Game Based Training for Fighter Pilots

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Abstract

How could computer games be used to augment training for fighter pilots? This paper is aimed at providing one answer to this research question. Three current methods of training fighter pilots are: working in the actual aircraft, working with high-fidelity aircraft simulators, and working with desktop computer based courseware systems. All of these approaches have strengths and weaknesses. This paper describes a low-cost game-based training framework that attempts to provide pilot instruction that students would actually *want* to use. This framework is meant to augment, not replace, the existing training modalities. First we describe our requirement-gathering process and the set of requirements we defined for a game-based training system aimed at a specific group of fighter pilots. Next, we explain a prototype game-based training system for the iPod Touch that was developed based on this research. Following this we present a description of the initial game based training system developed in response to feedback on the prototype system. We conclude with a discussion of the future directions for this research.

Introduction

Three current methods for learning the systems in an F-16 aircraft are working in the actual aircraft, working with high-fidelity aircraft simulators, and working with desktop computer based courseware systems. Both of the first two training methods utilize limited and expensive resources. Flight time is extremely expensive, resulting in limited flying hours; high-fidelity simulators, with or without motion, offer a much more cost-effective solution but are still quite expensive, require support personnel, and exist in a relatively limited number at few locations. Additionally, these systems are overkill for learning some tactics, techniques, and procedures. For example, if the training objective involves realistically flying the aircraft then high-fidelity simulators with wrap around screens and physical cockpits are very important. However, a much simpler training environment could be used if the objective is to learn which button on a throttle, or what stick button performs a particular defensive function in a realistic setting, or to verify that the student knows what is indicated by a particular symbol on a radar display. The third method of instruction, desktop-computer based courseware, is useful for just these types of tasks. However, this means that students can spend six hours a day in a computer lab clicking the OK button to advance through the courseware.

The goal of the research described in this paper is to develop a low-cost training environment that focuses on providing instruction for pilots (initially focusing on the F-16) that they would actually *want* to use. This system uses game-based training to augment the existing instructional modalities. First we explain our requirement gathering process and the set of requirements we defined for a game-based training system aimed at F-16 pilots. Next we describe a prototype game-based training system that was developed based on this research. Following this we present a description of the initial game based training system for F-16 pilots (GBT F-16). We conclude by presenting some of the expected directions for future work.

Requirements

The first research objective was to identify the specific requirements for a game-based training system that would help to address the gaps in F-16 training. We developed these requirements based on meetings with, and feedback from, cognitive psychologists and instructor pilots who work on teaching F-16 pilots the skills they need to master. In working with these subject matter experts, we derived two different sets of high-level requirements. The first set of requirements relate to the training material and integration into existing coursework, while the second set of requirements are aimed at ensuring a deployed training environment pilots want to utilize. In some cases these requirements are specific to the intended user group, while in others they mirror commonly acknowledged principles of learning (e.g. see http://www.psyc.memphis.edu/learning/whatweknow/index.shtml)

The first set of requirements is aimed at developing relevant training that makes efficient use of the student's time. First, the system should prepare pilots by training towards identified mission essential competencies and enhancing flight safety, in a way that allows for transfer of learning from the training environment to the actual plane. Second, the training games themselves should provide guidance during the game to help the students make the right decision the first time, rather than only providing feedback in an after action review. This requirement highlights a need to take advantage of intelligent tutoring systems (ITSs) [e.g., see Woolf, 2008] to provide the right information to the student at the right time. Third, the system should support integration with a learning management system that relates scores in games to desired skills, in order to track performance and assign specific training games to students based on their needs. This would not necessarily mean that the system would become part of the course requirements, but that the system could point out to students the specific areas that they could use a little more practice in.

However, as our discussions with subject matter experts pointed out, students are busy. If a training program is only available in the lab and is not a required part of the curriculum, students won't use it. Even when required, some of the online training material is dry and the students get easily bored with it. The second set of requirements is aimed at ensuring that the students actually use the training system. First, the system needs to be available. At a minimum it should run on any desktop computer, including home computers so students do not need to sit in the lab. Ideally, the training environment would run on a portable device so that students could work on skills whenever, and wherever, they happen to have free time. Second, the system needs to be inherently interesting to motivate students to use it. One of the goals of game-based training is to make training more fun, e.g. providing something that engages students by tapping into their competitive spirits.

Prototype Development

The second research objective was to create and demonstrate a prototype system to provide a concrete example of the envisioned training concept. The prototype was developed on the iPhone/iPod Touch platform (referred to as iPod from now on). Training on an iPod is inherently available to students – they can easily take it everywhere they go. Additionally, the likelihood of some content being used is increased simply by not requiring the student to sit in the computer lab while working on it. The iPod prototype also leveraged the competitive instincts of fighter pilots for motivational purposes by including head-to-head multiplayer games – it is fun to win. This innovative prototype, having the potential to be fun to use, provide valuable training, and serve as a resource center, all at once, sparked significant interest.

The particular game developed for the iPod prototype, shown in Figure 1, focused on teaching the buttonology of the radar system. In either single- or multi- player mode, the student is asked to configure the radar to a given set of settings. In multiplayer, the goal is to get the radar configured first, and you can see your score relative to your opponent as shown in Figure 2. This prototype uses a simple form of hinting as a placeholder for a more powerful intelligent tutoring system, where the next step is given to the student below the radar screen if the student seems to be stuck.

Figure 1: iPod prototype for Radar buttonology, with the hint *Select TWS* displayed

Figure 2: Be the first to reach the given radar settings on the prototype in head-to-head competition

The iPod prototype was demonstrated with the subject matter experts and they responded enthusiastically to it, including an unscripted example of how the system could tap into their competitive spirits. The prototype was seen to have the potential to be fun to use, provide valuable training, and serve as a resource center all at once.

Related Work

We concentrated our review of related work on existing iPhone applications for training pilots. While a significant amount of web-based training material exists that could be accessed via wireless Internet, it did not meet our criteria for availability as many of the intended client sites do not have wireless Internet access.

There are a number of related iPhone applications publicly available from the iTunes App Store. This is the only approved method for selling applications to the public, though like work presented in this paper it is possible to privately release applications to a limited number of users. We identified several types of related public training applications: video-based, game-based, and test-based, within the App Store.

The first type of training application uses the audiovisual capability of the iPhone to play back pre-recorded training videos. One example of this is VFR Communications [On the Flight Line Productions, 2009], which plays back training videos on user selected topics.

A second type of application is game-based training for pilots, which we found to be primarily flight simulators. Most the offerings are non-realistic, with many of the fighter applications more akin to first person shooter games. One exception to this is the X-Plane series of flight simulators [Laminar Research, 2009]. Even when flight simulators are more realistic it is not clear how learning would be transferred from the iPod to the actual plane.

The third type of application is test preparation software. These applications are more closely related to the work described in this paper. Of the current iTunes App Store offerings, all of the ones we identified focused strictly on multiple choice questions. Some supply questions randomly selected from a pool [Pusenjak 2008a, 2008b], some remember the student's index into a series of questions [Hodapp, 2008], while others provide both random questions and practice test modes [Aviation Supplies and Academics, 2009]. All of these programs are available only in single-player mode and rely exclusively on multiple choice questions.

Initial Training System

The initial Game Based Training for F-16 (GBT F-16) system is a work in progress that demonstrates a pilot training system that contains a reference viewer and several single and multi-player games: Radar Buttonology, Symbol Recognition, Visual Recognition, Master Question File, and Comm Format. This system blends elements from all three types of training applications previously identified, combining audio-visual, game-based, and test-preparation elements into a single training application. The GBT main screen is invoked by starting the application on the iPod. Figure 3 illustrates the list of reference materials and training games available to the student on the application's main screen.

Figure 3: The main application screen, presenting the reference viewer and a list of training games

Reference Viewer

The goal of the reference viewer is to augment all of the large binders that the pilots are given with a customized list of references that can easily travel with the student, as shown in Figure 4. In the course of this research, we have identified specific reference files essential to F-16 student training. However, it is expected that in order to be most useful, the files/links of the reference viewer will need to be customized for each particular end user group, so the list of references is easily updated by altering a configuration file and including the appropriate reference PDFs.

Games

For most of the games, the user has a choice between launching in single- or multi-player mode after selecting a game. The single player version supports self-paced study of topics, while the multi-player version focuses on more engaging head-to-head competition. Currently, GBT F-16 supports two players, but the future versions will allow four competing players, based on the functionality provided by the iPhone software development kit. The

initial version of GBT F-16 supports five different training games: Radar, Master Question File, Visual Recognition, Communications Format, and Symbol Recognition.

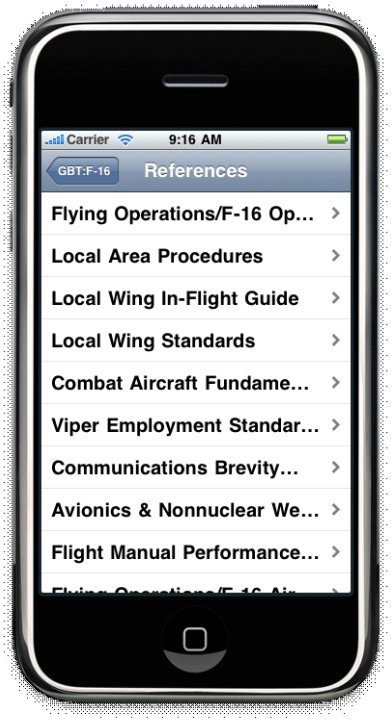

Figure 4: List of PDF references for F-16 pilots

Radar. This game focuses on teaching the buttonology of the radar system. In either single or multi- player mode, the student is asked to configure the radar to a given set of settings by touching the appropriate soft key buttons on the iPod touch screen. In multiplayer, the goal is to get the radar configured first, and you can see your score relative to your opponent as shown in Figure 2.

Master Question File. The Master Question File (MQF) game is aimed at allowing students to practice for their MQF tests. It is based on a standard quiz format, presenting a question through text, pictures, video, or audio (or some combination) followed by multiple-choice answers. The prototype contains a number of sample MQF questions as shown in Figure 5, where the user has selected an incorrect answer. An example question is: A 2000-foot acceleration check speed will be computed anytime computed takeoff roll exceeds ( ) feet. When computed takeoff roll is less than or equal to this number, use actual takeoff distance versus computed takeoff distance to evaluate aircraft performance. a.1500 b. 2000 c. 2500 d. 3000 Answer: c

Figure 5: Getting a MQF multiple choice question wrong (red) with the correct answer shown (green)

Visual Recognition. The visual recognition game (Figure 6) is another take on the quiz style of game. In this case, an image of a platform (e.g. aircraft) is presented for 1 second, followed by three seconds to pick an answer. The quiz feedback is a little edgier than found in standard training programs, with statements such as "Are you sure you're a Fighter Pilot?" when the student answers incorrectly. This feedback style was suggested by two experienced instructor pilots, and is somewhat at odds with research investigating the utility of polite feedback [McLaren et al, 2007]. However, the instructors' intuition was that this type of feedback would have greater resonance with F-16 pilots than polite feedback.

Communications Brevity Format. Pilots depend heavily on brevity words to say as much as possible without having to talk on the radio for a long time. For instance, during air-to-air targeting of a group of aircraft, there are required calls in a specific format that must be made. Talking and flying in the tactical arena is a very difficult skill to develop in young aviators, and, critically, the more practice they get, or examples they hear, the better. Instructor pilots are adamant about proper communication examples in the flight briefing. The mantra is "if you can't say it correctly at zero knots and one G, you definitely won't say it correctly in the heat of battle."

The communications format game makes use of sound clips of radio calls or text, of the format "Viper 1 singer 6 north defending 280". The student would then correct the

statement by dragging and dropping the pieces into the correct statement. In this case it would be "Viper 1 singer 6 280 defending north." An example of this game is shown in Figure 7.

Figure 6: Visual recognition game

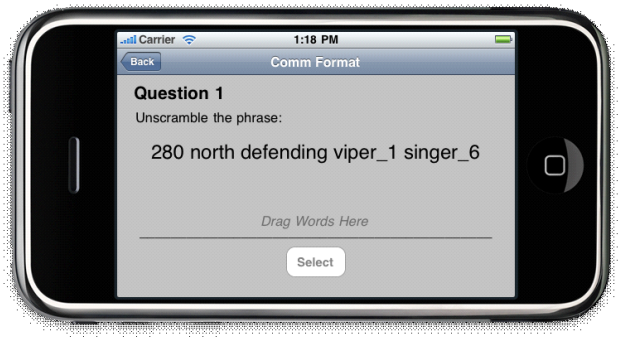

Figure 7: Communication format game

Symbol Recognition. The symbology recognition game addresses the problem of understanding complex and crowded displays. The horizontal situation display in the aircraft is filled with information…too much in some cases. There are numerous symbols of different colors and shapes that mean completely different things. Being tested on timely comprehension of symbols is invaluable to training, as this is an area where practice makes perfect.

Questions in this game pit one pilot against another based on the time required to figure out what a single symbol is, by asking the player to select a specific symbol in the simulated display as fast as they can. A sample question from the symbol recognition game is shown in Figure 8.

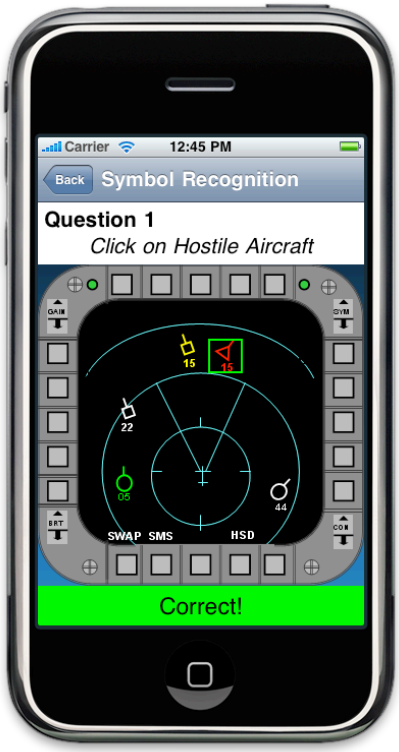

Figure 8: Symbol recognition game where the student has selected the correct symbol

Conclusion

To summarize, this paper described progress on three specific research objectives. First, we analyzed training needs of F-16 pilots and defined training system requirements. Second, we developed and demonstrated an initial prototype. Based on the response to this prototype concept, we went on to develop an initial version of the GBT F-16 training system as a vehicle in which to demonstrate its training possibilities. However, a significant amount of additional work is required to develop this into a deployable system. We describe three specific areas of future improvement.

First, we envision creating a general GBT framework that would be re-used across pilot training programs to support the creation training systems for different aircraft, such as the upcoming F-35. The framework would contain the general implementation required to support a variety of training programs, such as a game plug-in manager responsible for loading domain-specific games for a particular aircraft, as well as game-templates to ease the construction of domain-specific games.

Second, we envision an intelligent tutoring system that would fill multiple roles in the GBT systems. The ITS would be responsible for creating a student model that

reflects scores received on the games, in both single-and multi-player modes. This model provides an overview of performance both within individual games and across the entire training package. Eventually, this information would feed back into a learning management system. The ITS would also function within games, appropriately scheduling multiple choice questions based on the student model in quiz games and helping the student learn the correct concept by providing advice/feedback while the student is playing other types of games. A simple example of providing advice is shown in Figure 1, where the player seems to be stuck when trying to reach the desired radar settings. We envision that advice/feedback would be implemented using solution template techniques that have been previously applied to military training domains [Ramachandran et al., 2008]. However, a significant research question to be answered is how to best translate the ITS user experience from desktop computing to an iPhone-based tutoring experience. Brown et al. [2008] lay out a number of research questions on the use and implementation of mobile intelligent tutoring systems

Third, the games and reference viewer in the initial version of GBT F-16 are in their proof-of-concept phase. Each of these games is missing key features as currently implemented (e.g. PDF search in the reference viewer; performing a mock test in the solo version of the Master Question File game). Additionally, all of the existing games have only limited content behind them, from only one or two examples up to twenty examples. We have also identified additional games; these would expand the number of games available to F-16 pilots, for example providing instruction on audio-tone recognition or pre-flight check procedures. Finally, additional research would likely yield a number of potential games and game play styles that could be added to this system, such as pitting cooperative teams against one another. Future work would address each of these topics in further developing the domain specific games available for F-16 pilots.

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