
TriggerHunter: Designing an Educational Game for families with Asthmatic children

Hwajung Hong

School of Interactive Computing
Georgia Institute of Technology
Atlanta, GA, 30308 USA
hhong31@gatech.edu

Hee Young Jeong

School of Interactive Computing
Georgia Institute of Technology
Atlanta, GA, 30308 USA
hyj@gatech.edu

Rosa I. Arriaga

School of Interactive Computing
Georgia Institute of Technology
Atlanta, GA, 30308 USA
arriaga@gatech.edu

Gregory D. Abowd

School of Interactive Computing
Georgia Institute of Technology
Atlanta, GA, 30308 USA
abowd@gatech.edu

Copyright is held by the author/owner(s).
CHI 2010, April 10–15, 2010, Atlanta, Georgia, USA.
ACM 978-1-60558-930-5/10/04.

Abstract

In this paper, we propose a collaborative and educational game for families with asthmatic children to improve their health. This paper describes design approaches and specifications of a game called *TriggerHunter* that enables asthmatic children to see asthma triggers in their home environment through an augmented reality technology. The goal of designing a game for tracking asthma triggers in the real world is to educate asthmatic children and their parents about triggers that may cause asthma attacks or worsen symptoms. By providing tailored learning experience that is enjoyable, this interactive game aims to increase awareness of asthma triggers and changes behaviors as to improve pediatric asthma management.

Keywords

Healthcare, Asthma, Interactive system, Educational game, Augmented Reality

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design

Introduction

Asthma is a chronic disease that causes coughing, wheezing, and breathlessness resulting from a complex interplay between many factors including environmental exposures, and genetics. There are more than 22 million asthmatics in the U.S., approximately 6 million of whom are children [7]. In children with asthma, airways are swollen and inflamed. When these inflamed airways come into contact with an asthma trigger, symptoms of asthma appear. Certain triggers may cause asthma attacks or worsen symptoms [11]. These triggers can include allergens and irritants which are associated with environmental conditions. This has implications for the environmental management of asthma [12].

Children spend the majority of their time indoors including at home and at school, where they may be exposed to asthma triggers, such as secondhand smoke, mold, perfumes, aerosol sprays, cleaning products, fumes from paint, and animal dander [9]. Asthma can occur in response to a trigger in the environment. However, not all children with asthma have the same triggers. Finding out which factors trigger an attack and taking steps to avoid the triggers are important components of good asthma management.

Teaching patients and their families specific management skills improves asthma management, reduces the use of emergency services, and improves quality of life [7]. This is particularly important for asthma management, since the environmental management of asthma requires knowledge of asthma triggers and specific actions that can be taken to reduce exposures to these triggers.

In an attempt to assist parents in caring for their children with asthma, governmental and non-governmental organizations (such as the U.S. environmental protection agency [10] and Mother's of Asthmatics [1]) have developed the home environment checklists. These are checklist of questions and action steps to assist in the identification and mitigation of environmental asthma triggers at home [10]. The problem with these lists is that they provide general information about improving the family's knowledge and practices. They also do not reflect the individual's actual home environment.

The work we describe in this paper is concerned with providing asthmatic children and their families with a tailored learning experience that is enjoyable. It is based on mobile technologies that are available anywhere at any time. In other words, we create an interactive adventure game that uses experiential learning to improve the self-management skills of asthmatic children.

The goal of designing a game for tracking asthma triggers in the real world is to educate asthmatic children and their parents about triggers around them by visualizing possible, but invisible harms. It reflects the real environment they live in and raises awareness of the existence of triggers. Ultimately, it recommends how to control the indoor triggers.

With this in mind, a series of research questions were developed. They are:

- How can we integrate educational contents for asthma into a real life situation through a technology intervention?

- How can an educational game increase awareness of asthma triggers and encourage children to change their behavior?
- What type of technological approaches, in the form of a 'game' (e.g. augmented reality, tangible object, or screen-based) will be suitable for this educational purpose?

Related work

Our research focuses on the education of asthmatic children and their parents to minimize the impact of the disease and improve children's health. Most children today have been growing up in the midst of computers and gaming. Thus gaming is a fun activity that can be leveraged by researchers to improve learning, develop skills, and change behavior [8].

A large number of studies on health-related educational games have produced significant contributions to the field. Many studies have focused on the self-management of various diseases (e.g. *Bronkie the Bronchiasaurus* for asthma and *Packy and Marlon* for diabetes [3,6]). Researchers have attempted to teach children about how to control their chronic disease by using on-screen characters that provide immediate feedback on performance. The study of this health-related educational game revealed that it helped children improve self-concepts, knowledge and self-care behaviors [6]. Another study of an interactive multimedia asthma education program also reported that the intervention improved children's and caregivers' knowledge and health status and decreased the use of health care resources [5]. However, the majority of existing educational games cannot reflect personal health issues because the games are based on pre-designed instruction or tutorials. Therefore, our

research addresses the reflection of real life that affects each individual's health.

Design Process

This section is based on our literature review and in-depth interviews with 6 healthcare providers, 10 asthmatic children, and 9 caregivers. After having analyzed interview data, we generated ideas. Our goal was to understand the needs in pediatric asthma management and to develop implications of game design based on our research findings.

In order to maximize the benefits of the in-depth interview at home, we used three interview methods: participatory design, projective technique, and a home tour with a semi-structured interview questionnaire. Interviewing participants during the home tour prompted them to actively describe different strategies of asthma management and device usages in each room. The findings from interviews informed the design of an educational tool to be used in the home environments.

Analysis

The results of a systemic and qualitative approach to data analysis provided implications regarding a design of a system for families with asthmatic children and their healthcare providers. We discovered an importance of interplay between people involved in asthma management and needs for educational medium for better asthma management.

Healthcare providers described the need for educational tools that encourage both caregivers and patients to be aware of their environmental condition and to keep the environment clean to reduce the asthma triggers. They

also suggested that it would be beneficial to have collaborative actions between community health workers, parents and their children to support long-term asthma management.

"I think the first part is the increase of their asthma awareness, educate them, and then we encourage them to change their behaviors" (Healthcare Provider2)

"...some families live in an environment where they are exposed to a tremendous number of triggers. They have a leaky roof. They have dirty worms at their homes. They have problems with their pets. They have poor diets. They have things like that. The poverty is a tremendous trigger for asthma." (Healthcare Provider1)

Parents had their own strategies for controlling environmental triggers. They wanted to collect information about asthma trigger to manage their children's asthma effectively for the best outcome.

"Mothers of Asthmatics have a healthy home checklist and so I went through the whole house and did the healthy home checklist. It's about thirty pages." (Parents8)

One of our main findings is that trigger management is a challenge because of its dynamic nature. Triggers change over time, place, and personal condition. Therefore, caregivers have to constantly pay attention to what additional components might induce asthma incidences.

"There is some way to check but you don't think about checking mold. When you see something you want to get it checked but if you can't see it... With her having

a low immune system it might've triggered it and I found out later there was some mold in the apartment." (Parent7)

Our participant groups provided important design implications. 1) Healthcare providers: want to educate families with asthmatic children about asthma triggers in real life and how to manage them for bridging the gap between doctor's office visits. 2) Parents: want to prevent their children's asthma attacks and know more about asthma triggers and how to avoid them. Therefore, fostering the asthmatic child's independent management about indoor triggers is important. 3) From parents and children: need for effective ways to educate children with asthma.

Design Requirement

Our analysis regarding various stakeholders led us to come up with the following design requirements:

1. Helping community health workers provide education, support for behavior change, and resources to control triggers effectively
2. Helping parents control environmental asthma triggers and minimize children's exposure to indoor triggers
3. Supporting children's experimental learning about asthma triggers in real-world environments

Prototype

An important step in managing children's asthma is understanding which contexts may contain triggers. It is difficult to know where triggers are concentrated because we are not able to see them directly. For example, stuffed toys in the child's room are likely to

contain dust mites that will trigger asthma flares. However, triggers are not obvious thus augmented reality could be one of the possible means to solve this problem by embedding virtual synthetic information into the real environment [2].

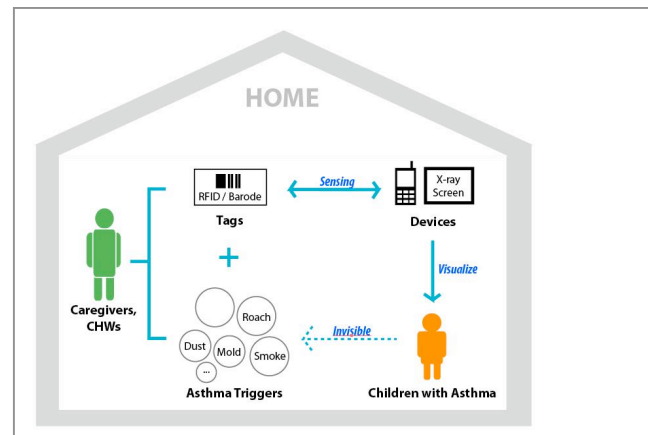


figure 1. Systemic diagram of an interplay between healthcare provider, caregivers and asthmatic children in the home

Based on the implications and requirements that we developed, we began designing an augmented reality game, "TriggerHunter" that can educate asthmatic children and their parents on creating healthier home environments. The system (Figure 1) allows for collaboration between healthcare providers, parents and children. Healthcare workers provide updated information and downloadable printable marker tags that identify real world triggers via their website. They also give parents instructions that explain the spots or objects where the marker tags should be placed. Once parents download and print out the marker tags, they embed them into objects or specific areas that may include asthma triggers. After deploying all the marker

tags to the home, a child can scan the area with a handheld device such as mobile phone (Figure 2). The device, equipped with a camera, identifies a trigger which is assigned to the specific marker tag. Then, it visualizes a virtual trigger on its screen. The following screen provides further information about the trigger and provides the users with information on how to reduce the triggers.

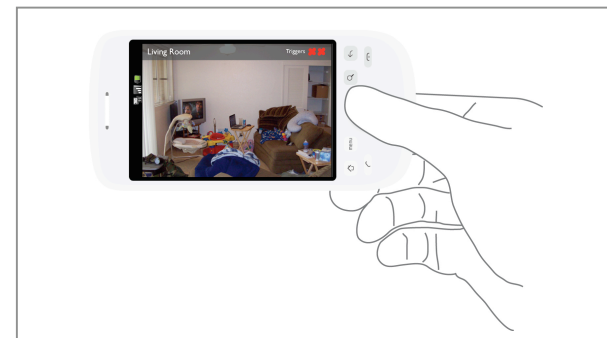


figure 2: Handheld device which renders a combination of virtual triggers and real-world environment

Usage Scenario

TriggerHunter (Figure 3) is an adventure game in which the player assumes the role of the protagonist in an interactive story that is driven by exploration and problem-solving. The ultimate goal of this game is to hunt down all the triggers in the home.

1. A child starts TriggerHunter from the overview screen. The screen shows a simple map of the home indicating the number of triggers in the home. This is based on the number of markers that the parent has downloaded, printed and applied throughout the home.

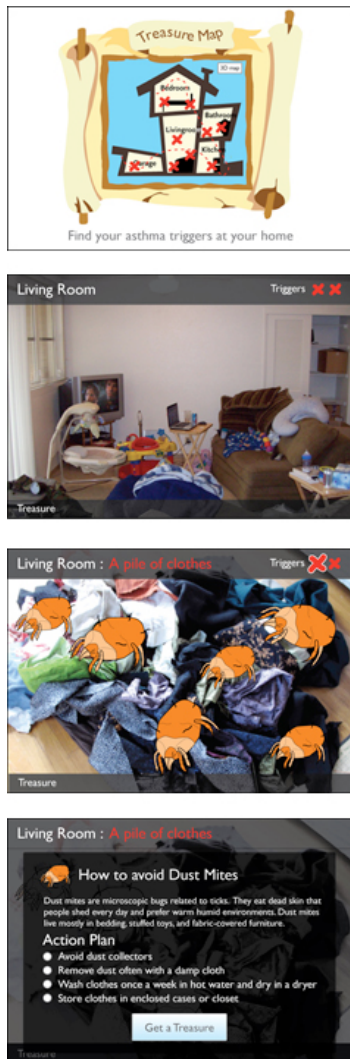


figure 3. Procedures of the game, *TriggerHunter*

2. The player begins by scanning their room to look for asthma triggers with his/her mobile phone.
3. When the player approaches the object with a marker tag, the screen renders a direct view of a physical real-world environment whose elements are merged with virtual imaginary (e.g. virtual dust mites is animated on the real stuffed toys).
4. Once the player detects the trigger, the device provides information about the captured trigger. To hunt the trigger, the player must answer a question about how to reduce the trigger in the environment.

Conclusion

In this paper, we presented a design of interactive game for pediatric asthma management. Through interviews with healthcare workers and families with asthmatic children, we discovered needs of collaborative actions among them and necessity of educational medium that helps them manage indoor asthma triggers. We are currently refining the usage scenario and will soon begin developing a deployable system. We will conduct a field test with the system on a small sample of families and healthcare providers to ensure its acceptability and functionality. After we collect sufficient data, we will propose a guideline for designing games for healthcare management that allow for collaborative actions between healthcare providers and families with asthmatic children. We will also need to address the problem of the scalability, which will be another future work.

References

[1] Allergy & Asthma Network Mothers of Asthmatics (AANMA). <http://www.aanma.org/>

[2] Bimber, O., and Raskar, R., *Spatial augmented reality*, A K Peters, Ltd., 2005.

[3] Brown, S.J., Lieberman, D.A., Gemeny, B.A., Fan, Y.C., Wilson, D.M., & Pasta, D.J. Educational video game for juvenile diabetes: Results of a controlled trial. *Medical Informatics*, 22, 1 (1997), 77-89.

[4] Fireman, p., Friday, G.A., Gira, C., Vierthaler, W.A., and Michaels, L., Teaching Self-Management Skills to Asthmatic Children and Their Parents in an Ambulatory Care Setting. *Pediatrics*, 68 (1981), 341-348.

[5] Krishna, S., Francisco, B.D., Balas, E.A., Konig, P., Graff, G.R., and Madsen, R.W. Internet-Enabled Interactive Multimedia Asthma Education Program: A Randomized Trial. *Pediatrics*, 111 (2003), 503-510.

[6] Lieberman, D.A. Management of Chronic Pediatric Diseases with Interactive Health Games: Theory and Research Findings. *Journal of Ambulatory Care Management*, 24, 1 (2001), 26-38.

[7] National Heart Lung and Blood Institute Diseases and Conditions Index. <http://www.nhlbi.nih.gov>

[8] Prensky, M. *Digital Game-based Learning*. McGraw-Hill, New York, 2001.

[9] Takaro, T.K., Krieger, J.W., and Song, L. Effect of environmental interventions to reduce exposure to asthma triggers in homes of low-income children in Seattle. *Journal of Exposure Analysis and Environmental Epidemiology*, 14 (2004), 133-143.

[10] United States Environmental Protection Agency. Asthma home environment checklist. EPA, Washington, D.C., USA, 2004.

[11] US EPA/OAR/ORIA/Indoor Environments Division, Asthma: Indoor Environmental Asthma Triggers, EPA, Washington, D.C., USA, 2009.

[12] Wu, F., Takaro, T.K., Childhood Asthma and Environmental Interventions, *Environmental Health Perspectives*, 115, 6 (2007), 971-975