HIGHER TECHNICAL INSTITUTE

COMPUTER STUDIES COURSE

DIPLOMA PROJECT

ANALYSIS, DESIGN AND IMPLEMENTATION OF A GRAPHICAL PENDULUM SIMULATION PROGRAM

NICOLAS EPAMINONDA

CS/397

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by

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SUMMARY

ANALYSIS, DESIGN AND IMPLEMENTATION OF A GRAPHICAL PENDULUM SIMULATION PROGRAM

The idea of this project was originated from the great Foucault's pendulum that stands in the middle of the Realfagbygget building in the campus of NTNU in Trondheim, Norway. This is a huge pendulum that stands from the top ceiling to the ground floor, where a huge ball is hanging from it. This pendulum gave me the idea of making this project and I believe that I can achieve it.

As from the very beginning, this project was considered as one of great difficulty, requiring a lot of time and knowledge in programming. The four months provided for the projected seemed rather inadequate. The material to study from was also quite unfamiliar to me and taking in mind that I had no knowledge in physics or applied mathematics, except what I was taught by the lecturers of HTI, it seemed to me a challenging project to be achieved.

Moreover, I had the luck to take the C/C++ Programming Language course and the Computer Graphics course, which, for me, was a plus. These two courses were the ones that provided me with the special programming skills I needed in writing the code for this project. But, most of all, I needed a greater understanding of the physics behind the oscillating balls.

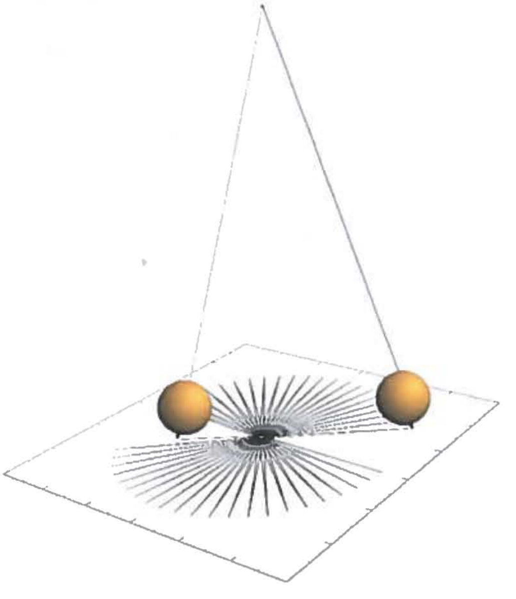
The building of such a program required a lot of dedication and hard thinking. Algorithms for the string and balls oscillations were not similar and very difficult to be produced and, in addition, the formulas used to make the oscillations look more realistic were difficult to make.

Surely, this project will be not be my last, but will be the first of the many more to come, and hopefully, the next ones will be more exciting.

INTRODUCTION

As an introduction to the design of the simulation program, it would be a good idea to look at some facts and history regarding pendulums.

THE FOUCAULT PENDULUM



In 1851, Léon Foucault, A French physicist, demonstrated the rotation of the Earth on its axis by his new invented Foucault pendulum, or Foucault's pendulum, named after him, by suspending a 67-metre wire from the dome of the Panthéon in Paris.

The Foucault pendulum is a tall pendulum free to oscillate in any vertical plane and capable of running for many hours. It is relatively a large mass suspended from a long wire mounted so that its perpendicular plane of swing is not confined to a particular direction and, in fact, rotates in relation to the Earth's surface. Foucault first pendulums of this type, consisted of a 28-kilogram (62-pound) iron ball suspended from the dome of the Panthéon in Paris by a steel wire 67 m (220 feet) long and kept in motion by a mechanism. The rotation of the plane of swing of Foucault's pendulum was the first laboratory demonstration of the Earth's spin on its axis.

While any Foucault pendulum swings back and forth in a plane, the Earth rotates beneath it, so that relative motion exists between them.

But is the plane of the pendulum's swing fixed in space? It is worthwhile correcting a common misunderstanding about Foucault's Pendulum. It is sometimes said that the pendulum swings in a plane which is fixed with respect to an inertial frame, or more poetically that the Earth rotates underneath the pendulum. This is true at the poles and also true for a pendulum swinging East-West at the equator. At all intermediate latitudes, however, the plane of the pendulum's motion rotates with respect to an inertial frame. (Remember that the point of suspension of the pendulum is accelerating around Earth's axis.)

At the North Pole, latitude 90° north, the relative motion as viewed from the plane of the pendulum's suspension is a counterclockwise rotation of the Earth once every 24 hours; whereas the plane of the pendulum as viewed from the Earth looking upward rotates in a clockwise direction once a day. A Foucault pendulum always rotates clockwise in the Northern Hemisphere with a rate that becomes slower as the Equator is approached. Foucault's original pendulums at Paris rotated clockwise at a rate of more than 11° per hour, or with a period of about 32 hours per complete rotation. The rate of rotation depends on the latitude. At the Equator, 0° latitude, a Foucault pendulum does not rotate. In the Southern Hemisphere, rotation is counterclockwise.

The rate of rotation of a Foucault pendulum can be stated mathematically as equal to the rate of rotation of the Earth times the sine of the number of degrees of latitude. Because the Earth rotates once a day, or 360° every 24 hours, its rate of rotation may be expressed as 15° per hour, which corresponds to the rate of rotation of a Foucault pendulum at the North or South Pole. At latitude 30° north, for example, at Cairo or New Orleans, a Foucault pendulum would rotate at the rate of 7.5° per hour, for the sine of 30° is equal to one-half. The rate of rotation of a Foucault pendulum at any given point is, in fact, numerically equal to the component of the Earth's rate of rotation perpendicular to the Earth's surface at that point. (http://www.juliantrubin.com/bigten/foucaultpendulum.html)