# Learning Math Using Gesture

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***ABSTRACT:*** *The current system of education is not as interactive as it can be. It lacks participatory learning from the student point of view. The future of learning is visual and interactive. Keeping this aspect in mind, the primary goal of our research work "Learning Math Using Gesture" is to interface 3D animation software and gesture recognition hardware to create an interactive learning environment. Blender an Open Source 3D animation tool provides a way for modeling and animation aspects. Another important ingredient is Microsoft Kinect that provides a way for capturing real time gestures of users. In this paper we present a method for manipulating Blender models using Kinect. This Human-Computer Interaction method can be used to make various learning tools to make teaching more visual, animated and lively rather than mere reading from the book.*

**Keywords:** Blender, Kinect

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## 1. Introduction

The traditional method of black board teaching has been in place since long and is customary means of education. However, for certain concepts such as mathematics, actual practice is better. 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.

Use of contemporary devices like laptops and LCD projectors are becoming common in our education system. In addition to this, various e-learning resources like online videos, websites and e-books are also freely available. Teachers are keen in using these devices and resources in the classrooms. But all these learning models are not effective. The reason is that the learner is not in an active mode. Learning is not learner centric. Learner is most of the time in a receptive mode. This makes learning process uninteresting for learner.

Apart from the commonly used devices mentioned above, there are new devices which are emerging. These include: motion sensing devices, portable video recorders, etc. Also, there are many devices and applications available which are combination of hardware and software. One such device is Microsoft Kinect. It is a motion sensing input device by Microsoft for the Xbox 360 video game console. Based around a webcam-style add-on peripheral for the Xbox 360 console, it enables users to control and interact with the Xbox 360 without the need to touch a game controller, through a natural user interface using gestures and spoken commands [1].

In the software domain, there are a lot of free and open source tools available. One such tool is Blender. Blender is a free open source 3D graphics application. Blender can be used to create interactive 3D applications, games, animated film, or visual effects [2].

Till date no significant work has been done in learning mathematics using gesture with respect to integration of Blender and Kinect. We used these two tools to teach mathematics using gesture, which creates learning interesting in the utmost important subject, i.e., mathematics and in turn improves student's skill. In this paper, we present some of the results obtained during the ongoing research. In the next section, we discussed in detail our approach to teach mathematics using gesture.

## 2. Our Approach

Our research work focused on improving Mental Mathematical skills of the students. Other than the customary paper solving method of learning mathematics, several online tutorials and games have become popular. We intend to encourage students to practice mathematics daily by using gesture based input for our mathematical maze. These gestures make the game fun and interactive. As mentioned earlier, we used Kinect and Blender to carry out the development of this project. There are various reasons for selecting Kinect. They are: (1) Kinect does not require any controller or remote, (2) Kinect supports 3D.

Similarly, there are reasons for selecting Blender. They are: (1) Blender can be used for modeling, animation, rendering and game logic, (2) It is open source. Both tools are having strengths as mentioned above and are important from our research point of view where we used gesture to teach mathematics. Let us see the role played by each tool in this model

### 2.1 Current System of Integrating Blender with Kinect

As mentioned earlier, Blender and Kinect combination is currently being researched, there is no existing system as far as we know. One may use pre-recorded input from Kinect as a .bvh file and map it to a skeleton in Blender. Currently, there are two major ways to do this. In first case, one has to prepare a setup of Kinect – Blender. Next, you have to import a .bvh file. Then, you need to map the bones for gesture recognition. Finally, you need to retarget and play the animation. In second case, firstly a .bvh file is imported. Then, you have to do scaling and rotation of armature. Next, one has to make connection of bones. After connecting the bones, you have to set the armature to T pose. Finally, append skin on the armature.

The major problem with above mentioned two approaches is that they are offline. Hence, there are useful only for animations and not for live gesture recognition. Since our aim is real time gesture recognition, so, we came with new architecture to address this need. Figure 1 depicts the basic architecture of the system.

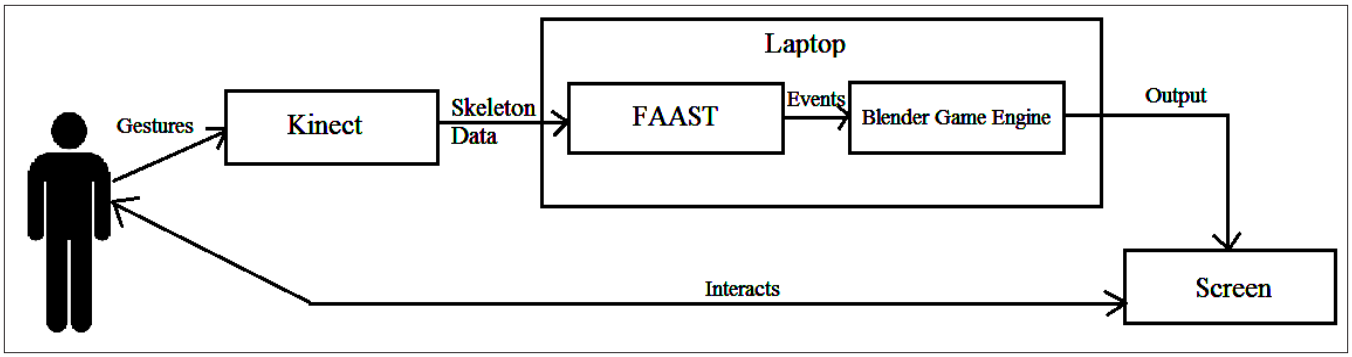


Figure 1. System Architecture

In the system, Kinect a motion sensing device serves as an input device which is used to capture and recognise the gesture in real time. This device has a 3D depth sensor that captures the movement of the user in 3d space and provides this live gesture of the user. Then, this live gesture is passed to FAAST (The Flexible Action and Articulated Skeleton Toolkit). Here, FAAST acts as a middleware between Kinect and Blender to facilitate integration of full-body control with games and VR applications using either OpenNI or the Microsoft Kinect for Windows skeleton tracking software. Each time, the system recognises user's gestures and then interprets the meaning of those gestures. When relevant gestures are performed by the user, (here T pose), the system replicates corresponding actions in it with the help of FAAST. Basically, FAAST is used to convert the output from Kinect to a format which is understood by Blender. The toolkit can also emulate keyboard input triggered by body posture and specific

gestures. This allows the user to add custom body-based control mechanisms to existing off-the-shelf games that do not provide official support for depth sensors [3].

Now, this translated output from FAAST is used as inputs by Blender to control the model. All the modeling is done in Blender which acts as the visual carrier. Here, Blender uses a combination of '*sensors*', '*controllers*' and '*actuators*' to control the movement and display of objects in the engine. Blender has its own Python API that enables python scripts to control the game [4]. The Blender Game Engine runs the core logic of the game. Finally, the output is projected on a laptop/screen.

**2.2 Sample Results**

The game titled as MathMazing integrates multiple intelligences. It is a single player, gesture controlled mathematical maze. It consists of multiple levels, with each level having a mathematical quiz. Each level will have a randomly generated equation with multiple options as shown in Figure 2.

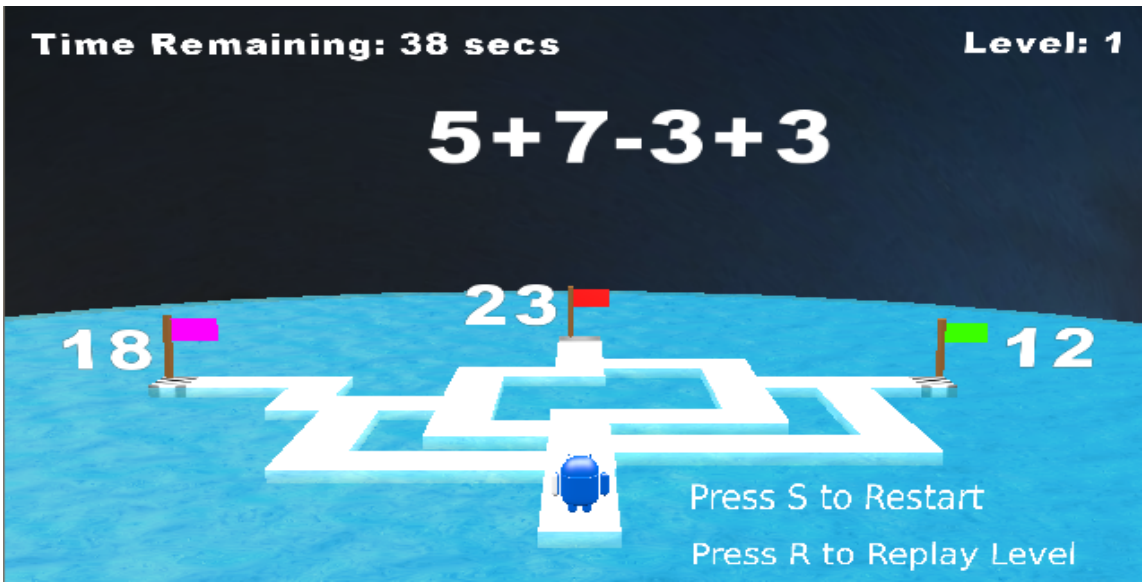


Figure 2. Example of Randomly Generated Equation

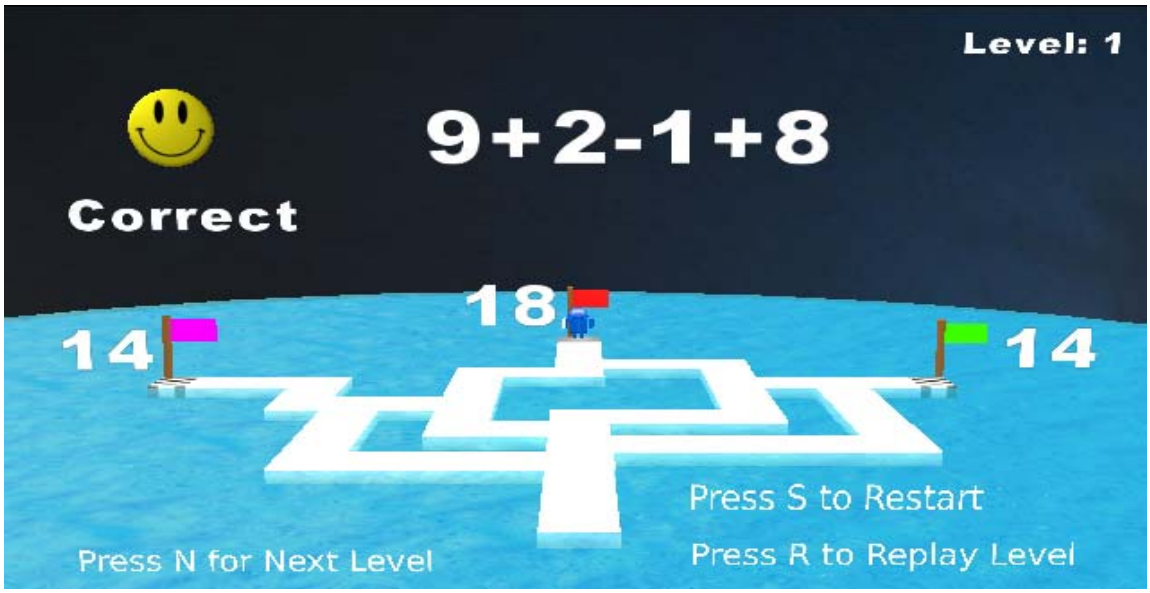


Figure 3. An instance showing user got the correct answer

The player is represented by a 3D object in the maze. The object moves along when relevant gestures are provided by the user through Kinect. The player needs to guide the object along the path leading to the correct answer. If the player gets the wrong answer, he can replay the level and sharpen his skills. Figure 3 shows an instance when the user got the correct answer.

Once the player gets the correct answer, he has two options: either to replay the level or move to the next level. Complexity of the equations increases with higher levels. Figure 4 shows a snapshot of level 2, where user has selected to solve the complex equation as compared to previous levels.

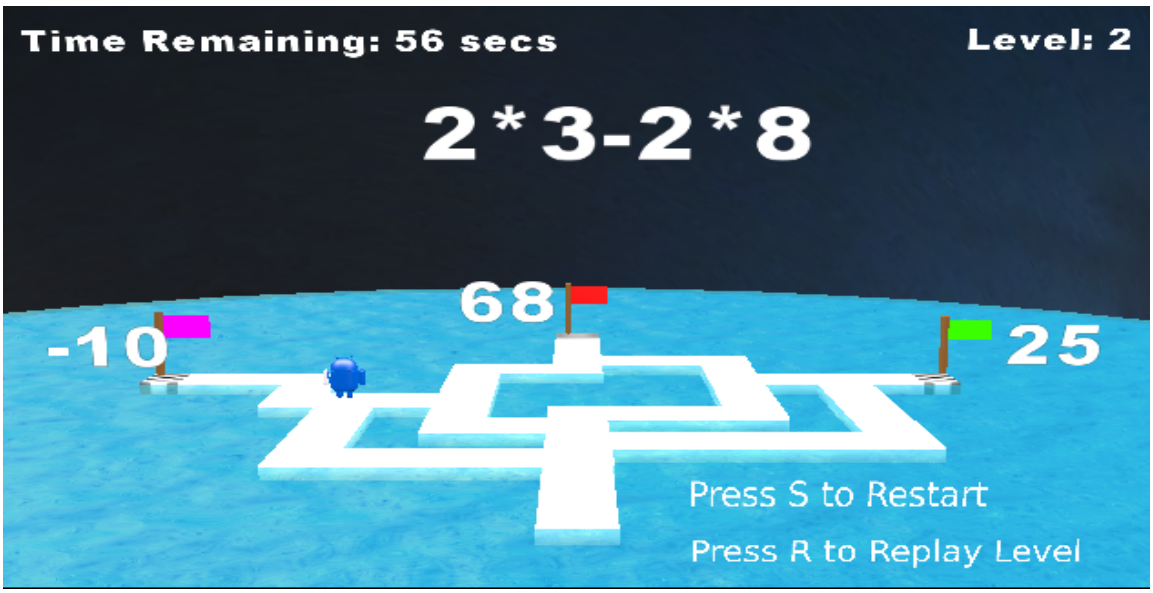


Figure 4. Complex Equations

Each level is timed so the player is not only expected to get the correct answer but to get it within the allotted time. Time available reduces with each level thereby training the user to calculate faster. As a result, user will learn to calculate faster while they are having fun. In this way, learning math using gesture improves the various skills of students. These are: (a) Logic Building - Equation solving improves student's mathematical calculation skills. This process repeatedly makes him/her faster and more accurate at calculation, (b) Kinesthetic - The use of gestures makes student more active in learning process and it in turn helps in reducing boredom and improves interest levels, (c) Spatial - It develops the sense of location and direction for the student. It improves student's spatial awareness as they move object through space.

**3. Conclusion**

'*Learning Math Using Gesture*' is an Open Source Project. The various tools used in this research such as Blender for modeling, FAAST for interpreting Kinect inputs are all open sources. As a result, this product will be freely available to all users. The key features of this approach are: (1) It is intuitive, i.e., users can interact with the objects using natural gestures. Although it is a virtual experience it will be as good as a real one. (2) Since, user's gestures are used to manipulate objects in real time; hence, this will enhance student's level of understanding as they will immediately see the consequences of their actions. (3) Students love playing Kinect games. Thus, by teaching lessons while they play games will improve their learning skills. Finally, we can say that '*Learning Math Using Gesture*' which gives an emphasis on repetition, practice and learner centric the most fundamental principles of e-learning improves the learner's mental mathematics skills.

**4. Future Scope**

Using the approach mentioned in this paper, we believe that it is possible to adapt it for creating more educational applications. For instance, to perform a chemistry experiment by each student will require separate chemicals. This involves chemical reaction, which will make the input chemical non-reusable. This increases the overall cost. On the other hand, performing the experiment in the virtual world involves no cost of tools, apparatus or chemicals as all they will be modeled using Blender which is free software.

**5. Acknowledgment**

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