

ChangeEngine Game Engine

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Abstract

We propose to design a game engine which will provide the framework for fast, simple deployment of games. We analyzed several different game engine designs to allow programmers to work on game design rather than programming the structure of windows, graphics, sounds, et cetera, but allow them to program a wide range of 2D games. The programmer will handle the logic of each interaction on his own, but trivial functions such as drawing, collision detection, and input will be handled by this engine. The engine is available as a static library programmed in C++, which gives the user the power to program in any language that can implement such a library. A major feature of this engine is pluggable functions which can be implemented by the user, such as artificial intelligence.

1 Introduction

Game engines can be difficult to learn for a programmer who has just downloaded the libraries or source code for it. The main issues we see are that the programmer is expected to do a lot of work to get started: rudimentary operations like window creation and input detection can be hard to wrap one's mind around. Our goal is to look from a novice's point of view, with an engine which will hand-hold them through these operations until they feel able to extend my own engine's classes. We have no delusions of grandeur: If a programmer sufficiently experienced in game programming sees a need that we do not fulfill, he is free to overload it with his own code.

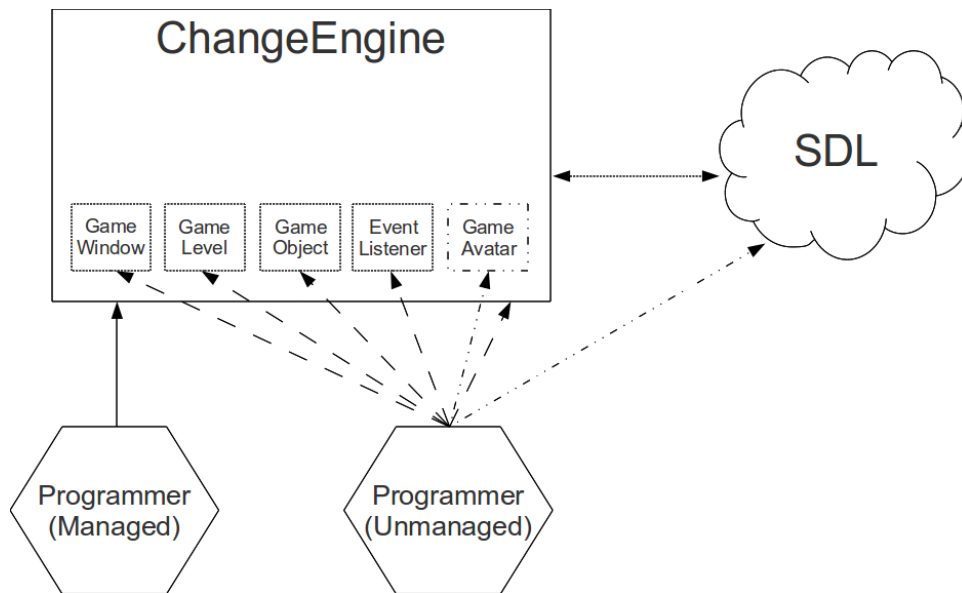
We also feel that the basic logic of the program is the responsibility of whoever is programming the game. Our engine provides functions which are necessary to most games, namely collision detection, but the implementer of the engine is responsible for what happens between the objects our engine provides.

2 Game Engine

The game engine supports two main ways of implementing its classes: managed and unmanaged.

2.1 Class Diagram

The following shows the interaction between the programmer, the ChangeEngine, and SDL.



2.1.1 Managed Style

In the Managed style of programming, ChangeEngine and its subsidiary classes all handle interactions with SDL themselves and the user need not concern himself with learning the mechanics of SDL. The programmer only interacts with the ChangeEngine class to perform game operations.

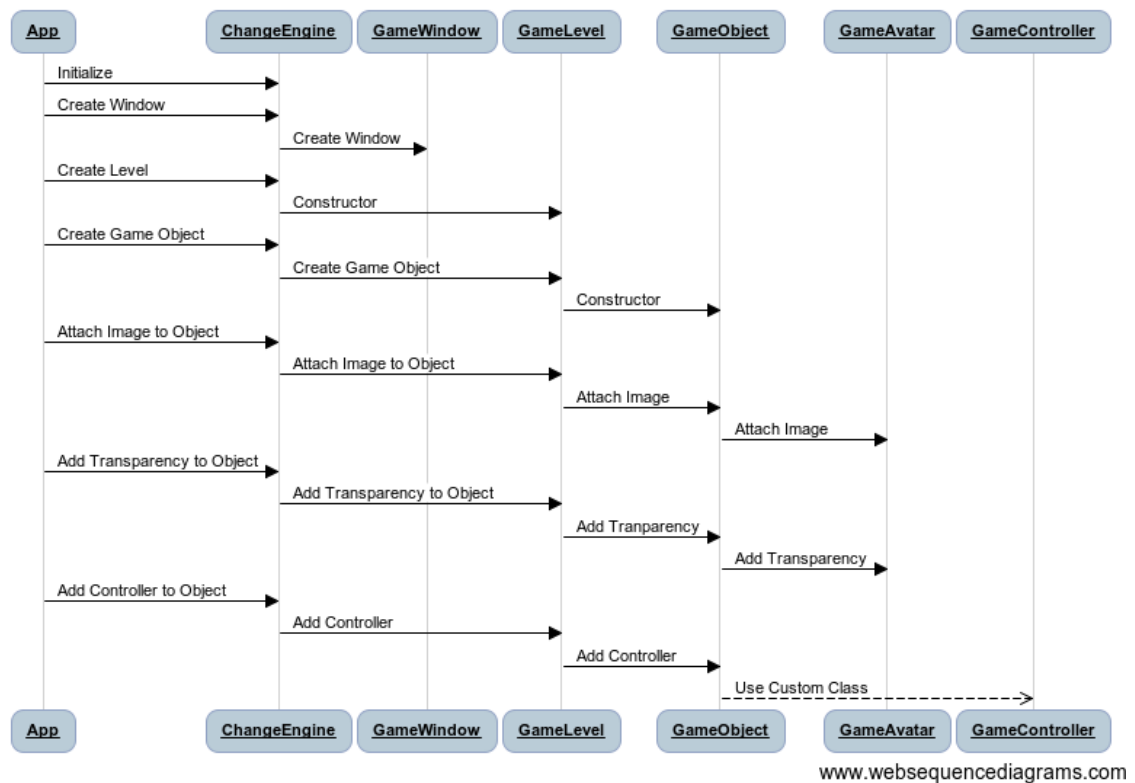
2.1.2 Unmanaged Style

In the Unmanaged style of programming, the user has the option of using any combination of ChangeEngine and its subsidiary classes, and even SDL directly to interact with those objects. The alternate line styles to GameEngine and SDL above relate to the rarity I anticipate the programmer making use of these options.

2.2 Sequence Diagrams

The following diagrams show the general sequence of events using the managed engine to run a game. Take note that this sequence is based off of the Galaxterminate demo, which I believe best exemplifies the order of events for this engine.

2.2.1 Initialization



The sequence of initialization of a standard game in a managed style is as follows:

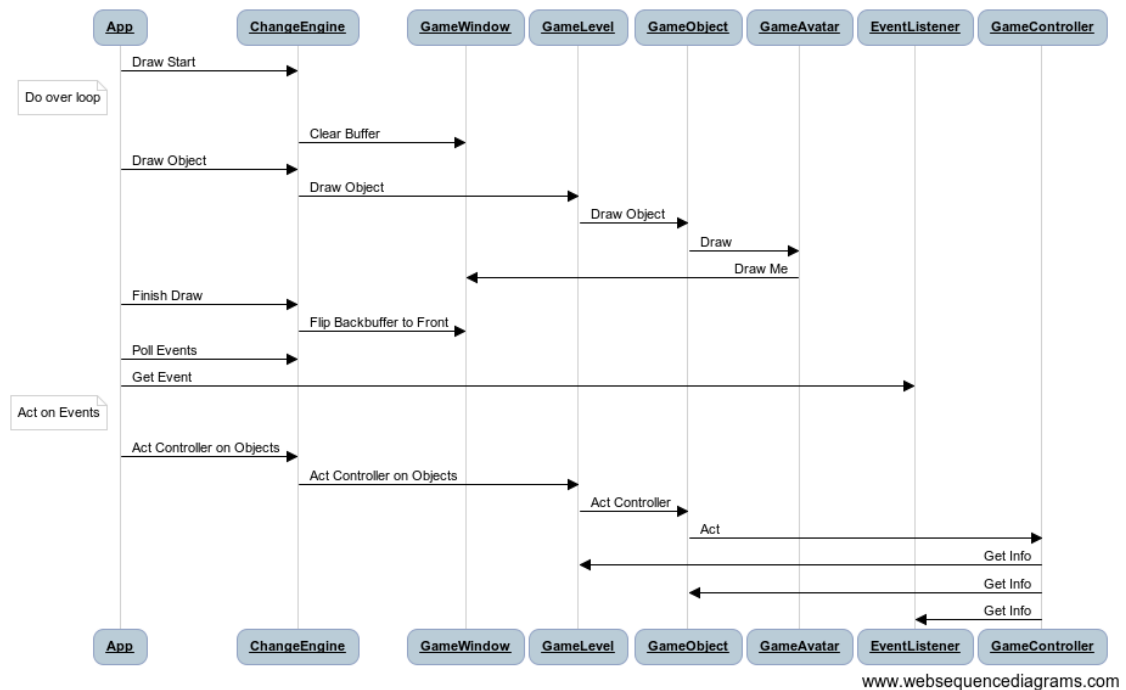
1. Programmer initializes ChangeEngine
2. Programmer creates GameWindow from ChangeEngine
3. ChangeEngine creates GameWindow
4. Programmer creates GameLevel from ChangeEngine

5. ChangeEngine creates GameLevel
6. Programmer creates GameObject from ChangeEngine
7. ChangeEngine calls GameLevel to create GameObject
8. GameLevel creates GameObject

The above shows the chaining together of different tasks from the ChangeEngine through its subsidiary classes. This is done to enable an unmanaged user to use any subsidiary class in the same way that the ChangeEngine would.

Giving extra properties to those GameObjects in the form of images and controllers is also demonstrated above. In the same way, each command to GameEngine goes through a chain to public functions in each subsidiary class to attach images to an object or attach a controller to an object.

2.2.2 Game Loop



The game loop is done repeatedly over a level using either an infinite loop, a timer, threads, or some combination of those.

The programmer starts the drawing process through ChangeEngine, which calls on GameWindow to clear the backbuffer. The programmer then draws all objects to the backbuffer through ChangeEngine, which progresses the command through the chain to GameAvatar, which calls on GameWindow to draw the image stored in the GameAvatar.

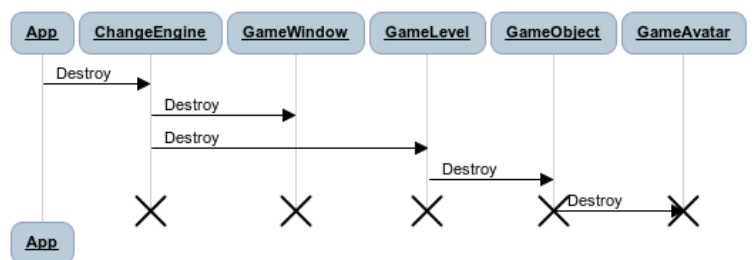
When the programmer is finished drawing objects to the backbuffer, he calls on ChangeEngine to finish drawing, which flips the backbuffer to the front buffer. ChangeEngine will then call on GameWindow to complete this process. This should only be done once, in this sequence, as multiple calls to flip the backbuffer in the same loop can result flickering.

The programmer uses ChangeEngine to poll the engine for events, such as keypresses and the like. After this, the programmer must get the EventListener from the ChangeEngine and use it to grab an integer value for whatever event has just occurred. In the future, this will ideally be accessible through ChangeEngine itself.

The programmer then uses the event integer value to decide what to do with that event. The event can take the form of window actions (like clicking the close button), key presses, and mouse buttons.

The decision of what an object will do is done through the controllers that the programmer attached to the object in the initialization step. The user calls on ChangeEngine to act on all objects with a controller in that level, and GameLevel calls on all of its objects correspondingly to act with their GameController classes. The programmer's implementation of these classes will use any or none of the level, object, and event listener information.

2.2.3 Destruction of Engine



www.websequencediagrams.com

Destruction of a managed engine is designed to be simple. The programmer calls on ChangeEngine to destroy itself. The ChangeEngine then calls on each level to destroy itself, which in turn calls on each object to destroy

itself, which in turn calls on each applicable avatar to destroy itself. The ChangeEngine will also destroy its GameWindow. The programmer is ideally left with a clean slate of memory.

2.3 Managed Engine

The managed engine provides memory management benefits and ease of use at the cost of flexibility to the user. Everything the programmer creates or instantiates will be done through the overarching game engine class.

2.3.1 Usage

1. `ChangeEngine* engine = ChangeEngine::Initiate();`

This is the overarching game engine class, through which most of our operations will take place.

2. `engine->setWindowCaption("Test Window");`

The programmer may wish to use a custom window title, as this is a windowed application. Full screen is not yet supported.

3. `engine->createWindow(screen_width,screen_height,bpp);`

This sets up the game window with the given width, height, and color depth.

4. `engine->createLevel("Level1");`

Scenes in this engine are split into “Levels”, each of which contains several GameObject classes.

5. `engine->createGameObject("Level1","Object1");`

This creates “Object1” and places it into “Level1” to be handled there.

6. `engine->attachImageToGameObject("Level1","Object1",
"filename.png",tilewidth,tileheight);`

This will attach an image to “Object1”, also known as an ‘avatar’. This is not a default operation for GameObjects, as it is likely the user will want to have an object with no image (for logical operations and such). “tilewidth” and “tileheight” are terms used in the context of tile sets, where multiple sprites of animation are contained in the same file.

Sprite width and height are considered to be the same for all sprites in a tile set.

7. `engine->addAvatarState("Level1","Object1",spritecount);`

This creates a state for the avatar and sets the number of sprites in that state. In the actual image file, each state is on a single row of tiles, and the sprite count is the number of sprites available on that row of animation. In this way, the tile set can have a variable number of frames of animation for each state.

A state can be something as simple as the direction the object is facing, or an action it is taking, or both. The programmer must make sure to keep track of the order states are given, as they added from the top of the file down, and are indexed by integer starting from zero.

8. `engine->drawObject("Level1","Object1",state,frame);`

This will draw “Object1” of “Level1” to the window with the given state and frame, as given above. Going outside the bounds of the number of states added, or the number of frames in that state, will result in undefined operation.

9. ... Game Operations ...

10. `ChangeEngine::Destroy();`

This will make use of the game engine’s internal memory management framework to remove all objects created so that the programmer need not worry about it.

2.4 Unmanaged Engine

The game engine provides the programmer with unrestricted access to each class contained therein. While the programmer must do his own memory management to prevent leaks, he is not restricted to our “Level” framework or even our own drawing functions. What follows is only an example of what can be done with the freedom of an unmanaged engine.

1. `ChangeEngine* engine = ChangeEngine::Initiate();`
2. `engine->setWindowCaption("Test Window");`

3. `engine->createWindow(screen_width,screen_height,bpp);`
4. `GameObject* object = new GameObject();`
5. `object->setWidth(tilewidth);`
6. `object->setHeight(tileheight);`
7. ... Game Operations ...
8. `object->drawImage(engine->getWindow(),state,frame);`
9. `SDL_Flip(engine->getWindow()->getScreen());`
10. ... Game Loop until Finished ...
11. `GameObject::Destroy(object);`
12. `engine->Destroy();`

We have made every attempt to expose useful variables in each object. One need only browse the available header files to understand each function. For example, ChangeEngine’s GameWindow class contains an SDL_Surface called “screen”, which we make available for use in SDL operations with

`getScreen()`

Take note that the GameObject class also has its own static destruction function. In an unmanaged engine, it will be the programmer’s responsibility to locate all applicable class destruction functions and use them.

2.5 Object Controllers

This engine uses the concept of “controllers” to handle objects that need to be moved for whatever reason. Every object has a private GameController instance, which is null at first, since many objects may not require being controlled. The controller depends on using a managed engine, or an effective use of GameLevels. The game engine provides

`actObjects(GameLevel*)`

as an easy way to force all objects to be controlled, and this can be done every loop of the game engine.

The GameController class is an abstract class. In order for the programmer to control an object, he must make a new class which inherits GameController and write the

```
act(GameLevel*,GameObject*,EventListener*)
```

function himself. The act() function will take in three variables: the level the object is on, the object the controller acts on, and an event listener. Not following these standards for the variables will result in wholly undefined behavior.

2.5.1 Artificial Intelligence

The implementation of this function can be as simple as moving the object back and forth on its own, but its access to the level makes it aware of all objects in the field, so that the programmer is able to use artificial intelligence to make the object decide its actions based on its environment.

2.5.2 User Interaction

The controller object also allows the programmer to have the user interact directly with the object. The reason the EventListener is included in the function is to make the object aware of events such as keypresses or mouse clicks and act accordingly.

3 Design and Implementation

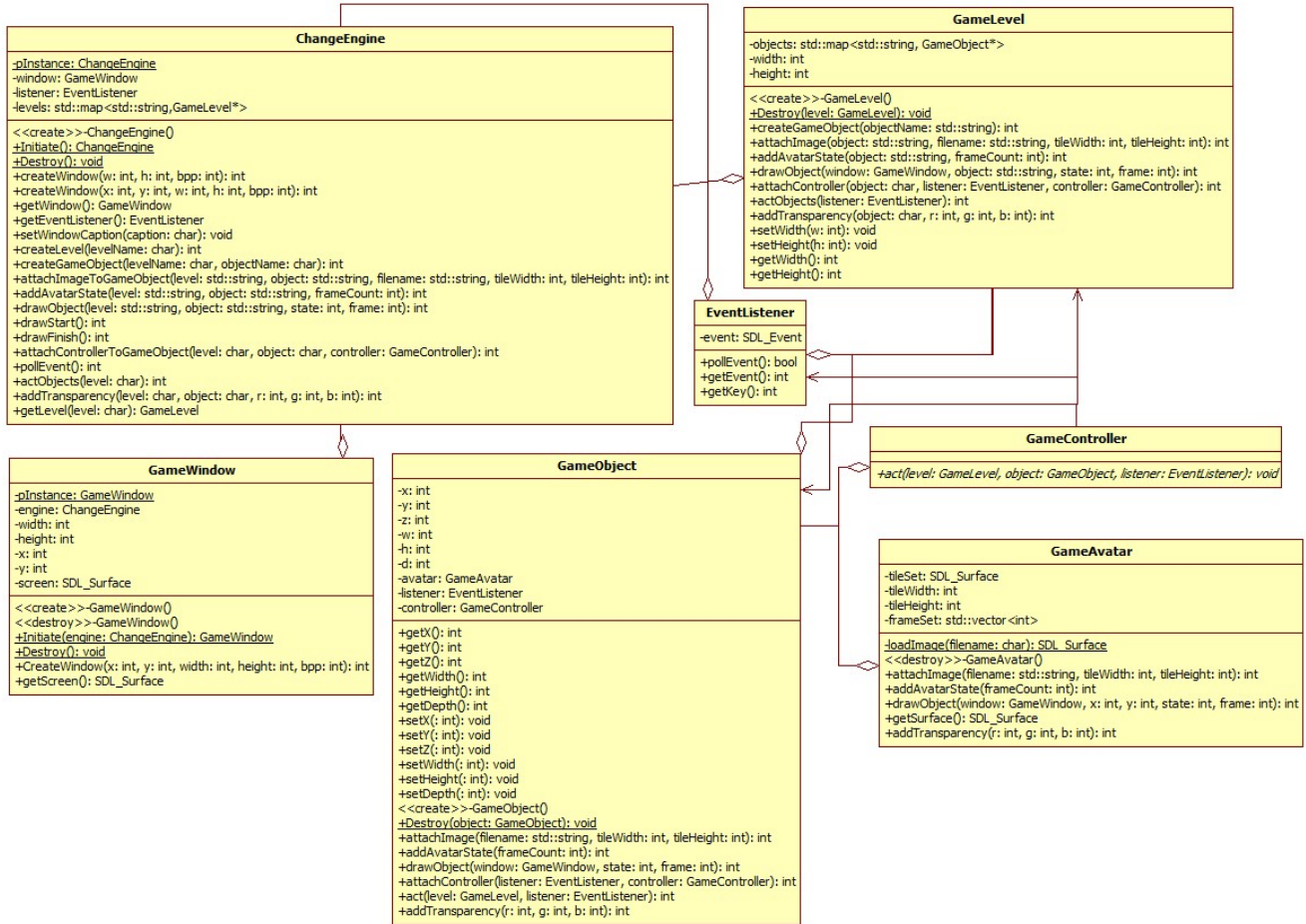
3.1 Requirements

ChangeEngine will fulfill the following software requirements:

1. General Requirements
 - (a) Single library implementing all functions for a rudimentary game
 - i. Engine Class
 - ii. Window Container

- iii. Level Container
 - iv. Game Object Container
 - v. Game Avatar (Tilemap Container)
 - vi. Event Listener
 - vii. Object Controller
- (b) Extensible classes for programmers to “plug in” their own logic
- i. Object Controller (Artificial Intelligence or User Input)
 - ii. Event Handler

3.2 Class Diagram



The class diagram shows a comparably simple relationship between all the classes of the game engine. The entire ChangeEngine project (thus far) is comprised of several classes: ChangeEngine, GameWindow, GameLevel, GameObject, GameAvatar, and EventListener. The ChangeEngine class contains three of these: an EventListener, a GameWindow, and an array of GameLevels.

ChangeEngine makes direct use of GameWindow, EventListener, and GameLevel. The EventListener is kept at a close level to the programmer so that it is easy to obtain from the ChangeEngine class when the user requires direct access to it, which currently is necessary.

GameWindow is located at this level because a single instance of it is a

universal requirement for all subsidiary classes to draw output to the screen.

The array of GameLevels is the last piece of the puzzle, existing because GameObjects can live under it and because it helps the programmer organize scenes into levels without concerning himself about stray objects that are not related with the current scene.

GameLevels, as mentioned, manage arrays of GameObjects. Each GameObject has a null-valued GameController pointer, which will point to a class created by the programmer which inherits GameController. That class will control the movement or actions of the object. If the GameController pointer remains null, it will not be controlled by anything.

GameController takes in a GameLevel, the current GameObject to act on, and an EventListener. This is done to maximize exposure to a GameObject's environment and allow the user to directly handle events from the engine. Specifying the GameObject in the act() function is done to allow the same GameController implementation to control several objects.

GameObject contains a GameAvatar. This class is meant to be specific to the handling of ChangeEngine, in that it manages tile sets and eventually ChangeEngine should handle nextFrame() functions itself so the programmer would not need to handle loop conditions themselves.

4 Tools and Teamwork

This project will primarily be programmed by Cedric Wienold using various programming environments supporting C++ code. Teamwork will be limited to interviews with industry professionals concerning algorithms and class organization advice.

5 Analysis

Testing this engine is an important way of determining if its current programming is at all useful for programmers.

To test the engine's managed object framework, I would run through a loop of progressively more objects (tens, hundreds, thousands, tens of thousands, etc.) and log the amount of time the game engine takes to create the objects, use the objects functions (such as attaching images and using the controllers on every loop), and destroy the objects.

Controllers of the same class should be placed on multiple objects to see how they handle. How many artificial intelligence units of the same type can work on several thousand units before the system lags? This is more a task for the implementer of the class to make sure his algorithm is not too burdensome on the system.

6 Related Work

In studying for construction of this engine, I have looked at many engines, the standout being the Source Engine because of its organizational design.

6.1 Source Engine

- Levels: Each scene is modularized into levels. I used this concept to contain all objects inside of a level, and have the programmer manage which level is being drawn or operated on at the time.
- Connected Areas: Doors, teleporters, etc. are used to connect scenes. I wish I had time to implement this, as it would make level handling easier for the engine. (At the moment the engine only handles levels as individual units with no connection between them) My hope is that future development will involve this feature.
- Nodes: AI in the Source Engine uses “Nodes” to tell an entity how to react to its environment, among other things. I have simplified this concept in my implementation, giving the Controller full view of the Level and forcing the programmer to define all interactions with it.

6.2 Klik

This development suite, first known as Klik & Play, is a very simplified way of making a game via a WYSIWYG interface. Despite its apparent simplicity, it had much influence in this engine.

- Object modularization: Each active object is its own unit with all properties unique to it. This seems straightforward, but merits mention in terms of why I thought of it.

- Per-object Control: Each object has an independent controller, be it via keyboard input, predefined paths, or more complex AI. The idea of making the universal GameController comes from this concept, since each object, at a very general level, is merely controlled by something, be it input or some level of artificial intelligence.

6.3 DirectX

DirectX is an extremely complex library set to make hardware interactions easier. Apart from that complexity being the driving force behind wanting to create a simplified engine between it and the programmer, a few organizational influences come out of it.

- DirectX Object: This begins all interactions with the libraries, and any other objects or properties come only out of this object. I took this idea, and while I leave open the possibility of the programmer managing objects in the engine by himself, my managed ChangeEngine object follows the same principle.

7 Conclusions

The programmer must be careful to ensure his usage of this class's available functions is logical.

7.1 ChangeEngine

`pollEvents()`

should only be called once per loop to ensure that multiple functions depending on the same event are not deprived of it because they did not act on the event quickly enough.

`createWindow(int w, int h, int bpp)`

should only be used with sensible, non-negative values.

`createLevel()`

and

`createGameObject`

have protections against being called with same-named values repeatedly. Keep in mind that if debug mode is off, the programmer will not be informed of a failure unless he is specifically checking for it.

`addAvatarState()`

should be used on a row-by-row basis for tile sets.

`drawObject()`

will not actually output an object to the screen.

`drawFinish()`

is necessary to flip the backbuffer to the front, and should only be called once every loop to prevent flickering.

8 Future Improvements

This project will remain open source for any programmer to extend and improve upon it. ChangeEngine will maintain a pluggable interface in many ways so that programmers need only design their own functions and pass them into the engine if they wish to use them. Artificial intelligence, collision detection, and input detection are all areas which programmers can design their own plug-ins for.

As far as future improvements to the game engine go, the following is a noncomprehensive list:

1. Change object references from strings to integers, to make loop-based instantiation easier.

2. Use several debug modes to change terminal output.
3. Continue building more specific error codes for all classes.
4. Create single “draw” function for a level which will draw all managed objects.
5. Handle timers or threads in ChangeEngine so the user need not be concerned with it.
6. Include a pointer to a CollisionDetector class in every level, and implement said class.
7. Fix the problem where the screen will not update its contents despite actual changes in Object coordinates.
8. Improve documentation of functions not in ChangeEngine class, to improve support for non-managed implementations.
9. Put level and object destructor access in ChangeEngine class.
10. Expose individual GameLevel and GameObject instances to the user via the ChangeEngine class.

A Research

A.1 Collision Detection

In an interview with Cal Poly Alumni Computer Science alumni Daniel Nutting, methods of collision detection employing best possible complexity in average cases were outlined, with worst possible complexity in edge cases being sacrificed. This method will be called the “Grid Collision Detection” method.

A.1.1 Grid Collision Detection

Theory: Truly basic collision detection entails each object checking against all other objects for collision, and doing the same for every object. This leads to an average $O(n^2)$.

The most apparent problem is repeated checks. One solution can be a stack method. For each object, push onto stack. Check collision with everything behind it.

The next issue is restricting the number of objects to check on. If objects are not close to each other, there is no point in checking. This is where the grid comes in. For a set of objects, calculate the average X and Y coordinates, and split the field there into 4 quadrants. Do this more as is necessary for the number of objects.

B Source Code

B.1 ChangeEngine

B.1.1 ChangeEngine.cpp

```
/**
 * @file ChangeEngine.cpp
 *
 * @date May 12, 2011
 * @author Cedric Wienold
 */

#ifdef DEBUG
```

```

#include <stdlib.h>
#endif

#include "ChangeEngine.hpp"
#include <stdio.h>

// Set singleton to null at start
ChangeEngine* ChangeEngine::pInstance = NULL;

ChangeEngine::ChangeEngine() {

    window = NULL;
}

ChangeEngine* ChangeEngine::Initiate(void) {

#ifdef DEBUG
    fprintf(stderr, "ChangeEngine: Initiate\n");
#endif

    //Initiate ChangeEngine if it doesn't already exist
    if (pInstance == NULL) {

#ifdef DEBUG
        fprintf(stderr, "ChangeEngine: ChangeEngine
            Singleton does not exist. Creating.\n");
#endif
        pInstance = new ChangeEngine();
    }

    //Create event listener
    if (pInstance->listener == NULL) {

        pInstance->listener = new EventListener();
    }

#ifdef DEBUG

```

```

        fprintf(stderr, "ChangeEngine: ChangeEngine
        Singleton Returned\n");
    #endif

    return pInstance;
}

void ChangeEngine::Destroy(void) {

    #ifdef DEBUG
        fprintf(stderr, "ChangeEngine: Destroy\n");
    #endif

    // Clean up engine objects

    //If this engine is initialized
    if (pInstance != NULL) {

        //Destroy any levels in the array
        for(std::map<std::string, GameLevel*>::iterator it
            =pInstance->levels.begin(); it!=pInstance->
            levels.end(); it++) {

            #ifdef DEBUG
                fprintf(stderr, "GameEngine: Destroying level %
                s.\n",(*it).first.c_str());
            #endif

            GameLevel::Destroy((*it).second);
        }

        //See if the GameWindow has been initialized
        if (pInstance->window != NULL) {

            #ifdef DEBUG
                fprintf(stderr, "ChangeEngine: Window has been
                initialized. Destroying.\n");
            #endif

```

```

        GameWindow::Destroy();
    }
#ifdef DEBUG
    else {

        fprintf(stderr, "ChangeEngine: Window not
            created yet. Not destroying.\n");
    }
#endif

    //Destroy the game engine instance
    delete pInstance;
}
}

int ChangeEngine::createWindow(int w, int h, int bpp) {

    return this->createWindow(0,0,w,h,bpp);
}

int ChangeEngine::createWindow(int x, int y, int w, int
    h, int bpp) {

#ifdef DEBUG
    fprintf(stderr, "ChangeEngine: CreateWindow\n");
#endif

    //Create game window
    window = GameWindow::Initiate(pInstance);

    int result = window->CreateWindow(x,y,w,h,bpp);

    if (window == NULL) {

#ifdef DEBUG
        fprintf(stderr, "ChangeEngine: EINITIATE_FAILED\n
            ");

```



```

        #endif

        return EINITIATE_FAILED;
    }

    if (result != EENGINE_SUCCESS) {

        #ifdef DEBUG
            fprintf(stderr, "ChangeEngine: EWINDOW_FAILED\n
                ");
        #endif

        return EWINDOW_FAILED;
    }

    return EENGINE_SUCCESS;
}

GameWindow* ChangeEngine::getWindow() {

    return window;
}

EventListener* ChangeEngine::getEventListener() {

    return listener;
}

void ChangeEngine::setWindowCaption(const char* caption
    ) {

    SDL_WM_SetCaption(caption, NULL);
}

int ChangeEngine::createLevel(const char* levelName) {

    #ifdef DEBUG

```

```

    fprintf(stderr, "GameEngine: Creating level %s.\n",
        levelName);
#endif

//Make sure the level name doesn't already exist
if(levels.find(levelName) == levels.end()) {

    #ifdef DEBUG
        fprintf(stderr, "GameEngine: Level %s is unique,
            creating.\n", levelName);
    #endif

    levels[levelName] = new GameLevel();
}
#ifdef DEBUG
else {

    fprintf(stderr, "GameEngine: Level %s already
        exists. This ain't right.", levelName);
    return ELEVELCREATE_ALREADY_EXISTS;
}
#endif

return EENGINE_SUCCESS;
}

int ChangeEngine::createGameObject(const char*
    levelName, const char* objectName) {

    #ifdef DEBUG
        fprintf(stderr, "GameEngine: Creating Object (%s:%s)\n",
            levelName, objectName);
    #endif

    //If the level doesn't exist, this is bad
    if(levels.find(levelName) == levels.end()) {

        #ifdef DEBUG

```

```

        fprintf(stderr, "GameEngine: Uh oh, level %s DOESN
            'T EXIST\n", levelName);
    #endif

    return EOBJECTCREATE_INVALID_LEVEL;
}

//Make object in level
if ((levels[levelName] -> createGameObject(objectName)
    ) != EENGINE_SUCCESS) {

    return EOBJECTCREATE_CREATE_FAILED;
}

return EENGINE_SUCCESS;
}

int ChangeEngine::attachImageToGameObject(std::string
    level, std::string object, std::string filename, int
    tileWidth, int tileHeight) {

#ifdef DEBUG
    fprintf(stderr, "GameEngine: Attaching image \"%s\"
        to object (%s:%s)\n", filename.c_str(), level.c_str
            (), object.c_str());
#endif

    //Check if level exists
    if (levels.find(level) == levels.end())
    {
#ifdef DEBUG
        fprintf(stderr, "GameEngine: Uh oh, level %s DOESN
            'T EXIST\n", level.c_str());
#endif

        return EATTACHIMAGE_INVALID_LEVEL;
    }
}

```

```

    if ((levels[level]->attachImage(object, filename,
        tileWidth, tileHeight)) != EENGINE_SUCCESS) {

        return EATTACHIMAGE_FAILED;
    }

    return EENGINE_SUCCESS;
}

int ChangeEngine::addAvatarState(std::string level, std
::string object, int frameCount) {

#ifdef DEBUG
    fprintf(stderr, "GameEngine: Adding state\n");
#endif

    //Check if level exists
    if (levels.find(level) == levels.end())
    {
#ifdef DEBUG
        fprintf(stderr, "GameEngine: Uh oh, level %s DOESN
            'T EXIST\n", level.c_str());
#endif

        return EADDSTATE_INVALID_LEVEL;
    }

    if ((levels[level]->addAvatarState(object, frameCount
        )) != EENGINE_SUCCESS) {

        return EADDSTATE_FAILED;
    }

    return EENGINE_SUCCESS;
}

int ChangeEngine::drawObject(std::string level, std::
    string object, int state, int frame) {

```

```

#ifdef DEBUG
    fprintf(stderr, "ChangeEngine: Drawing %s to level %s
        \n", object.c_str(), level.c_str());
#endif

    if (levels.find(level) == levels.end()) {

        return EENGINE_FAILURE;
    }

    if ((levels[level]->drawObject(window, object, state,
        frame)) != EENGINE_SUCCESS) {

        return EENGINE_FAILURE;
    }

    return EENGINE_SUCCESS;
}

int ChangeEngine::drawStart() {

    SDL_FillRect(this->window->getScreen(), &(this->
        window->getScreen())->clip_rect, SDL_MapRGB(this
        ->window->getScreen()->format, 0x00, 0x00, 0x00))
        ;

    return EENGINE_SUCCESS;
}

int ChangeEngine::drawFinish() {

    //Complete the drawing process
    SDL_Flip(window->getScreen());

    return EENGINE_SUCCESS;
}

int ChangeEngine::attachControllerToGameObject(const

```

```

char* level, const char* object, GameController*
controller) {

    levels[level]->attachController(object, this->
        listener, controller);

    return EENGINE_SUCCESS;
}

int ChangeEngine::pollEvent() {

    if (!(listener->pollEvent()))
        return EENGINE_FAILURE;

    return EENGINE_SUCCESS;
}

int ChangeEngine::actObjects(const char* level) {

    levels[level]->actObjects(this->getEventListener());

    return EENGINE_SUCCESS;
}

int ChangeEngine::addTransparency(const char* level,
    const char* object, int r, int g, int b) {

    if (levels[level]->addTransparency(object, r, g, b) !=
        EENGINE_SUCCESS) {

        return EENGINE_FAILURE;
    }

    return EENGINE_SUCCESS;
}

GameLevel* ChangeEngine::getLevel(const char* level) {

```

```

        return levels[level];
    }

```

B.1.2 ChangeEngine.hpp

```

#include "mitlicense.hpp"

/**
 * @file ChangeEngine.hpp
 * Game engine which handles most game elements.
 *
 * @date May 12, 2011
 * @author Cedric Wienold
 */

#ifndef CHANGEENGINE_HPP_
#define CHANGEENGINE_HPP_

#include <map>
#include <string>

#include "debug.hpp"

#include "GameWindow.hpp"
#include "GameObject.hpp"
#include "GameLevel.hpp"
#include "GameController.hpp"
#include "EventListener.hpp"
#include "EventTypes.hpp"
#include "errorcodes.hpp"

/**
 * Main class of ChangeEngine which handles game
 * elements.
 */
class ChangeEngine {
public:

```

```

/**
 * Construct the engine with a null window.
 */
ChangeEngine();

/**
 * Initiates the engine if it is not already
   initiated and returns a pointer to its
   singleton.
 * @return A pointer to the game engine object,
   or NULL on failure.
 */
static ChangeEngine* Initiate();

/**
 * Shuts down the game engine and removes it from
   memory.
 * This function will make every effort to detect
   leftover engine-created objects
 * and destroy them before exiting.
 */
static void Destroy();

/**
 * Create the game engine's window with the given
   width and height at (0,0).
 * @param w The window's width.
 * @param h The window's height.
 * @param bpp The window's color depth.
 * @return True if creation was successful. False
   otherwise.
 */
int createWindow(int w, int h, int bpp);

/**
 * Create the game engine's window with the given
   width and height at (x,y).

```



```

    * @param w The window's width.
    * @param h The window's height.
    * @param x The x coordinate of the window on the
      screen.
    * @param y The y coordinate of the window on the
      screen.
    * @param bpp The window's color depth.
    * @return True if creation was successful. False
      otherwise.
    */
int createWindow(int x, int y, int w, int h, int
  bpp);

/**
 * Return the game engine's window.
 * @return The game engine's window, or NULL if
   it does not exist.
 */
GameWindow* getWindow();

/**
 * TODO: Build functions to access listener
   without needing to return it here.
 */
EventListener* getEventListener();

/**
 * Sets the title text of the game window.
 * @param caption The desired text of the game
   window.
 */
void setWindowCaption(const char* caption);

/**
 * Creates a level for the game engine to manage.
 * @param levelName The custom name of the level
   to create. Your choice here.
 */

```

```

int createLevel(const char* levelName);

/**
 * Create a managed object for a given level.
 */
int createGameObject(const char* levelName, const
    char* objectName);

/**
 * Attach an image to a game object's avatar with
 * a given filename.
 * @param level Name of level to attach image to.
 * @param object Name of object to attach image
 * to.
 * @param filename Filename of image to attach to
 * object.
 * @param tileWidth Width of a single tile in the
 * image.
 * @param tileHeight Height of a single tile in
 * the image.
 */
int attachImageToGameObject(std::string level,
    std::string object, std::string filename, int
    tileWidth, int tileHeight);

/**
 * Add a state to the avatar tileset manager. A
 * state will be a single row on the tileset.
 * The parameter will be the number of frames on
 * that row. Add states from the top of the
 * tile set to the bottom, in that order
 * specifically.
 * @param frameCount The number of frames on the
 * current row of the tile set.
 */
int addAvatarState(std::string level, std::string
    object, int frameCount);

```

```

/**
 * Draw an object in a level of the given state
 * and frame to the backbuffer. This will not
 * actually draw anything to the front buffer. To
 * complete drawing, call draw().
 */
int drawObject(std::string level, std::string
    object, int state, int frame);

/**
 * Begin the drawing process.
 */
int drawStart();

/**
 * Complete the drawing process.
 */
int drawFinish();

/**
 * Attach a controller to the given game object
 * of the given leve.
 */
int attachControllerToGameObject(const char*
    level, const char* object, GameController*
    controller);

/**
 * Poll the event buffer.
 */
int pollEvent();

/**
 * Runs controller on all objects that have one.
 */
int actObjects(const char* level);

/**

```

```

    * Sets the transparency color of the given
      object to the given RGB values.
    */
int addTransparency(const char* level, const char
    * object, int r, int g, int b);

GameLevel* getLevel(const char* level);

private:

    /**
     * The game engine's singleton.
     */
    static ChangeEngine* pInstance;

    /**
     * Window for the game engine.
     */
    GameWindow *window;

    /**
     * Event listener
     */
    EventListener *listener;

    //// Now for managed objects, so the user need
      not care about lots of crap for memory
      handling

    /**
     * Array of levels.
     */
    std::map<std::string, GameLevel*> levels;
};

#endif /* CHANGEENGINE_HL */

```

B.1.3 debug.hpp

```
#define DEBUG
```

B.1.4 errorcodes.hpp

```
#include "mitlicense.hpp"
```

```
/**
 * @file type.hpp
 * Error code declarations.
 *
 * @date May 9, 2011
 * @author Cedric Wienold
 */
```

```
#ifndef _ERRORCODES_HPP
#define _ERRORCODES_HPP
```

```
/**
 * Yeah this means "basically perfect" in all contexts.
 */
#define EENGINE_SUCCESS 0
#define EENGINE_FAILURE 99999 /*
    Don't use this so much. It's a placeholder for more
    specific errors */
```

```
/*
 * ChangeEngine Errors
 */
#define EWINDOW_FAILED 1 /*
    Window creation failed */
#define EINITIATE_FAILED 2 /*
    Multimedia Library Initialization failed */
#define ELEVEL_CREATE_FAILED 3 /*
    Creation of a game level has failed */
#define ELEVEL_CREATE_ALREADY_EXISTS 4 /*
    Game level creation attempt on preexisting name */
#define EOBJECT_CREATE_INVALID_LEVEL 5 /*
    Object create attempt on level that doesn't exist */
```

```

#define EATTACHIMAGE_INVALID_LEVEL      6          /*
    Attaching image to invalid level */
#define EATTACHIMAGE_INVALID_OBJECT     7          /*
    Attaching image to invalid object */
#define EOBJECTCREATE_CREATE_FAILED     8          /*
    Object create attempt failed */
#define EATTACHIMAGE_FAILED              9          /*
    Attaching of image to object failed */
#define EADDSTATE_INVALID_LEVEL         10         /*
    Attempted adding state to avatar of invalid level */
#define EADDSTATE_FAILED                 11         /*
    Attempt to add state to avatar failed. */

/*****
 * GameWindow Errors      *
 *****/
#define ESETVIDEOMODE_FAILED             20

/*****
 * GameObject Errors      *
 *****/
#define EOBJECT_ALREADY_EXISTS           40
#define EATTACH_AVATAR_ALREADY_EXISTS    41

/*****
 * GameLevel Errors       *
 *****/
#define EADDSTATE_INVALID_OBJECT         60

#endif /* _ERRORCODES_HPP */

```

B.1.5 EventListener.cpp

```

/**
 * @file EventListener.cpp
 *
 * @date May 21, 2011

```

```

*   @author Cedric Wienold
*/

#include "debug.hpp"

#include "EventListener.hpp"
#include "EventTypes.hpp"
#include "errorcodes.hpp"

bool EventListener::pollEvent() {

    return SDL_PollEvent(&event);
}

int EventListener::getEvent() {

    return event.type;
}

int EventListener::getKey() {

    return event.key.keysym.sym;
}

```

B.1.6 EventListener.hpp

```

#include "mitlicense.hpp"

/**
 * @file EventListener.hpp
 * Listener used for grabbing events.
 *
 * @date May 21, 2011
 * @author Cedric Wienold
 */

#ifndef _EVENTLISTENER_HPP
#define _EVENTLISTENER_HPP

```

```

#include "SDL/SDL.h"

class EventListener {
public:
    /**
     * Poll the system for events. This is generally
     * run in a loop for as long as you wish to
     * listen for events.
     */
    bool pollEvent();

    /**
     * Receive the currently held event.
     * @return Event that the listener has heard.
     */
    int getEvent();

    /**
     * If the event is a keypress, this will return
     * which key.
     * @return The keypress triggering the event.
     */
    int getKey();
private:
    SDL_Event event;
};

#endif /* _EVENTLISTENER_HPP */

```

B.1.7 EventTypes.hpp

```

#include "mitlicense.hpp"

/**
 * @file EventTypes.hpp
 * Defined types for events for use with this engine.
 *

```



```

* @date May 21, 2011
* @author Cedric Wienold
*/

// TODO: This is a non-comprehensive list of events.
// Finish it.

/** Main Events */
#define CE_QUIT          SDL_QUIT
#define CE_KEYDOWN      SDL_KEYDOWN
#define CE_KEYUP        SDL_KEYUP
#define CE_MOUSEMOTION  SDL_MOUSEMOTION
#define CE_MOUSEDOWN    SDL_MOUSEBUTTONDOWN
#define CE_MOUSEUP      SDL_MOUSEBUTTONUP

// TODO: Finish defining these keyboard events out of
// comments
/** Keyboard Events */
//Format: CE_KB_[key_identifier]
#define CE_KB_RETURN    SDLK_RETURN
#define CE_KB_ENTER     SDLK_RETURN
#define CE_KB_ESCAPE    SDLK_ESCAPE
#define CE_KB_SPACE     SDLK_SPACE
#define CE_KB_UP        SDLK_UP
#define CE_KB_DOWN      SDLK_DOWN
#define CE_KB_RIGHT     SDLK_RIGHT
#define CE_KB_LEFT      SDLK_LEFT
/*
SDLK_BACKSPACE
SDLK_TAB
SDLK_CLEAR
SDLK_PAUSE
SDLK_EXCLAIM
SDLK_QUOTEDBL
SDLK_HASH
SDLK_DOLLAR
SDLK_AMPERSAND
SDLK_QUOTE

```

SDLK_LEFTPAREN
SDLK_RIGHTPAREN
SDLK_ASTERISK
SDLK_PLUS
SDLK_COMMA
SDLK_MINUS
SDLK_PERIOD
SDLK_SLASH
SDLK_0
SDLK_1
SDLK_2
SDLK_3
SDLK_4
SDLK_5
SDLK_6
SDLK_7
SDLK_8
SDLK_9
SDLK_COLON
SDLK_SEMICOLON
SDLK_LESS
SDLK_EQUALS
SDLK_GREATER
SDLK_QUESTION
SDLK_AT
SDLK_LEFTBRACKET
SDLK_BACKSLASH
SDLK_RIGHTBRACKET
SDLK_CARET
SDLK_UNDERSCORE
SDLK_BACKQUOTE
SDLK_a
SDLK_b
SDLK_c
SDLK_d
SDLK_e
SDLK_f
SDLK_g

SDLK_h
SDLK_i
SDLK_j
SDLK_k
SDLK_l
SDLK_m
SDLK_n
SDLK_o
SDLK_p
SDLK_q
SDLK_r
SDLK_s
SDLK_t
SDLK_u
SDLK_v
SDLK_w
SDLK_x
SDLK_y
SDLK_z
SDLK_DELETE
SDLK_KP0
SDLK_KP1
SDLK_KP2
SDLK_KP3
SDLK_KP4
SDLK_KP5
SDLK_KP6
SDLK_KP7
SDLK_KP8
SDLK_KP9
SDLK_KP_PERIOD
SDLK_KP_DIVIDE
SDLK_KP_MULTIPLY
SDLK_KP_MINUS
SDLK_KP_PLUS
SDLK_KP_ENTER
SDLK_KP_EQUALS
SDLK_INSERT

SDLK_HOME
SDLK_END
SDLK_PAGEUP
SDLK_PAGEDOWN
SDLK_F1
SDLK_F2
SDLK_F3
SDLK_F4
SDLK_F5
SDLK_F6
SDLK_F7
SDLK_F8
SDLK_F9
SDLK_F10
SDLK_F11
SDLK_F12
SDLK_F13
SDLK_F14
SDLK_F15
SDLK_NUMLOCK
SDLK_CAPSLOCK
SDLK_SCROLLLOCK
SDLK_RSHIFT
SDLK_LSHIFT
SDLK_RCTRL
SDLK_LCTRL
SDLK_RALT
SDLK_LALT
SDLK_RMETA
SDLK_LMETA
SDLK_LSUPER
SDLK_RSUPER
SDLK_MODE
SDLK_COMPOSE
SDLK_HELP
SDLK_PRINT
SDLK_SYSREQ
SDLK_BREAK

```

SDLK_MENU
SDLK_POWER
SDLK_EURO
SDLK_UNDO
*/

```

B.1.8 GameAvatar.cpp

```

/**
 * @file GameAvatar.cpp
 *
 * @date May 22, 2011
 * @author Cedric Wienold
 */

#include "GameAvatar.hpp"
#include "SDL/SDL_image.h"
#include "errorcodes.hpp"
#include "debug.hpp"

GameAvatar::~GameAvatar() {

    #ifdef DEBUG
        fprintf(stderr, "GameAvatar: Destructing avatar.\n");
    #endif

    if (tileSet != NULL) {

        SDL_FreeSurface(tileSet);
    }
}

SDL_Surface* GameAvatar::loadImage(const char* filename
) {

    // Algorithm source: http://lazyfoo.net/SDL\_tutorials/lesson03/linux/cli/index.php
    SDL_Surface* loadedImage = NULL;

```

```

SDL_Surface* optimizedImage = NULL;

loadedImage = IMG_Load(filename);

if (loadedImage != NULL) {

    //Create optimized image
    optimizedImage = SDL_DisplayFormat(loadedImage);

    //Free old image
    SDL_FreeSurface(loadedImage);
}

return optimizedImage;
}

int GameAvatar::attachImage(std::string filename, int
    tileWidth, int tileHeight) {

#ifdef DEBUG
    fprintf(stderr, "GameAvatar: Attaching image %s\n",
        filename.c_str());
#endif

    tileSet = GameAvatar::loadImage(filename.c_str());

    if (tileSet == NULL) {

        return EATTACHIMAGEFAILED;
    }

    this->tileWidth = tileWidth;
    this->tileHeight = tileHeight;

    return EENGINE_SUCCESS;
}

```

```

int GameAvatar::addAvatarState(int frameCount) {

    #ifdef DEBUG
        fprintf(stderr,"GameAvatar: Adding state\n");
    #endif

    frameSet.push_back(frameCount);

    return EENGINE_SUCCESS;
}

int GameAvatar::drawObject(GameWindow* window, int x,
    int y, int state, int frame) {

    SDL_Rect *srcrect = new SDL_Rect();
    SDL_Rect *dstrect = new SDL_Rect();

    //Position the crop rect around the frame we want
    srcrect->x = state*tileWidth;
    srcrect->y = frame*tileHeight;
    srcrect->w = tileWidth;
    srcrect->h = tileHeight;

    #ifdef DEBUG
        fprintf(stderr,"GameAvatar: Drawing object to (%ix%i
            ),(%i,%i)\n",x,y,state,frame);
    #endif

    //Now we totally want to set the destination rect
    for the output
    dstrect->x = x;
    dstrect->y = y;
    dstrect->w = tileWidth;
    dstrect->h = tileHeight;

    //Blit to the window's surface
    //SDL_BlitSurface(tileSet,&srcrect,window->getScreen
        (&dstrect);

```

```

        SDL_BlitSurface(tileSet , srcrect , window->getScreen() ,
                        dstrect);

        delete srcrect;
        delete dstrect;

        return EENGINE_SUCCESS;
    }

    int GameAvatar::addTransparency(int r, int g, int b) {

        if (this->tileSet == NULL)
            return EENGINE_FAILURE;

        int colorkey = SDL_MapRGB(this->tileSet->format , r ,
                                   g , b);

        SDL_SetColorKey(this->tileSet , SDL_SRCCOLORKEY,
                        colorkey);

        return EENGINE_SUCCESS;
    }

```

B.1.9 GameAvatar.hpp

```

#include "mitlicense.hpp"

/**
 * @file GameAvatar.hpp
 * This class describes a 2-D sprite-based avatar built
 * with a tile set. Its only function to to
 * maintain the tile set, and draw it out on request.
 *
 * The frames are stored with one state per row. Every
 * call for the next frame will loop through
 * the available frames in that row/state.
 *
 * When constructing the tile set, the user must add

```



```

        each state row separately with the number of
    * frames it holds.
    *
    * @date May 22, 2011
    * @author Cedric Wienold
    */

#ifndef GAMEAVATAR_HPP_
#define GAMEAVATAR_HPP_

#include <string>
#include <vector>
#include "SDL/SDL.h"
#include "SDL/SDL_image.h"
#include "GameWindow.hpp"

class GameAvatar {
private:
    SDL_Surface *tileSet;
    int tileWidth, tileHeight;

    std::vector<int> frameSet;

    static SDL_Surface* loadImage(const char*
        filename);

public:
    virtual ~GameAvatar();

    int attachImage(std::string filename, int
        tileWidth, int tileHeight);

    int addAvatarState(int frameCount);

    int drawObject(GameWindow* window, int x, int y,
        int state, int frame);

    SDL_Surface *getSurface() {return tileSet;}

```

```

        int addTransparency(int r, int g, int b);
};

```

```

#endif /* GAMEAVATAR_HPP_ */

```

B.1.10 GameController.hpp

```

/**
 * @file GameController.hpp
 * Interface for classes which will control the actions
 *   of GameObjects.
 *
 *
 * @date May 21, 2011
 * @author Cedric Wienold
 */

```

```

#ifndef _GAMECONTROLLER_HPP
#define _GAMECONTROLLER_HPP

```

```

class GameObject;
class GameLevel;

```

```

#include "GameLevel.hpp"
#include "EventListener.hpp"

```

```

class GameController {

```

```

    public:

```

```

        /**
         * Gives the object instructions on how to act
         *   given the conditions of the GameLevel.
         *
         * @param level The current level to give the
         *   object a basis upon which to act.
         * @param object The same object that contains
         *   this controller, which will be controlled.

```

```

        */
        virtual void act(GameLevel* level, GameObject*
            object, EventListener* listener) = 0;
};

#endif /* _GAMECONTROLLER_HPP */

```

B.1.11 GameLevel.cpp

```

/**
 * @file GameLevel.cpp
 *
 * @date May 12, 2011
 * @author Cedric Wienold
 */

#include "GameLevel.hpp"

GameLevel::GameLevel() {

    width = height = 0;
}

void GameLevel::Destroy(GameLevel* level) {

    #ifdef DEBUG
        fprintf(stderr, "GameLevel: Destroying level.\n");
    #endif

    //Go through managed objects array and destroy each
    one.
    for(std::map<std::string, GameObject*>::iterator it =
        level->objects.begin(); it != level->objects.end
        (); it++) {

        //Sanity check
        if ((*it).second != NULL) {

```

```

        #ifdef DEBUG
        fprintf(stderr,"GameLevel: Destroying object %
            s.\n",(*it).first.c_str());
        #endif

        //This is where I would call GameObject::
        Destroy(*it) or something along those lines
        GameObject::Destroy((*it).second);
    }
}

delete level;
}

int GameLevel::createGameObject(std::string objectName)
{

    //make sure object doesn't already exist here
    if (objects.find(objectName.c_str()) != objects.end
        ()) {

        #ifdef DEBUG
        fprintf(stderr,"GameLevel: Object %s already
            exists.\n",objectName.c_str());
        #endif

        return EOBJECT_ALREADY_EXISTS;
    }
    else {

        #ifdef DEBUG
        fprintf(stderr,"GameLevel: Object %s does not
            exist. Should create now.\n",objectName.c_str
                ());
        #endif

        objects[objectName] = new GameObject();
    }
}

```

```

    return EENGINE_SUCCESS;
}

int GameLevel::attachImage(std::string object, std::
    string filename, int tileWidth, int tileHeight) {

#ifdef DEBUG
    fprintf(stderr, "GameLevel: Attaching \"%s\" to
        object %s\n", filename.c_str(), object.c_str());
#endif

    //make sure object exists here
    if (objects.find(object.c_str()) != objects.end()) {

#ifdef DEBUG
        fprintf(stderr, "GameLevel: Object %s exists.
            Attaching image \"%s\"\\n", object.c_str(),
            filename.c_str());
#endif

        if (objects[object.c_str()]>attachImage(filename
            ,tileWidth,tileHeight) != EENGINE_SUCCESS) {

            fprintf(stderr, "GameLevel: Failed to attach
                image \"%s\" to %s", filename.c_str(), object
                .c_str());
            return EATTACHIMAGEFAILED;
        }
    }
    else {

#ifdef DEBUG
        fprintf(stderr, "GameLevel: Object %s does not
            exist. Somebuddy dun fuj 'd up\n", object.c_str
            ());
#endif
    }
}

```

```

        return EATTACHIMAGE_INVALID_OBJECT;
    }

    return EENGINE_SUCCESS;
}

int GameLevel::addAvatarState(std::string object, int
    frameCount) {

#ifdef DEBUG
    fprintf(stderr, "GameLevel: Adding level to %s\n",
        object.c_str());
#endif

    //make sure object exists
    if (objects.find(object.c_str()) != objects.end()) {

#ifdef DEBUG
        fprintf(stderr, "GameLevel: Object %s exists.
            Adding state.\n", object.c_str());
#endif

        objects[object.c_str()]>addAvatarState(
            frameCount);
    }
    else {

#ifdef DEBUG
        fprintf(stderr, "GameLevel: Object %s does not
            exist. Cannot add state.\n", object.c_str());
#endif

        return EADDSTATE_INVALID_OBJECT;
    }

    return EENGINE_SUCCESS;
}

```

```

int GameLevel::drawObject(GameWindow* window, std::
    string object, int state, int frame) {

    #ifdef DEBUG
    fprintf(stderr, "GameLevel: Drawing %s (s,f)=(%i,%i)\
        n", object.c_str(), state, frame);
    #endif

    if (objects.find(object.c_str()) != objects.end()) {

        //We DRAW NOW
        return objects[object.c_str()]>drawObject(window
            , state, frame);
    }

    return EENGINE.FAILURE;
}

int GameLevel::attachController(const char* object,
    EventListener* listener, GameController* controller)
{

    objects[object]>attachController(listener,
        controller);

    return EENGINE.SUCCESS;
}

int GameLevel::actObjects(EventListener* listener) {

    std::map<std::string, GameObject*>::iterator it;

    for (it=objects.begin(); it!=objects.end(); it++) {

        it->second->act(this, listener);
    }

    return EENGINE.SUCCESS;
}

```

```

}

int GameLevel::addTransparency(const char* object, int
    r, int g, int b) {

    if (objects[object]->addTransparency(r,g,b) !=
        EENGINE_SUCCESS) {

        return EENGINE_FAILURE;
    }

    return EENGINE_SUCCESS;
}

void GameLevel::setWidth(int w) {
    width = w;
}

void GameLevel::setHeight(int h) {
    height = h;
}

int GameLevel::getWidth() {
    return height;
}

int GameLevel::getHeight() {
    return width;
}

```

B.1.12 GameLevel.hpp

```

#include "mitlicense.hpp"

/**
 * @file GameLevel.hpp
 * Level of the game containing actual game objects and
 * regulating interactions between said objects.

```



```

*
* @date May 12, 2011
* @author Cedric Wienold
*/

#ifndef _GAMELEVEL_HPP
#define _GAMELEVEL_HPP

class GameController;

#include <map>
#include <string>

#include "GameObject.hpp"
#include "GameController.hpp"
#include "EventListener.hpp"
#include "debug.hpp"
#include "errorcodes.hpp"

#include "SDL/SDL.h"

class GameLevel {
private:
    /**
     * Array of game objects being handled by this
     * engine.
     */
    std::map<std::string, GameObject*> objects;

    int width, height;

public:

    GameLevel();

    /**
     * Destroy the given level and all managed
     * objects therein.

```

```

    */
static void Destroy(GameLevel* level);

/**
 * Create a game object to be managed by the
 * level.
 */
int createGameObject(std::string objectName);

/**
 * Attached an image to an avatar of the desired
 * object in this level.
 */
int attachImage(std::string object, std::string
    filename, int tileWidth, int tileHeight);

/**
 * Add state with given number of frames to
 * desired object in this level.
 */
int addAvatarState(std::string object, int
    frameCount);

/**
 * Draw an object of the given state and frame.
 */
int drawObject(GameWindow* window, std::string
    object, int state, int frame);

/**
 * Attach a controller to the given object.
 */
int attachController(const char* object,
    EventListener* listener, GameController*
    controller);

/**
 * Run controller on all objects that have one.

```

```

        */
int actObjects(EventListener* listener);

int addTransparency(const char* object, int r,
                    int g, int b);

void setWidth(int w);
void setHeight(int h);

int getWidth();
int getHeight();
};

#endif /* _GAMELEVEL_HPP */

```

B.1.13 GameObject.cpp

```

/**
 * @file GameObject.cpp
 *
 * @author Cedric Wienold
 * @date May 12, 2011
 */

#include "GameObject.hpp"
#include "errorcodes.hpp"
#include "debug.hpp"

GameObject::GameObject() {

    x = y = z = w = h = d = 0;
    avatar = NULL;
    controller = NULL;
}

int GameObject::getX() {
    return x;
}

```

```

int GameObject::getY() {
    return y;
}

int GameObject::getZ() {
    return z;
}

int GameObject::getWidth() {
    return w;
}

int GameObject::getHeight() {
    return h;
}

int GameObject::getDepth() {
    return d;
}

void GameObject::setX(int x) {
    this->x = x;
}

void GameObject::setY(int y) {
    this->y = y;
}

void GameObject::setZ(int z) {
    this->z = z;
}

void GameObject::setWidth(int w) {
    this->w = w;
}

void GameObject::setHeight(int h) {

```

```

    this->h = h;
}

void GameObject::setDepth(int d) {
    this->d = d;
}

void GameObject::Destroy(GameObject* object) {

    #ifdef DEBUG
        fprintf(stderr, "GameObject: Destroying object.\n");
    #endif

    if (object->avatar != NULL) {

        delete object->avatar;
    }

    delete object;
}

int GameObject::attachImage(std::string filename, int
    tileWidth, int tileHeight) {

    #ifdef DEBUG
        fprintf(stderr, "GameObject: Attaching %s to object.\n",
            filename.c_str());
    #endif

    if (avatar == NULL) {

        avatar = new GameAvatar();
    }
    else {

        #ifdef DEBUG
            fprintf(stderr, "GameObject: There's already an
                attached avatar!\n");
        #endif
    }
}

```

```

        #endif

        return EATTACHAVATAR_ALREADY_EXISTS;
    }

    if ((avatar->attachImage(filename, tileWidth,
        tileHeight)) != EENGINE_SUCCESS) {

        return EATTACHIMAGE_FAILED;
    }

    return EENGINE_SUCCESS;
}

int GameObject::addAvatarState(int frameCount) {

    #ifdef DEBUG
    fprintf(stderr, "GameObject: Adding state to avatar\n
        ");
    #endif

    if (avatar == NULL) {

        #ifdef DEBUG
        fprintf(stderr, "GameObject: NO AVATAR HOLY HELL
            NOOOOO\n");
        #endif

        return EADDSTATE_FAILED;
    }

    avatar->addAvatarState(frameCount);

    return EENGINE_SUCCESS;
}

int GameObject::drawObject(GameWindow* window, int
    state, int frame) {

```

```

    if (avatar == NULL) {

        return EENGINE_FAILURE;
    }

#ifdef DEBUG
    fprintf(stderr, "GameObject: Drawing object to (%i,%i
        )\n", state, frame);
#endif

    return avatar->drawObject(window, x, y, state, frame);
}

int GameObject::attachController(EventListener*
    listener, GameController* controller) {

    if (controller == NULL) {

        return EENGINE_FAILURE;
    }

    if (controller == NULL) {

        return EENGINE_FAILURE;
    }

    this->listener = listener;

    this->controller = controller;

    return EENGINE_SUCCESS;
}

int GameObject::act(GameLevel* level, EventListener*
    listener) {

    if (controller != NULL) {

```

```

        controller->act(level, this, listener);
    }

    return EENGINE_SUCCESS;
}

int GameObject::addTransparency(int r, int g, int b) {

    if (avatar->addTransparency(r, g, b) !=
        EENGINE_SUCCESS) {

        return EENGINE_FAILURE;
    }

    return EENGINE_SUCCESS;
}

```

B.1.14 GameObject.hpp

```

#include "mitlicense.hpp"

/**
 * @file GameObject.hpp
 * Game object for interacting with our wonderful game.
 *
 * @date May 12, 2011
 * @author Cedric Wienold
 */

#ifndef GAMEOBJECT_HPP_
#define GAMEOBJECT_HPP_

#include <string>
#include "GameAvatar.hpp"
#include "GameController.hpp"
#include "EventListener.hpp"

```



```

class GameObject {
    public:

        /**
         * Return the X coordinate of this object.
         * @return The X coordinate of this object.
         */
        int getX();

        /**
         * Return the Y coordinate of this object.
         * @return The Y coordinate of this object.
         */
        int getY();

        /**
         * Return the Z coordinate of this object.
         * @return The Z coordinate of this object.
         */
        int getZ();

        /**
         * Return the width of the object.
         * @return the width of the object.
         */
        int getWidth();

        /**
         * Return the height of the object.
         * @return the height of the object.
         */
        int getHeight();

        /**
         * Return the depth of the object.
         * @return the depth of the object.
         */
        int getDepth();

```

```

void setX(int);
void setY(int);
void setZ(int);
void setWidth(int);
void setHeight(int);
void setDepth(int);

GameObject();

/**
 * Destroy this object and its related avatar, if
 * applicable.
 * @param object the game object ot destroy.
 */
static void Destroy(GameObject* object);

/**
 * Attach an image to this object's avatar.
 * @param filename Filename of the image to
 * attach to the avatar.
 */
int attachImage(std::string filename, int
    tileWidth, int tileHeight);

int addAvatarState(int frameCount);

int drawObject(GameWindow* window, int state, int
    frame);

int attachController(EventListener* listener,
    GameController* controller);

int act(GameLevel* level, EventListener* listener
    );

int addTransparency(int r, int g, int b);

```

```

private:
    int x, y;
    int z; //In 2D games, good for z-buffering. But I
           don't think I'll get to that.

    int w,h,d; //width, height, depth (latter is
               probably useless in 2D games)

    GameAvatar* avatar;
    EventListener* listener;

    GameController* controller;

};

#endif /* GAMEOBJECT_HPP_ */

```

B.1.15 GameWindow.cpp

```

/**
 * @file GameWindow.cpp
 *
 * @author Cedric Wienold
 * @date May 12, 2011
 */

#ifdef DEBUG
    #include <stdio.h>
#endif

#include <stdlib.h>

#include "GameWindow.hpp"
#include "errorcodes.hpp"
#include "SDL/SDL.h"

GameWindow* GameWindow::pInstance = NULL;

```

```

GameWindow* GameWindow::Initiate(ChangeEngine* engine)
{

#ifdef DEBUG
    fprintf(stderr,"GameWindow: Initiate\n");
#endif

    int result = EENGINE_SUCCESS;

    if (pInstance == NULL) {

#ifdef DEBUG
        fprintf(stderr,"GameWindow: Window not found.
        Creating.\n");
#endif

        pInstance = new GameWindow();
    }

    result = SDL_Init(SDL_INIT EVERYTHING);

    if (result != EENGINE_SUCCESS) {

#ifdef DEBUG
        fprintf(stderr,"GameWindow: SDL Initialization
        FAILED.\n");
#endif

        delete pInstance;
        return NULL;
    }

    pInstance->engine = engine;

    return pInstance;
}

void GameWindow::Destroy() {

```

```

#ifdef DEBUG
    fprintf(stderr,"GameWindow: Destroy\n");
#endif

    if (pInstance != NULL) {

        #ifdef DEBUG
            fprintf(stderr,"GameWindow: GameWindow
                instance found. Destroying.\n");
        #endif

        //Check if I made my screen
        if (pInstance->getScreen() != NULL) {

            SDL_FreeSurface(pInstance->getScreen());
        }

        SDL_Quit();
        delete pInstance;
    }
    #ifdef DEBUG
    else {

        fprintf(stderr,"GameWindow: No GameWindow
            instance found. Not destroying.\n");
    }
    #endif
}

GameWindow::GameWindow() {

    screen = NULL;
}

GameWindow::~~GameWindow() {}

int GameWindow::CreateWindow(int x, int y, int width,

```

```

    int height, int bpp) {

#ifdef DEBUG
    fprintf(stderr, "GameWindow: CreateWindow\n");
#endif

    this->width = width;
    this->height = height;
    this->x = x;
    this->y = y;

    //Set up the screen
    screen = SDL_SetVideoMode(width, height, bpp,
        SDL_SWSURFACE);

    if (screen == NULL) {

#ifdef DEBUG
        fprintf(stderr, "GameWindow: ESETVIDEOMODE_FAILED\n");
#endif

        return ESETVIDEOMODE_FAILED;
    }

    return EENGINE_SUCCESS;
}

SDL_Surface* GameWindow::getScreen() {

    return screen;
}

B.1.16 GameWindow.hpp

#include "mitlicense.hpp"

/**

```

```

* @file GameWindow.hpp
* Game window which creates and controls the output
  window for the game.
*
* @date May 12, 2011
* @author Cedric Wienold
*/

#ifndef GAMEWINDOW_HPP_
#define GAMEWINDOW_HPP_

#include "SDL/SDL.h"

#include "debug.hpp"

//Forward declaration to manage circular dependency
class ChangeEngine;

class GameWindow {
private:
    static GameWindow* pInstance;

    ChangeEngine* engine;

    int width, height, x, y;

    //Main screen surface
    SDL_Surface* screen;

public:
    GameWindow();
    ~GameWindow();

    static GameWindow* Initiate(ChangeEngine* engine)
    ;
    static void Destroy();

    int CreateWindow(int x, int y, int width, int

```

```

        height, int bpp);

        //Expose variables
        SDL_Surface* getScreen();
};

#endif /* GAMEWINDOW_HPP_ */

```

B.1.17 mitlicense.hpp

```

/**
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 *
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 * AND

```



```

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  DEALINGS IN THE
* SOFTWARE.
*/

```

B.2 Galaxterminate Demo

This is a demo which showcases the major features of the managed engine and its ability to control objects with Controllers.

B.2.1 main.cpp

```

#include "mitlicense.hpp"

#include "ChangeEngine.hpp"
#include "KeyboardController.hpp"
#include "BallController.hpp"

int main(int argc, char** argv) {

    ChangeEngine *engine = ChangeEngine::Initiate();

    engine->setWindowCaption("Galaxterminate!");

    engine->createWindow(800, 600, 32);

    engine->createLevel("Level1");
    engine->getLevel("Level1")->setWidth(800);
    engine->getLevel("Level1")->setHeight(600);

    engine->createGameObject("Level1", "Object1");
    engine->attachImageToGameObject("Level1", "Object1", "
        spaceship.png", 37, 32);

```

```

engine->addTransparency("Level1","Object1",255,255,255);
engine->attachControllerToGameObject("Level1","Object1",
    (GameController*)(new KeyboardController()));

engine->createGameObject("Level1","Ball");
engine->attachImageToGameObject("Level1","Ball","red_ball.png",200,200);
engine->addTransparency("Level1","Ball",255,255,255);
;
engine->attachControllerToGameObject("Level1","Ball",
    (GameController*)(new BallController()));

int frame=0;

int event;

bool gameRunning = true;

while (gameRunning) {

    frame == 2 ? frame = 0 : frame++;

    engine->drawStart();
    engine->drawObject("Level1","Object1",0,frame);
    engine->drawObject("Level1","Ball",0,0);
    engine->drawFinish();

    engine->pollEvent();

    event = engine->getEventListener()->getEvent();

    switch (event) {

        case CEKEYDOWN:

```

```

        if (engine->getEventListener()->getKey() ==
            CEKB_ESCAPE)
            gameRunning = false;
        break;
    case CE_QUIT:
        gameRunning = false;
        break;
    default:
        break;
}

engine->actObjects("Level1");

}

engine->Destroy();

return 0;
}

```

B.2.2 KeyboardController.hpp

```

#include "mitlicense.hpp"

/**
 * @file KeyboardController.hpp
 * Class extending GameController which gives simple
 * keyboard access.
 *
 * @date May 21, 2011
 * @author Cedric Wienold
 */

#ifndef KEYBOARDCONTROLLER_HPP
#define KEYBOARDCONTROLLER_HPP

#include "GameController.hpp"
#include "EventTypes.hpp"

```

```

#include "EventListener.hpp"
#include "GameObject.hpp"

class KeyboardController : public GameController {

    public:

        void act(GameLevel* level, GameObject* object,
                EventListener* listener);
};

#endif /* _KEYBOARDCONTROLLER_HPP */

```

B.2.3 KeyboardController.cpp

```

/**
 * @file KeyboardController.cpp
 *
 * @date May 12, 2011
 * @author Cedric Wienold
 */

#include "KeyboardController.hpp"

void KeyboardController::act(GameLevel* level,
    GameObject* object, EventListener* listener) {

    int event, key;

    event = listener->getEvent();

    //There's probably a much better way of doing this
    //that will allow simultaneous key presses.
    //My demo isn't here to prove that bit of the puzzle

    if (event == CEKEYDOWN) {

        key = listener->getKey();
    }
}

```

```

        if (key == CE_KB_RIGHT)
            object->setX(object->getX() + 1);
        if (key == CE_KB_LEFT)
            object->setX(object->getX() - 1);
        if (key == CE_KB_DOWN)
            object->setY(object->getY() + 1);
        if (key == CE_KB_UP)
            object->setY(object->getY() - 1);
    }
}

```

B.2.4 BallController.hpp

```

#include "mitlicense.hpp"

/**
 * @file BallController.hpp
 * Class extending GameController which controls the
 * ball.
 *
 * @date May 21, 2011
 * @author Cedric Wienold
 */

#ifndef BALLCONTROLLER_HPP
#define BALLCONTROLLER_HPP

#include "GameController.hpp"
#include "EventTypes.hpp"
#include "EventListener.hpp"
#include "GameObject.hpp"

class BallController : public GameController {
public:

```

```

        void act(GameLevel* level, GameObject* object,
                EventListener* listener);
};

#endif /* BALLCONTROLLER_HPP */

```

B.2.5 BallController.cpp

```

/**
 * @file BallController.cpp
 *
 * @date May 12, 2011
 * @author Cedric Wienold
 */

#include "BallController.hpp"

void BallController::act(GameLevel* level, GameObject*
    object, EventListener* listener) {

    static int xvel = 1;
    static int yvel = 1;

    if (object->getX() <= 0) {

        xvel = 1;
    }

    if ((object->getX() + object->getWidth()) >=
        level->getWidth()) {

        xvel = -1;
    }

    if (object->getY() <= 0) {

        yvel = 1;
    }
}

```

```

    if (level->getHeight() <= (object->getY() +
        object->getHeight())) {

        yvel = -1;
    }

    object->setX(object->getX() + xvel);
    object->setY(object->getY() + yvel);
}

```