Displaying curves and surfaces in Unity 3D system

**BACKGROUND**

Students of SCSE are required to understand how mathematical equations can be visualized as 2D and 3D shapes using the coursework software **FVRML**.

FVRML has many drawbacks:
- It relies on 3rd party vendors to provide support
- It is a language extension without GUI
- It is single platform - Windows-based and requires IE and Firefox to use

**CHALLENGES**

Design and make a new coursework software that can perform the same functions as the current software without the limitations of the old software.

New coursework software should be able to:
- Display curves, surfaces and solid objects using parametric and implicit functions
- Present an intuitive, easy to use GUI
- Run on multiple platforms - Windows, MacOS, iOS and Android

**PROPOSED SOLUTION**

Use **Unity 3D** as a development platform to make the new coursework software.

- Have a GUI-level oriented to novice/student level of the user
- Have more advanced user level feature supported at the script level of the Unity 3D system

**INVESTIGATION**

After 200 hours of investigation, Unity 3D is able to create a standalone software application to complete the challenges. The new software currently provides the following:
- Flexible GUI for editing of all the function scripts and their parameters with the ability to correct, undo, cancel and abort rendering
- Enlarge and Reduceable GUI
- Defining geometry of curves, surfaces and solids by parametric and implicit mathematical formulas within the GUI
- Defining visual appearance of these shapes by using mathematical functions
- Using time as another dimension/variable to animate shapes
- Saving and Loading
- Runs on Windows, Mac, iOS and Android devices

**ADVANCE FEATURE**

Additional tests have shown that Unity 3D is capability and available for advance users.
- Physics, simulated gravity and wind can be applied to objects
- Multiple objects can be define in one scene
- Objects can collide and bounce off from each other
- Advance object appearance control using scripts and can be loaded from various online libraries.
- Generation of objects can be done on the GPU to increase generation speed.
- Scene can be introduce as an interactive or puzzle room as a gamification to the coursework to entice students.
- Objects can be saved and loaded into another 3D software.

**USER STUDY**

A total of 58 participants was provided a demo software to try. User feedback shows that:
- New software is **easier** to use compared to the old software because of the proposed GUI system.
- New software is more **convenient** to run on multiple systems without requiring internet browsers.
- New software is able to create shapes with similar speed and **greater visual quality** compared to the old software.
- Participants expressed willingness to **see improvements** done on the new software.