FixedWingLib CGF

FixedWingLib CGF offers high-fidelity maneuvers for air combat, close air support and other real-world military and civil manned and unmanned fixed wing operations. Developers can use FixedWingLib CGF aircrafts and maneuvers in their simulation scenarios and they can build new high-precision maneuvers by using the maneuver controllers from the real-time C++ library.

FixedWingLib offers more than the typical SAF, CGF solutions or physics engines, by adding:
- High level navigational maneuvers (fly to point, waypoint following, loiter around point and more)
- Air combat maneuvers (wingman, Immelmann, formation flying).
- Direct pitch, roll, throttle and air brake control
- Extensible controllers to create new maneuvers
- Standalone C++ library
- Very fast real-time simulation performance up to 80 aircrafts on a regular PC
- 6 DOF flight dynamics

Realistic CGF Aircraft Entities

High fidelity aircraft entities

Unlike basic models found in today's tactical simulations, the dynamics of FixedWingLib CGF aircrafts are simulated with 6 DOF flight dynamics and flight maneuvers are performed by advanced maneuver controllers instead of simple scripts. These improvements allows developers to program even the most complex air combat simulations with highest fidelity.

AI and rule set ready

Your AI rules or scenario scripts can re-start, cancel and change maneuvers in their if/then/else logic as often as required. The flight controllers prevent unrealistic behavior. Moreover, maneuver parameters (e.g. altitude or target aircraft) can be changed any time during the execution of the maneuver. And finally, all maneuvers report their current states so that you can easily check if the maneuver has completed.

Combat Maneuver Library (CML) add-on

CML (available as a separate add-on) includes attack and defensive air combat maneuvers, for in-visual-range and out-of-visual-range air combat, close air support and aerial refueling.

Fast Simulation Model

FixedWingLib CGF can simulate a large number of aircraft entities simultaneously in the same scenario, e.g. 80 on modern PC hardware can be easily simulated in real-time. This sort of simulation performance is
possible, because FixedWingLib CGF doesn't depend on any additional libraries, all maneuvers and flight dynamics models are hand-written in C++ and not generated by a modeling tool.

**Snapshot and restore**

Snapshot and restore feature allows developers to save simulation the state to a disk file and restore later on. FixedWingLib CGF can restore the whole simulation state including flight dynamics, control systems, maneuvers and reference entities such as wingmen or enemy aircraft.

**Model and Fly any Type of Conventional Aircraft**

FixedWingLib CGF allows developers to customize the flight model and maneuver models. Each maneuver is configured with a number of parameters, such as altitude or desired g load, which specify the way the maneuver will be performed. For example, one can determine how agile a break turn maneuver will be executed.

XML files can be used to configure the aircraft models and the maneuver parameters. This effort requires no programming.

The parameters can also be changed with the C++ API. The obvious advantage of this method is that the model parameters can be kept proprietary.

FixedWingLib CGF implements both the aircraft model and the maneuvers as C++ classes. Virtual methods are provided so that C++ developers can customize a maneuver completely.

**Supported Aircraft Types:**
Almost all conventional types are supported. Including:
- cargo and carrier airplanes
- military jet aircraft
- fixed wing UAVs

```
<SimpliedAirplane version="1.0">
  <MomentsOfInertia Ixx="75673" Iyy="12874" Izz="85"
  <Mass mass="11755"/>
  <Limits>
    <Load minLoadFactor="-3" maxLoadFactor="9.3"/>
    <AoA AoAlimelterActivationPoint="23.5"/>
  </Limits>
  <Aerodynamics>
    <Lift liftCurveSlope="0.06" maxLiftCoeff="1.8"
    <Sideforce sideforceCurveSlope="0.1" maxSide
    <Drag dragRefArea="27.87">
    <CdCurve>
      -10  0.1560
      -5   0.0410
      0    0.0220
    </CdCurve>
  </Aerodynamics>
</SimpliedAirplane>
```

Flight dynamics model can be customized with XML files.
Maneuver controllers have meaningful and safe defaults. If required, XML files can be used to tweak the maneuvers.

Maneuver Library

FixedWingLib CGF comes with ready-to-use maneuvers. Each maneuver can be started by calling a C++ class method and allows setting its initial parameters. Maneuvers parameters can be changed anytime (e.g. it is possible to change the altitude after starting the maneuver). You can also change to another maneuver anytime without waiting for current maneuver to end.

Navigational Maneuvers:
- fly on route over waypoints
- loiter around a point
- fly at a given speed, heading and altitude
- banking
- accelerate and decelerate
- fly with a given velocity vector
- fly at the given attitude (roll and pitch), speed, throttle setting and air brake setting

Starting a maneuver

```cpp
LoiterController::Params params;
params.m_altitudeFeet = 1500.0f;
params.m_radiusNM = 2.0f;
params.m_speedKts = 300.0f;
myAircraft->loiter( params );
```

Custom Maneuvers

In addition to the existing maneuvers, FixedWingLib CGF allows creation of completely new maneuvers such as a variant of high yoyo or a special air refueling maneuver. For this purpose, it is sufficient to derive a new class from the AirplaneBot class and re-implement its update() method. A number of powerful low level controllers are available for use within custom maneuvers. These include velocity controller, basic flight controller (maintains speed, heading and altitude, and direct pitch, roll, throttle and air brake controls.)
RotorLib CGF® is a real-time C++ SDK for simulating rotary wing computer generated forces. RotorLib CGF® control technology provides physics based helicopter models for CGF entities in real-time simulations. RotorLib CGF uses real-time flight dynamics and rigid body dynamics to create realistic insertions, search and rescue operations, bob-up attacks, terrain following patterns and more. True physics and automated control commands make RotorLib CGF an ideal toolkit for helicopter pilot- and crew-training applications.

RotorLib CGF provides high level, easy to program autonomous helicopter CGF entities for real-time simulations. RotorLib CGF powered CGF helicopters can perform maneuvers like land, hover and move to. When combined, these maneuvers can simulate highly realistic battlefield scenarios such as insertion and search & rescue. The maneuvers are available to developers through an easy to use C++ API.

**Features:**

- Physically-based real-time helicopter dynamics model and virtual pilots for CGF
- Supports saving and loading simulation state
- Faster or slower than real-time simulation and pausing the simulation supported
- Deterministic simulation model (i.e. it is possible to repeat scenarios)
- High level commands for autonomous CGF: move to, land, hover, follow waypoints and more
- Low level commands for custom maneuvers and special operations like rescue hoist and cargo operations: attitude hold, velocity hold
- Built-in terrain contour following capability
- Helicopter models and control systems are configurable using XML files
- Customizable for application specific maneuvers (e.g. nap-of-the-earth flight)
- Easy to use C++ API
- Up to 80 helicopters simultaneously on modern PC hardware
- Available on Windows® and Linux®
Applications

RotorLib CGF has a wide variety of applications, including but not limited to:

- Computer Generated Forces Applications
  - Battlefield and urban helicopter operations
  - Autonomous wingman
  - Autonomous targets
  - Simulation of autonomous UAV entities
- Helicopter and ground crew training
  - Door gunner training
  - Winch operator training
  - Load master simulator
  - Marshaling simulator
  - UAV operator training
- Entertainment
  - Entertainment simulators
  - Computer games

Helicopter Operations

A large number of military and civilian special helicopter operations can be simulated with RotorLib CGF:

- Patrol insertion and extraction
- Submarine operations
- Fast-rope operations
- Cargo transfer
- Combat Search and Rescue (CSAR)
- Anti-Surface Warfare (ASUW)
- Organic Airborne Mine Countermeasures (OAMCM)
- Vertical onboard delivery (VOD)
- Special Warfare Support (SWS)
- Airhead operations
- Recovery of torpedoes, drones, unmanned aerial vehicles, and unmanned undersea vehicles (UUV),
- Aeromedical evacuations (MEDEVAC)
- Airborne Mine Countermeasures (AMCM)
- Non-combatant Evacuation Operations (NEO)