Cross-field Usage of Rice Paddy Digitalization

Chuan-Lin Lai, Chia-Chen Kuo, Yi-Haur Shiau, and Sheng-Hua Wang

***Abstract*—Given that Rice Paddies are of great importance to the environment, we launch and retain in this research a platform called "My Paddy" (http://efarm.nchc.org.tw) in cross-field integration method in the purpose of advocating the three functions of paddies (environment, society and economics). We invited experts in agricultural hydrology, information technology and children's book painting to work together and interpret related documents as colloquial context which are suitable for kids; we also used computer graphics. In addition, we developed mobile multimedia learning modules for users to adjust protocols and speed according to devices and network conditions. Furthermore, we used Augmented Reality so that users can observe hydrologic facilities from all sides, which make the interaction more fun.**

With this platform, the K-12 community can know more about the three functions of rice paddies, and ordinary network communities can also gain more knowledge regarding rice paddies. Furthermore, we intend to expand international communities of rice paddies. Since the launch of our platform in June 2005, we have got 1.15 million visits by December 2010; and the number has increased by 700,000 to 800,000 visits in the past three years.

***Index Terms*—the three functions of rice paddies, K-12, Network Communities, Augmented Reality**

I. Introduction

Household usage of the internet has increased from 54%(2003) to 75%(2009), and people above the age of 12 who has used the internet take up 71% of global population, according to an investigation on the usage of internet in Taiwan. Besides, the data from UN in 2008 also shows that internet in Taiwan has world's 17th popularity. Dexter, Anderson and Becker pointed out that information technology helps education revolution and innovation of traditional teaching [1]. In a highly informational zed society, we can use the internet to spread knowledge and create a learning environment for communities which enables users to fully participate and explore through tools and resources on the internet.

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There are already quite some examples of advocating the internet and digital technology in the field of education. USDA launched a website for children and created cartoon characters to introduce the development of its livestock industry; EPA also created the cartoon figure of a chameleon to teach kids how to identify the level or air pollution. In Korea, MIFAFF (Ministry for Food, Agriculture, Forestry and Fisheries) illustrates the importance of culture and ecology protection with cartoon characters and interactive animation. MAFF (Ministry of Agriculture, Forestry and Fisheries) in Japan has tried a different way to display its development in relative fields using comic. As for Taiwan, the leading character and spokesperson, Uncle Shih, shows the exhibitions in National Museum of History with interesting and easy pictures and words; National Museum of Natural Science provides kids an opportunity to learn science by role-play and adventure games. Maolin National Scenic Area introduces its unique aboriginal culture and ecology. Thus, we can conclude that cartoon characters are recognizable and easy to remember. The hydrological system in Taiwan has developed for more than three hundred years, and it's an important basis to modernize and industrialize the three functions of rice paddies (Environment, Society and Economics) [2]. A research done by Chen [3] shows that rice paddies not only provide food but regulate flood, store water and keep the soil from being washed away; Lai and Shy also pointed out that analyzed that the water in rice paddies are valuable to revival of biosphere around the paddies [4]. Meanwhile, a research by Wu and Fang [5] shows that rice paddies can regulate microclimate and absorb carbon dioxide. However, all these findings are usually focused on the academic aspect, so it's hard for the masses to understand. On the other hand, Tu [6] suggests that most people who built up the network information platform do not specialize in education, while those who major in education don't have the specialty of information technology. Therefore, it's crucial to plan and launch cross-field cooperation and integration. Sun [7] indicated that the cross-field method which brings information technology into life proved to be very helpful to 95% of students, and 71% are willing to keep learning out of class.

In conclusion, since the three functions of rice paddies, Kuo uses the internet as a carrier and turn research findings into games, animation and videos, hoping to attract learners' interest [8]. This research is structured by using Web 2.0, and we put human resources of agricultural hydrology, children's book painting and information to develop a digital platform about the three functions of rice paddies using the technology and tools by National Center for High-Performance Computing (NCHC). Moreover, we built a mobile multimedia learning module providing media streaming in several file formats and resolutions so that users can browse

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the content in all network conditions.

II. CORE TECHNOLOGY

A. Cross-field integration

This research is structure by integration of agricultural hydrology, information technology and children's book painting [8]. First, we collect the documents and research findings about the three functions of rice paddies and rewrite them. Then we digitalize characters created by children's book painters, scenes and scripts with computer graphics in order to boost learning motivation with digital contents (graphics, animations, sounds and videos, etc.).

B. Real-time multimedia learning platform

A platform with distributed real-time multimedia streaming technology, Paddy Media Grid, is created to reach the goal of Learning Anywhere. Learning will not be restricted by place or time. Users can access multimedia streaming anywhere with internet connection. The distributed real-time streaming system is loose coupling and three-tier architectures, includes stream receiving unit, stream processing unit, and presentation unit [9]. Fig. 1 illustrates the distributed real-time streaming architecture and stream pipeline.

The learning platform, based on three-tier architecture, includes stream receiver unit, stream processor unit, and presentation unit. It is a distributed computing and a loose coupling architecture. Stream receiver unit supports a variety of capture source devices, such as HDV, DV, Webcam, TV Card, Capture Card, etc., and stream compress encoding formats, such as MPEG-1/2/4, FLV, WMV, MJPEG, etc., that are commonly used. The multiple format supported feature made our system an outstanding platform, on which streaming can easily be broadcasted in real-time. The functions of VLC [10] and ffmpeg [11] are modified to automatically identify which device the video comes from and which streaming format it is.

Stream processor unit has two options: one directly streaming to presentation unit, the other slices streaming into sequence of images and can be extracted and stored for further implement image processing. Presentation unit supports multiple display devices handy to end users. The easiest way for users to view the streams is to use web browser. A web-based user interface was designed to allow users to select multiple real-time streams to browse.

C. Augmented Reality

Fiducial Marker is often used in Augmented Reality, and Fiala [12] mentioned that systems like ARToolKit and ARTag usually has a square frame as positioning graphic with a variety of patterns. The block with a quadrilateral outline will be first captured from the video to make sure if it's the positioning graphics used by the system. Fiducial Marker is good because it can provide useful position information even in a small area, and it's easily detectable. 3D virtual image will be right on the screen once the Augmented Reality system is set up and the position of graphic is identified by video cameras.

At present, there are several tools which develop augmented reality. Flash is very good at designing games, and the later FLARToolKit enables human-machine interaction developers to develop augmented reality. This research digitalized Lai's [13] paddle wheel project to help users to experience the 3D visual effects in the most intuitive way. 3D graphic software, Maya, is used modify the modes and scenes, which are later exported to PaperVision3D format for production in Flash; the sounds of flowing water and paddle wheel are also put into the project to make it more interesting. Fig. 2 shows the steps.

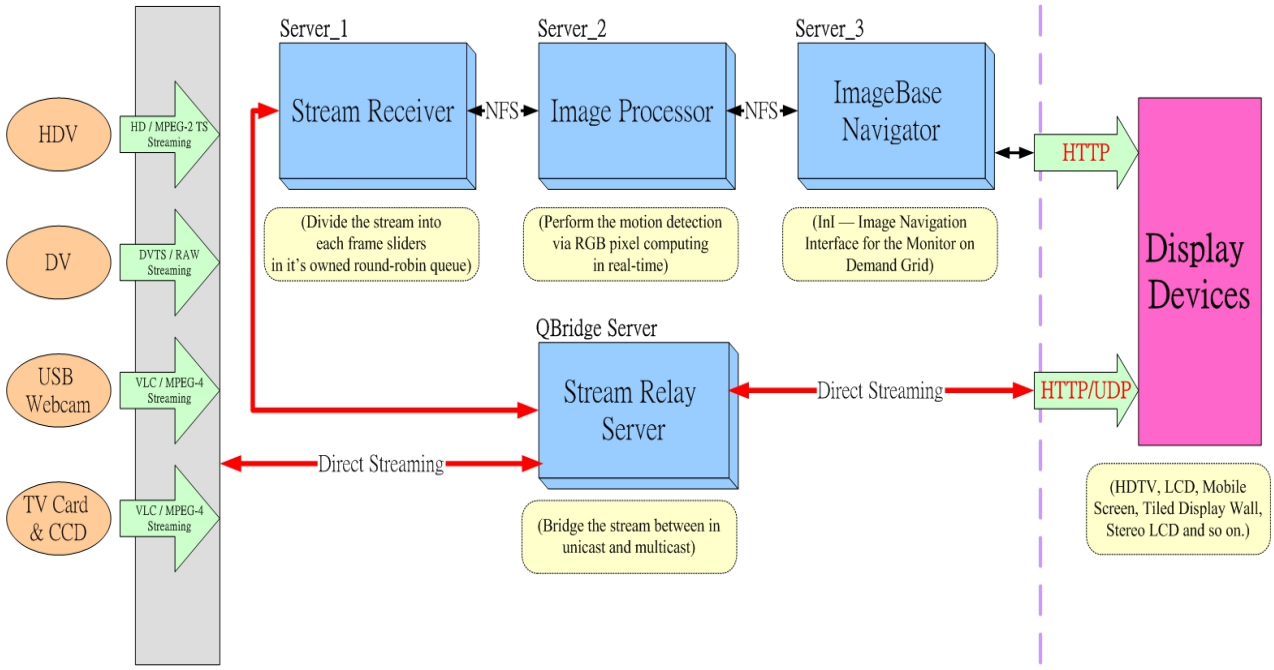

Fig. 1. Architecture blocks and stream pipeline of distributed real-time streaming system

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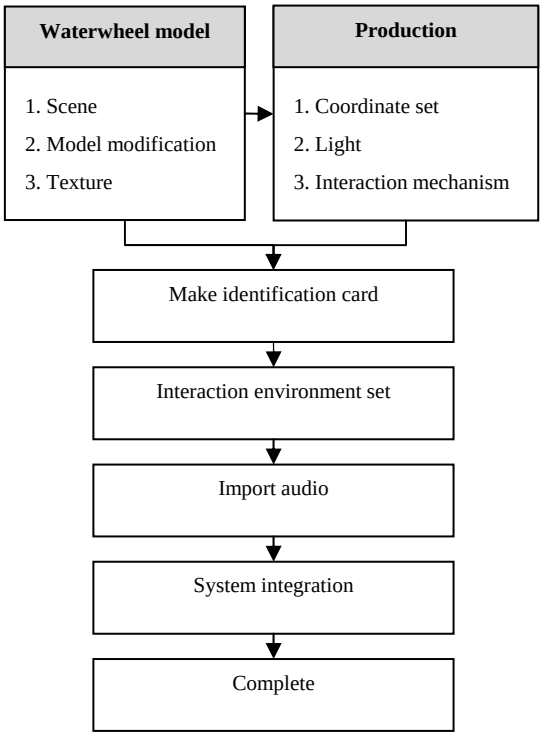

Fig. 2. Steps of using augmented reality in paddle wheel

III. INTERPRETATION

To help advocating the three functions of rice paddies, this research interpreted documents about rice paddies into common context.

Wu and Fang [5] tested and collected data like leaf area index, radiation levels, wind speed and direction, temperature and humidity, carbon dioxide concentration and so on, and evaluated the effect of rice paddies absorbing carbon dioxide with CO_2 flux model. Guandu Nature Park was chosen to be a research objective. He recorded the effect of rice paddies in different stages of growth (Tillering, Panicle Initiation, Panicle Development, Dough Grain and Mature Grain) and compared the results with emissions of automobiles. Every hectare of rice absorbs CO_2 emissions equal to that of 3,180 medium cars driving for 1 kilometer or 4,280 medium car, 780 buses, 8,720 scooters on the highway. Converted to economic value, the level has reached to NTD 29,500 (USD 910) per hectare.

Apart from this, data and information from various resources are also taken as reference to design relative contents.

IV. DIGITAL CONTENTS

After this research interpreted and digitalized documents, these data were made into multimedia games, interactive animations, audio books, videos and put on My Paddy platform. Fig. 3 shows the homepage of this platform. To help the K-12 community learn knowledge in a systematic way, relative contents are linked to one another for convenience of advanced search. Aside from the K-12 community, courses about rice paddies were also opened in universities; furthermore, the blog “Write about Paddies” helped to build up the virtual network, collect and spread knowledge [13]. Contents designed for the K-12 community on this platform will be listed and introduced as follows:

Fig. 3. My Paddy platform homepage

A. Carbon Reduction

This is a game and animation from Wu and Fang research [5].

Happy Paddy

This game helps users to realize the importance of environment protection. In this game, factories and automobiles keep emitting CO_2; users have to buy the right tools and plant rice, but things such as blight will happen at random to affect the growth of rice. It takes good care from the users to keep rice safe and growing to absorb CO2, so that people could have a clean living environment. (Fig. 4)

Fig. 4. Happy Rice Paddies

Breathing Paddy

This animation helps users understand how rice paddies absorb CO_2 and protect the environment. (See Fig. 5)

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Fig. 5. Audio animation of breathing paddy

B. Paddle Wheel

This project was based on the 3D model of Paddle Wheel Revolution [13]. Augmented reality was integrated to create this interactive platform which is different from the traditional interaction with mouse and keyboard. Users can view the paddle wheel from all sides and know it better. To users who have never used a mouse and keyboard, they can also easily use this platform. Fig. 6 shows how this platform works.

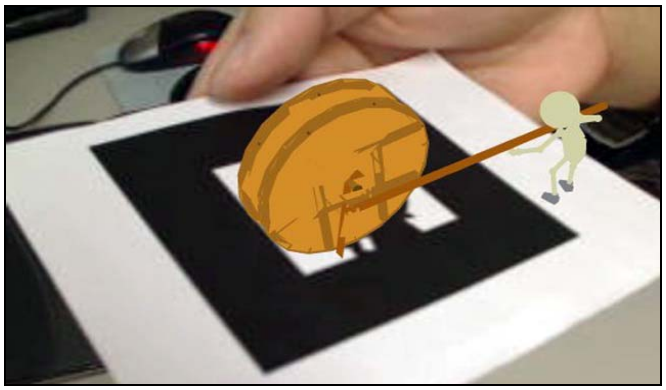

Fig. 6. Paddle wheel

C. Irrigation Baby

This game shows the process of irrigation through the guidance of Irrigation Baby and animation.

Water Bank

Since enough water should be collected before irrigation, this project is designed on the basis of an irrigation bank. Users can move the Irrigation Baby with arrow keys on the keyboard to catch water drops from the sky, but they should be careful not to be attacked by lightning and falling rocks. Once enough water is collected, users can start Irrigation Baby's wonderful journey. Fig. 7 shows the process.

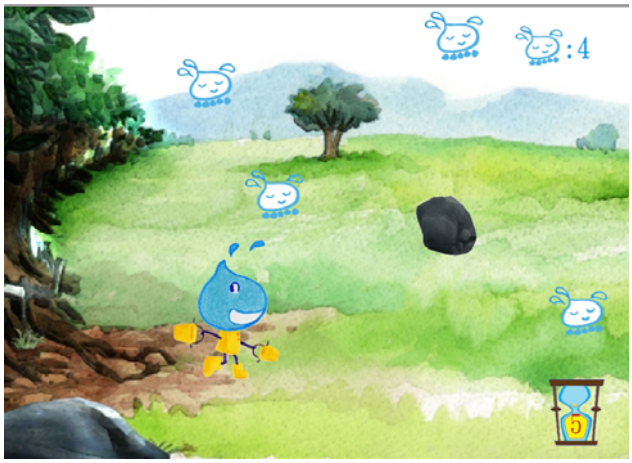

Fig. 7. Water bank

Irrigation Navigation

The main character, Irrigation Baby, introduces the process of irrigation. After collecting enough water, Irrigation Baby will lead water drops to the rice paddies. Every stop on the way, including the reservoir, aqueduct, the gate, main lane, is fully illustrated with animation and audio sounds. Fig. 8 shows a screenshot of Irrigation Navigation.

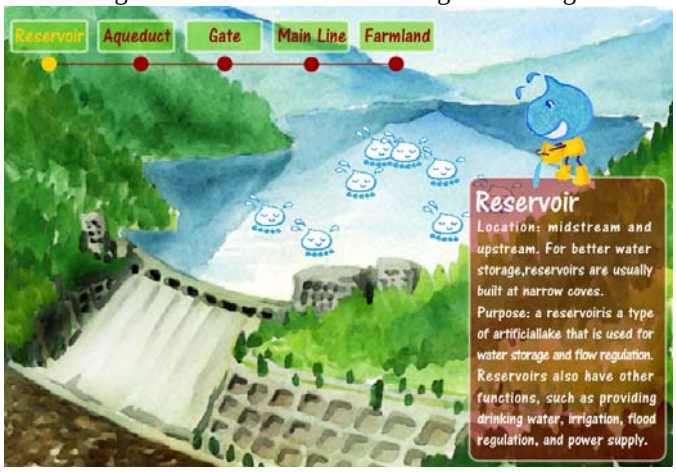

Fig. 8. Water navigation

D.Agriculture and Hydrology Corner

This is a game with animation of irrigation which displays ten common agricultural hydrology facilities (see Fig. 9).

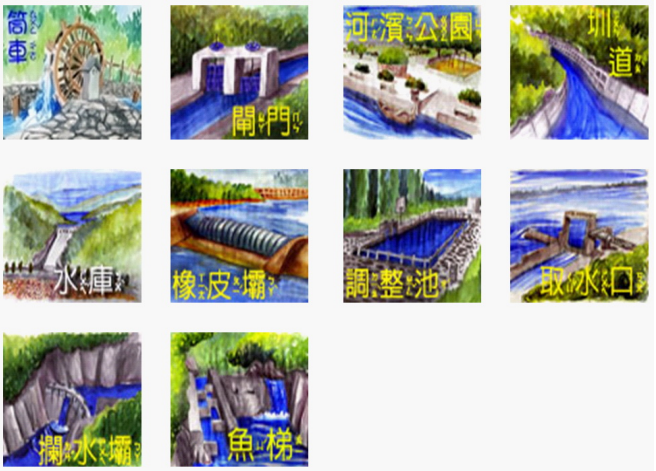

Fig. 9. Hydrologic facilities

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Coloring the Village

Users can enjoy coloring with a mouse to create their ideal villages (see Fig. 10).

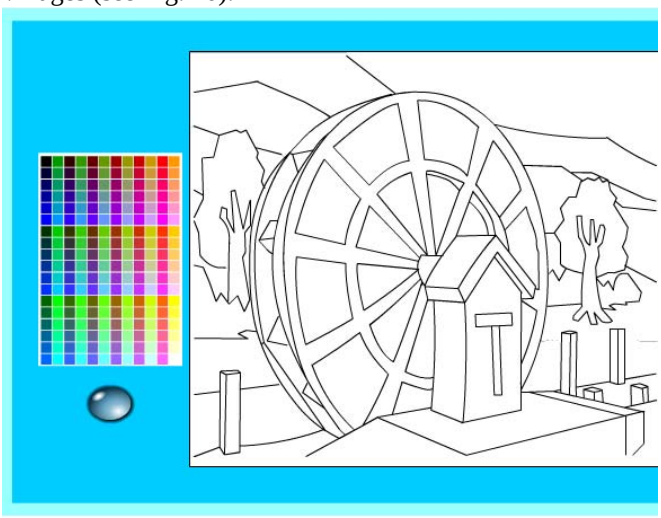

Fig. 10. Coloring pictures

V.MOBILE MULTIMEDIA LEARNING BROADCASTING LIVE

Grid Technology can solve problems like server breakdown due to too many connections and slow reply and the videos can still have good definition [9]. In this research and the courses held by National 4-H Club Association, Grid Technology was applied to broadcast live on the internet. This is extremely good news to users who were too late to sign up, because they could still participate in the courses together with other students in the classroom. See Fig. 11 for a snapshot.

Fig. 12. Broadcast of mobile multimedia learning Courses

VI. CONCLUSION

So far, the platform "My Paddy" has got 1,150,000 visits since it was launched back in June 2005. And the number has increased by 700,000 to 800,000 visits in the past three years, making it 4/10 in Goggle PageRank.

This research develops a mobile multimedia learning mechanism through cross-field integration and interactive audiovisual synchronization, and interprets the research findings into contents suitable for kids; these contents are later digitalized using computer graphics and streaming technology for the platform "My Paddy". The objective of this research is to advocate the three functions of rice paddies through information technology, and spread knowledge using animations, videos and games on the internet. The digital contents on this platform are both interesting and of knowledge enough to appeal to the K-12 community.

In the long run, more information technology will be used to advocate the three functions of rice paddies and environment protection. As for international communities, the plan is to let more and more people know the outcome of cross-field integration in information education with English version of digital contents.

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