

# Computer Graphics as a Space Journey and as a Murder Mystery

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Figure 1 : Frames from some of the animations created by the students in the “Mission Atlantis” story.

## Abstract

Story centered curriculum (SCC) is a novel method of instruction that is well-suited for online learning over the web, where the physical presence of the instructor is minimal or even missing. A new introductory course on computer graphics (CG) has been developed and tested, in which the student participates as an actor in a story. Two stories have been designed to capture the two facets of CG – that as a direct and as an inverse problem, and to motivate the student to explore the synergy between the two.

In the first story, the student is a member of the simulation team of *NASA*, building virtual reality (VR) models for the next space journey. In the second story, the student is a detective investigating a murder that happens in a museum.

## Keywords

Teaching CG, virtual instructor, online learning, story-centered curriculum

## 1 Introduction

Computer graphics is an important course in most undergraduate curricula of computer science. A typical introductory course on 3D Computer Graphics can be broadly divided into four sections - 3D geometric transformations, camera projection models, lighting models and visibility.

These four topics constitute four weeks of instruction. Our course was conducted for a period of one month, during which time the students have worked exclusively on this, the effort being equivalent to that of a typical undergraduate course spanning one semester.

CG is both a theoretical principle and a practical art. Thus, it is possible to distinguish two ways of understanding CG. The first way is a direct problem, which is that of creating a VR scene. This job is most well done by artists, with the help of sophisticated tools such as Maya. The second way is an inverse problem, which is that of observing the VR scene, and understanding the mathematical principles behind the rendering of the scene. This job is well suited for computer programmers, the knowledge of which helps them in creating efficient graphics algorithms, which go behind the tools that are used by the artists.

In the four weeks of instruction of the CG course, the student acts through two different stories, there by understanding the two different facets of CG.

The course was administered as part of the MSIT (Masters of Science in Information Technology) program. This program is a hands-on approach to training software engineers, through the principle of learning by doing. [2]

## 2 A Space-Flight to the Moons of the Saturn

This story is created as a direct problem, and the several tasks in the story provide a gentle introduction to CG. The objective is to let the computer science student appreciate the task of the artist, without resorting to any high-end software tool. They were permitted to use the OpenGL programming API. However, the nature of the story permits them to create very realistic scenes, regardless of the restrictions.

“**Mission Atlantis**” starts in a futuristic scenario set in 2010. A robotic mission dispatched to the moons of Saturn makes an amazing discovery - the presence of life forms on Titan. This sparks several interesting questions about the metabolism and the level of advancement of these life forms.

NASA plans “Mission Atlantis”, a manned expedition to the moons of Saturn. The ground crew prepares several simulations to help the astronauts in training and rescue operations. As a member of the simulation team, the student builds some animations, and the several topics of CG are introduced over the 4 weeks.

Week 1	Basic model of the cockpit of the spacecraft
Week 2	Moving a camera inside the cockpit. Making a fly-by of the spacecraft through the rings of the Saturn
Week 3	Landing the spacecraft onto the surface of Titan. Simulating darkness in a low power scenario, and identifying objects using a torch light
Week 4	A flight simulation game through an asteroid belt.

Table 1 : Tasks in “Mission Atlantis” over the four weeks

This has proven to be a great story for motivating the students, as they learnt about inter-planetary travel and astrobiology, along with the principles of CG. Also, since the geometric complexity of the objects is minimal, the students were able to produce strikingly realistic scenes.

### 3 A Murder in the Imperial War Museum

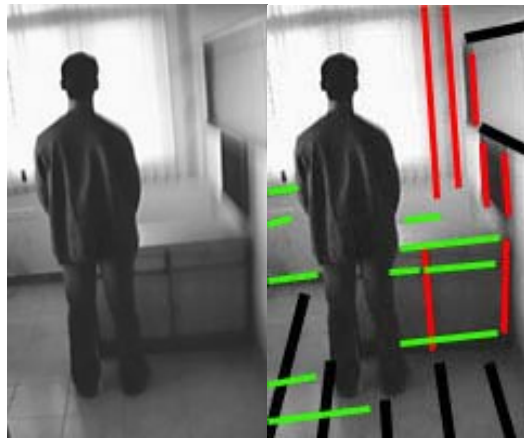


Fig 2 : A still of the murderer captured by a surveillance camera. The students have to use the parallel lines in the image to identify the culprit’s height

This story is created as an inverse problem. The designed problems were presented as challenges to the student at the end of each week. These problems are mathematically intense and a few of them draw inspiration from recent advances in computer vision and image processing.

“The Trafford Case” is a story is set in a fictional place called the Imperial War Museum, in the city of Trafford, England. The museum oversees a multi-storey parking lot on the other side of the road. At late night, a man is murdered while trying to retrieve his car. Circumstantial evidence pinpoints the culprit to between two people working night-

shift in the museum, and nobody beyond. The gun that is used for murder is an exhibit in the Imperial War Museum. The fingerprints on the gun are soiled by both the suspects.

The loose ends of the crime are the holes left on the window panes of the car by two bullets and an extremely bad picture of the murderer taken from a surveillance camera inside the museum. It is not possible to identify the features of the person by observing the photograph (Fig 2). As a detective, the job of the student is to calculate the height of the person in the photograph and cross-check it with the evidence found from the bullet holes on the window panes.

These problems serve to complement the knowledge acquired by the student through the direct problems in the “Mision Atlantis” story.

The measurements of the parking lot are taken and a 3D model is reconstructed. The student is also provided with the 3D model of the car of the victim, and the measurements of the bullet holes on the window panes of the car.

The first bullet hits the front window pane and misses the victim. It escapes through the back window pane. The victim frantically applies the brakes in horror. But the second bullet hits the right window pane, and then strikes the victim’s temple fatally.

The challenge of the student is to assign global 3D coordinates to the various points, and then trigonometrically calculate the height of the person who has shot the bullets.

This evidence is then cross-checked with the photograph. This is an uncalibrated setting (the parameters of the camera are unknown). The challenge is to make use of the parallel lines in the image and identify the height of the person relative to a cupboard which is present in the image. (Refer to Figure 2)

This involves thoroughly understanding the geometry of perspective projections. The students are referred to the paper “Single View Metrology” by Criminisi et al. [3]

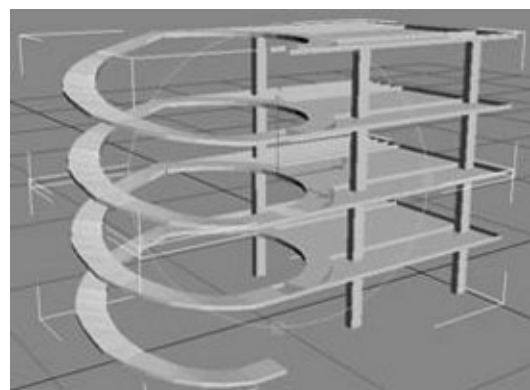


Fig 3 : The architectural model of the multi-storey parking lot. The victim gets shot as he drives his car through the spiral staircase.

The advantage of using a crime scenario for setting these problems is obvious. The sense of curiosity imbibed in the story is a big motivation for the student to learn the intricacies of the underlying mathematics.

#### 4 Conclusion and Future Work

The attraction of the story centered curriculum is that the learning experience is self sufficient without the need of an instructor. And the story offers an entertaining and engrossing experience to the students. The designer shall also have the chance of interconnecting the several problems and of presenting a holistic learning experience.

This methodology is well suited for online environments where the students are dispersed over several geographical areas. This is a particularly happening scenario in today's inter-networked world. In developing countries such as India, where the ratio of qualified instructors to the students is poor, this provides a very promising alternative.

In the future, we intend to continue this work. Particularly, there is scope for designing several interesting inverse

problems in other areas of CG such as lighting models and visibility graphs.

#### 5 Acknowledgements

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#### 5 References

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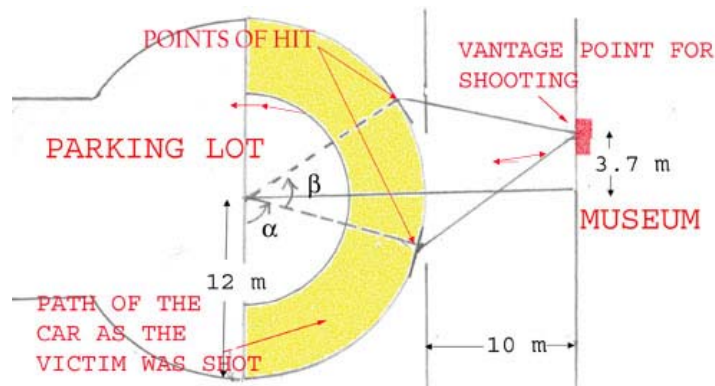


Fig 4 : A blue-print of the architectural model of the museum and the parking lot, that was given to the student as part of "The Trafford Case"

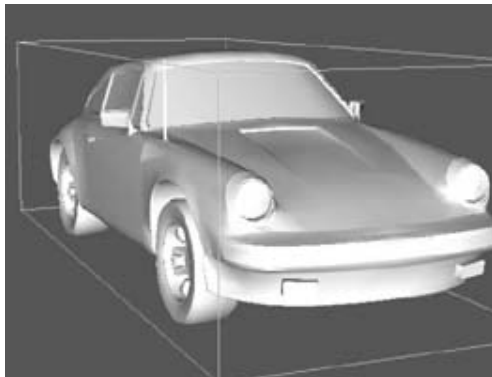


Fig 5 : The car of the victim in "The Trafford Case"

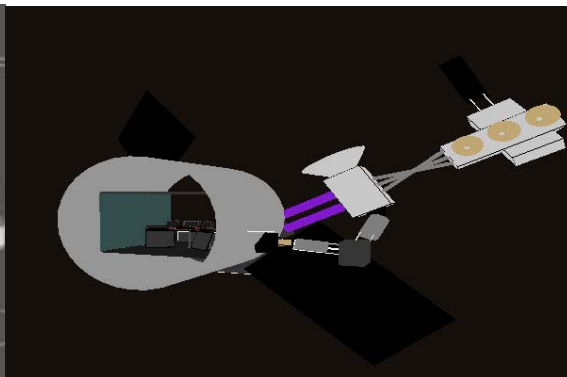


Fig 6 : A robotic arm being operated through virtual reality in "Mission Atlantis"