A Team Report

Obstacle Avoidance - Walk in the Road

A Proposal Project Report
Presented to
The Department of Engineering & Computer Science
Concordia University

In Partial Fulfillment
of the Requirements of
COMP 471

by

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1. Abstract

Obstacle avoidance is one of the key components in robotics. For a detecting mechanism, anything that is on its path will be considered as an obstacle. In order to avoid obstacles, counter measures such as finding a detour within the constraints, dodging depending on the mechanism, etc., are applied. This collision avoidance technique will be considered obstacle avoidance. This feature could be interpreted and implemented in several ways having different degree of abstraction and complexity. This obstacle avoidance concept could be either found in some critical real-time applications such as bio-medics, security, etc., or in any purely entertainment based realm such as amusement and computer games.

We could analyze objects avoidance notably in three main categories. In the first case, there will be a detecting mechanism in the motion which has to determine its path depending on the static objects that it would encounter. In the second case, there will be a detector stationed in a certain location and it will be dodging within a certain parameter from the randomly or deterministically moving objects. In the third category, all the objects that are obstacles for the detector and the detector itself would be in motion. Further to the above categories, we could also come up with systems that are customized according to the requirements and own creativity. [2]

In the scope of our project, we have adapted real-time motion detection and controlling system coupled with the human interaction that will be actuating and performing the obstacle avoidance. Not like any other complex robotic systems that are fully automated with the artificial intelligent capabilities, the system that we are building will be requiring human interaction. Decisions will be made by the user as how and when to make a movement to avoid an obstacle, and only the detection and processing is done by the computer system. Reaction and the current position correction will be done by user by observation with the naked eye upon the oncoming objects. Depending on the user's movement, the system will change its state.

2. Origin of the name and URL

We have named our project "Obstacle avoidance – Walk in the road". This project is hosted in the following URL: http://www.ece.concordia.ca/~sv_venga. Obstacle avoidance is such a topic that is being used widely in several research fields. [1] Thus, just to make it more comical, we have added the phrase "Walk in the road" since we don't usually walk in the road but in the pavement.

3. Introduction

We have a continuously flowing road projected on a screen. The flow of the road is bidirectional. This road will be having conventional objects such as vehicles, road blocks, people (no pedestrian walk and people will be walking on the road), etc. The road emerges as a flow from the top of the screen, comes down towards the floor, and continues on the floor for a certain distance. In front of the display screen, we will be having a location where a person stands as shown in Figure 1 in order to interact with the system. Once the person is on that spot, he or she would have already started getting the virtual feeling of the motion.

There are four ways that one could interact with this system, and they are forward stepping, backward stepping, right hand waving and left hand waving. Stepping forward makes the road to flow downwards and accelerate, whereas the backward stepping makes it to decelerate the frontward motion and reverse the flow of the road in the bottom-to-top manner. This will create a virtual feeling that the person is going backwards in reverse. To step front or back only right foot is used. Right hand waving makes the user to virtually feel that he/she is drifting rightwards and left hand waving for leftward drifting. Hands waving are expected to be mutually exclusive in order to be recognized by the system. However, if both of the hands are waving or hanging down, such situations will be regarded as no change in the state in terms of the simulation. If an object comes forward and the user doesn't drift sideward then nothing happens. The road will keep flowing from the top.

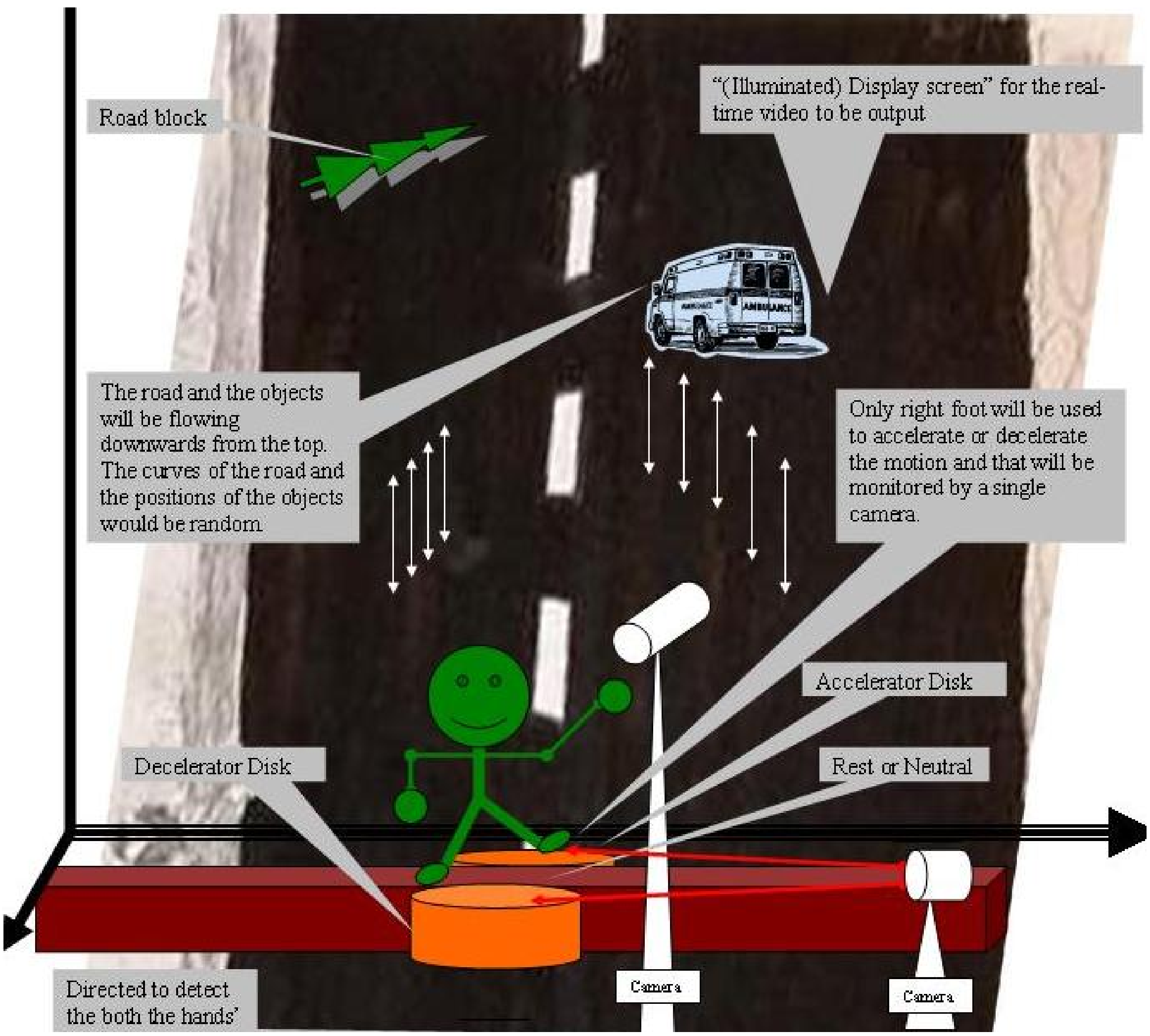


Figure 1: Depiction of the "Obstacle avoidance – Walk in the road" system

4. Design Analysis

In our design, we will be having a road projected onto a screen/wall or displayed in a monitor. Among the choices of screen, unified colored screen and monitor, considering the practical constraints, one of the above will be decided later during the design implementation phase. The road will be flowing from top to bottom continuously in a loop. A movie will be created having random objects in the road for a certain amount of time, and it will be continuously projected or played in a loop. The length of this movie will be at least 5 minutes in order to get the randomized feeling of the road during the course of trial by the user.

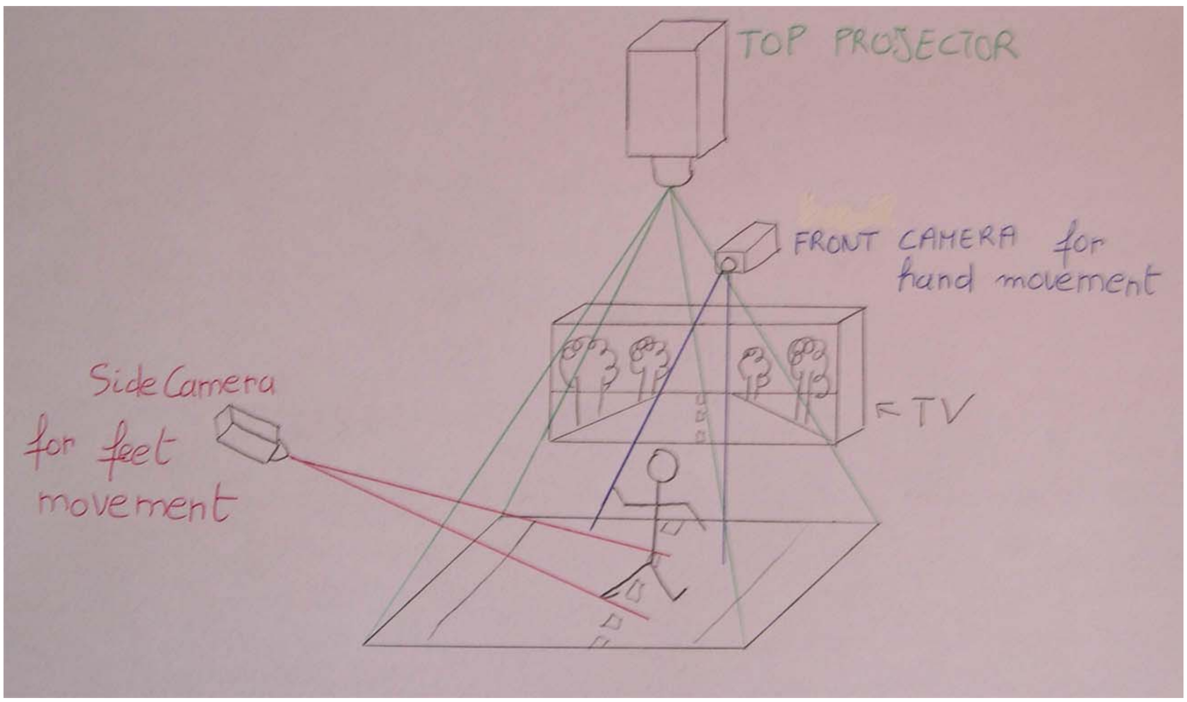


Figure 2: Design diagram

The top part of the road will be narrower and as it flows down, it gets widened. This gives the feeling for the user that the road ahead of him or her is non-ending and converging in a single point as it is in reality.

We will be having two cameras to capture the motion. The first one is to capture motion of the right foot and second one is for the hands motion. The first camera will be set in the height of 1 – 1½ feet and the second one would be located somewhere around 5 – 6 feet. As shown in Figure, The first one will be a side camera, and special care have to be taken on its location that nobody should be able to cross that during course of the simulation. To avoid this, we could install the side one very closely. The second camera has to be installed pointing outwards from the screen. Otherwise, while capturing the hands motion, it will also get the projected image, and this will result in the unexpected behavior of the system.

We may need a white screen to project the road. We might also use a monitor for this purpose depending on our future work. Also, the illumination of the surrounding is another issue. It has to be dim in order to have the clear projection. If we were to use the white screen/wall and the projector, then the position and the direction of the projector matters and that has to be determined according to the other equipments and requirements.

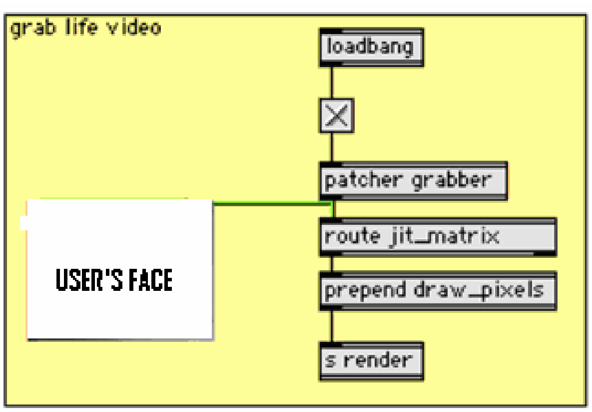
Finally, sound effects will be made for every time the user avoids a collision. In addition, there will be default sound track of the theme will be playing. Every time the user collides, another kind of sound will be played to distinguish the states.

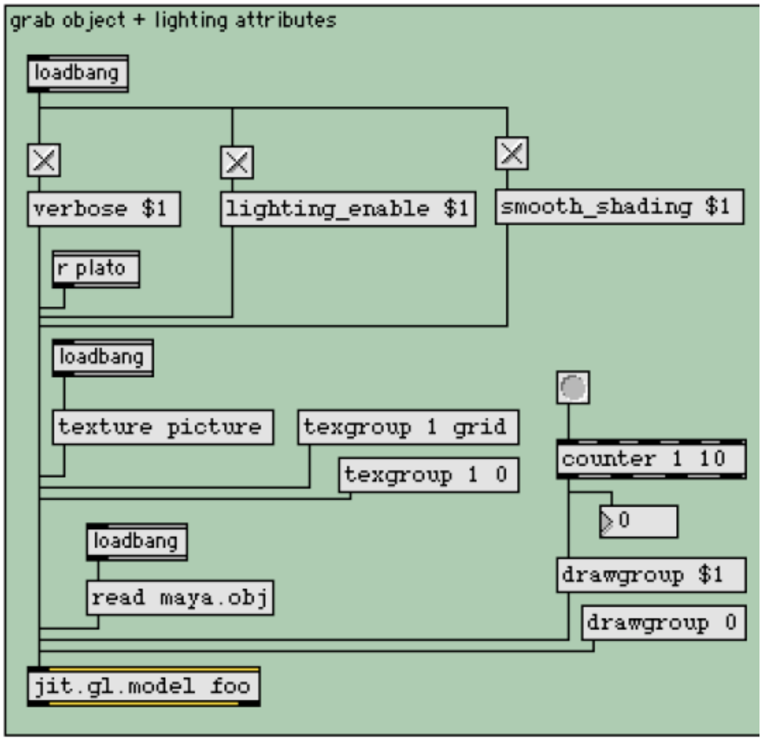
User will be able to quit and leave the game at anytime, and in such a case, the road flow will be reset and start flowing in the top-to-bottom manner. This is used as one of the techniques of attraction.

A low illuminated long hall way will be used for the installation. Also, specific time will be chosen in order to be more effective.

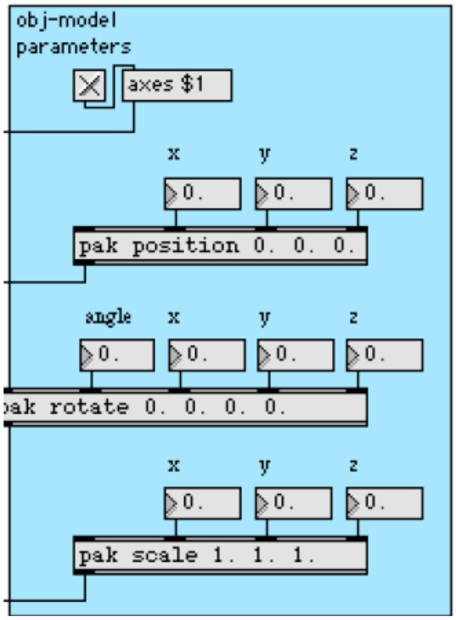
5. Software Architecture

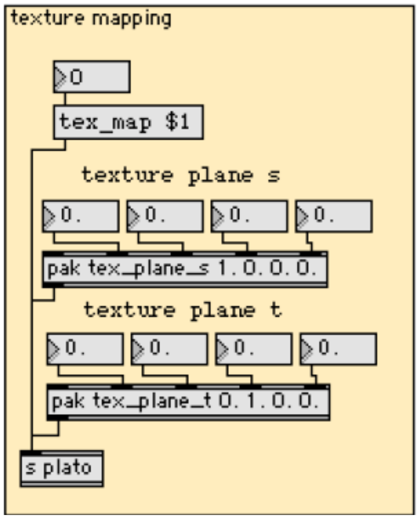
Max/Jitter, with its graphic interface offers the possibility to develop software without writing code on the base of C++ and the access to the basic parameters is still open. Jitter grabs life video with the “jit.qt.grab” object and is able to add several 3D-models at a time with the “jit.gl.model” object. With 3D-modeling tools like **Maya ®**, 3D model groups can be created and imported. Jitter has several objects to generate models with OpenGL too.





With the "jit.gl.render" object the two images (the player's face and the imported 3D model) can be superimposed and hence used as a 3D object inside the texture of the proposed game. The parameters of generated and imported 3D-objects can be controlled also using the objects provided by Jitter. Textures can be generated or imported and applied as still image or video. The video image grabbed from the user camera can be influenced in real time with several jitter objects. Jitter accesses all the parameters QuickTime offers.





6. People and Role

We are four people in our team and we have divided our responsibilities based on our abilities, strengths and weaknesses. We have had several group meetings and discussions which gave us ample chance to get to know each other and their capabilities.

Although, we have divided the work as shown in Table 1, every body will be going through each other's work and provide their comments and contribution. Since we are operating in a smaller scale, it is mandatory that we all work together. This overall common knowledge of the project would help us in the integration phase.

Concept Leader	Sri Venkadanathan Vengadesa
Mathematics	Sri Venkadanathan Vengadesa
Jitter Programming	Vincent Garreau
Jitter Programming	Thibault Lecat
OpenGL Programming – cartoon objects	Ahmad Shakhtour
Logistic	Vincent Garreau
Sound Programming	Thibault Lecat/ Vincent Garreau/ Ahmad Shakhtour
Integration of all the artifacts	Sri Venkadanathan Vengadesa
Installation	Vincent Garreau / Thibault Lecat / Ahmad Shakhtour
Presentation preparation / delivering	Sri Venkadanathan Vengadesa
Documentation – All phases	Sri Venkadanathan Vengadesa

Table 1: Activity distribution

7. Milestones

The members of our team have agreed to operate according to the following scheme as shown in Table 2. As we go along, this schedule may be amended according to the needs. However, the final due deadlines will be met and preserved.

Event	Completion
Team project proposal Due	October 23, 2006
Documentation – proposal	October 23, 2006
Presentation – proposal	October 23, 2006
Artifacts – Making movie – road/random objects	October 26, 2006
Artifacts – calculations / math involving	October 27, 2006
Artifacts – motion detection and video analysis by jitter / coding	October 30, 2006
Building the system – trouble shooting of individual components	October 31, 2006
Integration – all the design work together	November 06, 2006
Calculations on installation – positions/ angles/ background	November 10, 2006
Trouble shooting	November 17, 2006

Amendments	November 20, 2006
Team project	November 20, 2006
Team project	November 27, 2006
Team project – Final presentation	December 04, 2006

Table 2: Milestones

8. Resources

As shown in Figure 2, there are two cameras used. One of them will be capturing the motion of the foot and the other one will be capturing the hands' waving. In addition, a projector is required in order to project the movie clip. Depending on our further future research, a white screen, a unified colored wall or a monitor might be needed to project the video on. To make scene realistic and to create the road atmosphere, we need a quite a longer space. The surrounding and its lighting density might also require to be controlled depending on the need. To get the input from the cameras, do the mathematical manipulation on them and movie projection on the screen, we require a MAC based computer with jitter capabilities at the location of installation.

9. Conclusion

Having visual and audio effects coupled with the human interaction, this will be an interesting and public adoring project. This project will be appropriate for COMP471 since we are utilizing most of the techniques that we have learnt in the course such as motion detection, realtime video processing, OpenGL programming, Max/Jitter, etc.,

There are several technical interests exist in our project. For instance, the first camera would be constantly capturing the foot motion and constantly checking versus a still image that will be already stored in the system as to see if the foot movement has already taken place. Now, the challenging part is about finding the transition threshold for each foot position stage. In addition to that preemption of the processes and communication and coordination among the inputs outputs some of other technical details.

Our design has a symbolic significance such that it could be interpreted as an amusement video game whereas the player has to be avoiding all the oncoming objects by dodging. This kind of technique might be implemented, for instance in a treadmill, whereas the users just have to watch a monitor screen at the top. If they are going off the side of the treadmill then it will show the left/right side edge in the monitor and the user could rectify his or her motion naturally. Thus, our design techniques could be used as a basic module in order to build some of the real world critical applications. [1]

10. References

[1] Obstacle Avoidance - training with computer simulated environments, <http://guide.stanford.edu/96reports/96dev1.html>

[2] Obstacle Avoidance, <http://webdiis.unizar.es/~jminguez/interest5.htm>

[3] Edge detection, <http://knight.cis.temple.edu/~shape/partshape/overview/1.php>

[4] Motion planning, <http://www.robotics.utexas.edu/rrg/research/oamp/>