A flight-training system using case-based reasoning

Michel Aka       Claude Frasson

Université de Montréal  
Département d’informatique et de recherche opérationnelle  
C.P. 6128, Succ. Centre-Ville  
Montréal, Québec Canada H3C 3J7  
E-mail: akakoasm, frasson @iro.umontreal.ca

Abstract. This paper describes the implementation of a distance learning flight-training system. We described the various methods used during the implementation of the software (Virtual reality and Case Based Reasoning). ASIMIL proposes a client/server architecture that enables the user to have automated real-time assistance in addition to normal error detection.

Keywords: Simulation, Case Base Reasoning, Client-Server, Virtual Reality, Flight training.

1 Introduction

Flight training is the main objective of the ASIMIL (Aero user-friendly SIMulation-based distance Learning) project. ASIMIL aims at developing a tool that will train and sharpen the skills of pilots in the Aeronautical domain. By the combining Virtual Reality (VR) and Case Based Reasoning (CBR) we hope to enhance the traditional training processes.

ASIMIL does not only rely on CBR to help the learner. It also uses a concept-based analyzer that identifies user mistakes and indicates the lessons that should be reviewed.

The Virtual Aeronautical Instructor (VAI) is one of the main modules in ASIMIL. It identifies and reacts to all errors committed during the execution of the exercise. VAI’s implementation is based upon Case Based Reasoning (CBR) technology. As an Artificial Intelligence (AI) technique, CBR enables us to solve problems by correctly identifying them and associating them to their corresponding solutions. VAI is not only used to understand mistakes but also to prevent them. A human Instructor is able, in some cases, to anticipate a failure or identify a situation that leads to an eminent error. VAI acquires its anticipation technique by monitoring the advices given by human instructors and by associating these advices to the situations in which they were given.

In this paper we will look at the global architecture of ASIMIL then we will turn our attention to the flight simulator which realism and fluidity are important for the learner.
2 Architecture

On the top most level of architecture ASIMIL is a client/server application that operates over TCP/IP-compatible networks.

The role of the server side of the application is to regroups all activities that are in relation to the instructor. These activities consist of supervision, management, follow up and providing online Help. These functionalities are derived from the fact that the server is tied to the instructor’s role. The server can only manage a certain amount of connections (students/clients). This limitation is mostly imposed by network speed capacity and computational capabilities. The CBR engine is also implemented on the server side of the application.

The client (figure 2) side of the application provides the student with the tools necessary for him to learn and practice his piloting skills.
Also integrated in the client GUI a TTS agent reads out the all-incoming messages from server. This enables the learner to have knowledge of the instructor’s words without taking his eyes off the cockpit. This also makes expert-learner communication more intuitive. There is no need to read the advice; instead it can be listened to.

3 Overview of the Main Models

3.1 The flight Simulator

In ASIMIL the VR module creates the 3D virtual environment inside which the learner will carry out his exercises. The simulation itself is completely independent from the rest of the software. It can be run as a normal flight simulator, where one would fly the plane without any precise objective.
As seen in the figure 4, four forces affect the aircraft’s movement: gravity, lift, thrust and drag.
The creation of the objects present in the simulation (modeling) was done using 3D studio MAX which is a software that enables us to build the binary data set representing the virtual objects through a graphical interface. With the help of this software we are can modify or add various other attributes such as light effect, polygon detail and texture.

The landing strip, the plane, the control tower and all the objects seen in the simulation were modeled in 3D studio Max. A great deal of attention given to realism and file size. In an effort to prevent lag the simulation was stripped of a lot of details. For example, High detailed textures were replaced by textures that provide adequate mapping, which is the art of applying textures or image on a virtual objects in order to make it look more real. Also, Objects like trees cars that account for “décor “ were not added. As a results a better frame rate is possible on slower machines thus giving the learner a better “feeling” of flying.

![3D Studio's Interface](image)

**Figure 5: A view of 3D Studio’s interface**

### 3.2 The analyzer

An exercise (Lift-off, Landing, Taxi, Straight level flight…) is a simulation that has to follow a predefined sequence in order for it to be carried out properly.

A concept is the notion that is associated to a step of the sequence. Each step of the sequence is characterized by a combination of concepts. Concepts are both linked to exercises and lessons in two databases (Concepts-Lessons and Concepts-Exercises). Notions relative to a specific concept can be present in more than one lesson.

When an error is made in the sequence, the analyzer memorizes the associated concepts. At the end of the exercise the lessons that are linked to the concepts that have been fouled are remembered.
3.3 The Virtual Aeronautical Instructor

The Virtual Aeronautical Instructor is responsible for analyzing and explaining errors committed by the user. VAI can also anticipate user-mistakes and provide the student with assistance that might prevent an exercise-threatening situation. When VAI anticipates an error it informs the expert (if any is present) by using color codes applied on the user’s name. These colors indicate the importance of the mistake. VAI comes as an addition to the Analyzer module which main roll is to correct and not assist. VAI works in a cycle that can be illustrated by the following figure.

![Figure 6](Image)

**Figure 6**

*Case Retrieval in VAI*

Case Retrieval’s roll lies on the ability to find a set of cases that are similar or equal to the target case. Case retrieval can be divided in sub steps known as: feature identification, search and select.

*Case Reuse in VAI*
Case reuse is the step where the explanation that will be given to the user is generated. Depending on the Case Retrieval’s results Case Reuse will either copy or merge some cases’ solutions to generate the target case’s solution.

If the target case was already in memory then there is no need to apply Case Reuse. When Case Retrieval returns only one case, the solution is copied. When the Case Memory returns more that one case then the solutions are concatenated and separated by “or”. The target case is also marked as “not certified”.

Case Revision in VAI

This step of VAI’s cycle does not necessarily take place in real time. All the cases that are marked as “not certified” have to be reviewed by the expert. If the explanation and help do not correspond to the situation then the expert corrects the case. Cases that have recurrent complaints from user feedback are also marked as “not certified”. This step helps VAI to better its error analyzing capabilities.

Case Retain in VAI

Once a new solution has been generated for the target case VAI can add it to its case memory. The target case is added according to the indexing method that makes up the Case Memory.

4 Conclusion

As a client/server software, ASIMIL is a tool that integrates Virtual Reality, Artificial Intelligence and distance learning. We have seen that assistance is brought to the user in real time and after each exercise when needed. The assistance provided in ASIMIL is mostly an automated process but it can also be given directly by the instructor thanks to the possibility of remotely viewing the learner’s actions. (For more implementation detail please refer to ASIMIL: Overview of a distance learning flight-training system
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