Game Engine Development II

Week5

Hooman Salamat

Input Handling

Objectives

- Examine SFML events and explore their purpose as input
- Assess real-time input and evaluate its difference from events
- Analyze and reproduce a command-based communication system to deliver events
- Explore how to dynamically bind keys at runtime

Win32 Keyboard Input Model

- https://docs.microsoft.com/en-us/windows/win32/inputdev/about-keyboard-input

Polling Events

- Events are objects that are triggered when something happens
  - E.g., user input
- Behind the scenes, the OS reports an event to the application
  - SFML processes such a report
  - Converts it into a corresponding SFML event type

Polling Events (cont'd.)

- Specifically, we extract events using the `sf::Window::pollEvent()` function

- It's signature is:

```
bool sf::Window::pollEvent(sf::Event& event);
```

Polling Events (cont'd.)

- Generally we want to poll an event with an event parameter as well as a bool that will tell us to keep polling the event or not
  - If there are no more of that event type to poll

Events Thus Far

- In the examples up to now, we've handled events in SFML thus:

```
sf::Event event;
while (window.pollEvent(event))
{
  // Handle the event
}
```

Events

- We can group events to four different categories:
  - **window**, **joystick**, **keyboard** and **mouse**

- The next few slides outline these events

Window Events

- Window events concern windows directly

- `sf::Event::Closed`
  - Occurs when the user requests that the window be closed
  - Pressing the [X] or Alt-F4 for example
  - No data associated with this event

Window Events (cont'd.)

- `sf::Event::Resized`
  - Occurs when the window is resized
  - User drags on edges to manually resize it
  - Window must be enabled to resize
  - Data type is `sf::Event::SizeEvent` that is accessed through `event.size`

Window Events (cont'd.)

- `sf::Event::LostFocus`
- `Sf::Event::GainedFocus`
  - Window is active or inactive (clicked away from)
  - No extra data for event

Joystick Events

- Whenever a joystick or gamepad changes its state
  - Each input device has an ID number

- `sf::Event::JoystickButtonPressed`
- `sf::Event::JoystickButtonReleased`
  - Data structure associated is `sf::Event::JoystickButtonEvent` with the member `event.joystickButton`

Joystick Events (cont'd.)

- `sf::Event::JoystickMoved`
  - Triggered when analog stick or D-pad moves
  - Data is `sf::Event::JoystickMoveEvent` and accessible through member `event.joystickMove`

Joystick Events (cont'd.)

- `sf::Event::JoystickConnected`
- `Sf::Event::JoystickDisconnected`
  - Data is `sf::Event::JoystickConnectEvent` and accessible through member `event.joystickConnect`

Keyboard Events

- Generates event as the primary input device for computers

- `sf::Event::KeyPressed`
  - Data structure associated is `sf::Event::KeyEvent` with the member `event.key.code`
  - `event.key.control` are Booleans that state whether a modifier is pressed
  - Key repetition can be deactivated using `sf::Window::setKeyRepeatEnabled()`

Keyboard Events (cont'd.)

- `sf::Event::KeyReleased`
  - Counterpart to `KeyPressed`
  - Similar in function

- `sf:Event:TextEntered`
  - Designed for receiving formatted text from the user
  - Data is `sf::Event::TextEvent` and accessible through `event.text`

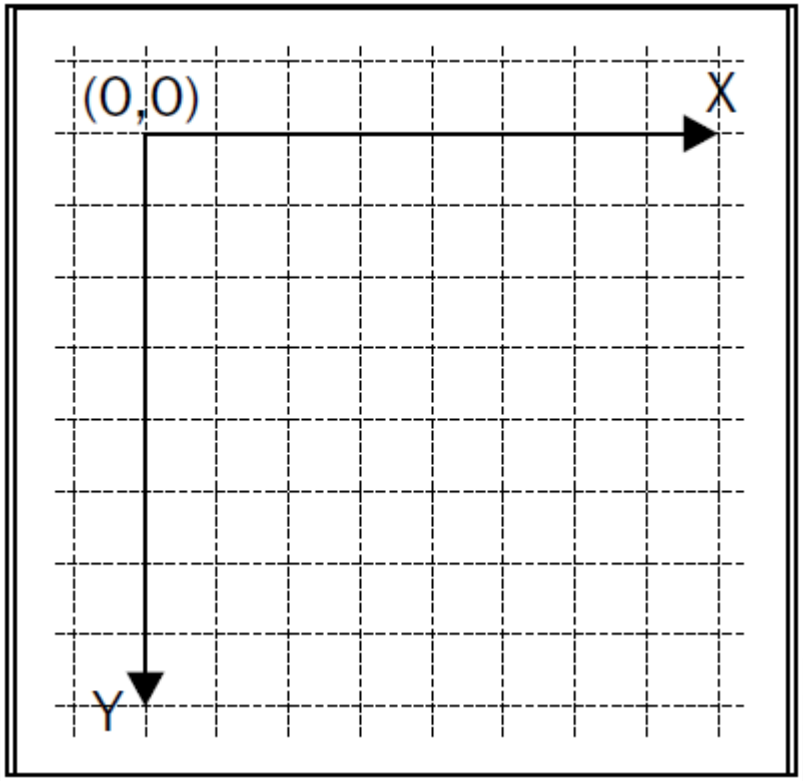
Mouse Events (cont'd.)

- Events generated when the state of the cursor, mouse buttons or mouse wheel changes

- `sf::Event::MouseEntered`
- `sf::Event::MouseLeft`
- `Sf::Event::MouseMoved`
  - Data structure for `MouseMoved` is `sf::MouseMoveEvent` and can be accessed via `event.mouseMove`

Mouse Orientation

- As most platforms, coordinates measures in window pixels



Mouse Events (cont'd.)

- `sf::Event::MouseButtonPressed`
- `sf::Event::MouseButtonReleased`
  - Data structure is `sf::MouseButtonEvent` and can be accessed via `event.mouseButton` member

- `sf::Event::MouseWheelMoved`
  - Data structure is `sf::MouseWheelEvent` and can be accessed via `event.mouseWheel` member

Handling Input

```
void Game::handlePlayerInput(sf::Keyboard::Key key, bool isPressed)
{
    if (key == sf::Keyboard::W)
      mIsMovingUp = isPressed;
    else if (key == sf::Keyboard::S)
      mIsMovingDown = isPressed;
    else if (key == sf::Keyboard::A)
      mIsMovingLeft = isPressed;
    else if (key == sf::Keyboard::D)
      mIsMovingRight = isPressed;
}
```

Handling Input (cont'd.)

```
void Game::update()
{
    sf::Vector2f movement(0.f, 0.f);
    if (mIsMovingUp)
      movement.y -= 1.f;
    if (mIsMovingDown)
      movement.y += 1.f;
    if (mIsMovingLeft)
      movement.x -= 1.f;
    if (mIsMovingRight)
      movement.x += 1.f;
    mPlayer.move(movement);
}
```

Combining Into Update

```
void Game::update(sf::Time elapsedTime)
{
    sf::Vector2f movement(0.f, 0.f);
    if (sf::Keyboard::isKeyPressed(sf::Keyboard::W))
      movement.y -= PlayerSpeed;
    if (sf::Keyboard::isKeyPressed(sf::Keyboard::S))
      movement.y += PlayerSpeed;
    if (sf::Keyboard::isKeyPressed(sf::Keyboard::A))
      movement.x -= PlayerSpeed;
    if (sf::Keyboard::isKeyPressed(sf::Keyboard::D))
      movement.x += PlayerSpeed;
    mPlayer.move(movement * elapsedTime.asSeconds());
}
```

Events vs. Real-Time Input

- If a state has changed, you should use events
- However, if you want to know the current state, then of course you must check using a function

```
// WHEN the left mouse button has been pressed, do something
if (event.type == sf::Event::MouseButtonPressed)

// WHILE the left mouse button is being pressed, do something
if (sf::Mouse::isButtonPressed(sf::Mouse::Left))
```

- So the second method is good for sustained input

Delta Movement

- The different in cursor position between two frames

```
sf::Vector2i mousePosition = sf::Mouse::getPosition(mWindow);
sf::Vector2i delta = mLastMousePosition - mousePosition;
mLastMousePosition = mousePosition;
```

Applying the Focus

```
void Game::run()
{
     while (mWindow.isOpen())
     {
          if (!mIsPaused)
            update();
          render();
          processEvents();
     }
}
void Game::processEvents()
{
     sf::Event event;
     while(mWindow.pollEvent(event))
     {
          if (event.type == sf::Event::GainedFocus)
            mIsPaused = false;
          else if (event.type == sf::Event::LostFocus)
            mIsPaused = true;
     }
}
```

Commands

Commanding the Entities

- Some example commands might be as follows:

```
// One-time events
sf::Event event;
while (window.pollEvent(event))
{
    if (event.type ==
       sf::Event::KeyPressed
    && event.key.code ==
       sf::Keyboard::X)
       mPlayerAircraft-
       >launchMissile();
}
```

```
// Real-time input
if
   (sf::Keyboard::isKeyPressed(
   sf::Keyboard::Left))
   mPlayerAircraft->moveLeft();
else if
   (sf::Keyboard::isKeyPressed(
   sf::Keyboard::Right))
   mPlayerAircraft-
   >moveRight();
```

Commanding (cont'd.)

- Commands are messages that are sent to game objects
    - Alter the object
    - Issue orders:
        - Movement
        - Firing weapons
        - Triggering state changes

Command struct

```
struct Command
{
   std::function<void(SceneNode&, sf::Time)> action;
};
```

`std::function` is a C++11 class template to implements callback mechanisms. It treats functions as objects and makes it possible to copy functions or to store them in containers. The `std::function` class is compatible with function pointers, member function pointers, functors, and lambda expressions. The template parameter represents the signature of the function being stored.

std::function Example

```
int add(int a, int b) { return a + b };
std::function<int(int, int)> adder1 = &add;

std::function<int(int, int)> adder2
= [] (int a, int b) { return a + b; };
```

- Then it can be used thusly:

```
int sum = adder1(3, 5); // same as add(3, 5)
```

Movement Example

```
void
  moveLeft(SceneNode&
  node, sf::Time dt)
{
  node.move(-30.f *
  dt.asSeconds(),
  0.f);
}
Command c;
c.action = &moveLeft;
```

Using Lambda expression, the equivalent being:

```
c.action = [] (SceneNode&
  node, sf::Time dt)
{
  node.move(-30.f *
  dt.asSeconds(), 0.f);
};
```

Commanding (cont'd.)

- The different game objects should each receive their appropriate commands
- So they are divided into different categories
- Each category has one bit set to 1 and rest are set to 0

```
namespace Category
{
    enum Type
    {
        None = 0,
        Scene = 1 << 0,
        PlayerAircraft = 1 << 1,
        AlliedAircraft = 1 << 2,
        EnemyAircraft = 1 << 3,
    };
}
```

Commanding (cont'd.)

- A bitwise OR operators allows us to combine different categories, for example all airplanes:

```
unsigned int anyAircraft =
  Category::PlayerAircraft
                          |
  Category::AlliedAircraft
                          |
  Category::EnemyAircraft;
```

The SceneNode class gets a new virtual method that returns the category of the game object. In the base class, we return Category::Scene by default:

```
unsigned int
SceneNode::getCategory()
const
{
return Category::Scene;
}
```

Commanding (cont'd.)

- `getCategory()` can be overridden to return a specific category
- an aircraft belongs to the player if it is of type Eagle, and that it is an enemy otherwise:

```
unsigned int
   Aircraft::getCategory()
   const
{
   switch (mType)
   {
       case Eagle:
              return
   Category::PlayerAircraft;
       default:
              return
   Category::EnemyAircraft;
   }
}
```

Command struct Revisited

- we give our Command class another member variable that stores the recipients of the command in a category:

```
struct Command
{
  Command();
  std::function<void(SceneNode&, sf::Time)> action;
  unsigned int category;
};
```

- The default constructor initializes the category to Category::None. By assigning a different value to it, we can specify exactly who receives the command. If we want a command to be executed for all airplanes except the player's one, the category can be set accordingly:

```
Command command;
command.action = ...;
command.category = Category::AlliedAircraft
| Category::EnemyAircraft;
```

Command Execution

- Commands are passed to the scene graph
- Inside, they are distributed to all scene nodes with the corresponding game objects
- Each scene node is responsible for forwarding a command to its children
- SceneNode::onCommand() is called everytime a command is passed to the scene graph

```
void
   SceneNode::onCommand(const
   Command& command, sf::Time
   dt)
 { //check if the current scene
  node is a receiver of the
  command
   if (command.category &
   getCategory())
        command.action(*this,
   dt);

   FOREACH(Ptr& child,
   mChildren)
        child-
   >onCommand(command, dt);
}
```

Command Queues

- A way to transport commands to the world and the scene graph
- A class that is a very thin wrapper around a queue of commands

```
class CommandQueue
{
public:
   void push(const Command&
   command);
   Command pop();
   bool isEmpty() const;

private:
   std::queue<Command>
   mQueue;
};
```

Command Queues (cont'd.)

- The `World` class holds an instance of `CommandQueue`:

```
void World::update(sf::Time dt)
{
    ...

    // Forward commands to the scene graph
    while (!mCommandQueue.isEmpty())
       mSceneGraph.onCommand(mCommandQueue.pop(), dt);

    // Regular update step
    mSceneGraph.update(dt);
}

CommandQueue& World::getCommandQueue()
{
   return mCommandQueue;
}
```

Player and Input

- Together now we're going to look at how the player's input is handled
- We will look at the following:
  - The `Player` class
  - The `processInput` function from `Game`

class Game

```
class Game : private sf::NonCopyable
{
public:
Game();
voidrun();


private:
voidprocessEvents();
voidupdate(sf::Time elapsedTime);
voidrender();
voidupdateStatistics(sf::Time elapsedTime);

private:
PlayermPlayer;
static const sf::TimeTimePerFrame;

sf::RenderWindowmWindow;
WorldmWorld;

  sf::FontmFont;
sf::TextmStatisticsText;
sf::TimemStatisticsUpdateTime;
std::size_tmStatisticsNumFrames;
};
```

Game::processEvents()

```
void Game::processEvents()
{
CommandQueue& commands = mWorld.getCommandQueue();
sf::Event event;
while (mWindow.pollEvent(event))
{
switch (event.type)
{
mPlayer.handleEvent(event, commands);
case sf::Event::Closed:
mWindow.close();
break;
}

mPlayer.handleRealtimeInput(commands);
}
}
```

class Player

```
class Player
{
public:
Player();
static const floatPlayerSpeed;
voidhandleEvent(const sf::Event& event,
CommandQueue& commands);
voidhandleRealtimeInput(CommandQueue&
commands);
};
```

Player::handleEvent

```
void Player::handleEvent(const sf::Event& event,
CommandQueue& commands)
{
if (event.type == sf::Event::KeyPressed && event.key.code
== sf::Keyboard::P)
{
Command output;
output.category = Category::PlayerAircraft;
output.action = [](SceneNode& s, sf::Time) {
std::cout << s.getPosition().x << ","
<< s.getPosition().y << "\n";
};
commands.push(output);
}
}
```

AircraftMover

```
struct AircraftMover
{
AircraftMover(float vx, float vy)
: velocity(vx, vy)
{
}

void operator() (Aircraft& aircraft, sf::Time) const
{
aircraft.accelerate(velocity);
}

sf::Vector2f velocity;
};
```

Player::handleRealtimeInput

```
void Player::handleRealtimeInput(CommandQueue& commands)
{
if (sf::Keyboard::isKeyPressed(sf::Keyboard::Left))
{
Command moveLeft;
moveLeft.category = Category::PlayerAircraft;
moveLeft.action = derivedAction<Aircraft>(
AircraftMover(-PlayerSpeed, 0.f)
);
commands.push(moveLeft);
}

if (sf::Keyboard::isKeyPressed(sf::Keyboard::Right))
{
Command moveRight;
moveRight.category = Category::PlayerAircraft;
moveRight.action = derivedAction<Aircraft>(
AircraftMover(PlayerSpeed, 0.f)
);
commands.push(moveRight);
}
```