

Moving Through Waypoints

Computer Graphics and Animation Programming Assignment 18



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**Table of Contents**

Cover Page 1

**Table of Contents 2**

[Chapter 1 Introduction 2](#_Toc499062470)

[Chapter 2 Basic Theory 2](#_Toc499062471)

[Chapter 3 Implementation 2](#_Toc499062472)

[3.1 Main Interface of the Application 2](#_Toc499062473)

[3.2 Features of the Applicaton 2](#_Toc499062474)

[Chapter 4 Design 2](#_Toc499062475)

[4.1 Representation of the Car in the Application 2](#_Toc499062476)

[4.2 Representation of the Waypoints in the Application 2](#_Toc499062477)

[4.3 Next Waypoint Direction Algorithm 2](#_Toc499062478)

[4.4 Waypoint Collision Detection Algorithm 2](#_Toc499062479)

[4.5 Car Acceleration and Deceleration Algorithm 2](#_Toc499062480)

[Chapter 5 Evaluation 2](#_Toc499062481)

[5.1 Adding Waypoints 2](#_Toc499062482)

[5.2 Moving the Car to Waypoints and Stopping After It Has Reached the Final Waypoint 2](#_Toc499062483)

[5.3 Stopping the Car Abruptly and Making It Move Again 2](#_Toc499062484)

[5.4 Setting a Low Torque Value for the Car and Making It Move 2](#_Toc499062485)

[5.5 Setting a High Torque Value for the Car and Making It Move 2](#_Toc499062486)

[5.6 Increasing the Car’s Acceleration 2](#_Toc499062487)

[Chapter 6 Work Log 2](#_Toc499062488)

[Chapter 7 Conclusion and Remarks 3](#_Toc499062489)

# Introduction

# Basic Theory

## Speed

Just as distance and displacement have distinctly different meanings (despite their similarities), so do speed and velocity. Speed is a [scalar quantity](http://www.physicsclassroom.com/Class/1DKin/U1L1b.cfm) that refers to "how fast an object is moving." Speed can be thought of as the rate at which an object covers distance. A fast-moving object has a high speed and covers a relatively large distance in a short amount of time. Contrast this to a slow-moving object that has a low speed; it covers a relatively small amount of distance in the same amount of time. An object with no movement at all has a zero speed.

The average speed during the course of a motion is often computed using the following formula:

*Average Speed = =*

The circumference of any circle can be computed using from the radius according to the equation:

Combining these two equations above will lead to a new equation relating the speed of an object moving in uniform circular motion to the radius of the circle and the time to make one cycle around the circle (**period**).

where **R** represents the radius of the circle and **T** represents the period. This equation, like all equations, can be used as an algebraic recipe for problem solving. It also can be used to guide our thinking about the variables in the equation relate to each other. For instance, the equation suggests that for objects moving around circles of different radius in the same period, the object traversing the circle of larger radius must be traveling with the greatest speed.

# Velocity

Velocity is a [vector quantity](http://www.physicsclassroom.com/Class/1DKin/U1L1b.cfm) that refers to "the rate at which an object changes its position." Imagine a person moving rapidly - one step forward and one step back - always returning to the original starting position. While this might result in a frenzy of activity, it would result in a zero velocity. Because the person always returns to the original position, the motion would never result in a change in position. Since velocity is defined as the rate at which the position changes, this motion results in zero velocity. If a person in motion wishes to maximize their velocity, then that person must make every effort to maximize the amount that they are displaced from their original position. Every step must go into moving that person further from where he or she started. For certain, the person should never change directions and begin to return to the starting position.

Velocity is a vector quantity. As such, velocity is direction aware. When evaluating the velocity of an object, one must keep track of direction. It would not be enough to say that an object has a velocity of 55 mi/hr. One must include direction information in order to fully describe the velocity of the object. For instance, you must describe an object's velocity as being 55 mi/hr, **east**. This is one of the essential differences between speed and velocity. Speed is a scalar quantity and does not keep track of direction; velocity is a vector quantity and is direction aware.

The task of describing the direction of the velocity vector is easy. The direction of the velocity vector is simply the same as the direction that an object is moving. It would not matter whether the object is speeding up or slowing down. If an object is moving rightwards, then its velocity is described as being rightwards. If an object is moving downwards, then its velocity is described as being downwards. So an airplane moving towards the west with a speed of 300 mi/hr has a velocity of 300 mi/hr, west. Note that speed has no direction (it is a scalar) and the velocity at any instant is simply the speed value with a direction.

The average velocity during the course of a motion is often computed using the following formula:

the instantaneous velocity computed using the following formula:

# 2.3 [Acceleration](https://www.google.com/search?client=firefox-b-ab&q=acceleration&spell=1&sa=X&ved=0ahUKEwjU6eLeidXXAhWFOI8KHZuZAUsQvwUIJCgA&biw=765&bih=751)

Acceleration is a [vector quantity](http://www.physicsclassroom.com/Class/1DKin/U1L1b.cfm) that is defined as the rate at which an object changes its [velocity](http://www.physicsclassroom.com/Class/1DKin/U1L1d.cfm). An object is accelerating if it is changing its velocity. Sometimes an accelerating object will change its velocity by the same amount each second. As mentioned in the previous paragraph, the data table above show an object changing its velocity by 10 m/s in each consecutive second. This is referred to as a constant acceleration since the velocity is changing by a constant amount each second. This is referred to as a constant acceleration since the velocity is changing by a constant amount each second. An object with a constant acceleration should not be confused with an object with a constant velocity. If an object is changing its velocity -whether by a constant amount or a varying amount - then it is an accelerating object. And an object with a constant velocity is not accelerating. The data tables below depict motions of objects with a constant acceleration and a changing acceleration. Note that each object has a changing velocity.

The average acceleration (a) of any object over a given interval of time (t) can be calculated using the equation:

Since acceleration is a [vector quantity](http://www.physicsclassroom.com/Class/1DKin/U1L1b.cfm), it has a direction associated with it. The direction of the acceleration vector depends on two things:

* whether the object is speeding up or slowing down
* whether the object is moving in the *+* or- direction

The general principle for determining the acceleration is, if an object is slowing down, then its acceleration is in the opposite direction of its motion. This general principle can be applied to determine whether the sign of the acceleration of an object is positive or negative, right or left, up or down, etc.

# 2.4 Parametric

A curve in the plane is said to be parameterized if the set of coordinates on the curve, (*x*,*y*), are represented as functions of a variable *t*. Namely,

*x* = f(*t*), *y* = g(*t*) *t*D.

where D is a set of real numbers. The variable *t* is called a parameter and the relations between *x*, *y* and *t* are called parametric equations. The set D is called the domain of f and g and it is the set of values *t* takes.

# Implementation

## Main Interface of the Application

## Features of the Applicaton

# Design

## Representation of the Car in the Application

## Representation of the Waypoints in the Application

## Next Waypoint Direction Algorithm

## Waypoint Collision Detection Algorithm

## Car Acceleration and Deceleration Algorithm

# Evaluation

## Adding Waypoints

## Moving the Car to Waypoints and Stopping After It Has Reached the Final Waypoint

## Stopping the Car Abruptly and Making It Move Again

## Setting a Low Torque Value for the Car and Making It Move

## Setting a High Torque Value for the Car and Making It Move

## Increasing the Car’s Acceleration

# Work Log

The work log is extracted directly from Visual Studio’s Git Log History, which is also available publicly at <https://github.com/bakanui/MovingThroughWaypoints/commits/master>.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No | Author | Date | Time | Commit Message |
| 1 | Bhaskara Ida Bagus | 11/21/2017 | 7:09:33 PM | Initialized project |
| 2 | Bhaskara Ida Bagus | 11/21/2017 | 7:16:34 PM | Added blank report document |
| 3 | Bhaskara Ida Bagus | 11/21/2017 | 9:24:34 PM | Update report with blank chapters |
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# Conclusion and Remarks