Politechnika Śląska

SILESIAN UNIVERSITY OF TECHNOLOGY

Faculty of Automatic control, Electronics and Informatics

Computer programming

Gravitational force - final report

Student: Robert Okenczyc 298990
Instructor: Piotr Fabian
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Project topic:

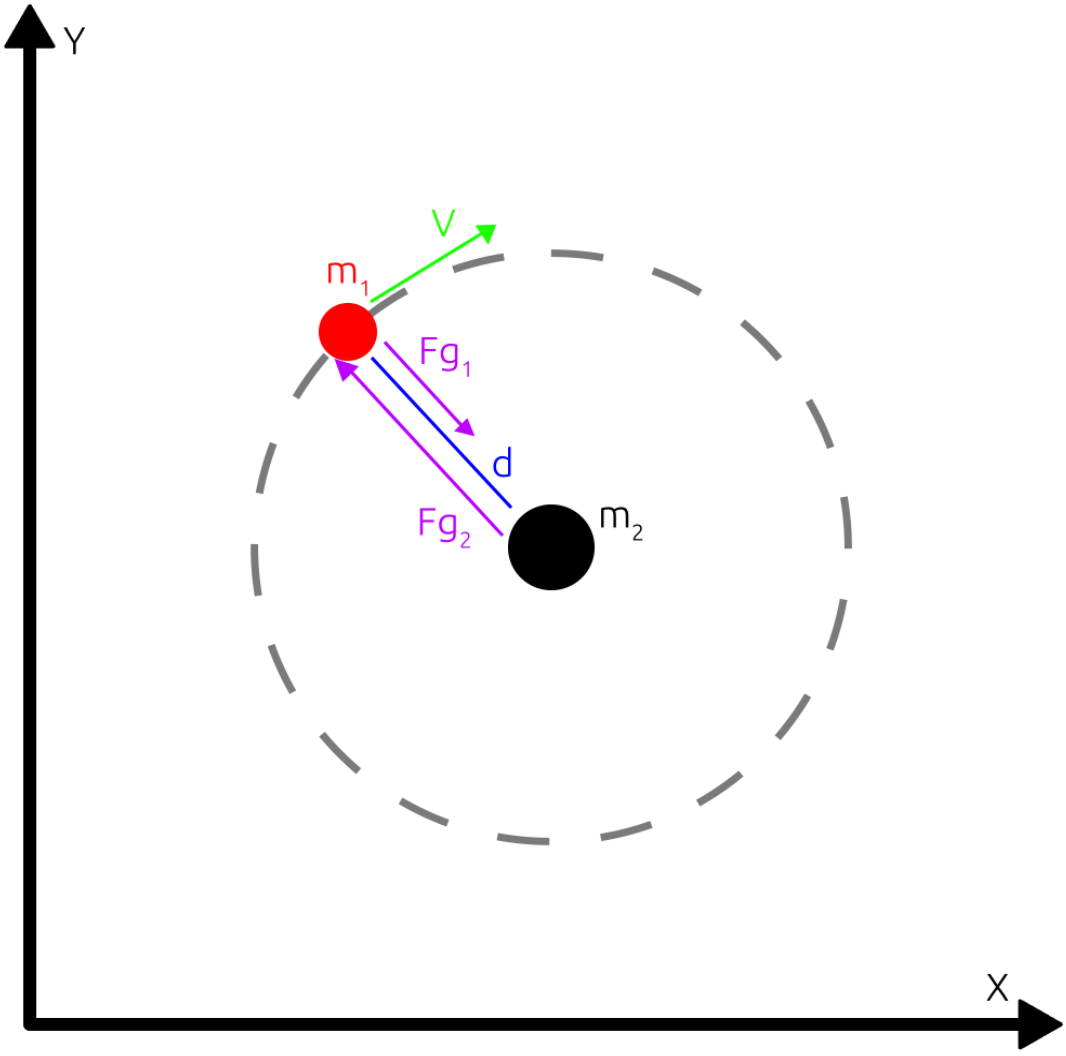
Gravitational Force - write a gravitation simulation program using graphics from Allegro 5

Brief description:

This library contains classes describing elements in 2D field, with parameters needed for proper gravity simulation and graphical expression (color and radius). Beside elements there are classes used for initialization of Allegro window and animating given data by ‘frames’ functionality.

Task Analysis:

The main problem of this task was to understand how time affects element position and calculating it using inner velocity and gravitational force from other elements. To know the distance to travel program uses Pythagorean theorem and velocity with gravitational force every frame.



Object with high mass are considered as stationary for visual purposes. On every objects forces are working with others objects. Meaning that, no mater where specific element is, every other elements are interfering its velocity, but in realistic manner. The larger distance between elements the weaker forces they are dealing with.

Externals:

This task did not ask for being external library, but I prefer to do it this way for code to be more readable and main program to be easy and basic. End user don't have to understand whole code to use it. Only things that may be need to code yourself are events. Events are handled by Allegrao 5 library. In task example is (poorly) written event for making new element each time the mouse buttons are pressed. In library there are also some debugging functions for printing elements into console. Also in ready-to-run project there is functionality of loading cvs files. The formating of data is as follows:

```
x_coordinate, y_coordinate, mass, radius, if_random_color, x_velocity, y_velocity
x_coordinate, y_coordinate, mass, radius, if_random_color, x_velocity, y_velocity

example:
500, 500, 10000, 30, 1, 0, 0
500, 380, 3000, 10, 1, 65, 0
500, 800, 1000, 10, 1, -50, 0
```

Task example:

An example of using this library is here or in the documentation below. This example is well commented for programmers to understand.

```
#include <iostream>
#include <string>
#include <time.h>
#include "gravitationLib.h"

using namespace std;

int main(int argc, char** argv)
{
   int seed = 1230;
   srand(seed);


   particleInit(50);

   canvas Canvas1(1000, 1000, "Gravitational Force");

   cout << "\nGenerating canvas\nPress Escape key to exit Allegro window\n";


   while (Canvas1.endCondition()) {

      if (Canvas1.event.type == ALLEGRO_EVENT_MOUSE_BUTTON_DOWN) {
         addParticle(Canvas1.event.mouse.x, Canvas1.event.mouse.y);
      }

         if (Canvas1.FrameInit()) return 0;

         particleDraw();
         movement();
         Canvas1.keyframe();
   }
   return 0;
}
```

Testing:

This library was tested with different values, but first - why I have chosen double over float. Well answer to this questions is pretty simple - precision. Whenever I used float or approximate values after some time with transformations the figures bend and deform - be not accurate.

The input file algorithm was not tested properly and some bugs may happen.
There is not limit in random generated elements (beside obvious memory limit), but rendering more than 5000 elements could slow down simulation at the beginning. In some frames later probably some elements will be deleted (if elements touches other element the older one get deleted) so the hypothetic slow down will occur only with a few seconds.

Concusion:

This task was easy to understand and the physics behind this was not complicated. If I could rewrite some of code or add some more functionality I would probably prepare this program to use real units. With real units it would be possible to (approximately because of 2D space) simulate natural real cosmic object simulation, like solar system. For convenience I would make file handling in library and make it more resist for any user mis usage and more open for changes.

Gravitational Force

Generated by Doxygen 1.9.1

Chapter 1

Class Index

1.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 2

Class Documentation

2.1 canvas Class Reference

Class for Allegro 5 canvas initiation and animation handling.

`#include <GravitationLib.h>`

Public Member Functions

- **canvas** (int ix=1000, int iy=1000, const char ∗ititle="3D program")
- void **keyframe** ()
- bool **endCondition** ()
- bool **FrameInit** (ALLEGRO_COLOR bg=al_map_rgb(0, 0, 0))

Public Attributes

- ALLEGRO_EVENT_QUEUE ∗ **eQueue** {}
- ALLEGRO_DISPLAY ∗ **display** {}
- ALLEGRO_MOUSE_STATE **state**
- ALLEGRO_KEYBOARD_STATE **keyboard** {}
- ALLEGRO_EVENT **event** {}

2.1.1 Detailed Description

Class for Allegro 5 canvas initiation and animation handling.

Parameters

x	= width of an Allegro 5 window
y	= height of an Allego 5 window

The documentation for this class was generated from the following files:

- GravitationLib.h
- GravitationLib.cpp

2.2 Line Struct Reference

Structure for defining line, the idea was to use it for mouse input.

`#include <GravitationLib.h>`

Public Attributes

- double **x1**
- double **y1**
- double **x2**
- double **y2**

2.2.1 Detailed Description

Structure for defining line, the idea was to use it for mouse input.

The documentation for this struct was generated from the following file:

- GravitationLib.h

2.3 Particle Class Reference

Class for Particle (or just element) with needed parameters.

`#include <GravitationLib.h>`

Public Member Functions

- **Particle** (double tx, double ty, double tr, double tvx, double tvy, double tm)
- void valueOfProp (int index, double value)

  Function for converting floating point values of relational values into right data type.
- void valueOfProp (int index, string value)

  Function for converting string values of relational values into right data type.
- void printAll ()

  Debuging function for printing particle data.

Public Attributes

- double **x**
- double **y**
- double **r**
- double **vx**
- double **vy**
- double **m**
- double **color** [3]
- string **name**
- double **mass**
- string **relation**
- double **distance**
- double **speed**

2.3.1 Detailed Description

Class for Particle (or just element) with needed parameters.

Parameters

x	= absolute (in px) horizontal position
y	= absolute (in px) vertical position
r	= radius of element (visual purpuses)
vx	= velocity (or delta position) in horizontal vector
vy	= velocity (or delta position) in vertical vector
m	= true mass for calculating force
rest	= rest parameters was made for relational positioning, not absolute

2.3.2 Member Function Documentation

2.3.2.1 valueOfProp() [1/2]

```
void Particle::valueOfProp (
            int index,
            double value )
```

Function for converting floating point values of relational values into right data type.

Parameters

index	= what data is to be changed
value	= value of data to be changed

2.3.2.2 valueOfProp() [2/2]

```
void Particle::valueOfProp (
            int index,
            string value )
```

Function for converting string values of relational values into right data type.

Parameters

index	= what data is to be changed
value	= value of data to be changed

The documentation for this class was generated from the following files:

- GravitationLib.h
- GravitationLib.cpp

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