The DDRC T-Learning Framework: An Interactive T-Learning System with Variable Interfaces

Tzu-Chih Chung
Assistant Professor at Dept. of Digital Media Design,
Hwa Hsia Institute of Technology.
Email: clock@cc.hwh.edu.tw

Kuo-Qin Yan
Professor at Dept. of Business Administration,
Chaoyang University of Technology.
Email: kqyan@cyut.edu.tw

***Abstract*— For a long time, T-Learning is passive because of the restrictions of TVs, the relevant restrictions can be attributed to the input function, i.e. normal TV remote control. Many researchers have proposed various solutions for improving the normal TV remote control but those are difficult to be in practice now. At present, it has been confirmed that dual-device services may be helpful for T-Learning. These studies usually lay particular stress on the cooperation of output function, and the input function of the cooperative device usually has been ignored. Hence, this study aims at the improvement of the normal TV remote control for advanced T-Learning. We propose an advanced T-Learning framework named as "DDRC T-Learning Framework" based on M2M cooperation to better the input function in T-Learning. In the DDRC T-Learning Framework, the touchscreen of a handheld device can serve a learner as an advanced TV remote controller for interactive T-Learning.**

***Index Terms*— T-Learning, Variable Remote Control, M2M cooperation, Dual-device Service.**

I. INTRODUCTION

In a household, television (TV) is one of the most common entertainment devices for a long time. Varied TV programs have been shown via TV in people's life. Nearly, the digital TV system which is different from the conventions analog TV have been more popular. Many areas or countries have transformed the analog TV systems into digital TV systems, such as Europe, American, and Japan etc. Hence, there is no question that digital TV is more important for people. Internet Protocol Television (IPTV) is one of the increasingly important appliances. IPTV provides digital television services over Internet Protocol (IP) for residential and business viewers at a lower cost; furthermore, the two-way communications provided by IPTV is an obvious characteristic [16] .

Digital TV can expand the power of multimedia by bringing interactive communications into a home. An advanced digital TV appliance should provide viewers with more interactive functions, and that is molded by hardware and software technologies. But the normal TV remote control has not been improved effectively for advanced IPTV services, such as games or T-Learning, and that is very important. Chunghwa Telecom, Taiwan's incumbent Telco, has provided IPTV service via its ADSL network, subscribers can select and watch digital TV programs via Set Top Boxes (STBs). In Taiwan, as of the end of December 2008, Chunghwa Telecom has already 600,000 IPTV subscribers [4]. In Korea, Hanaro Telecom has 500,000 IPTV customers. Moreover, a recently report of IMS Research considers that IPTV households are forecast to grow 52.2% annually though 2012 [5] .

A. T-Learning at home

Distance learning is particularly significant in social terms because it can provide learners who may be difficult to reach schools. Digital TV services can support the future of distance learning that can be adapted for viewers. As we know, T-learning is a distance learning based on video-rich materials in a home or other fixed locations ,like school or community learning centre, and that is usually via a TV system [1] . For a long time, T-learning has been implemented as TV programs embedded with content of courses, but that is a passive learning because viewers can only watch learning programs in the one-way broadcasting TV system. In fact, to provide viewers with more input functions and serve them with interactions are more important, so we consider improving an effective distance learning are researchable.

Daniel Atwere et al. considered around 99% of European households have access to a digital TV services, even though it being necessary to add other devices to the TV to make it digital and interactive [1] . At present, the IPTV technologies can provide the two-way interactive communications between viewers and TV appliances, so more and more probable issues can be generated.

In a normal E-learning system, to receive learners' feedback is an important foundation and that must rely on their inputs. This two-way communication architecture must lean on input devices, such as a mouse or keyboard. In PC using, learners can interact with E-learning systems via above input devices. We consider the interactive learning model should be extended to T-learning through IPTV, software technologies and other consumer devices.

B. TV remote control and interaction

In 1956 Robert Adler developed "Zenith Space Command," the first commercially successful wireless TV remote controller [11] [15] . The Zenith Space Commander 600 with four fixed buttons allowed people to use ultrasound to change the channel and volume. Compared to the Zenith Space Commander 600, obvious progress has been made with respect to operating interface, i.e. there are more buttons in a modern remote controller. In other words, the more functions must utilize more buttons. However, the size and appearance of a remote controller are limited; the control functions provided by the remote controller are limited by its size and the unchangeable appearance.

Most TV appliances work in conjunction with remote controllers via Near Field Communications (NFC). In NFC, different devices can communicate with one another via wireless technology, such as IrDA. Thus, a TV remote controller is a "sender" and the cooperative TV appliance is a "receiver"; i.e. this is a 1-to-1, one-way relation. Viewers have become accustomed to the sender-to-receiver mode. For T-Learning system, a TV remote controller is a most universal input device but it always works for the cooperative TV appliance, not TV programs. Hence, we consider the suitability of normal TV remote controllers should be opened to question how viewers can input correctly and easy for T-Learning programs. Otherwise, a normal TV remote controller is a redundant device when a viewer is learning by any T-Learning program except for adjusting sound volume, as shown in Figure 1.

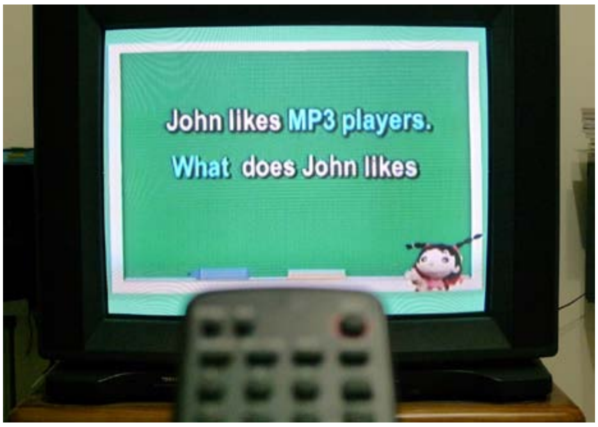


Figure 1. A T-Learning program and normal TV remote controller.

Viewers have being used to use remote controllers that are provided by different manufacturers. The compatibilities resulted from different controllers and TV appliances may affect the practice of T-learning. Above on all, normal remote controllers are developed for TV appliances to change channels and regulate other functions, such as sound volume. Moreover, TV remote controllers are input devices with fixed appearances and limited functions. Above restrictions have existed for a long time and they should be improved for more effective T-Learning, especially in the digital TV with Internet times.

The rest of this paper is organized as follows: Section 2 provides discussions of the literature related to this study. Section 3 introduced the framework of this research. Section 4 centers on experiments. Concluding remarks are drawn in Section 5.

II. RELATED WORK

Daniel Atwere and Peter Bates considered that digital TV has the potential in e-Learning, because of TV coverage of the family as much as 99%, and it will be a more effective medium to decrease digital divide [1] . Nevertheless, for most viewers, a normal TV-watch context is usually passive, how to improve the passive context when viewers are learning by TV programs is an important issue. An interactive learning must obtain the learner's feedback and that usually relies on input devices. Though TV remote controller is a convenient input device for TV appliances but:

- It has limited size and accommodates only fixed buttons with limited functions.
- The sender-to-receiver relation between a TV appliance and the cooperative remote controller is a limited one-way communication.
- Viewers are accustomed to the 1-to-1 and passive watching mode.

Digital TV is increasingly popular, and "adding buttons" seems the obvious "upgrade" for most TV remote controllers. But the upgrade method is limited in the fixed size and that has not been improved effectively until now. Moreover, it is more difficult to change the appearance of TV remote controller on demand, so researchers aim at the issue about advanced TV remote control and proposed different ways to improve the relevant restrictions for viewers' convenience operating.

A. E-Learning and T-Learning

Via the Internet, information and communication technologies for a better education have received many attentions of researchers, and they have contributed various solutions to improve the dynamic learning environments. It is more possible to enhance the variation and interaction of teaching via the Internet, because a "virtual" learning environments with electronic tools allow teachers and students to share knowledge without the restriction of distance, as well as, the evolution of education has become a fix trend during the last years.

Most of the E-learning environments are based on the architectures of web-based tutor systems [6] [8] . Because learners usually stay alone and face electronic appliances, such as computers or TVs. E-Learning with "alone" context is the most different from the physical education environments. In a real classroom, teachers can know the situations of learners immediately in a collaborative learning, and that is usually via human interactions with learners. But for T-Learning, most of learners are normal viewers and they have got used to use their eyes and ears only, this static and passive behavior context has been made from the restrictions of TV appliances. We consider viewers' passive habits from TVs will reduce the interactions and affect the interest in learning.

Francesco Colace et al. proposed the architecture composed of a server, client sides, and the structure of various educative channels [2] . The researchers considered it is necessary to carry out an opportune transposition of the contents from web to the Digital Terrestrial Television (DTT). The learners can use only remote control buttons as input device to interact with DTT pages in their study. Because the appearance of a remote controller cannot be changed freely; they must design a table to record the correspondences of remote control buttons and various DTT pages in advance. The architecture can provide different functions of DTT pages by a remote control button and that allows learners to operate and interact with the all T-Learning system.

We consider above researchers proposed compromise methods to improve the hardware restrictions of TV remote controllers for T-Learning. Though TV remote controllers can be suitable for various T-Learning pages in the special correspondence-changed architecture, and learners have to reaccommodate the re-definition of buttons on remote controllers for different pages. The imperative work must be finished before the official learning to avoid wrong operations. It is undeniable that to re-regulate the cognizance of buttons on the same remote controller may increase the learner's loadings. Moreover, the additional work may break off the regular learning context.

B. Dual-device architecture

Personal Digital Assistants (PDAs) and smart phones have become the most popular handheld devices. In-Stat considers smart phones will be the fastest growing product and that places them in the forefront of the highest profit for wireless operators, manufacturers and applications developers [14] . Gartner Inc. also reports the sale of handheld devices has been growing significantly [3] [10] . In above reports, it can be shown that an increasing number of users have begun to use handheld devices with more capabilities, such as computing capability, the Internet connectivity, etc.

Because the hardware manufacturing techniques have progressed, more and more handheld devices also are built-in with friendly input capabilities. Users have regarded handheld devices as a kind of miniature personal computers, due to their compactness, portability, and wireless Internet connectivity through GPRS, Wi-Fi, 3G, and WiMAX. People use handheld devices in mobile environments customarily. Essentially, the relevant applications or digital services for handheld devices are usually developed as the cooperative entity of a complete system. In this way, a handheld device can extend the own purpose.

Sanaz et al. aimed at the extended purpose of handheld devices and considered the dual-device architecture could help learners in language learning [12] [13] . They presented a dual-device scenario to integrate cooperative E-Learning services in handheld devices and TV. As shown in Figure 2, a learner could get relevant learning information by the devices. The synchronous dual-device service can provide TV learners relevant information in cooperative devices to improve the effectiveness of T-Learning. We consider the dual-device service laid particular stress on the output function of handheld devices, and that has not made the best use of other functions of cooperative handheld devices, such as input functions.

TV watching usually is in a passive context because of the one-way remote control; moreover, viewers have accustomed it for a long time. A normal remote controller communicates with the cooperative TV appliance in sender-to-receiver and one-way communication, in this way, learners can only learn without interactions in T-Learning. Above of all, we can know researchers have proposed different solutions to help learners with more convenience in T-Learning, still the interactions between learns and learning system cannot be improved effectively. After all, the T-Learning learners' input is the key issue for effective interactions but it is a main drawback of TVs.

People have thought a TV remote controller is a type of handheld devices because it is portable. Moreover, the appearance of normal TV remote controllers cannot be changed on demand and that have been accepted for most viewers. Furthermore, normal TV remote controllers from different manufacturers also are usually incompatible. Above restrictions are associated with that the designs of normal TV remote controllers are always suited to TV appliances, not viewers or TV programs.

Figure 2. The dual-device scenario proposed by Sanaz et al. [12] .

According to Sanaz et al., a handheld device can be used as a secondary screen of a TV appliance, so learners can get the other cooperative information from it. As shown in Figure 2, when learners watch a T-Learning program and they can receive the relevant information about the learning content by their handheld device at the same time. The screen of the handheld device can show the auxiliary content to help a learner's understanding [12]. The architecture utilizes handheld devices but aims at the output function, for this reason, learners cannot obtain more functions from the "adding" devices.

III. The DDRC T-Learning Framework

In the dual-device architecture proposed by Sanaz et al., text messages are delivered via handheld devices and shown on their screens. We consider that is a type of mobile services and the specific mobile service is designed to work in concert with the other cooperative service, such as a T-Learning service. Therefore, the dual-device architecture is an integration of cooperative services and that is a service-to-service cooperation, not a machine-to-machine cooperation. Above of all, we try to extend the dual-device architecture to machine-to-machine cooperation, and allow input functions of handheld devices can be utilized for a more advanced T-Learning system, so that they can serve learners with more interactions.

For machine-to-machine cooperation, we consider machine-to-machine communication is the essential foundation. And we propose a framework named "Dual-Device Remote Control T-Learning" (DDRC T-Learning) framework based on the machine-to-machine communication. The DDRC T-Learning framework comprises the dual-device architecture proposed by Sanaz et al. and communications between cooperative devices. The DDRC T-Learning framework architecture is shown in Figure 3. We separates the DDRC T-Learning framework into four entities by the purposes of various devices, it includes Communication Server, Main Servers, Show Client, and Input Client.

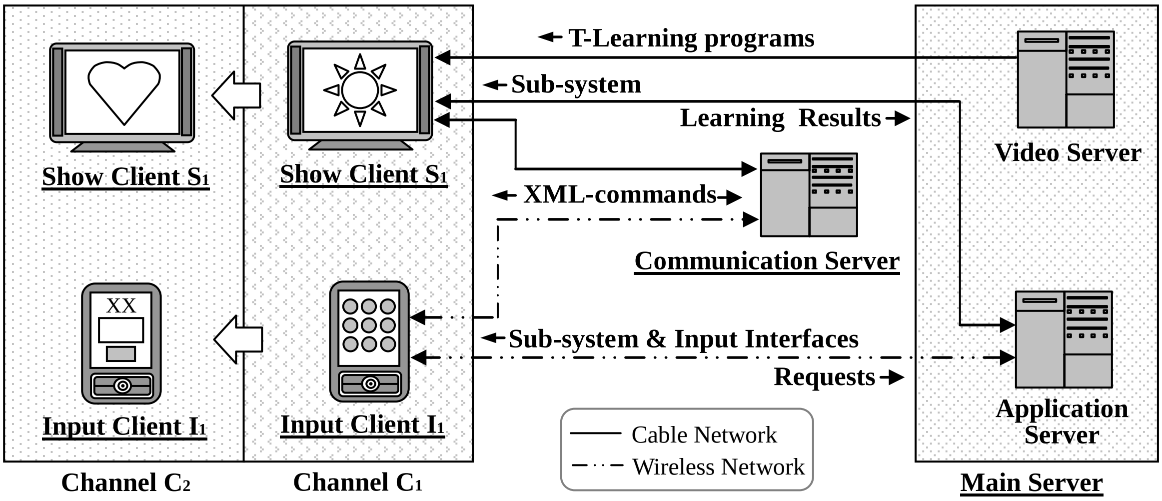


Figure 3. The DDRC T-Learning framework architecture.

The machine-to-machine communication in the DDRC T-Learning framework is shown in Figure 3. The XML-commands are XML format messages and they are used in data exchanged. The four entities of the DDRC T-Learning framework work in conjunction with a concept of "virtual room" to provide TV learners using handheld devices to interact with T-Learning programs. A virtual room means a Show Client can communicate with an Input Client via a specific communication channel. Moreover, a uni-roomid is an unduplicated code provided by Main Servers, thus it represents an unduplicated virtual room. In this way, we consider an Input Client can be an input device of a computer to work for a T-Learning system of a Show Client in the DDRC T-Learning framework.

- Communication Server: In a virtual room of the DDRC T-Learning framework, an Input Client must communicate with the cooperative Show Client like an input device and a monitor work together in a computer, for this reason, we design the Communication Server to process the communication data exchanged between cooperative Clients.
- Main Servers: Main Servers are composed of Application Server and Video Server. A Video Server can provide Show Clients with T-Learning programs and it may be set in a TV company or other relevant company, such as Chunghwa Telecom in Taiwan. The Application Server can provide Input Client and Show Client sub-systems to relevant devices and process the service requests for the two entities. Moreover, an Input Client can obtain corresponding input interfaces of the playing T-Learning program from it.
- Input Client: An Input Client means an Input Client sub-system from Main Servers is run in a handheld device. In an Input Client, a user can input data via varied interfaces that appears on the handheld device (such as a PDA or Smart Phone) after the interface has been downloaded from Main Servers. And then the Input Client will transform the input data into a XML-command and then it delivers the XML-command to the Communication Server

via wireless technology, such as GPRS, Wi-Fi, 3G, 3.5G, or WiMAX.

- Show Client: A Show Client can provide TV learners watching T-Learning programs from Video Server in the DDRC T-Learning Framework. Moreover, a Show Client accepts the XML-commands with the same uni-roomid and parses then to execute them immediately when a TV learner has input data in the cooperative Input Client. A Show Client sub-system can be applied in a STB or IPTV appliance beforehand.

In the DDRC T-Learning framework, the four entities are grounded on distributed computing to work in coordination with other. Moreover, the following sub-issues also have been adopted:

A. Virtual room communication

After a learner turning on an IPTV appliance, the Show Client will get a uni-roomid from Application Server and login in the virtual room named about the uni-roomid. A uni-roomid may be set from the machine number of an IPTV appliance or other unduplicated number and that can be designed for different applications. After that, a learner can choose a channel and the Show Client will downloads the corresponding T-Learning program from Video Server.

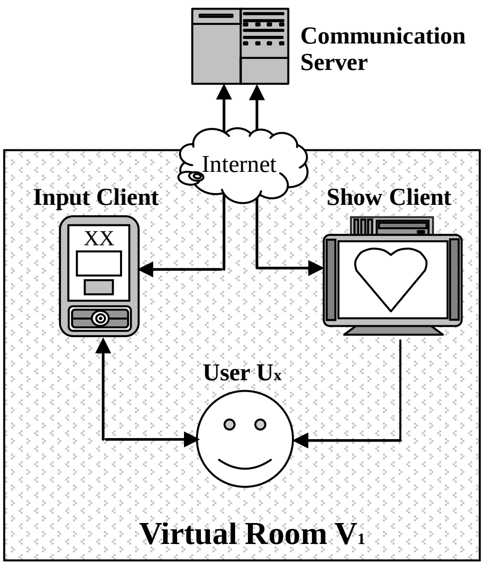


Figure 4. A virtual room in the DDRC T-Learning framework.

A TV learner can get the uni-roomid and then input the uni-roomid to the Start Page of Input Client on own handheld device. Then the Input Client sends a XML-command composed the uni-roomid to the cooperative Show Client via Communication Server. After that, a virtual room named as the uni-roomid has been set up and it has covered a Show Client (TV appliance), an Input Client (handheld device) and a user (TV learner), as Shown in Figure 4. In this way, the cooperative Input Client and Show Client can communicate with the other in the virtual room via XML-commands exchanged by Communications Server.

B. Time-related input interfaces

Every T-Learning program is set relation with specific input interfaces by producer in the DDRC T-Learning framework. Setting input interface for TV program is a new concept in TV fields and that is the most different from the normal TV remote control. We consider the fix input function of a normal TV remote controller should be improved by more advanced input function, and that must be easier for viewers. Hence, the varied input function on the touch panel of a handheld device will be adopted in the DDRC T-Learning framework.

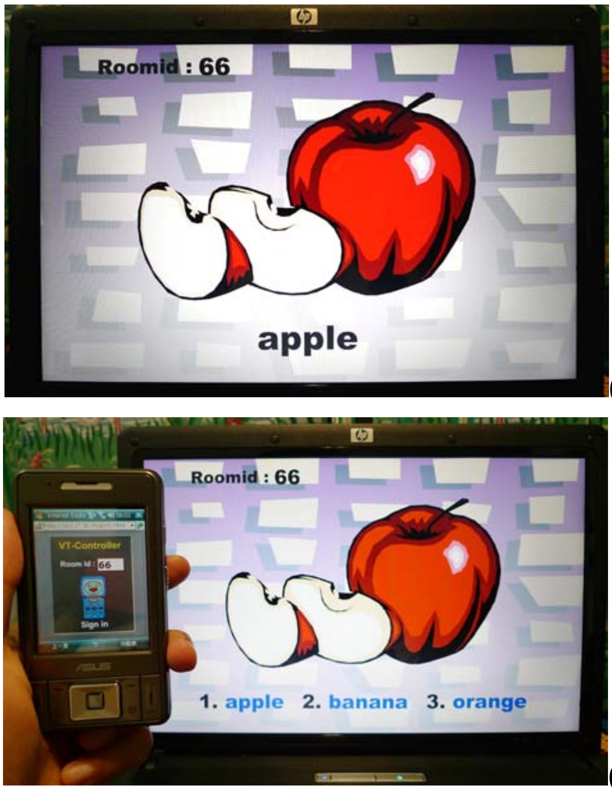
A little data embedded in a video is a mature technology and that has been in practice for some years, such as Adobe Flash Video technology. Via the kind of technologies, a playing system can obtain data from a video when the video is being played. In this way, we consider the data from a played video can be time-related messages, and we utilize them to be the important base of the M2M cooperation. A Show Client can “order” the cooperative Input Client to change the input interface, as well as, an Input Client also can deliver input data of a learner to the cooperative Show Client via the time-related messages.

The Instant Messaging (IM) system is a popular application. Via the Internet M2M communications, computers can exchange users’ input data, like the Microsoft MSN service. At present, an IM system can serves users message exchange successfully, so we consider the communication of messages may be helpful for the cooperation of different devices. The time-related input interfaces with the cooperative T-Learning program are based on the principle.

IV. Experiments And Results

In following experiments, we utilized Microsoft ASP scripting to develop the Application Server. Communication Server was Palabre XML Socket Python Server and that is a freeware [9] . Adobe Flash technology and HTML were adopted to develop the input interfaces and the Input Client sub-system. The Show Client sub-system was also developed by Adobe Flash technology. The Main Servers was powered by an Intel PC with Microsoft Windows XP, and a HP 540 notebook with 14.1'' monitor was simulated as an IPTV appliance.

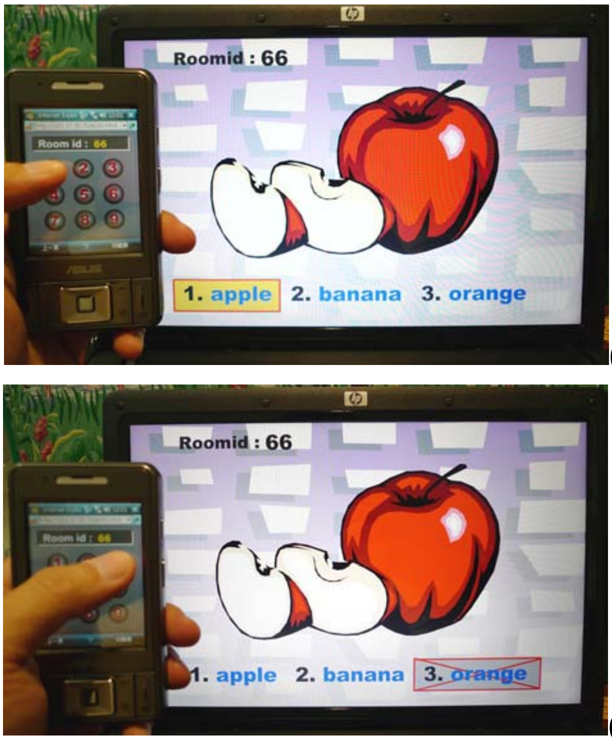
According to ComScore Media Metrix, 81% of worldwide online videos are viewed using Adobe Flash technology [7] , so the T-Learning program was encoded by Adobe FLV format in the experiment, and embedding data in a video was easier in this way. At this moment, though we cannot implement a large-scale experiment for the DDRC T-Learning framework because of the limited budget and time, we utilized above technologies and hardware/software systems to test and verify the proposed framework can be used in practice.



(a)
(b)

Figure 5. (a) A normal T-Learning program. (b)The DDRC T-Learning framework.

As shown in Figure 5(a), a normal T-Learning program usually can serve learners by visible image and audio. The learning context is passive and learners cannot feedback any information freely. Therefore, a producer of program always designs simply visible information on the screen but the monotonous layout may affect learners' interest. On the contrary, learners can input little data to a Show Client for a T-Learning program, the visual layout of the program may show more information for the learner's choose. As shown in Figure 5, the same teaching objectives are the word "apple" of the two T-Learning programs but the visual appearances of key items are different.

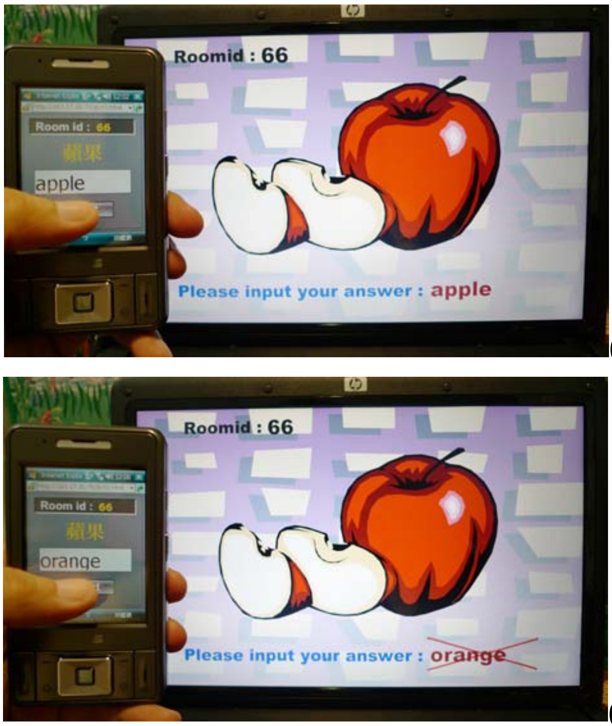


(a)
(b)

Figure 6. The simulation for existing IPTV.

We implemented the first experiment for the remote control of existing IPTV. The STB or IPTV appliances provide users to choose specific item on the screen. Users can click buttons to input what they want, and the cooperative appliances will received the input data via Near Field Communication (NFC). For this reason, the chooseable items are shown on the visual layout, as shown in Figure 5(b). A learner can choose the right answer by a button clicked of the cooperative remote controller. We simulated the existing operation in the DDRC T-Learning framework, as shown in Figure 6(a).

In the DDRC T-Learning framework, the existing input mode with the visual choosing can be implemented easily because that is a one-way remote control. As shown in Figure 6, we implemented the multi-button interface of Input Client to simulate a present TV remote controller. A present TV remote controller usually work in conjunction with STB or TV appliances, so a learner's input data cannot be judge whether it is right immediately. Moreover, a Show Client of the DDRC T-Learning framework can judge whether the answer is right by the embedded data of a program, so it can show the result to the learner immediately. As shown in Figure 6, the results of learner's inputs could be shown on the screen with different visual effects depending on whether the input data is right or not.



(a) (b)

Figure 7. (a) A normal T-Learning program (b).The DDRC T-Learning framework.

In the second experiment, we developed the other input interface to utilize the input functions of the viewer's handheld device. At present, there are several input functions in a PDA or Smart Phone, such as handwriting input and voice input. The two input function are helpful for the language learning and they are not provided by any existing TV remote controller. Hence, we wanted to test whether the helpful input functions can be adopted via the varied input interfaces of an Input Client.

As shown in Figure 7, the input interface in the Input Client is different from the existing TV remote control interfaces. We developed the input interface with textbox to train the learner for an efficient learning because typing characters is necessary for the language learning. The right answer no longer is shown on the screen to be one of the chooseable items and we consider that will help learners to memorize the words. As shown in Figure 7(a), the playing T-Learning program video was paused for waiting the learner's right input. The learner could input a word by any input functions of the handheld device, after that, the Input Client would delivered the input data to the cooperative Show Client via Communication Server. Then the Show Client judged whether the input data was the right answer or not and showed the result on the screen, as shown in Figure 7(b).

Figure 8. The input interface was changed with the playing T-Learning program.

After judging the learner's input data was the right answer, the Show Client continued to play the T-Learning program video, as shown in Figure 8. Variable Interfaces is an important issue of the DDRC T-Learning framework. Different interfaces that contain relevant output information and input item can be changed with the playing T-Learning program, and we consider that are better than existing TV remote control. As shown in Figure 6, Figure 7 and Figure 8, the 2 times interface changed with the different actions of the same T-Learning program could provide the learner specific input interfaces for different learning methods, and that can free the producer of T-Learning program from the restrictions on existing TV remote control. Because we consider the TV learners should not be limited in the restrictions of TVs, especially which could be improved.

IV. Conclusions

For a long time, T-Learning is passive because of the restrictions of TVs; the relevant restrictions can be attributed to the input function, i.e. normal TV remote control. To change the fixed appearance of existing TV remote controller is difficult now, so TV learners must accommodate themselves to learn in coordination with the limited button-clicked input. However, PC E-Learning system is more convenient because of the input from a mouse or keyboard. We consider the regulation of input by TV remote controller is not friendly for TV learners.

The DDRC T-Learning framework is a kind of dual-device framework and based on the M2M communications to integrate the functions of different devices for advanced T-Learning. Though Sanaz et al. have proposed related solutions for TV language learning, their studies have laid particular stress on the output functions of a handheld device. At present, there are easier input functions in PDA and Smart Phone, we consider to utilize the easier input functions in a dual-device framework should not be overlooked.

An IM system serves users' communications via digital message exchanged. In this way, a device only serve one user is familiar. However, we consider the M2M communication architecture should not be applied in the above service only. Therefore, the proposed DDRC T-Learning framework is novel and possesses the following characteristics:

- The input of TVs is fixed and difficult to change for specific applications on demand. In the DDRC T-Learning framework, a handheld device can be turned into a variable TV remote controller to improve the input for T-Learning.
- Make the best use of the specific functions of different devices via M2M communication. In this way, the integration of auxiliary functions from cooperative devices can serve TV learners with more interactions.
- According to Sanaz et al., the output function of a handheld device can be adopted for the dual-device learning service. Their opinion also can be achieved in an Input Client of the DDRC T-Learning framework.
- In the DDRC T-Learning framework, the producers of T-Learning programs can develop suitable input interfaces for specific learning objectives, and that is impossible before. We consider the improvement may increase TV learners' interest.

Above of all, the DDRC T-Learning framework is a beginning, not an end. The phasing result has shown the M2M communications is helpful for the integration of different devices. Moreover, the experiment of this study has verified the input functions of a handheld device can be adopts for the other device in specific application, and that may be conducive to T-Learning. A modern handheld device has more and more functions; therefore, we will extend the relevant researches in this way.

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