Gesture Recognition For Learning Math Using Kinect

Tareq M. AlZubi
Universidad de Santiago de Compostela
Santiago de Compostela ,Spain
tareqzubi@hotmail.com

Julián F. Gonzáleze
Universidad de Santiago de Compostela
Santiago de Compostela ,Spain
julian.flores@usc.es

Anas Al-Rahamneh
Universidad de Santiago de Compostela
Santiago de Compostela ,Spain
anas.abbadi@gmail.com

José M. Cotos
Universidad de Santiago de Compostela
Santiago de Compostela ,Spain
manel.cotos@usc.es

Abstract— In the last years, technology has been widely used in the educational sector. However, the methods that utilized in the education are still traditional, and also lacks to participatory learning of the student. The goal of our research is to develop a system for children to learn math using a hand gesture and help them to work based on two fundamentals: memory and Inhibitory. The system will identify the gestures of a student using Kinect to create an interactive learning environment; this environment will enhance the education methods to be more interactive.

Keywords: Human Computer Interaction HCI; Gesture Recognition; Education

I. INTRODUCTION

In the education field, there are many difficulties and barriers prevail. One of these issues is conceptual of mathematical knowledge during childhood stage, where the teachers need to find more techniques to make the student understand mathematics in an easy way. “The challenge is to make education intuitive from the user perspective while at the same time being useful, cost effective and feasible to implement at the grass root level” [1].

The most sensitive period in childhood is that within 5-8 years, being a critical stage for learning. Theoretical education of children within this age is challenging and not always interesting as they seem to favor learning by action due to the fact that it catches their attention faster and assist in integrating what they learn from these learning exercises. Kids at this age tend to play while they have less motivation to learn. Therefore, we have taken these facts into our consideration when we designed the exercises using games.

We aimed at stimulating their motivation to learn very interactively. Education plays a crucial role in the human advancement, and academic achievements as it meant to be to improve the quality of life. To best achieve this, is to enhance the learning process through improving memory skills. Many researchers found a strong correlation between learning and memory skill [2]. We adopted in the proposed study a technique to convert the article theory education module to an interactive module. The proposed module focused on the use of interactive tools such as hands motion to increases the working memory. Working Memory is the thinking skill that concentrates on memory-in-action: the ability to remember and use relevant information while in the middle of an activity. Through the continuity in keeping the students attention as they proceed with such interactive education system, and carry out instructions with multiple steps. Human-Computer Interaction (HCI) community are interested in applying interactive technology in a learning environment; The new Gesture-based interaction devices, such as WII, X-Box and Kinect are more interesting than conventional interaction devices like keyboard, mouse and joystick[3]. Use of gesture-based interaction devices for educational purposes has a positive impact not only on children's learning but also on their enjoyment in physical activities [4].

We have developed a 3D gesture recognition interactive motion control games called (Math Puzzle) using Kinect device, for teaching basic arithmetic to childhood. All the controls of games are through hand motion. Such an intuitive user interface makes the games easier to control and suits for kids who are not able to do complicated commands.
Moreover, it is expected that it will allow learners to focus more on learning objectives and not on using complex user interfaces. Learning with these technologies will be potentially more intuitive and efficient [5]. Our research focuses to implement a system for childhood, working memory and Inhibitory control. There are many types of research which claimed that game-based learning is more effective than learning in class [6,7,8]. All of the games are designed for kids to play at home, so they can continue learning after school.

II. ARCHITECTURE OF THE SYSTEM

In this section, we outline our design and the development of a prototype educational game using Unity 3D® game engine (2011, version 4.6), C# language, PHP 5, Kinect SDK, MySQL and standard HTML as a software, Kinect, desktop or laptop computer and screen as hardware.

We aim to help students to practice mathematics daily by using gesture-based input for our project. These gestures make the game fun and interactive. We used Kinect and Unity 3D to carry out the development of this project. It will be capable of running on standard internet web browsers, although, the project is designed primarily around MS Internet Explorer. The application operated using Windows 7 based PC. Figure 1 describes the basic architecture of our developed games (Math Puzzle).

![Figure 1. System architecture](image)

A. Software

The first part of the development is the software; it is a combination of 3 essential parts that allows the system to communicate with the hardware (Kinect). There is much software graphic game engine like unity3D, OpenSceneGraph (OSG). There are reasons for selecting Unity 3D. They are: (1) used to create interactive 3D application, games, and visual effects, (2) Unity 3D support active communication between Kinect and 3D Models where an important part of the development,(3)Unity3D has unique advantages in efficiently programming a game. A script program will automatically compile into a.NET DLL file. These script languages have real cross-platform Ability as well. That means developers can deploy games on different platforms such as Windows, Mac, Xbox 360, PlayStation, Wii, iPad, iPhone, and Android. Also, games can run on the Web by installing a plug-in [9].Microsoft Kinect SDK provides natural ways to get to the Kinect functions, and this is an essential Part in the development of the application. It is also compatible with a variety of tools to identify the gestures to simulate keyboard input caused by body posture and specific gestures. This feature allows the programmer to add to the existing control mechanisms intended to present the games that do not afford official support for sensors depth of the current body. The Kinect and the software library interact with the application, as shown in Figure 2.

![Figure 2. Kinect and the software library interact with application](image)

All result and data of study are stored by MySQL Database, which is connected with Unity game platform by the external interface. We use it because it is free , runs on Windows platform and it has a graphical user interface (GUI) that allows users to interact with electronic devices or programs through graphical icons and visual indicators such as secondary notation.

Third-party proprietary and free graphical administration applications are available that integrate with MySQL and enable users to work with database structure and data visually. Some well-known front end is: PHP MyAdmin is a free and open source tool written in PHP intended to handle the administration of MySQL with the use of a web browser. It can perform various tasks such as creating, modifying or deleting databases, tables, fields or rows; executing SQL statements; or managing users and permissions[10].
B. Hardware.

There are many devices and applications available which are a combination of hardware and software. One such device is Microsoft Kinect. This device captures the gestures performed by the player and sends it to the computer. There are various reasons for selecting Kinect. They are: (1) Students do not need a controller. This kind of technology encourages students to move just like they would move if they were playing the game indoors or outdoors, (2) Kinect supports 3D and (3) has an RGB camera, depth sensor, multi-microphone set. These features provide full-body 3D motion capture, Hand Gesture, which were necessary to play the game. Also, a Screen consists of a display device of a projector or LCD monitor. The idea is to show the child equation; then the player has to perform gestures to make onscreen Hand move to the right answer.

III. Experiment

We have developed four games: “Caught fish”, “Count by jumping”, “Order the numbers ascending” and “The representation of the number on the counter.”

The workflow of the application is described to know how it works (see Fig. 3). The classroom teacher was responsible on registration process of the children profiles in MySQL database regarding a unique ID tagged with their photos for easy recognition. The system designed to displays images in the screen to be a friendly-use interface within Unity 3D with a focus on kids using cartoon icons. The application automatically saves the results of each trial of these games; the resulted will be stored within each child’s profile, in function of how the child responded to the experiment. Also, a message appears telling the children that they completed the game and consequently results (final score) will be saved.

The workflow starts with a login screen to the system; in the first case the system stores the teacher login ID to bring the information for all children in his class. Then the system shows the main menu options: (1) play the game, (2) Report for the result and (3) exit. The option to play contains the main functionality of the application. In general, when the teacher selects one of the games from the main menu then he will move to next scene to select one of the children to start the game figure 4. The application indicates the children to be in front of the Kinect device. If the children are detected past ten seconds, the application invites children to start the new game. Therefore, the system shows a new math equation to solve it. The system adds a point or increases the evolution of the user if it detects the correct answer. If the teacher decided to finish the game for the student, the system shows the final mark. Then return to the main menu and select a new game.

Figure 3. Game Workflow
A. **Captured fish:**

The goal of this game is to recognize the concept of the number and the process of calculation by catching some fishes. The system shows the student a number on the screen, and the student will start catch fish based on the number display events until the student press the green button to confirm his/her answer. In this context, it will support the working memory and inhibitory control work. Working memory works because students must remember the number of fish that he catches. Inhibitory control will work because the child must be able to stop fishing once he or she has reached the amount displayed on the screen as illustrated in Fig. 4.

![Image of fish and number](image1)

**Figure 4.** Illustrate population of fish and presented number, action to be taken by students when the displayed fishes reach the displayed number.

B. **Count by jumping**

The goal of this game is to fill the missing number in the line numbers. In this game, the line composed of students from five numbers showing that four numbers, one of which is missed, the missed number is one of three choices in the bottom line as shown in Fig. 5, and the student should know the correct number within the existing chain. In this context, working memory and inhibitory control will work. Working memory is initiated when the students should work with the application numbers to reach the right ball. Inhibitory control will work because students must refrain from taking any ball that is not enough to complete the series.

![Image of numbered balls](image2)

**Figure 5.** Illustrate a chain of five balls in the line labeled with numbers except one, in a second line there are 3 labeled balls, one of which is the correct answer.

C. **Order numbers ascendingly**

The goal of this game is to order numbers. In this game, it shows the student four random numbers on the top of the screen and the form of the ladder climbing. The student will arrange the numbers in ascending order so that the student will catch the number from the lowest number to highest number and there is an arrow will appear for the student show him the position of the number after that the system will automatically shift the number to the right location show fig 6.

![Image of ladder with numbered balls](image3)

**Figure 6.** Illustrate an ascending order of numbers in a ladder with balls.
Working memory is initiated when the students should work with the application numbers to reach the right ball to put it in the correct place because the children have one chance to do it.

D. The representation of the number on the counter

The goal of this game is to teach students how to represent the number. The four-game present three number on the upper right, and three pins and ball on the top left. The student will have to fit into each pivot the indicated number of shots to the right of the application as shown in fig 7. Working memory will work because the students have to remember the number of balls you have to get into each stick and balls that have already entered. Inhibitory control will work because the child must be able to stop putting balls in the stick when it has reached the number of balls stated on the application.

IV. Conclusions

In this paper, we present a system that will enhance the traditional methods of teaching math to make the classroom environment more participatory and interactive. The system based on computerizing the math materials and using the Kinect to allow the students to interact with this material through recognizing their hands gestures. Children can interact with the elements. Hence, this will enhance student’s level of understanding as they will immediately see the results of their actions. The proposed module has been tested and validation is in the process. Detailed results will be published upon the completion of the project.

REFERENCES


