Managing Augmented Toy Environments – A New Perspective for Smart Space Management

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Abstract. Smart environments have been a popular and well-investigated research topic during the last decade. The focus of this research, however, has mostly been on technologies and possible applications, while the management of such environments has rather been of secondary importance. In this paper we present our current work-in-progress to manage complex smart environments based on the example of the Augmented Knights Castle, a play set equipped with pervasive computing technologies. We describe and investigate the challenges that such an environment inherently poses regarding the aspect of management, and discuss our approach towards surmounting these challenges.

Keywords: Smart Space Management, Smart Environment, Augmented Toy Environments, Smart Toys, RFID, Acceleration Sensor.

1 Introduction

Playing games has always been an important and essential part of human culture. Not only does playing serve the purpose of recreation and amusement; it also improves psychomotoric skills, and can often be considered as a common ground for socializing [9, 13]. While video games, having taken a large share of the gaming market in recent years, greatly enhance the capabilities of game design, thus potentially improving both the entertainment value and learning experience of a game, their rather solitary nature of interaction has often been criticized for lacking the social benefits of traditional non-computer games.

Augmented or smart toys [19, 20] attempt to retain the benefits of computer-supported interaction without hindering direct social interaction with other players. Augmented toys and augmented games are traditional toys or game pieces that are equipped with sensing technology, computing power, and communication capabilities, allowing designers to incorporate novel gaming elements previously available only in video games into traditional „real world” objects, such as dolls [11], game figures [12], or cards [7]. This approach looks especially promising in toys for small children, as such novel technical capabilities are preferably integrated in such a way that the „traditional” usage of a smart toy is not diminished in any way, in order not to interfere with the children’s free play and fantasy.

In contrast to smart card games or smart board games, however, smart toys pose significant technical challenges. This is because in contrast to a game with a set of fixed rules, toy pieces are usually combined and used in a totally free form, with the child's fantasy being the only limiting factor. Consequently, a smart play set must truly become context-aware [5, 18] in order to „know" where each toy is located, how it is used, and what other toys it is supposed to interact with. Just as with a traditional set of toys, children should be able to add, move, and remove elements freely, as well as redefine play elements and their roles at will.

The challenge of managing smart spaces or smart environments in general is not new – many research projects are addressing problems of smart space management, e.g., [1, 14, 16]. Such efforts, however, are often focused on smart living rooms or smart work environments, with often well-defined tasks and well-behaved users. In our work, in contrast, we want to specifically address management structures for supporting the entertainment and education of children. In a smart toy environment, designers, parents, and children should be able to set and modify roles of individual game pieces and their relationship to each other. Adding or removing toys should not interrupt the game flow. Therefore, smart toy environments require easy-to-use management interfaces and run-time support.

This paper presents our current work-in-progress addressing this topic and is structured as follows: first, we briefly introduce our augmented toy environment, the Augmented Knights Castle (AKC). The AKC will serve as a feasible and lucid demonstration for the further exposition. Second, the challenges and problems arising from such a smart environment are described and we discuss our approach towards managing such an environment. Finally, we conclude with a summary and an outline of future steps.

2 Augmented Toy Environments

With the emergence of computer and video games, the recent decade saw a significant shift in the way games are played. The creation of (and interaction with) virtual worlds, that are only limited by the creators' fantasy, not only opened up a completely new way of entertainment, but also significantly changed the game immersion: with today's computer technology, virtual gaming worlds can often be presented in such a realistic way that players spend hours on front of their screen, totally focused on the game.

The improved game immersion is probably both the biggest advantage and disadvantage of video games, depending on your perspective. Many criticize video games for inherently neglecting the social aspect of gaming, as even team-based computer games reduce player interaction to voice or even text messages. Also, the effects of video games on the psychological and physical well-being of players are often criticized, potentially leading to obesity and a lost sense of reality. Especially for small children, such risks often seem to greatly outweigh the potential benefits of computer-supported gaming. The field of Pervasive Computing Games offers a novel approach to solving this conundrum: by adding the „virtual world" to the „real world”, players can experience and enjoy the advantages of both worlds without having to give up crucial parts of their social life and fantasy.

As a case in point, we are developing the Augmented Knights Castle (AKC), a traditional Playmobil play set plus some additional toy figures and elements [10]. We equipped most play figures and elements with various pervasive computing technologies, e.g., Radio Frequency Identification (RFID) technology (FEIG OBID High-Frequency readers and antennas for the environment (see Fig. 1) as well as Skyetek M1-mini attached to BTnodes [2] that allows mobile reading (see Fig. 2)), and acceleration sensors (SparkFun WiTilt v2.5, see Fig. 2).

Fig. 1. A scene from the AKC (top), the same scene with two RFID antennas disclosed which allow the continuous tracking of play figures (middle).

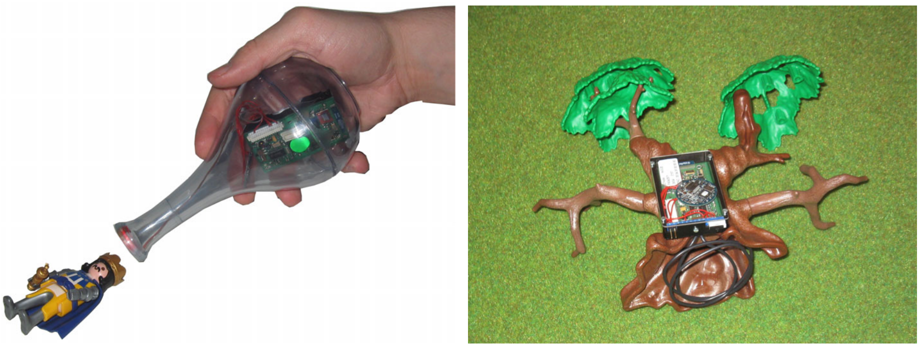

Fig. 2. The ”magic potion bottle”, a smart toy equipped with a BTnode, acceleration sensors and a mobile RFID reader; the magic potion can be administered to a figure (the RFID tag is integrated in its head) after having been shaken ”well enough” (left). The „magic tree”, a movable landscape element equipped with a BTnode and a mobile RFID reader (right).

In doing so, we add location-awareness to the play set and enable new forms of interactivity. This allows us to add an additional level of functionality to many play elements, thus enhancing the entertainment experience (e.g., by adding context-sensitive sound effects) and providing the basis for a playful learning environment.

As described above, our implementation of the AKC follows two goals: firstly, the integrated technology must be unobtrusive, if not even „invisible”, and secondly, the original functionality of the toys must be left unaltered, i.e., playing with the toys (in the traditional sense) is still possible, even if the technology fails to work or is intentionally switched off. Furthermore, we intend to design the system in such a way that elements can be added, removed and modified by the players easily and freely at any time. This, however, has several fundamental implications on the design and the management of this augmented play set.

3 Managing Augmented Toy Environments

An augmented toy scenario such as the one described above can easily become a very complex and extensive environment: on the one hand, we have an infrastructure that is integrated into the play set and responsible for tracking the objects, which, on the other hand, inhabit the play set and bring it to life. These objects furthermore interact with each other, dynamically taking on different roles [8], thus turning a simple play environment into an intricate smart space with numerous smart items.

Questions that initially appear simple turn out to be rather intricate on closer examination: how do non-trained users add a new smart toy to the set (e.g., a new set of knights)? How can this user set and change relationships between objects (e.g., configure the newly added knights to be friendly to the King's Knights, but hostile to the Dragon's Knights)? How can actions based on the current context be administrated (e.g., if the Dragon enters the castle, the sound effects „screaming" and „roaring", as well as a dramatic background music are played)?

Since the mid-1990s there has been a significant amount of research on smart spaces (also labeled as pervasive computing environment, smart environment, or ambient intelligence, depending on the origin, background and particular focus of each research group), for example [1, 3, 4, 6, 14, 16, 17]. Drawing on this work, we define a smart space as an area (i.e., the play set) that is populated with smart items (i.e., smart toys) belonging to a particular spatial and semantic domain. The smart space is equipped with means to track and identify these smart items, enabling it to react to changes in its configuration (i.e., playing) and providing appropriate feedback to the user (e.g., playing sounds or light effects).

Despite this effort spent on researching smart spaces, only few groups also address the challenging issue of managing these technologically enhanced environments, even though it is agreed upon that management aspects in smart spaces are of prime importance [15, 21, 22]. Many research projects are based on closed systems, meaning that the number and types of smart items and services inhabiting the smart space are pre-configured and thus constrained from the beginning. In addition to that, many presented models do not include a semantical model describing the smart items and the relationships between them (cf. [23]).

In the context of our augmented toy environment, we so far identified the following challenges for providing management support for smart environments:

- Highly dynamic environment (smart items are removed and added at runtime),
- Complex (semantic) network of smart items,
- Numerous actions (e.g., multimedia effects) based on location-awareness, and
- No explicit user interfaces.

We are currently addressing the challenges and issues: on the one hand, we are developing a semantic framework that describes this particular smart space; on the other hand, we are investigating user interfaces that allow interaction with the smart environment without destroying the game flow and the atmosphere created by this environment, i.e., we intend to keep the usage and even the management of this smart space as intuitive as possible, for example, by using the toys themselves as (tangible) user interfaces.

4 Conclusions and Next Steps

In this paper, we discussed the challenges of managing complex smart spaces. Our running example is the Augmented Knights Castle, a technologically enhanced play set that represents a particularly demanding smart space, given its highly dynamic use and diverse user base. We believe that the AKC serves as an excellent test environment for identifying and approaching smart space management issues.

After having successfully incorporated a number of pervasive computing technologies into our toy environment, we are now planning an extensive set of user tests in order to assert its usefulness as both a toy and a learning environment. To that extend, having a management interface that allows us to quickly setup and reconfigure our system will be of utmost importance. Once we ourselves are able to comfortably manage our system, we will need to extend our tools to allow players themselves to dynamically alter their gaming environment. A particular focus of this part of our research will be on both the simple and intuitive con- figuration of the most often required management features, as well as the ease-of-use of adding new elements, or even readily combining multiple smart spaces (e.g., a Knights Castle and a Pirates Ship).

While we explicitly concentrate on smart toys and smart play environments in our work, we believe that our work can be directly applied to smart environments in general. As Sullivan and Wade [15] point out, smart spaces must become easily manageable and usable by ordinary people, without any special technical knowledge and skills, in order to reach mass-market potential and guarantee the long-term success of such spaces.

By attending this workshop, we hope to receive valuable feedback through discussions and comments, as well as to have the opportunity to learn about the progress of current research projects and meet researchers focusing on similar topics.

References

1. The Aware Home, Georgia Institute of Technology, Available at http://www.awarehome.gatech.edu/ (22.01.2007)
2. Beutel, J., Kasten, O., Mattern, F., Rmer, K., Siegemund, F., and Thiele, L.: “Prototyping Wireless Sensor Network Applications with BTnodes”, 1st European Workshop on Wireless Sensor Networks (EWSN), Springer-Verlag, Berlin, Germany, January 2004, pp 323-338

3. Chen, A., Muntz, R.R., Srivastava, M.: “Smart Rooms”, In: Cook, D. and Das, S. (eds): “Smart Environments: Technology, Protocols and Applications”, Wiley-Interscience, Hoboken, New Jersey, September 2004, pp 295-322
4. Das, S. K.: “Mobility and Resource Management in Smart Home Environments”, (Keynote) Proceedings of the International Conference on Embedded And Ubiquitous Computing (EUC2004), Aizu-Wakamatsu, Japan, 2004
5. Dey, A.K.: “Understanding and Using Context”, Personal and Ubiquitous Computing Journal, Vol. 5, No. 1, 2001, pp 4-7
6. Essa, I.: “Ubiquitous Sensing for Smart and Aware Environments”, Special Issue on Networking the Physical World, IEEE Personal Communications, October 2000
7. Floerkemeier, C. and Mattern, F.: “Smart Playing Cards Enhancing the Gaming Experience with RFID”, Proceedings of the Third International Workshop on Pervasive Gaming Applications - PerGames 2006 at PERVASIVE 2006, Dublin, Ireland, May 2006
8. Hinske, S. and Lampe, M.: “Semantic Mapping of Augmented Toys between the Physical and Virtual World”, Workshop “Tangible User Interfaces in Context and Theory” at CHI’07, 2007
9. Huizinga, J.: “Homo Ludens”, Beacon Press, ISBN 978-0807046814, 1971
10. Lampe, M., Hinske, S. and Brockmann, S.: “Mobile Device based Interaction Patterns in Augmented Toy Environments”, Proceedings of the Third International Workshop on Pervasive Gaming Applications - PerGames 2006 at PERVASIVE 2006, Dublin, Ireland, May 2006, pp 109-118
11. Maeder, T.: “What Barbie Wants, Barbie Gets”, Wired Magazine, Vol. 10, No. 1, 2002
12. Magerkurth, C., Stenzel, R. and Prante, T.: “STARS - A Ubiquitous Computing Platform for Computer Augmented Tabletop Games”, Proceedings of UbiComp’03, Springer, UbiComp 2003, pp 267-268
13. Magerkurth, C., Engelke, T. and Memisoglu, M.: “Augmenting the Virtual Domain with Physical and Social Elements”, Conference on Advancements in Computer Entertainment Technology (ACE 2004), Singapore, ACM Press, 2004, pp 163-172
14. Microsoft Easy Living, Available at http://research.microsoft.com/easyliving/ (22.01.2007)
15. OSullivan, D. and Wade, V.: “A Smart Space Management Framework”, Computer Science Technical Report, TCD-CS-2002-23, Trinity College Dublin, 2002
16. MIT Project Oxygen: E21 Intelligent Spaces, Massachusetts Institute of Technology, Available at http://oxygen.csail.mit.edu/E21.html (22.01.2007)
17. Roman, M., Hess, C.K., Cerqueira, R., Ranganathan, A., Campbell, R.H. and Nahrstedt, K.: “Gaia: A Middleware Infrastructure to Enable Active Spaces”, IEEE Pervasive Computing, 2002, pp 7483
18. Schmidt, A.: “Interactive Context-Aware Systems - Interacting with Ambient Intelligence”, Riva, G., Vatalaro, F., Davide, F. and Alcaiz, M. (eds): Ambient Intelligence, IOS Press, ISBN: 978-1-58603-490-0, January 2005
19. Shwe, H.: “Smart Toys: Brave New World?”, Panel at CHI’00, Proceedings on Conference on Human Factors in Computing Systems, extended abstracts on Human factors in computing systems, The Hague, The Netherlands, pp 247-248
20. Shwe, H.: “Smarter Play for Smart Toys: The Benefits of Technology-Enhanced Play,” Zowie Intertainment White Paper 3208, 1999
21. van der Meer, S., and Jennings, B.: “Integrated Management of Smart Spaces”, in Proceedings of eChallenges (eChallenges 2004), Wien, Österreich, October 2004, pp 35-41
22. van der Meer, S., OConnor, R., and Davy, A.: “Ubiquitous Smart Space Management”, 1st International Workshop on Management of Ubiquitous Communications and Services (MUCS), Waterford, Ireland, December 2003
23. Wang, X., Dong, J.S., Chin, C., Hettiarachchi, S., and Zhang, D.: “Semantic Space: An Infrastructure for Smart Spaces”, in IEEE Pervasive Computing, Vol. 3, No. 3, 2004, pp 32-39