Liu, H (2007). In-flight Entertainment System: State of the Art and Research Directions. In *Proceedings of Second International Workshop on Semantic Media Adaptation and Personalization (pp. 241-244).* IEEE Computer Society Press.

State of the Art Report: In-flight Entertainment System

Hao Liu
Department of Industrial Design,
Technical University of Eindhoven, P.O. Box 513, 5600 MB Eindhoven, NL
hao.liu@tue.nl

Abstract

Air travel, especially long distance, expose passengers a number of factors that may cause them both physiological and psychological discomfort and even stress. Excessive stresses may cause the passenger to become aggressive, over-reactive and even endanger the passenger's health [1]. In-flight entertainment system which refers to the entertainment system available to aircraft passengers during a flight is commonly installed on the long-haul aircraft to increase the passenger's comfort level. In this paper, we first check how the current in-flight entertainment systems are designed and implemented to improve the passenger's comfort level. Then, we investigate the state of the art of related systems and enabling technologies. Finally, we conclude with the possible research directions.

1. Introduction

Many people experience some degree of difficulty when flying. The main problems encountered are negative psychological and physical stress [1]. The common methods of reducing negative stress during air travel are: (1) communication with other passengers to diffuse negative feelings if the passenger was edgy or tense; (2) on board exercises to consume the energy that has accumulated through the stress hormone secretions; (3) relax or distract with interesting reading materials, movies, music or games available on the aircraft's in-flight entertainment system. In the following sect. 2, we investigate how the current and commercially available in-flight entertainment systems are designed and implemented relating to these three stress reduction methods to increase the passenger's comfort level. After that, in sect. 3 we present the state of the art of related systems and enabling technologies that could enable a better in-flight entertainment system to improve the passenger's satisfaction level. Finally, in sect. 4 the possible research directions are presented and discussed.

2. Overview of the current in-flight entertainment systems

Liu [2] investigated the current installed in-flight entertainment systems in the aircrafts of Lufthansa, Air France, British Airways, KLM, American Airlines, Delta Airlines, and Japan Airlines, and also investigated the commercially available in-flight entertainment systems which are provided by two major players Matsushita and Thales. Besides centralized broadcasting, all these organizations provide in-flight entertainment service in the form of video/audio on demand; some of them also provide e-books, game, text, etc. on demand services. Concerning the first stress reduction method in section 1, the in-flight entertainment system provides video games with which the passenger can play and chat with fellow passengers. Also, with so many communication software emerging and the in-flight intranet and internet access, enriching the communication experience on board is not a technical problem anymore. For the second stress reduction method, considering the limited space and safety constraints [3], the airlines usually provide some on chair physical exercise tips to the passenger either in paper flyers in front of the passenger's seat or in electronic texts in the entertainment systems [4]. However, according to our investigation in most cases the passengers tend to ignore these exercise tips. About the third stress reduction method, the passenger can select his/her interest entertainments to relax via the on-demand system. However, the current on-demand systems are implemented based on pre-set concept of what customer likes and requires as a homogeneous passenger group that has similar tastes and desires. They present the same interface and entertainment contents to each passenger, regardless of the fact that the passengers come from highly heterogeneous pools (such as age, gender, ethnicity, etc.), and have different individual entertainment preferences. Also, from control system point of view, the current in-flight entertainment on demand systems are designed and implemented as user adaptive systems where the user is supposed to initiate the adaptation to get personalized entertainment services [5]. If the user wants to get desired entertainment services for recreation or stress reduction, he/she needs to use the interactive controller to browse and select the desired entertainment services from the provided options by himself/herself. On the one hand if the available choices are many and the interaction design is poor, the passenger tends to get disoriented and not manage to find the most appealing entertainment services; on the other hand if the available choices are limited, the chance for the passenger to find desired entertainment services is slim. Under these circumstances, the in-flight entertainment system does not contribute to improve the passenger's comfort level, on the contrary, to some extends, it exacerbates the situation.

In one word, the current installed and commercially available in-flight entertainment systems have much room to improve to increase the passenger's comfort level such as auto provision of personalized stress reduction entertainment services to the passenger when he/she was in stress, personalized entertainment contents and categorization provision to facilitate the passenger to find desired entertainment services if he/she declines the auto entertainment service provision function, etc. In the following section 3, we will investigate related systems and enabling technologies that could enable a new in-flight entertainment system to improve the passenger comfort level intelligently.

3. Related systems and enabling technologies

In the nineties the adaptive system paradigm was moving from user-adaptive system to context-adaptive system where the context [6] which implies the user's implicit requirement initiates the adaptation to facilitate the user to get personalized services. In the following subsections, we first present the current related context-adaptive system applications, their architectures and steps of the adaptation process. After that, we investigate the potential enabling technologies that could enable a new context-adaptive system of personalized entertainment service auto provision to reduce the passenger's physical and psychological negative stress intelligently and effectively.

3.1. Context-adaptive systems

There is a long literature involving the successful context-adaptive applications in several areas. Three areas are of prominent importance: (1) mobile shopping assistants [7], (2) mobile tour guides [8], and (3) mobile learning assistance [9]. In all these systems the current location of the user and corresponding domain objects in the environment were continuously identified and mapped to the interests and tasks of the user. To support these applications, the architecture of these context-adaptive systems include at least context sensing, context modeling, context adaptation and service delivery components [10]. With the support of the architecture, three adaptation steps can be distinguished: (1) the interaction logging function records and categorizes all incoming interaction events according to predefined dimensions of characteristics of the usage process [11]; (2) the result of this recording and categorization is reported to a central adaptation inference function [12]; (3) this adaptation inference function analyses the incoming interaction event messages, evaluates them according to predefined rules and algorithms and generates specific adaptation activities to be performed [13].

3.2. State of the art of enabling technologies

From 3.1, we can learn that if we want to design a context-adaptive system to reduce the passenger's negative stress intelligently and effectively, we first need the sensors to acquire, and then model the passenger's physical and psychological and other context information (e.g. the passenger's activity), After that, the adaptation inference function, based on the knowledge of how the entertainment services could be used to reduce negative stress, the passenger's context information and his/her user profile, provide the passenger desired entertainment services for stress reduction. Due to the passenger's physical, psychological and other context information modeling is the responsibility of our partners [14], the detailed investigation on state of art of this part is out of the scope of this paper. In the following sub section 3.2.1, we first investigate the related works about using entertainment services for stress reduction, after that, we present state of the art of user profile modeling which is crucial for personalized entertainment service provision. Then, we discuss the current technologies for user profile acquiring.

3.2.1. Methods of using entertainment services for stress reduction. As the first step towards a complete solution, in this paper we only focus on how music and games could be used to reduce the passenger's negative psychological and physical stress.

Music: There is a long literature involving the use of music for stress reduction. David [15] conducted an experiment and showed that "relaxing" music can be used to decrease stress and increase relaxation in a hospital waiting room. Steelman [16] looked at a number of studies of music's effect on relaxation where tempo was varied and concluded that tempos of 60 to 80 beats per minute reduce the stress response and induce relaxation, while tempos between 100 and 120 beats per minute stimulate the sympathetic nervous system. Stratton [17] concludes that there is a significant correlation between degree of relaxation and preference for music. User preference, familiarity or past experiences with the music have an overriding effect on positive behavior change than other types of music. Based on the literature, we can conclude that user preferred, familiar, and tempos of 60 to 80 “relaxing” music could have a better stress reduction effect than others.

Game: Depending on the genre and the playing devices of the games, for some of them [18], if the user wants to play the games, he must move with certain exercises patterns. Then, the user could improve their physical comfort level with fun.

3.2.2. User profile modeling. User profiles were suggested as an improvement for a variety of applications. Current trends are the integration of user profiling in the delivery of services for an aware environment such as customized museum tours [19]. Generally, the user profile modeling approaches of these applications could fall into two categories: (1) hierarchical tree modeling approach where the user is modeled by dimensions (e.g., knowledge, or interest), each dimension can be further refined with sub dimensions [20]; (2) rule-based language modeling approach where the delivery of services relates to the context of use with if-then logic [19]. The advantage of the hierarchical tree approach is that it is well organized and easier to understand, the disadvantage aspect is that it can only express user’s static characteristics. The advantage of the rule-based language approach is that it is based on clear formalism and can be used to express some of the user’s dynamic characteristics such as context-aware user preferences. The disadvantage side is that its expressive power is limited and it is not easy to model the relationships among rules.

3.2.3. User profile acquiring. There are two approaches to get user profile: (1) entered explicitly by the user; (2) learned implicitly by system. For some static information of the user such as his demographic information, it is reasonable to let the user fill in. But for some of the dynamic information of the user profile such as user preference, due to it depends on the context of use and is changing over time, it may be not a good idea to let the user enter such dynamic information explicitly. Much prior research has been carried out exploring the usefulness of implicit feedback [21] to acquire user preference because it is easy to collect and requires no extra effort from the user. Most of them have succeeded and get good results to some extends. However, there are more factors needs to be consider to get a more satisfied result. Quiroga and Mostafa [22] conducted an experiment to see how relevance feedback could be used to build and adjust profiles to improve the performance of filtering systems. Data was collected during the system interaction of 18 graduate students with SIFTER (Smart Information Filtering Technology for Electronic Resources), a filtering system that ranks in-coming information based on users’ profiles. The data set came from a collection of 6000 records concerning consumer health. In the first phase of the study, three different modes of profile acquisition were compared. The explicit mode allowed users to directly specify the profile; the implicit mode utilized relevance feedback to create and refine the profile; and the combined mode allowed users to initialize the profile and to continuously refine it using relevance feedback. Filtering performance, measured in terms of Normalized Precision, showed that the three approaches were significantly different. The explicit mode of profile acquisition consistently produced superior results. Exclusive reliance on relevance feedback in the implicit mode resulted in inferior performance. The low performance obtained by the implicit acquisition mode motivated the second phase of the study, which aimed to clarify the role of context in relevance feedback judgments. An inductive content analysis of thinking aloud proto-cols [22] showed dimensions that were highly situational, establishing the importance of context plays in feedback relevance assessments. Results suggest the need for better representation of documents, profiles, and relevance feedback mechanisms that incorporate dimensions identified in this research.

4. Research directions

In this paper, we first introduced three common methods of reducing negative physical and psychological stress during air travel. After that, we check how the current in-flight entertainment systems are designed and implemented relating to these three stress reduction methods. Then, the state of the art of enabling technologies that could enable a better in-flight entertainment system to improve the passenger’s comfort level is investigated. We believe that in order to develop a new context-adaptive system to provide passenger’s preferred entertainment services to reduce his/her negative stress intelligently and effectively, the following research problems should be addressed first:

1. A conceptual control framework of auto user preferred music provision to re-duce the passenger's negative psychological stress intelligently. The research challenge is that the passenger himself/herself is an adaptive system (e.g., user preferred music depends on the context of use and changes with time), so how to design a control framework that could couple the passenger's and the entertainment system's adaptive behaviors to provide the passenger with desired services is not a trivial task.
2. A user profile model which is pertinent to the desired adaptive behaviors of the context-adaptive in-flight entertainment system. The research challenge lies in user's music preference modeling and tracking and updating its changes.
3. User preference learning algorithms that could track and even "predict" passenger's preference change. In order to produce superior results, a better representation of music and user profile, user's explicit and implicit feedback and context of use all need to be considered.
4. New game console solution where if the passenger wants to play the recommended games, he must move like exercises tips which are recommend by the airlines. The research challenge is the limited space of the aircraft seat; moreover, the passenger's game playing behaviors can't bother other passengers and endanger the safety of the aircraft.

Acknowledgement

This project is sponsored by the European Commission DG H.3 Research, Aeronautics Unit under the 6th Framework Programme under contract Number: AST5-CT-2006-030958.

5. References

[1] World Health Organization. Travel by air: health considerations. Retrieved March 1, 2007 from World Health Organization's Web site: http://whqlibdoc.who.int/publications/2005/9241580364_chap2.pdf.

[2] Liu H. State of Art of In-flight Entertainment Systems and Office Work Infra-structure. Deliverable 4.1 of European project Smart tEchnologies for stress free Air Travel, Technical university of Eindhoven, 2006.

[3] Joint Aviation authorities (JAA). Anthropometric study to update minimum aircraft seating standard. Retrieved May 1, 2007 from JAA's Web site: http://www.jaa.nl/

[4] QANTAS AIRLINES. In-flight workout. Retrieved May 20, 2007 from QANTAS AIRLINES's Web site: http://www.qantas.com.au/info/flying/inTheAir/yourHealthInflight#jump3

[5] Edmonds E. A. Adaptive Man-Computer Interfaces. In: Computing Skills and the User Interface. (Eds. Coombs, M. C.; Alty, J. L.) London: Academic Press, 1981,pp. 4-10.

[6] Dey A.K.; Abowd G.D. Towards a better understanding of Context and Con-text-Awareness. College of Computing, Georgia Institute of Technology. Technical Report, 1999.

[7] Kaasinen E. User needs for location-aware mobile services. Pers Ubiquit Comput 7, 2003, pp. 70–79.

[8] Petrelli D.; Not E. User-centred Design of Flexible Hypermedia for a Mobile Guide: Reflections on the HyperAudio Experience. UMUAI (Special Issue on User Modeling in Ubiquitous Computing), 2005, pp. 85-86.

[9] Klann M.; Humberg D. et al. iManual - Mobile Endgeräte als kontextsensitive integrierte Bedien- und Hilfesysteme. Wirtschaftsinformatik 47(1), 2005, pp.36–44.

[10] Baldauf M. A survey on context-aware systems, Int. J. Ad Hoc and Ubiqui-tous Computing, Vol. 2, No. 4, 2007, pp. 263-277.

[11] Rauterberg M. AMME: an Automatic Mental Model Evaluation to analyze user behavior traced in a finite, discrete state space. Ergonomics, 36(11), 1993, pp.1369-1380.

[12] Schröder O., Frank K.-D., Kohnert K., Möbus C., Rauterberg M. Instruction-based knowledge for a functional, visual programming language. Computers in Human Behavior, 6(1), 1990, pp.31-49.

[13] Bartneck C., Masuoka A., Takahashi T., Fukaya T. The Learning Experience with Electronic Museum Guides. Psychology of Aesthetics, Creativity, and the Arts, 0(1), 2006, pp.18-25.

[14] Aliabadi F. et al. Proposal for Smart tEchnologies for stress free air travel, 2006.

[15] David A. Tansik; Robert Routhieaux. Customer stress-relaxation: the impact of music in a hospital waiting room. International Journal of Service Industry Management, Vol. 10 No. 1, 1999, pp. 68-81.

[16] Steelman, V.M. "Relaxing to the beat: music therapy in perioperative nursing", Today's OR Nurse, Vol. 13,1991, pp.18-22.

[17] Stratton, V.N. and Zalanowski, A.H. 'The Relationship between Music, Degree of Liking, and Self-Reported Relaxation', Journal of Music Therapy 21(4), 1984, pp. 184–92.

[18] Nintendo. Wii information. Retrieved November 27, 2006 from Nintendo's Web site: http://wii.nintendo.com/

[19] Oppermann R. From user-adaptive to context-adaptive information systems. i-com 3, 2005,4-14.

[20] Goel M.; Sarkar S. Web Site Personalization Using User Profile Information. In AH 2002, LNCS 2347, De Bra, P, Brusilovsky, P, Conejo, R, (Eds.), pp. 510-513.

[21] Kelly D.; Teevan J. Implicit Feedback for Inferring User Preference: A Bibliography. SIGIR Forum, Fall 2003, Volume 37, Number 2, retrieved March 1, 2007 from the

forum's Web site:
http://www.acm.org/sigs/sigir/forum/2003F/teevan.pdf
[22] Quiroga M. An experiment in building profiles in information filtering: the role of context of user relevance feedback. Information Processing and Management 38, 2002, pp. 671–694.