Common Cockpit Helicopter Training Simulator

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Abstract. SHAI is developing a training system that utilizes MS Flight Simulator to assist crewmembers learn the Navy's new Common Cockpit MH-60R and MH-60S helicopters. The Operator Machine Interface Assistant (OMIA) system is being used by the US Navy to assist operators learn the new common-cockpit MH-60R and MH-60S helicopters in an increasingly broad variety of mission tasks and analyses, using the wide assortment of sensor, navigation, and computational resources available. The OMIA system consists of proprietary software to reproduce the mission display portion and other aspects of the helicopters. Flight Simulator is being integrated with the present OMIA system to provide the flight display, and other capabilities built into flight simulator. An interface has been established between the programs so changes made by one system are propagated to the other system.

Introduction

The US Navy is introducing two new helicopters, the MH-60S and MH-60R (See Figure 1). Both of these helicopters utilize the Common Cockpit design. The Common Cockpit includes all the flight and mission instrumentation in both of the helicopters and enables both the pilot and co-pilot to share workload through dual flight and mission instrumentation, see Figure 2. SHAI is building a training tool called the Operator Machine Interface Assistant (OMIA) to teach the common cockpit. OMIA is currently in use by the US Navy and is being expanded to teach more of the overall domain.

Figure 1. MH-60R

The present Operator Machine Interface Assistant (OMIA) is actually a combination of many useful training tools, some of which can be used independently. On one level an operator system interface simulator partial-task trainer (PTT) has been developed that can be used independently from other modules. The operator system interface simulator PTT deals mainly with the operation of the mission display and the center console. As can be seen in Figure 2 the pilot and copilot each have two LCD screens, one of which is the Mission Display (MD) and the other is the Flight Display (FD).

The PTT is being expanded to handle more training tasks related to the Flight Display. This is where MS Flight Simulator is being incorporated. Flight Simulator will be used for training both as a standalone tool and fully incorporated with the rest of OMIA. When FS is used independently, it will be FS with an aircraft option for being an MH-60S or MH-60R. When fully incorporated with the rest of OMIA, FS still will provide all the functionality it normally provides, in addition it will be incorporated with the other modules of OMIA including the naval environment simulator and the intelligent tutoring system (ITS) further described below. The Flight Simulator integration with OMIA, including interface issues, is described in subsequent sections.

Another module is the naval environment simulator that has the capability of simulating a subset of the helicopter's environment. It models the interaction of physical objects in a tactical domain, including submarines, ships, other aircraft as well as the helicopter itself, weapons available to the respective platforms, and miscellaneous entities such as sonar buoys, as well as radar. The sonar capability (in the MH-60R) can be used with the active dipping sonar to search for submarines, the simulator takes into consideration the settings of the dipping sonar and will only find objects that can actually be 'heard' via the present settings. The simulator also takes into account the limitations of radar.

The OMIA system has a scenario generator that is used to build specific scenarios that can be used for training. That is, with the scenario generator an author can build a situation with multiple entities; e.g., one submarine, one plane and two boats. Each of the entities has programmable behaviors, that is, they can be set to attack under certain situations or flee under different situations.

The OMIA system includes an Intelligent Tutoring System (ITS), an ITS provides many of the benefits of one-on-one instruction without requiring a tutor for every operator [1]. An ITS employs information about the operational expertise of the operator in order to provide timely and effective tutoring. The individualized information about each operator is represented by a student-model, generated incrementally by the OMIA ITS as it observes the operator perform in simulated mission situations (scenarios) [2]. This student-model is expressed relative to a knowledge base representing the operational knowledge necessary to perform properly in the MH-60S/R mission domain. Using this knowledge base the system is able to determine the nature of an operator's deficiencies of knowledge, and apply those results toward appropriate real-time remediation/assistance during simulated mission training. The performance of any operator in any mission, then, is unaffected in areas of the operator's expertise, and the operator receives help/remediation in areas where the operator's knowledge is incomplete, deficient, or inappropriately applied. Intelligent Tutoring Systems are different from both computer-based training (CBT) and simulation. Computer based training is not adaptive to the individual weaknesses and strengths of the students; it is closer to being textbook than a teacher. Likewise, simulators provide an environment where the student can experiment, but do not actively teach the students. Often, simulators require human supervision to coach the students through exercises. For more information on the ITS portion of OMIA see [3] and [4].

Figure 2. Common Cockpit

The various components of the OMIA software have been implemented in a distributed manner to provide greater flexibility for future enhancements to the software. To deal with this reality, the OMIA components use the concept of an external system interface (ESI) to communicate between modules that may be distributed in the future. Presently, the operator system interface PTT and the Simulator (and the communications package) all communicate with the rest of the components via the ESI.

Evolving Navy Needs and Priorities

The OMIA system's development has evolved per the needs and priorities of the Navy. The following provides a brief summary of some of the changes the Navy has requested to the goals for OMIA. Originally, OMIA was intended primarily for the Romeo platform (MH-60R) that the Navy was planning to take delivery on prior to the MH-60S. The Romeo includes a Sensor Operator station in addition to the pilot and co-pilot. OMIA's goal was to provide unobtrusive assistance to the Sensor Operator and copilot in their performance on non-flying type operations; that it, it was to be embedded. To meet this goal many of the same techniques used in an ITS were employed to learn about the specific deficiencies of each operator. For the ITS to know what was occurring OMIA needed to understand the world the operator was performing in, that is, a naval environment simulator was required. Fortunately, SHAI had already developed such a simulator for another project [5], which was easily adapted for OMIA.

For many reasons, the Navy wanted to exploit the benefit of intelligent tutoring systems during the training process. So the primary goal has become to use the ITS technology in training. Also the first delivery platform became the MH-60S, which has only two seats (in its initial configuration). So the training is to be provided on the MH-60S platform first. Since both helicopters use the *Common Cockpit* all the development done for the copilot in the MH-60R could be immediately transferred to the co-pilot in the MH-60S.

Earlier the operator system interface (OSI) for the copilot was to be provided from another source. The Navy later decided it was best if SHAI developed the OSI (that is the entire user interface). To insulate the user interface from

the rest of the OMIA system an external system interface was developed so that it would be simpler to interface with other modules (e.g., MS Flight Simulator or the helicopter itself if the system becomes embedded). To drive the OSI to react properly to user interaction the naval environment simulator is used. Thus the developed user interface communicating via the external system interface (ESI) with the naval environment simulator evolved into the OSI simulator partial-task trainer (PTT) mentioned above. This is the tool that is currently in use by the Navy as part of the MH-60S training program for both the pilot and co-pilot.

Because of the success of the OSI simulator PTT, the Navy has requested that the functionality be expanded to include more flight related functionality. While investigating the best way to satisfy this request, one of the options was to utilize a commercial flight simulator. SHAI has already successfully interfaced with MS Flight Simulator for another helicopter training research project, so it was logical to utilize MS FS in OMIA.

User Interface sans Flight Simulator

Figure 3 shows the operator system interface simulator PTT portion of OMIA that is used to train with the Mission Display (MD) only. The MDs in the helicopter (as shown above in Figure 2) are the two inner screens. As can be seen in the figure, the functionality of the center console, which includes a programmable keypad and a fixed set of keys, is shown to the right of the mission display. The window that contains the center console can be moved away making a separate window, this can be moved to a separate touch display for more realistic ergonomics.

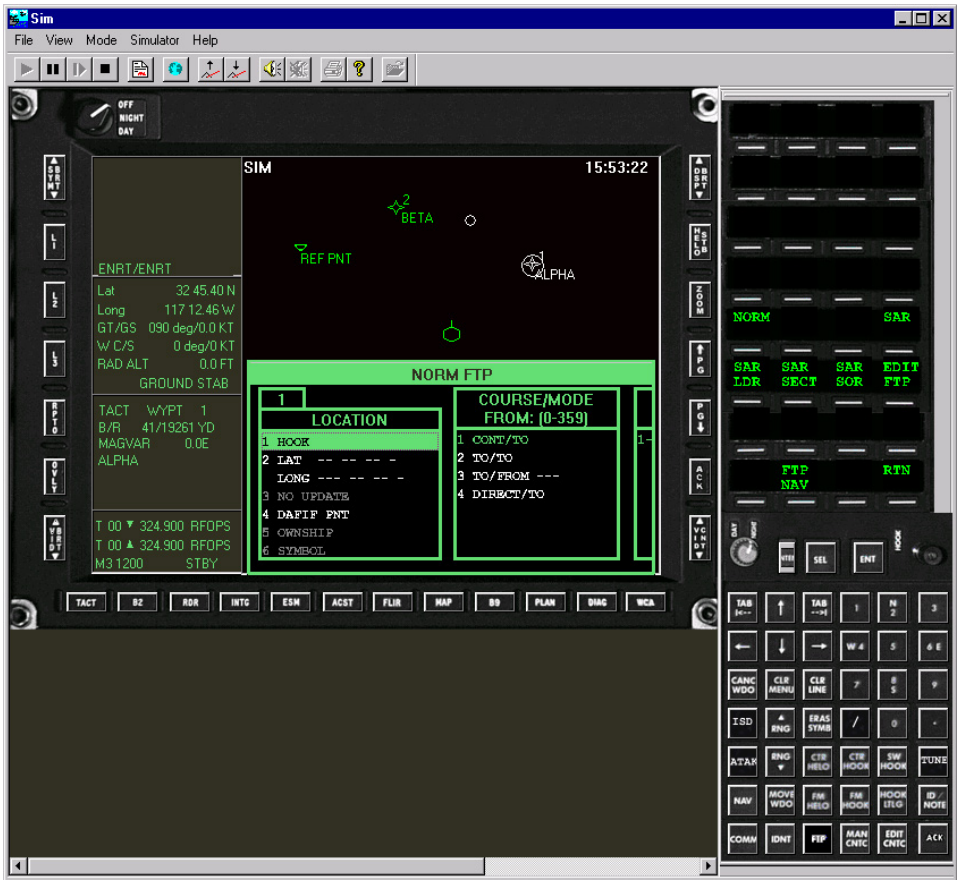

Figure 3. Operator System Interface

Flight Simulator Interface

As mentioned above MS FS is being utilized as a standalone tool and as a fully incorporated portion of OMIA. When FS is used independently, it will be FS simulator with an aircraft option for being an MH-60S or a MH-60R. The MH-60S/R *Common Cockpit* flight display utilizes flight instruments and other entities different from any currently developed. Figure 4 shows the *Common Cockpit* FD with most of the entities shown (even though all the entities would never be shown simultaneously under real conditions). This FD is surrounded by a set of bezel keys as can be seen in the cockpit image shown in Figure 2.

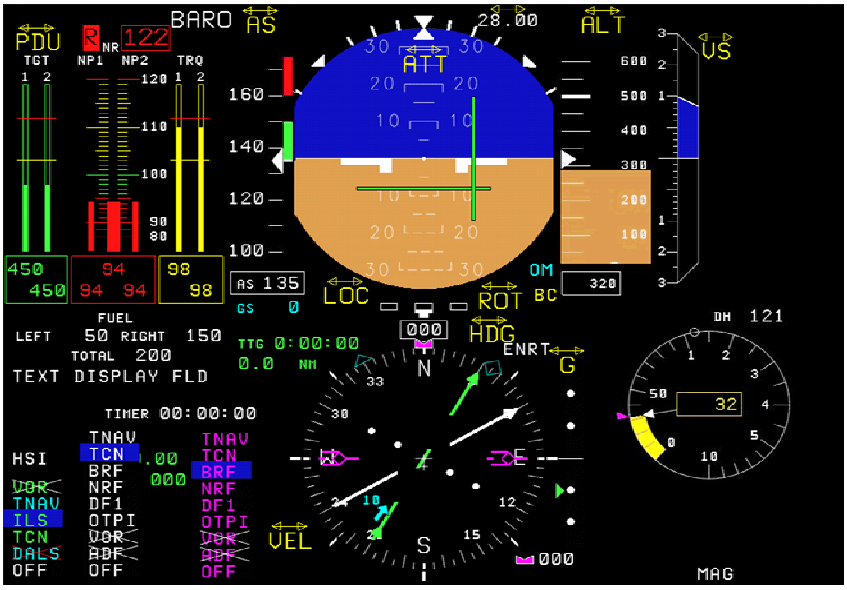

Figure 4. Flight Display (with almost all entities on)

Figure 5 shows the MS FS version of the flight display with many aspects of the actual flight display implemented.

Figure 5. MS Flight Simulator version of Flight Display

Interfacing OMIA with Flight Simulator

SHAI has utilized MS FS in another helicopter training research project, in this case the interface was performed utilizing the Microsoft Flight Simulator SDK. One of the project's capabilities is to teach hovering. Figure 6 shows the project with the MS FS cockpit view, a hover task visual aid, and the ITS providing assistance via text shown; in addition text-to-speech is used to provide audible help.

The original interface between OMIA and MS FS was via the MS FS SDK. However, this did not prove powerful enough. SHAI has changed to utilizing the third party extension

FSUIPC.dll (www.schiratti.com/dowson.html).

Figure 6. MS FS Interfaced to a SHAI Helicopter ITS (not OMIA)

The FSUIPC.dll allows external programs to communicate with (and in some limited situations control) MS Flight Simulator. A high-level diagram showing the interface is shown in Figure 7.

Upon startup, OMIA silently searches for a running instance of MS FS, and if found, then the interface is automatically established. Otherwise, OMIA will run in its non-MS FS mode and work properly.

Currently, if the interface is established, OMIA utilizes FSUIPC to get the:

- wind heading
- wind speed
- ground speed
- true heading
- altitude, and
- latitude and longitude.

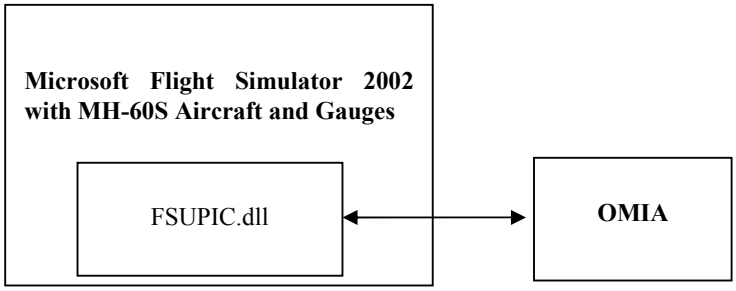

Figure 7. MS Flight Simulator OMIA Interface

This information is used to provide correct readings for the OMIA interface that shows the user all of the above information. An update is performed once each second. Currently, OMIA only gets information from FS, but successful experiments have been conducted in setting information as well. An example of the interface in action is represented in Figure 8. In the figure, the MH-60S is being flown from North Island Naval Air Station, near San Diego California. The top of the figure shows the out-of-window view provided by MS FS, and below is the mission display of OMIA, and to the right is part of the center console. In the mission display there is a hexagonal icon representing the helicopter with a white velocity vector depicting the direction and velocity. In the 2nd area from the top in the data strip along the left side of the mission display, note that the

latitude (Lat),
longitude (Long),
ground track (GT),
ground speed (GS),
radar altitude (RAD ALT)

are all being read in and updated from MS FS every second.

This level of integration greatly enhances the realism provided by OMIA. For example, many of the training exercises require the pilot and/or copilot to establish a set of fly-to points (FTPs) and then fly to (capture) the FTPs

Figure 8. OMIA Interfaced with MS FS

(while performing other operations). The establishment and management of FTPs points is performed via the mission display and center console, Figure 3 actually shows the menu for establishing a FTP. With flight simulator incorporated, OMIA can have the operator fly to the FTPs and then the mission display and the rest of OMIA will update properly when the operator captures the FTP.

Future Directions & More Information

The complexity and number of the sensors under control of the crew on the MH-60S and MH-60R helicopters pose a difficult training task for the Navy. To meet this challenge SHAI is developing a comprehensive Operator Machine Interface Assistant system that includes a operator system interface that is currently being expanded to utilizes MS Flight Simulator, as well as a scenario based intelligent tutoring system in conjunction with a naval environment simulator. Current and future development will be furthering the use of MS Flight Simulator, to provide more flight related functionality. In addition, helicopter familiarization may be performed using the virtual cockpit capability of FS. To learn more regarding the past, present and future of the OMIA project, please visit the OMIA WEB page at, www.shai.com/omia. The WEB page includes many AVI videos that further demonstrate the system.

References

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