

# **DISCENTES – A GESTURE TRACING INTERACTIVE LECTURE BOARD**

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**Abstract**— Technology is playing a very vital role in human life. New technological trends are the reflections of the demands and needs of the society. Today we have solved many social problems using technology. It has completely transformed many fields like transportation, education, space, industries etc and helped for the improvement of the society.

This paper presents the work done targeting the education sector. The idea is to provide a dynamic lecture experience wherein all concepts taught can be visualized clearly instead of just by equations and numbers.

Discentes is an interactive lecture board wherein gesture tracing, optical character recognition and the use of other sensors combine to give a tangible UI where the professor can see his equations and numbers come to life . The board is an minicomputer which functions as an advanced calculator to deal with vectors, equations, plots in an interactive way.

**Keywords**— *Gesture tracing, Optical character recognition, tracking algorithm, interactive lecture board, Real time computing, On board Internet access.*

## I. INTRODUCTION

The work basically focuses on providing quality education in the developing and underdeveloped world with minimal cost. Discentes is an attempt to provide a solution to all students having a problem visualising concepts and is an approach to a tangible learning experience.

This is the continued work of interactive lecture board published in International Journal of Advanced Computing [1].

The board is a conventional white lecture board mounted with a projector, camera, ultrasound sensor and a wii-mote (belonging to Nintendo). The projector displays the UI and the infrared camera of the wii-mote recognizes movements of LED's mounted on the hand of the user to trace movements. The camera is mounted so as to focus on an area where the

user writes coefficients of standard equations which will be read and plotted automatically.

For a better user experience the board has an ultrasound sensor which uses a tracking algorithm to detect the users distance from the board. This is used to zoom in and out in the user interface of the lecture board.

Additionally the board can be connected to any circuits to act as an oscilloscope in the class room. Hence lecturers can improve the teaching experience.

Totally the board contains five features-

1. Vector mathematics.
2. Plotting of equations.
3. On Board Oscilloscope
4. On Board Internet Access
5. Entertainment

## II. USER INTERFACE

The entire user interface as well as the operations was developed on open frameworks IDE: Code blocks. A clean clutter free UI was developed as shown in figure 1.

The options are given in bubbles which blow bigger and then shrink as the cursor is placed above them to give an aesthetic appeal. A click on any of the listed options takes you the relevant screens. The pointer is controlled using gesture tracing to navigate and select the options throughout the entire user interface.

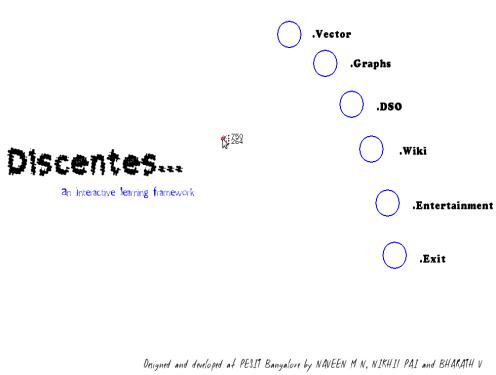


Figure.1. Screen shot of the home page of the user interface.

### III. GESTURE TRACKING

Nintendo's Wii-mote has two components that make it useful in this application – an infrared camera and Bluetooth. The infrared camera can detect the position of infrared LED's and this information is mapped to the movement of the cursor. A finger mountable '3-D mouse' was made for this purpose. It had 3 LED's out of which one was always on and the other two were controlled by a contact switch. The always on LED would provide the movement of the cursor whereas the switch controlled ones were used to emulate mouse clicks. This enabled the user to control the UI.

To provide an alternative control of UI an android phone implementation is used. This is a faster, accurate and more user friendly interface which uses a touch screen interface and Bluetooth to connect to the computer to control the mouse pointer. This is implemented using a standard application available in the Google Play Store for free. A small application has to be installed in the computer using which a Bluetooth connection is set up and the mouse pointer can be controlled.

Mobile Mouse Lite instantly transforms your Android device into an in air, wireless remote for your computer. Mobile Mouse Lite uses the built in accelerometer to translate your hand motions into mouse movements on your screen. It can also operate as a track pad remote, allowing you to control your computer with a single finger.

The application for this purpose is available on net. The Application provider is Mouse Lite. This application can be downloaded for free on Android Store. But the application which runs on the phone is not the complete package its only the transmitter program. The receiver Program has to be downloaded on to the client machine. The communication is not just limited to Bluetooth, the application allows user to connect over Wi Fi network.



Figure.2. Infrared 3-D Mouse

### IV. USER APPLICATION

#### A. Vector Mathematics.

The idea here is to allow the visualization of a 3-D vector space wherein a user can navigate through the space, draw vectors and perform vector mathematics. This was carried out on openframe works IDE- Code blocks.

A 3-D co-ordinate system was created i.e. x,y and z axis. Then a loop was used to create reference points all throughout the 3-D space going from 0 to 19 in all the axis directions. These points were numbered from 0 to 7999.

Each reference point could be mapped to a (X,Y,Z) co-ordinate location using the following algebraic equations-

$$x \text{ co-ordinate} = (\text{Reference Point Number}) / 400$$

$$y \text{ co-ordinate} = ((\text{Reference Point Number}) - ((x \text{ co-ordinate}) * 400)) / 20;$$

$$z \text{ co-ordinate} = ((\text{Reference Point Number}) - ((x \text{ co-ordinate}) * 400)) - ((y \text{ co-ordinate}) * 20))$$

These (X, Y, Z) locations were stored in an array and vectors could be drawn between points. The drawn vectors were appropriately named in the display and stored. Mathematical operations were provided in bubble options in the same as before. The user can turn the reference grid points on and off. Then by selecting draw, vectors can be drawn. All vectors drawn are referenced to the origin for better understanding and visualization. Mathematical operations can then be performed by selecting the relevant bubbles.

Special bubble option called draw is provided. This turns on an ultrasound sensor connected via an Arduino which uses

a tracking algorithm and senses the users distance from the lecture board. This information is used to zoom in or out of the 3-D co-ordinate space.

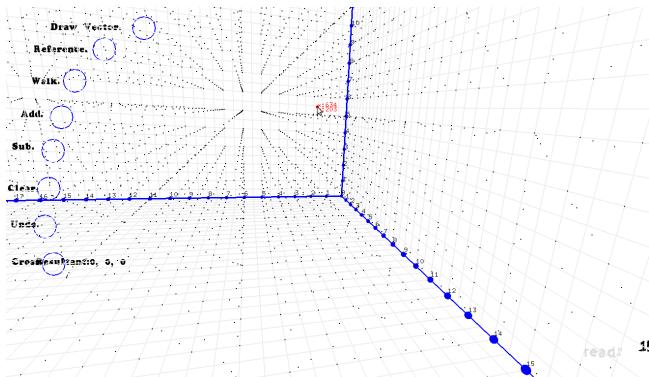


Figure.3. Screen shot of the reference points in 3-D co-ordinate system

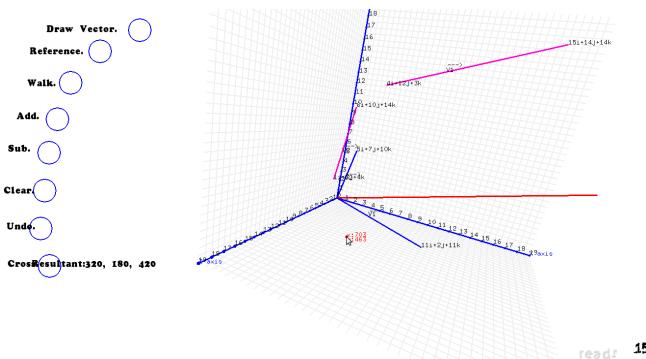


Figure 4. Screen shot of vector addition in 3-D co-ordinate system.

### B. Graph Visualization.

This module is aimed at achieving optical character recognition of digits and using this to plot useful graphs in real time in the class room. This gives easy and clear visualization of 3D objects such as spheres in the class room in real time. It can be used to explain concepts of flux or fields in 3D in subjects such as electromagnetics. A lecturer or student can choose an object to draw and then write the relevant values of the variables pertaining to the object selected on the lecture board. This will be captured by a webcam mounted on the board and then the object will be plotted with these values.

The GUI screen consists of standard geometrical figure representation that can be plotted on the 3D grid which can be panned and zoomed interactively, each of these standard figures can be selected one at a time or many at once and can be visualized on a graph screen. The geometrical figures incorporated are: Circle, Sphere, Rectangle, Cube. When the cursor is placed over the option the user will be guided as to what co-efficient need to be entered and in what order. The

coefficients are stored in an array and is used as a buffer so that it can be cleared and reused later for a different graph.

*Capture:* When this button is pressed the video capture module of python script is called and the webcam activates and a small pop up window of video appears on the screen. All the relevant coefficients that are present in the standard equations of selected geometrical figure is asked on the screen and the webcam is focused on the lecture board to capture the numbers/coefficients written . The OCR engine constantly captures the changes on the lecture board and all enhancement, optimization, conversion to greyscale image and comparison with reference image all happens background and it returns the digits that was written on the board, that is substituted in the standard equations and plotted.

*Draw:* When this button is pressed it takes us to the next screen which is the 3D grid screen as explained under vectors module. We can view the already plotted standard figure according to the entered coefficients on the screen, we can pane and zoom as to know where and at what location two figures intersect or the common area of cross section if more than one figure is plotted. Even here we have all the options like clear undo and back.

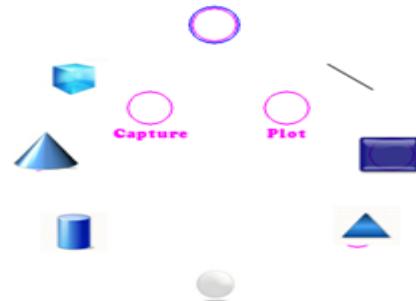


Figure 5. Screen shot of UI of Graph module.

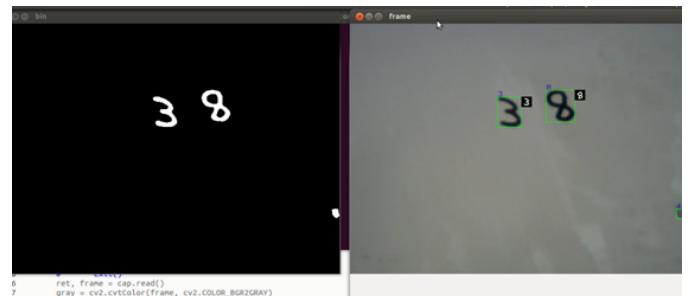


Figure 6. Screen shot of greyscale conversion and digit detection.

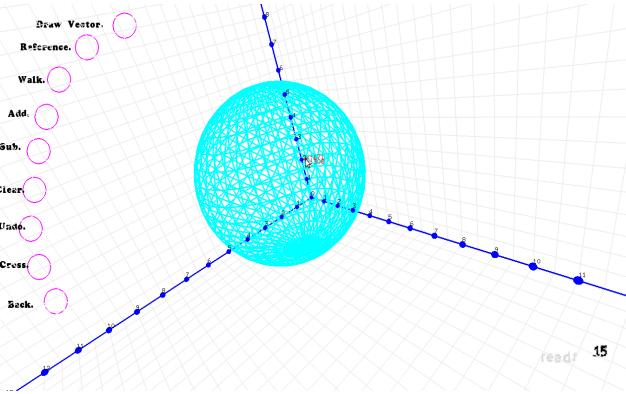


Figure.7. Screen shot of 3D shpere representation

Recognition process happens in back hand python code. First live video feed is taken and it is converted to binary image. Character recognition SVM is kept in the local folder. The a reference image having all the possible hand written number images is kept as a test image in the same folder. When the python code runs it compares the captured live image with the test image and runs SVM. The image which resembles closely to the handwritten character in board will be concluded as the data input. All these data will be written to a text file. As soon as this python code executes and terminates another code starts to run this code will pick the length of number of character written and writes to another file. This file will contain only the numbers which we need to plot the data. In the openframeworks code we have facility to convert the numbers which were received as text to integer.

#### C. On Board Oscilloscope.

Oscilloscope is a kind of electronic test instrument which keeps constant observation on varying signals, some of the devices are CRO (Cathode Ray Oscilloscope) and DSO(Digital Storage Oscilloscope). These devices are quite bulky in nature but may server for various purposes. They have their own small screen to display the variation in measured signal at real time by controlling electron movement. But making this device a virtual one just by projecting the real time variations of measured signal on a lecture screen makes its usage simpler, user tangible, understanding and reaches broader audience especially for classroom lectures.

The method that is implemented in this paper is, any time varying signal that is need to be visualized is tapped and fed to the relevant Arduino pins (analog/digital) and a short code that is running on Arduino measures the amplitude of the signal on a range from 0 to 1023, then this value can be scaled as per user requirement of units/div(Y-axis) representation on the screen interactively. In a similar way time/div(X-axis) can be scaled. Smoothening of signal is done by collecting various samples of amplitude and averaging it out, this is required because time variant signal can be continuously fluctuating in nature over a period of time and could be erroneous. This scaled and smoothened data from the Arduino is fed serially to the openFrameworks environment that is running on PC

which keeps reading data received serially through COM port(s). openFrameworks is an open source toolkit for creative coding and written in C++. Thus we have more user control on how things need to look on lecture screen giving even more and intuitive functionalities that are present in actual Oscilloscope to the virtual world. It is just a code running on your machine and a small device to measure the signals, this makes it highly portable and economical

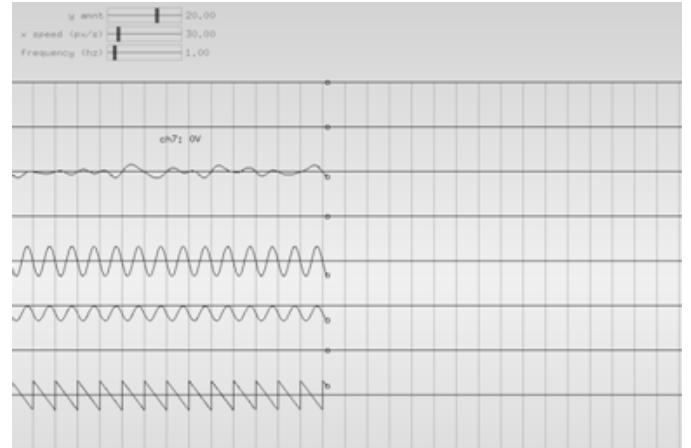


Figure.8. Screen shot of Sample signals that are generated.

#### D. Wikipedia

This module is meant for internet access. It opens a new window of the Firefox browser and connects you to the internet. Using this we can access information in real time in the class room. A teacher can introduce a new concept to the class by searching and displaying all relevant data on the lecture board from the internet via Wikipedia. The idea here is to make the vast internet accessible to the class room environment and aid in the whole teaching learning experience. Any search query can be linked directly to Wikipedia so that instant answers are available through world wide web in the classroom.

#### E. Entertainment

This module is provided for pure entertainment purposes. It opens a new window with a small game. This game can be controlled either by the wii remote interface or the android phone interface. Any puzzles or strategic games can be linked in this module and can help kids in developing their skills.

#### V. CONCLUSIONS

The paper aimed to bring a new trend in the technology with reference to education sector. The work presented in this paper can be implemented in technical colleges at decent expenses and can provide a quality education. The board provided a platform to merge many software and provided an intuitive interaction techniques with those software to the students and professors by preserving the traditional chalk and

board conventions.

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