# Improve Mobile and Ubiquitous Learning with a Self-Propelled Toy Car Based Learning System

Li-Der Chou, Tzu-Chien Liu, David Chunhu Li, Chen-Ming Lin, and Yi-Chun Lin

***Abstract*—How to improve mobile and ubiquitous learning with an innovative approach is a challenge task. To achieve this objective, we designed and implemented a self-propelled toy car based learning system. Our new learning system integrated various advanced technologies such as the Radio Frequency Identification (RFID), location service, wireless sensor network, an attractive remote control toy car, three-dimensional toy models and multimedia teaching contents, etc. With the aid of this system, the teacher can easily conduct teaching activities in the classroom, the building hall or the outdoor anytime. The most important features of our system are not only to save the students' trouble and cost on transportation to learn, but also to motivate the students to learn knowledge as if they are playing the game with the toy car. Our learning system has merits of easily assembling and flexibly updating teaching content.**

***Index Terms*—Mobile, ubiquitous, learning, toy car, multimedia system.**

## I. Introduction

Wireless multimedia technologies have greatly impacted peoples' daily life. The peoples may change their learning habits because various scientific technologies introducing conveniences to the world. There are numerous types of wireless multimedia learning system applied in different learning institutions [1]- [4]. Those learning systems have greatly affected peoples' learning behaviours. Each type system has its own merits and demerits. Numbers of research correlative to performance evaluation of learning system can be found in previous literatures [5]- [7]. Thank to great advantages brought by wireless networks and other advanced scientific technologies, the people are able to learn new knowledge anytime and anyplace. It is possible to move the whole learning system into a classroom even in a living room. The people thus do not have to visit the learning institutions such as the museum or the library in person to obtain new information. This is going to save numerous troubles of transportation and labour cost. Therefore, the motivation of this research is to study application of information technologies that improve mobile and ubiquitous learning. In addition, a new novel self-propelled toy car based learning system is designed and implemented to improve the efficiency of mobile learning and motivate the student study.

In our system, a self-propelled toy car is modified and integrated with advanced technologies such as wireless sensor network, Radio Frequency Identification (RFID), Infrared and location service, *etc*. Moreover, abundant teaching materials including maps, three-dimensional toy models, photos, texts, audio-visual multimedia information are involved in the system to enrich teaching contents. Thus, the whole learning environment is improved to more attractive when compared with other existing learning methods. With the aid of our new learning system, the students are motivated to actively participate in learning and can easily understand the learning knowledge. Our learning system has merits of easily assembling and flexibly updating teaching contents.

The reminder of this paper is organized as follows. In section two, various related works of mobile learning system are discussed. System analysis and design are described in section three. Section four presents details of system implementation. Finally, we conclude our work in section five.

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## II. Related work

Mobile learning system has been studied in recent years. Nowadays, a type of more promising learning service with the help of handheld guide device such as a PDA (Personal Digital Assistant), mobile phone is widely applied to overcome those intrinsic deficiencies that the traditional learning service (tour guide, tape or disc recorder, *etc.*) may have. Handheld guide devices introduced in guide learning institutions can improve the efficiency and provide plentiful teaching contents. In addition, a number of mobile learning systems with handheld devices have been broadly implemented in actual guide institutions in Taiwan. All those systems can provide abundant multimedia exhibition by using handheld devices such as PDA and Tablet PC. The following learning systems are some typical examples.

### *A. Taipei Planetarium Mobile Tour Guide Learning System [8]*

This mobile tour guide learning system was developed and implemented in the hall of Taipei Planetarium. The visitors can freely and interactively learn the exhibition collections via holding a handheld PDA device. Moreover, they are able to choose their own favorite tour itineraries and enjoy a self-learning trip.

### *B. Location-Aware Museum Tour Guide Learning System [9]*

In a location-aware museum tour guide learning system,

each display exhibition is implemented with an infrared transmitter. In addition, there is a unique code to represent the exhibition. The visitors holding a PDA device will receive the infrared signal once they are in the transmission range of infrared exhibition. As a consequence, the explanation contents related to the exhibitions are presented in the users' PDA. The main feature of this location-aware museum tour guide system is offering a group visit and self-learning scenario.

### C. Wireless Multimedia Butterfly and Ecology Pool Tour Guide Learning System in Da hu Elementary School, Taipei [10], [11]

This multimedia guide system utilizes Tablet PC as an assisted teaching facility. The teachers are able to carry out an outdoor teaching activity about butterflies and other insects with the help of infrared location service implemented in the Tablet PC. On the one hand, the Tablet PC can automatically display the knowledge of various species of butterflies in the garden. On the other hand, this learning system can avoid the risk of damage on teaching equipment by the students. Therefore, the students can focus their observations on butterflies and other insects. Teaching content and student account management modules are also implemented in this system.

Although those aforementioned learning systems have demonstrated their particular features, such as location awareness, ease of the use, the systems still have many problems need to be solved. Inflexibility in implementing the learning system is the first demerit. Furthermore, it is very difficult to move the learning systems to other places. In particular, the system users have to travel a lot to learn knowledge at the learning institution, such as at the museum or the planetarium. Therefore, we are motivated to improve mobile and ubiquitous learning environment by design and implement a new easily assembling mobile learning system. The detailed system analysis and design are introduced in following sections.

## III. System Analysis and Implement

The major purpose of this new mobile learning system is to provide the system user a convenient and easy access learning environment by implementing abundant multimedia guiding exhibitions, wireless guided toy cars and users friendly management interfaces, *etc*.

Our new proposal is a self-propelled toy car based learning system. It can be used in the areas of education applications, such as e-learning and outdoor teaching. The students are able to acquire knowledge of exhibitions while playing a game with the remote toy car. RFID and infrared location service technologies are used to provide an accurate location discovery. The remote controlled toy cars are modified as wireless sensor nodes travelling among display exhibitions. A database is also used to save teaching contents to enhance the interactivity between the students and multimedia learning system. A real map is deployed on the floor with many living three-dimensional exhibition toy models. Thus, the students can manipulate remote controlled toy cars and explore the exhibition toy models along the tracks on the map. When the students learn the exhibition knowledge with simply clicking the exhibition lists on the computer, the toy car will automatically move along the track on the map and sequentially stop near the exhibition toy models which are placed around the track and the continents on the map where the real exhibition actually located. For example, the Great Wall is located in Asia. The RFID reader implemented on the modified self-propelled toy car will read the RFID tag that is deployed under the exhibition toy model. The wireless network then transfers the location information of exhibition model that the toy car sensed to the computer, the computer will automatically display the students with relative exhibition knowledge correlated to the exhibition models.

### A. Layers Stacks of System Architecture Design

To assist the reader to understand our system architecture, we depict the detailed system architecture as illustrated in Fig. 1. In our proposal, there are four layers comprise the layer stack of system architecture. Physical layer is a fundamental layer including all hardware and physical objects to support the whole system. Communication layer is the second layer consists of wireless communication technologies applied in this system. Service layer and application layers are the third and fourth layer which have their own specific functions described in the below sections.

### B. Learning Function Design

Having briefly introducing the system concept and layer stacks in system architecture, the following section will explain details about learning function and teaching function in the application layer.

1) Self -Learning Function: As most of students may know little about the exhibitions before the learning, this system contains detailed explanation about each exhibition as the students' references. Thus, the students can conduct a self-learning activity to study relative display knowledge in depth.
2) Prepare Teaching Function: The teachers can plan and design various exhibition subjects and teaching contents according to different teaching requirements and purposes. After the teacher's preparing, the students are attracted to enjoy varied impressive learning experience with those pre-designed teaching contents.
3) Achievement Test Function: Distinct from other multimedia learning systems, our system provides an important feature of evaluation work after the student learning knowledge. Achievement test service offers the teachers or the parents a facility to analyze and evaluate the students' learning performance. It also assists the teachers track teaching problems occurred during students' study. Thus, this service provides an excellent tool to improve instructors' teaching.

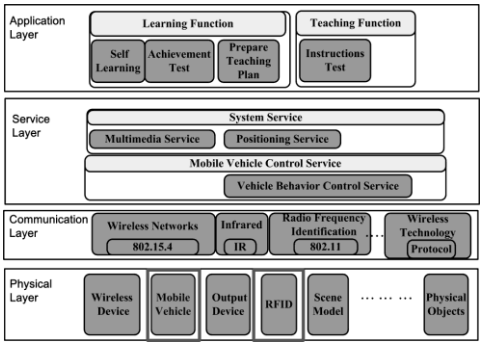


Fig. 1. System architecture

4) Instruction Test Function: Instruction test supplies an interactive interface between the users and mobile remote controlled toy car. Two instruction modes are provided in this service. One mode is used to test the abilities of manipulating toy car. Another mode is for RFID tags function test.

## IV. System Implementation and Evaluation

We implemented our new self-propelled toy car based learning system and evaluated this system with twenty different ages of students. Our learning system was awarded a silver medal at the 2009 Taipei International Show and Technomart. In order to achieve a wireless communication in this self-propelled toy car based learning system. A wireless sensor network is implemented to accomplish this task. We chose two wireless sensor network products from Crossbow Technology [12]. MICA2DOT sensor node and MIB510 sink node are two major components of wireless sensor network. TinyOS is the operating system software installed.

### A. Hardware Environment

We modified a self-propelled car and implemented it as a mobile remote controlled toy car. In our new modified toy car as shown in Fig. 2, an Intel 8051 central process unit (CPU) is embedded, a CNY70 light gauging sensor is built in to sense tracking route and deliver a precise and long-distance sensing at the speed of light. Two 200rpm DC motors are used to drive the movement of guided toy cars.

### B. Software Implementation

Considering the expense of developing system and maintenance, we try our best to make use of open source free software to design the web pages and database of backend management system. PHP 5.0 and IIS 5.1 are used to develop the web page. MySQL Server 4.1 is the software to implement the database of system. We choose the tool of Microsoft Visual Studio 2003 to code main structure of the system.

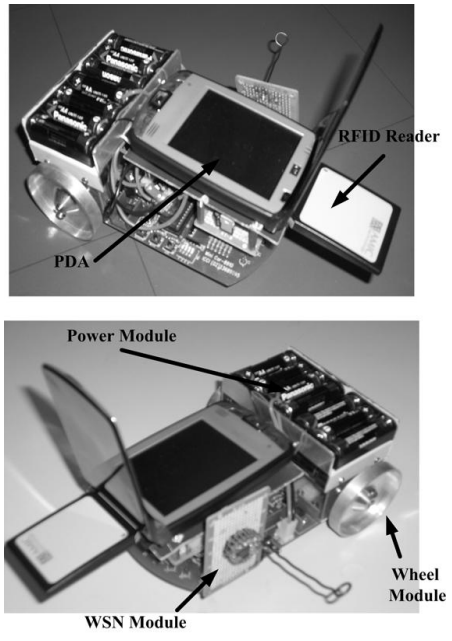


Fig. 2. Modified self-propelled toy car

### C. Self-Propelled Toy Car based Learning System

We implemented our self-propelled toy car based learning system as illustrated in Fig. 3. In our current work, the three-dimensional exhibition toy models of some world famous architectures were selected in our learning system. In addition, we also designed and developed attractive graphic user interfaces (GUI) to assist the students in learning knowledge with our learning system.

To accomplish a self-learning function which introduced before, we implement many friendly GUIs to attract the students and deepen their impression. As shown in Fig. 4, there is a view list located on the left side of this interface, when the students select one of world famous architectures, the corresponding view explanations with texts, photo and background music will automatically display in this interface. The student therefore can freely learn the knowledge based on their favours.

On the other hand, we also designed and implemented some interfaces to assist the users configure the system, for example the wireless sensor network connection, the RFID connection and the remote control toy car function. As shown in Fig. 5, there are two categories of system configuration function implemented. One category is used to set parameters of wireless sensor networks, for instance the host IP and port numbers. Another category is used to regulate the RFID connection.

Fig. 3. Self-propelled toy car based learning system


Fig. 4. Screenshot of self-learning interface

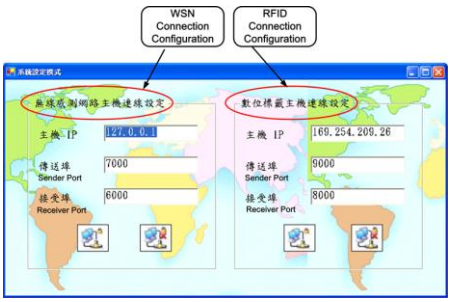


Fig. 5. Screenshot of system configuration module

Having implemented our new self-propelled toy car based learning system. We evaluated our system with twenty various ages of elementary school students. The student studied the geography knowledge by using our new learning system. The feedback result indicated that most of students were attracted to learn as if they are playing the game. They were motivated to learn the details of exhibition models because they stated our new learning system is more interesting than the ordinary text books and other learning software. In addition, the teacher can flexibly change the teaching content on the computer of our learning system, and simply replace correspondingly exhibition toy models which are related to the teaching content. The most important merits of our new learning system are its easy assembling and carrying feature, which allows the teacher to assemble the whole learning system in the classroom, the building hall or the outdoor. Therefore, the teacher can conduct a mobile and ubiquitous teaching activity by using our new learning system.

## V. Conclusion

In this work, we designed and implemented a self-propelled toy car based learning system to improve a mobile and ubiquitous learning service. We described our system concepts and architecture in details. We also presented the system implementation and evaluation work to demonstrate that our system can assist the teacher to perform an attractive teaching lesson. As our system is easy assembled and carried, the student can learn knowledge by using our system in the classroom or the outdoor ubiquitously. As a result, we improve the existing learning system by integrating mobile and ubiquitous learning feature.

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