Proposal submitted to MHRD for the **National Mission on ICT in Education**
under the thrust areas

Adaptation & deployment of open source simulation packages
&
Development and realization of Virtual Reality Laboratories

**Development and deployment of open source 3D animations using BLENDER**

Principal Investigators:
Sameer Sahasrabudhe & Prof. Sridhar Iyer

Department of Computer Science and Engineering
Indian Institute of Technology Bombay
February 2009
Development and deployment of open source 3D animations using BLENDER


Executive Summary
This project aims at using open source 3D animation package – Blender, to create virtual lab experiments for the subjects in undergraduate engineering. Information about Blender is not yet known to Indians; hence, we propose to create audio-video teaching tutorials in Indian languages to popularize Blender. We also intend to use Blender for 3D content creation for academics. An important initiative of this project is to create a web based repository of open source 3D animations for academic usage.

Goals
The main goals of this project are in five interlinked broad areas:

1. Creation of detailed eLearning material for imparting information on the use of the open source software: Blender
2. Building up a virtual repository of Blender laboratory components (from various disciplines of the UG engineering like electrical, mechanical, chemical etc)
3. Creating Blender animations for laboratory experiments using the components.
4. Popularizing Blender in India at UG engineering colleges and universities
5. Usefulness study and impact assessment of the eLearning material created.

Three auxiliary goals of the project are:

1. Providing training opportunities to large number of students aspiring for a career in animation.
2. Empowering students from any part of the country to use and participate in this effort.
3. Translating the developed material in Indian languages.

Deliverables Overview (over a period of 3 years)

1. 100-130 open source audio-video tutorials for Blender training in English, Hindi and few other Indian languages.
2. Repository of components required for 100-120 lab experiments using Blender of UG engineering subjects as mentioned earlier.
3. 30-50 Blender animations for lab experiments in the subjects like Electrical, Mechanical or Chemical engineering domains for the undergraduate level.

Funding Requested
The total budgeted estimate for the project (for three years) is Rs. 1 crore, 92 lakhs

(Details can be seen in section 4)
Implementation Methodology Overview
The project implementation is planned in four stages. The first stage will comprise of training and preliminary trials of the software. The next stage will involve creation of tutorials for imparting information. The third stage would be of translating the tutorials to Indian languages and creation of a repository of components of lab experiments in open source. The final stage would comprise of creating animation of lab experiments in various subjects.
A detailed usefulness and impact analysis is planned at the end of the project to provide guidelines for the future work in this area.

Target Beneficiaries
Students in approximately 4000 engineering colleges: Assuming the content is distributed to 1000 colleges and each college has 100 students, the total number of students who would benefit will be 1 lakh per year and 3 lakhs in three years and many more lakhs of students in the years to come.
Students in the distant education mode: The number of students opting for distance education is continuously increasing. It is estimated that at least 10 thousand such students would benefit annually.
Students in Sciences stream: Assuming that the content is distributed to 1000 colleges and each college has 200 students, the total number of students who would benefit will be 2 lakhs per year and 6 lakhs in three years and many more lakhs of students in the years to come.

Some sample 3D models created using Blender
Project Details:

1. Motivation:

Laboratory experiments (labs) are an important component of science and engineering education. Hands on sessions in lab offer an experience of handling the actual components and performing the processes in person contributing significantly to student learning. In developing countries such as India, the most common problems faced in setting up of a lab are: quality of infrastructure, availability of skilled manpower, and maintenance issues.

In such conditions, using multimedia based eLearning to augment the lab experiments is an attractive solution. Additionally, multimedia could also enrich and improve the learning experience. Multimedia based eLearning typically comprises of camera videos, and animation. These mediums can facilitate visual communication. They are able to show change over time, are portable, and can be interactive. Most researchers agree that these solutions cannot replace the instructors, but they can be certainly used as additional aid for the students to understand the concepts.

Audio-visuals (Camera videos) are preferred in certain domains where reality of the visuals would be more convincing for the students. On the other hand, animation provides the ability to add motion to static diagrams (given in books). Two dimensional (2D) animation is widely prevalent, and has been shown to be successful in many areas. Advent of three dimensional (3D) animation has expanded the possibilities and scope of the content in many ways. 3D animation not only continues to have the advantages offered by 2D, like interactivity and reusability, but also adds a whole new dimension of visualization possibilities. It makes it feasible to go beyond the flat view and see the experiments/models from any angle. For example: Internal organs of human body right up to micro/nano level of DNA strands, walkthroughs in a solar system and cross sections of mechanical engines.

Sample of a 3D model created using Blender for a Chemical experiment
Content creation with 3D animation is often a costly proposition. The cost of proprietary software, high end hardware to support 3D graphic display in real time, and need for trained personnel, make it a costly medium. Hence the reach of 3D animations in eLearning has not extended as expected, especially in developing countries.

**Blender** is a free open source 3D content creation suite, available for all major operating systems under the GNU General Public License (Blender website, 2009). It supports a variety of geometric primitives, including polygon meshes, and fast subdivision surface modelling. It has advanced tools for key framed animation, including inverse kinematics and armature (skeletal). It also has a game engine for adding interactivity to the animations. Blender has been used currently in different entertainment domains like animated movies, short films, television commercials and gaming.

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<td>Not as CG &quot;industrial&quot; standard - Fast workflow, can be more intuitive</td>
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*Comparison Chart showing comparison between Blender and other available 3D softwares.*

We have found that Blender has most of the desired features to create the eLearning 3D animation. Therefore we would like to popularize Blender, and encourage its use for academic purposes. Formal training and certification of Blender is currently not available in India. In fact the information about this open source software is very limited, and most of the content creators are unaware of it. Majority of the content creation in 3D is done using the proprietary tools available, but the cost of the software and training makes it a costly proposition.
2. Methodology:

Stage 1: Training of Developers & Preliminary trials:
- Training: The initial period of approximately 3 – 5 months would be utilized for training the developers and the animators for the Blender software. It would be conducted through various technical experts and consultants coming to IIT Bombay, as there is no formal facility of Blender training in India.
- Preliminary trials
  Parallel to the training program, the developers would start creating some sample e-learning content. This could be related to various lab experiments from undergraduate engineering education. The output of these trials would be tested by conducting a usefulness study at the end of First year.

Stage 2: Creation of tutorials:
Blender training is mostly available in online formats. They include web-based tutorials, video tutorials etc. The medium of instruction available is mostly English. Blender is divided into four areas. They are
- Modeling, Texturing, Materials, Lighting etc
- Animation, Rendering
- Interactivity, Game engine
- Python Scripting

Under this project we would be creating approximately 4-6 tutorials of important topics in each of the above mentioned areas. These would be web-based and would have sufficient visual support in terms of screenshots, images or videos.

Stage 3: Adaptation of tutorials in Indian languages:
The Blender tutorials created earlier would be adapted to our national language -Hindi. Subsequently based on the demand and the availability of translators, dubbing artist we would be adapting the tutorials to other Indian languages. This has potential to benefit large number of student users from various states of India.

Stage 4: Building up a repository of Lab experiment components using Blender:
Keeping in view the above perspective a pilot project was undertaken at IIT Bombay and was titled Project OSCAR (Open Source Courseware Animations Repository). The aim was to create a repository, of educational courseware with animations using JAVA, for independent and distance learning, whose contents are open sourced. At present, about 100 animations available across various disciplines have been created. Details of the project are available at the website http://oscar.iitb.ac.in/ and are provided in Appendix I at the end of this proposal.

The contents at present uploaded on the project Oscar website are mainly created using JAVA and are two dimensional (2D). We plan to extend the scope of this website by adding
repository of three dimensional (3D) lab experiment components. These would include all the components required to perform lab experiment and would be created in 3D using Blender. The advantage would be whenever users would be required to create a virtual experiment; the components would be readily available in 3D form in open source. We feel that this has a potential to benefit large number of students and even teachers who can use this virtual labs for augmenting the existing lab teaching.

Stage 5: Creating Animations for the Lab experiments:
This would be a crucial stage in the project as we would be creating animations of the actual lab experiments. The components created in the earlier stage would be used for animation. The programming logic built in Blender like collision detection & fluid dynamics would be used to animate the experiments. We propose to add supportive audio to the 3D animation of the experiment.

Stage 6: Assessing usefulness and impact:
The content created using Blender would be interactive 3D animations of the lab experiments. Usefulness studies would be conducted based on these animations with the help of the major users of the content, like the students, lab instructors, and the faculty. The impact of the content would be assessed by conducting pre and post test methods.

3. Deliverables:

3.1 Creating Audio Video tutorials for teaching Blender:
In this project we plan for creating systematic training segments, which will enable in extending the reach of this software. Keeping this in view, we have planned for creating tutorials for Blender training. The available resources for this are in English, and the presenter’s accent makes it difficult for the Indian users to comprehend. Blender training can be divided into 4 main modules: (i) Modeling, Texturing, Materials, Lighting. Etc, (ii) Animation, Rendering, (iii) Interactivity, Game engine, and (iv) Python Scripting

We plan to select 6-10 important topics from each of the module mentioned above to create the tutorials. Initially we plan to create the tutorials in English. In subsequent phases we have plans for translating, or recreating all the tutorials in Hindi. Further we would be creating the tutorials in other Indian languages based on the requirement, and the availability of translators and presenters.

3.2 Creating components of UG lab experiments in Blender:
The next phase of the project would be focused on creating components required for the various lab experiments. These would be typically selected from the UG engineering domains like electrical, mechanical, chemical etc. The deliverable in this phase would have a complete sets of the components required for performing a given experiments. We plan to select 10-12 experiments from each domain and create the set of equipment for the same.
3.3 Creating 3D animations for the lab experiments:
In the subsequent phase we propose to create animated version of the lab experiment. The entire set of the components would be created in the earlier phase. The important task in this phase would be to create the interactive 3D animation of the experiment, which can demonstrate the actual process.

3.4 Year wise detailed plan for the deliverables:

1st Year
- A completely trained team of 10 Blender developers and animators.
- 5-6 audio-video tutorials in English for teaching Blender.
- 3-5 test animations of lab experiments from UG engineering education.
- Components creation for 5-6 lab experiments.
- Building up an open source repository of Blender objects for academic purposes.

2nd Year
- 20-25 Audio-Video Tutorials for Blender training in English.
- 30-40 audio-video tutorials translated from the available English tutorials created earlier.
- Components created for around 20-25 lab experiments.
- 3D interactive animation for 8-10 lab experiments from UG engineering.
- Usefulness analysis of the content created so far.

3rd Year
- 25-30 Audio-video tutorials for Blender teaching in English.
- 55-60 audio-video tutorials translated from the available English tutorials created earlier.
- 3D interactive animation for 25-30 lab experiments from UG engineering.
- Impact assessment report of the tutorials, and the eLearning content.

A bar chart representation of the timeline is given below:
4. Budget

The details of the budget are presented in a tabular format below:

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5. Brief description of the key persons who are involved in this project (500words)

Sameer Sahasrabudhe is a Project Manager in the Department of CSE, IIT Bombay. He is a graduate of Fine arts and a Animation film maker. His animation films have been screened at national and international film festivals, and have won awards. He has been associated as Studio Manager with the Distance Education Program of IIT Bombay during its inception stage. He is an Academic Council member with Yashwantrao Chavan Maharashtra Open University Nashik, India. He can be reached at s1000brains@iitb.ac.in

Sridhar Iyer is an Associate Professor in the Department of Computer Science & Engineering at IIT Bombay. His research interests include: eLearning technologies, networking protocols and multimedia tools for distance education, wireless networking and applications, and some areas in program/protocol verification. Sridhar Iyer received his BTech, MTech and PhD from the Dept of Computer Science & Engg at IIT Bombay. He is overall coordinator (Principal Investigator) of this project. He can be reached at sri@iitb.ac.in
Note:
The softcopy of the proposal is being uploaded on Sakshat web portal, and the hardcopy is being forwarded through Dean (R&D), IIT Bombay.

The potential reviewers for the project could be:

Dr. Arun Nigvekar
Former Chairman, UGC, Raja Ramanna Fellow, Senior Advisor, Science & Technology Park, University of Pune Campus, Pune
narun42@gmail.com, narun42@hotmail.com

Prof. Mohan Deshpande
Consultant, Engineering education, GH Raisoni College of Engineering, Nagpur
mudeshpande@gmail.com

Dr. M Sasikumar
Senior Research Scientist, C-DAC, Mumbai
sasi@cdacmumbai.in

Prof. KR Srivatsan
Pro Vice Chancellor, IGNOU

Documents attached:

Appendix I: Case study of an experiment created using Blender (3 pages)

Signatures

Sameer Sahasrabudhe   Sridhar Iyer   Dean (R &D)
APPENDIX I

Case Study:

We are in process of creating a 3D animation model of an experiment from the UG lab of the chemical engineering department. We present the preliminary work done regarding this experiment in this case study. This particular experiment of VLE is suitable to test our design goals since it is from the UG lab and has a complex assembly of glass apparatus with motion of fluids. As shown Figure 1 the two important parts of the apparatus are: (1) Vaporizer, and (2) Flash chamber or the Equilibrium chamber. The assembly of four concentric glass flasks in the equilibrium chamber has a peculiar position, and the printed diagram of the same is difficult to comprehend. The students have difficulty in visualizing the actual assembly (Figure 2) and the motion of the fluids by referring to the 2D diagram (Figure 1). The experiment is conducted real time, and it becomes difficult to register the details of the flow.

![Figure 1: Diagram of the VLE experiment](image1)

![Figure 2: Actual photograph of the experiment](image2)

![Figure 3: 3D animation model of the experiment created using Blender](image3)

The lab instructor explains this experiment using the manual mentioned above. It is a PDF document consisting of a detailed description of the procedure, the chemical equations and a labelled diagram of the apparatus as shown in Figure 1. The faculty for this course expect a 3D animation as an additional aid to the lab instructor. They are also curious to explore the effectiveness of using 3D animated models to explain the lab experiment. They are also interested in the other benefits like anytime access to the content, ease of portability, etc.
The decision of using 3D for VLE experiment was justified by the faculty instructor, and the students in unison. The instructors were particularly happy for the multiple viewpoints to explain the intricate steps in the process. The students were excited about the new medium, and found it easier to visualize the VLE apparatus using the animation as compared to the diagram. The faculty was satisfied with the quality and correctness of the programming. They were pleased with the interactivity and portability of the solution. We also found that 3D enabled lab sessions would be able to enthuse students towards lab experiments.

**Figure 4:** Blender software screenshot showing different view ports.

**Figure 5:** Image of the cross section

**Figure 6:** Modelling details
We found that Blender can be useful for animation in the eLearning domain. It has most of the components necessary to model, apply texture and animate almost any object. It has features comparable to commercial, proprietary, high end and mid range 3D software such as mesh collision detection, LBM fluid dynamics, Bullet rigid body dynamics, particle system etc. Blender’s ability to deploy the programming logic to the different ingredients in the experiment like water, glass and other chemicals is suitable for the project requirements.

The Blender game engine allows the creation of stand-alone, real-time applications ranging from architectural visualization to video game construction. Adapting its features to build more advanced experiments for eLearning is of great value. We are studying the use of Blender for more detailed lab experiments in various domains.

________________________________________________________________________

Signatures

Sameer Sahasrabudhe       Sridhar Iyer       Dean (R &D)