**	(←)User identification	(←)**Play MP3 music**
Printer	(↑)**Printer connection**	(↑)Print TV schedule		(←)**Print photo**	(←)Print pho-nebook	(←)Print album title
Camera	(↑)**Camera connection**	(↑)**Slide show**	(↑) Print photo		(↑)Set as wallpaper	
Mobile Phone	(↑)**Sync connection**	(↑)User iden-tification	(↑)Print pho-nebook	Set as wallpa-per	(F)**Exchange name card**	(←)Set as ring tone
MP3	(↑)**Network connection**	(↑)**Play MP3 on TV**	(↑)Print album title		(↑)Set as ring tone	(F)**Playlist sync**

Table 1. Context-aware matrix between two devices for TAP. The arrow shows which will be the master. F suggests that the first one who sends the packet will be the master. The interaction written in bold type font is group A. Others belong to group B.

Coexistence with other communication Method

Although intrabody communication has several advantages, it still have many disadvantages. To name a few, the user have to hold touching while communicating and the data rate is still low compared to the wireless LAN or ultra wide band (UWB) communication. However the TAP can be used with these technology to complement them. For example when the users with their laptop meet at the conference, they may establish the temporary network. This may require many contexts like MAC address, IP address, etc. These contexts can be transfered safely with TAP and once these information is shared, wireless LAN can be used to communicate. Similarly when the camcorder and TV is touched to enable TAP, the user can go to the sofa and watch the video while the movie data of camcorder is transfered to TV using wireless 1394 or wireless USB. In this way the complex network setting process can be simplified.

CONCLUSION

The technical feasibility of the using intrabody communication to enable context aware service was evaluated. Intuitiveness is an important requirement in future appliances. As more devices become complex, people have a hard time learning how to use them. TAP is very intuitive because the user using TAP can focus more on the purpose of his/her action than the required process of the action like setting up and managing network connection.

Because our work deals with the higher layer in communication, it does not matter what physical layer is used to communicate. For example, previously developed electro-optic transceiver module [9] or FSK module by various group [7] [8] can be used to make TAP experience.

For future research, user experience with TAP needs to be evaluated. And the context automation matrix should also be extended due to the technology development. Also a more standard way of imposing an automation interaction between two devices is required.

ACKNOWLEDGMENTS

REFERENCES

1. Dey, A. K. Understanding and using context. *Personal and Ubiquitous Computing 5*, 1 (2001), 4–7.

2. Hinckley, K., Sinclair, M. Touch-Sensing Input Devices. In *Proc. CHI 99*, ACM Press (1999), 223–230.

3. Rekimoto, J. Pick-and-Drop: A Direct Manipulation Technique for Multiple Computer Environments. In *Proc. UIST'97*, ACM Press (1997), 31–39.

4. Rekimoto, J., Ayatsuka, Y., Kohno, M. SyncTap: An Interaction Technique for Mobile Networking. In *Proc. Mobile HCI*, (2003)

5. Zimmerman, T. Personal Area Networks: Near-Field Intrabody Communication. *IBM Systems Journal 35*, 3/4, (1996), 609–617

6. Hachisuka, K., Nakata, A., Takeda, T., Terauchi, Y., Shiba K., Sasaki, K., Hosaka, H., Itao, K. Development and performance analysis of an intrabody communication device. In *Proc. of the 12th International Conference on Solid State Sensors, Actuators, and Microsystems*, (2003).

7. Partridge, K., Dahlquist, B., Veiseh, A., Cain,A., Foreman, A. Goldberg,J., Borriello G. Empirical measurements of intrabody communication performance under varied physical configurations. In *Proc. UIST 01* ACM Press (2001) 183–190

8. Matsushita, N.,Tajima, S., Ayatsuka, Y., Rekimoto, J. Wearable key: Device for personalizing nearby environment. In *proc. ISWC 00* IEEE Computer Society 2000.

9. Shinagawa, M., Fukumoto, M., Ochiai, K., Kyuragi, H. A Near-Field-Sensing Transceiver for intrabody Communication Based on the Electro-Optic Effect *IEEE Trans. on Instrumentation and Measurement 53*, 6 (2003), 296–301