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Kinesthetic Learning Applied to Mathematics Using Kinect

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Abstract

Mathematics is one of the main courses in education, learning the basics of this area is essential for any student. But along time Teachers have found several factors that takes the pupil attention away. Here is where Kinesthetic Learning have proven to be a determinant factor on learning this courses, with the inclusion of mechanical, and virtual devices is possible to extend the pupil knowledge, minimize distraction and gain focus on difficult topics and practices. In the past years, technology have become an important part of the educational system in many countries, in most cases the school or university requires the student to bring a laptop or mobile device to school, but in most cases this devices becomes the main distraction. The purpose of this research is to demonstrate that kinesthetic learning offer a new experience in education, allowing better understanding of mathematical concepts, graphs and formulas and allow the student to take action in the learning process. Trying to find a viable way to implement the kinesthetic learning, several test where held containing elements of augmented reality, the results of this demonstrate that AR provides a huge boost on the learning curve but is limited by the "marker" and the amount of movement, here is where Kinect comes in. With this capacity the Kinect makes a perfect hardware piece for Kinesthetic learning, now the main objective is to develop a set of tools involving augmented reality and virtual reality for the understanding and learning of mathematics for College students.

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Keywords: Augmented Reality; Virtual Reality; Kinect; Mathematics; Kinesthetic; Learning;

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1. Introduction

In the past years technology have become an important part of learning, with the develop of several devices such as tablets, light weight laptops and smartphones teachers around the world have found new ways to bring students the concepts and exercises needed on each lecture. One of the most demanding courses in any educational level are the mathematics where practices is a vital part in the learning curve instead of the reading and learning of theory, "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].

One of the most difficult task is to make education intuitive, mathematics are a pencil and paper based course with little or non-variants at all, in previous works several approaches have been taken including Augmented Reality, Virtual Reality, Virtual Worlds, Gesture recognition and Mobile based Applications [2] [3].

Most of the previously mentioned technology provides a great enchantment in the learning process but have one big issue, the user is taken outside reality in different ways or is forced to use specific devices that limit their movements for example in VR the user is forced to use devices such as glasses, joysticks and many more and is taken to a different world, in the case of AR is a hybrid form of virtual elements and reality but is again forced to use a "marker" or tablet like device and a marker to trigger AR.

Here is where the term kinesthetic learning comes in, this term refers to the ability to learn with physical activity instead of listening or watching. This kind of learning is mainly used in the basic level of education such as kindergarten and early elementary scholar's where playing several games they learn about nature, time and space and in some cases mathematics. This is a great opportunity to expand and improve the learning process, with the help of technology and computer software researches are able to capture data from human movement such as speed, position, pattern recognition and much more, and Microsoft Kinect is a perfect device for this.

Kinect is a motion detection device, equipped with RGB camera, infrared depth detection sensor, microphone and a dedicated processor. Originally designed to be a gaming accessory for the Microsoft Xbox 360 Kinect quickly gained popularity within developers and a windows compatible version where released, this new version allows developers to create movement based applications and games, "in order to exploit Kinect's technical affordances, classroom activities should be designed to use the information gathered by Kinect"[4]. In this paper we are going to expose a kinesthetic learning based app developed using Kinect and unity 3d game development IDE focused on the learning of mathematical concepts graphs and their derivations to obtain velocity and acceleration based on any position given from the movement of the user.

Nomenclature

AR	Augmented Reality
VR	Virtual Reality
VW	Virtual World
Unity	Video Game IDE
ITESM	Instituto Tecnologico y de Estudios Superiores de Monterrey (Monterrey Institute of Technology and Higher Education)

2. Scope and objectives

The ITESM searching for a way to improve the learning of mathematics in their courses in several engineering careers, at this point the main objective is develop and application for the Position vs. Time graph

that allows the student to replicate with their hands several different kind of movements and the software will detect, compute and generate graphs based on the positions in the selected time lapse.

For this NOVUS created a project and reunited a team of investigator and students to research and develop a computer software that uses Kinect as the motion sensor device. At the final stage of the development the application will be able to detect hands movement, full body movement, interaction with the User interface via body movements and gestures

3. System Architecture

After the requirements of the system have been collected several options for development come in, first of all Microsoft provides their own SDK for Kinect and is designed to work with visual studio, however other variables comes in play like the necessity of a quick and affordable way to integrate 3D models, animations and 2D Lines and sprites, with this in consideration the following architecture was defined.

3.1 Software

The first part of the development is the software itself, it is combination of 3 essential parts that allows the system to communicate with the hardware (Kinect).

a) Unity 3D: As mentioned before the need of a platform that allow direct interaction between Kinect and 3D Models where an important part of the development, also unity provides the ability to display graphs using splines and can be used with c# code.

b) Kinect SDK: Microsoft provides native ways to access Kinect and its functions, this part is vital in the development of the application.

c) ZIGFU Plugin: Unity is a multiplatform IDE for gaming development, and have a great selection of additional interfaces and plugins, in fact unity is not able to communicate with Kinect directly, so a third party plugin is needed. Zigfu is a license based plugin for unity that allows creation of Kinect based application, allowing the developer to access different Kinect SDK functions such as the camera, sensors, microphone and movement.

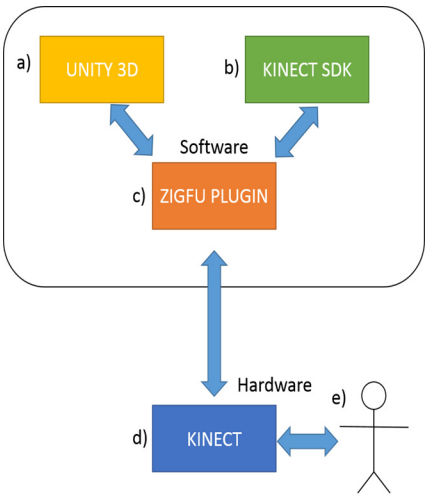

Fig. 1. System architecture

*3.2 Hardware*structure

d) Kinect: the only hardware component in the system is the responsible of capturing user data through several sensors including the infrared camera, with this data collected it is send to the software and analysis begins.
e) User: the student or teacher, that after explaining the theory part of the class will interact with the Kinect sensors to replicate graphs related to the topic previously studied.

4. Results

After several months of development the first beta is available, in this demo app the user interacts with the Kinect and the GUI as fallows

a) The application starts and a main menu is displayed, in this menu the user can get instructions on how to operate and use the application. Figure 2.

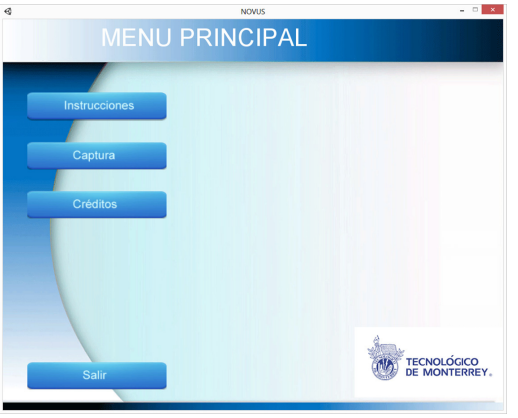

Fig. 2. Main menu

b) After the user select to capture data a new screen with a Cartesian coordinate plane, appear on screen, at this point the user can control the pointer with his right hand allowing to travel across the plane, the student must be standing in a distance aroun 1.5 meters from the Kinect camera in a wide open space without sun light. Figure 3

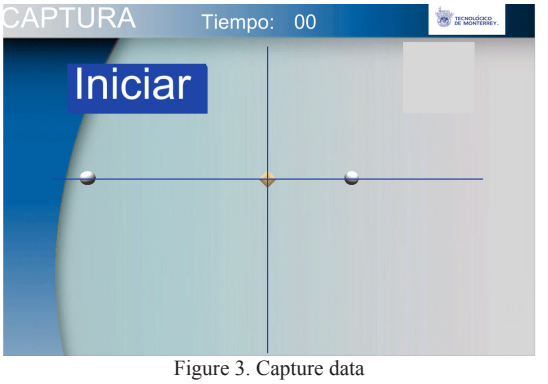

Figure 3. Capture data

c) At any time the user can make a "virtual click" with the left hand on the start button, this will start a countdown and all positions of the right hand will be captured by the Kinect on the X and Y axis.

d) At the end of the countdown the user will be presented with several graphs, including X and Y axis representing the position, velocity and acceleration of the right hand from time 0 to time n where n is the time selected on the previous screen, all this graphs are created real time within the application.

5. Conclusion and future work

The Kinect based kinesthetic learning was tested with several students in campus, most of them provided positive feedback of the application and where able to reproduce several graphs and patterns with the Kinect, also the research team where able to collect valuable data of the movement of the human body and how it is related to the learning process, the next step is to define a learning plan that meets the selected courses and extend them to the use of Kinect and augmented reality.

6. Online license

Acknowledgements

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