AI, AIBO and ART: Inspiring Interaction with Computer Science

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Abstract

The field of human-robot interaction (HRI) is growing due to the availability of cost effective robots that can be employed for research and in education. Robots, like the Sony Aibo, can capture the imagination of the public. Being a robot dog encourages human interaction, which is relatively intuitive. To better understand human-robot interaction, HRI projects were included into undergraduate courses in Robotics and Artificial Intelligence. The classroom became an unofficial research environment, where undergraduate students developed robotic projects that then were used to get children and adults excited about robotics and spur their motivation to learn more about computer science. This paper will describe three of these projects, the AiBee Robotic Art project, the Cassandra chat robot, and Woofie, the Kinesthetic Intelligent Tutor.

Inspiring Interaction

Robots can capture the imagination of the public. Cost effective robots, like the Sony Aibo, that can be employed for research and in education have spurred growth in the field of human-robot interaction (HRI) [1]. For the Aibo, a robot dog, human interaction can be relatively intuitive. To better understand the nature of human-robot interaction, highly interactive HRI projects were included in undergraduate courses in Robotics and Artificial Intelligence. The classroom became an unofficial research environment, where undergraduate students developed robotic projects as budding scientists, trying to devise the best ways to entice people to interact with robots and learn what were successful modes of interactions. All project were presented to the public on campus, in museums and at conferences, such as the AAAI robot competition. The goal in public demonstrations was not only to get children and adults excited about robotics, but to also inspire the undergraduates to learn more about computer science. In this paper three of these projects, the AiBee Robotic Art project, the Cassandra chat robot, and Woofie, the Kinesthetic Intelligent Tutor, will be described in further detail.

Undergraduate Class Projects

The first project to be discussed is the AiBee Robotic Art Project. It began as one of seven multi-disciplinary class projects, developed by teams consisting of both digital media art students and computer science students. Next, the Cassandra chat robot was created as a starting point for a variety of research in HRI, primarily classified under the sociable partner paradigm. The last example is Woofie. This is a multi-faceted project incorporating a Sony AIBO robot with a full-body, tactile interface to engage children in a vocabulary learning game.

AiBee: Robotic Artwork

The AiBee Robotic Art Project employed Virtual Synergy[10,11] to act as a basis for humans and robots to interact and collaborate in creating works of art. Virtual Synergy is a 3D graphical interface that represents a collaboratively shared map of an area or virtual world for both autonomous multi-robot and multi-agent systems. The use of the 3D virtual allows both users who can see the real world and those who can't, to interact with the robots. The virtual world thus acts as hub through which different participants are connected.

Figure 1: AiBee Robot

The AiBee project existed in three different dimensions: a real world physical installation, a 3D virtual world called "HoneyComb city", and a web interface to the AiBee robot. The real world installation, the AiBee Hive, consisted of three hexoganal tents. One tent housed the AiBee robot, based on the Sony Aibo (Figure 1). Visitors were allowed to visit the tent and place red or blue origami flowers on the floor where the robot could see them, and the robot's movements were affected by the number and placement of the different types of flower. The second tent held a projection of HoneyComb city — the state of the city reflected input coming from the robot — and the third tent contained laptops connected to the internet and through that to the AiBee website. Visitors could influence the robot's behavior by voting for different actions on the AiBee website.

Figure 2: AiBee Installation at Museum

During the museum exhibition of this project (Figure 2), hundreds of people collaborated in unexpected ways and created art both in the real world and in the virtual world of the Honeycomb city. For example, when the exhibit first opened, the robot was finding mostly red flowers and so the buildings in HoneyComb city were red (Figure 3). On seeing the city was red, visitors responded in the virtual world by voting on the website for the robot to look for blue flowers and also in the real world by creating more blue origami flowers and chasing after the robot with them. The pace of activity was rapid, with visitors running from tent to tent to make their interventions and see the effects of them, until HoneyComb city began to change blue. Once their work had begun to take affect people stood by watched as the city continued to change color.

The resulting artwork was truly mixed-reality. The components were the layout of flowers in the robot's environment, Honeycomb city — created by the collaboration of visitors with each other and the robot — and the performance art of the participants modifying the first two components.

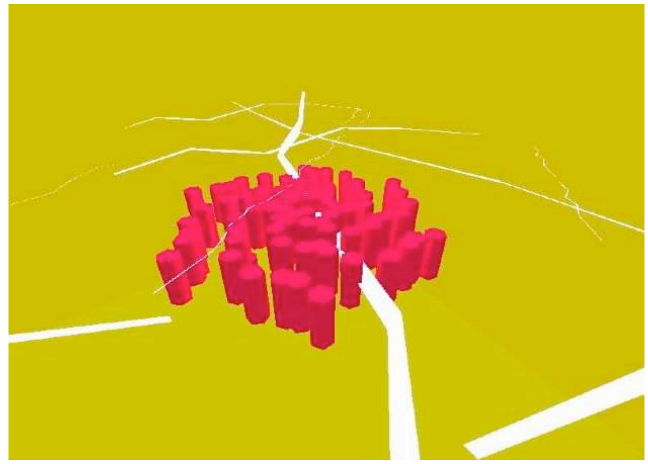

Figure 3: Red HoneyComb City

Cassandra: Chat Robot

The Cassandra chat robot was developed with the motivation that interactions with robots at any age can be a learning experience. The primary goal was to develop a system in a short period of time that people could interact with using natural language by using "off the shelf" components. This system could then be used to get children and adults excited about robotics and spur their motivation to learn more about the subject.

The Cassandra receives a text-based input, and then responds verbally to what was said, as if it had its own personality. In order to accomplish this goal a form of natural language processing would be necessary. After a short survey of many different natural language processing techniques the Artificial Intelligence Markup Language (AIML) was selected. The core features of the language is the easy ability to create conversational agents through the process of pattern matching [5].

Development in AIML of a custom personality was necessary. A demographic was developed for Cassandra and tags were added and modified to fit this model. Once this was accomplished we had the backbone of the system, its ability to speak. Next, to further the human interaction with the robot, a female TTS voice was selected for Cassandra. Custom motions were developed to allow Cassandra's mouth and body to move as she spoke a response. Finally, new sensors information was added to the robot, so that it did not react to text input only. Using image recognition and facial tracking the robot was to see a face in its field of vision with would center the face in its field.

Several of the internal AIBO semantics were also used to generate responses. The first was that of "happy". If the robots sensors would be touched several time as if you were petting the dog the "happy" semantic would be returned. This was captured and one of several responses would be spoken. These responses were meant to convey that the dog was enjoying being petted. The second semantic was that of “exercise”. When the robot would not move for a period of time the value of the exercise semantic would begin to rise. When it crossed specific thresholds Cassandra would express that she is tired of standing in the same place. Further work with Cassandra focused on developing an emotional model for the platform, so that when Cassandra responded it had an emotional inflection based on a history of inputs to the system.

Woofie: Kinesthetic Intelligent Tutor

The goal of the Woofie robot was to encourage interaction with children at the Chinchuba Institute’s KidSpeak Learning Center, in order to strengthen their language skills. Chinchuba’s KidSpeak Learning Center provides early intervention services to children age two through five with a focus on teaching deaf children and children with speech and language delays to speak intelligibly and to understand the speech of others. Their language delays can come from many different conditions.

The first implementation of Woofie presented the children with a simple word identification game. The robot read aloud the instructions and asked for the child to select a specific object. Some responses were to be directed at a touch screen in front of the child. A few special questions instructed the child to respond by touching different heat sensitive areas on the body of the AIBO itself. If the child correctly identified the object, the robot gave positive feedback by dancing to an exciting music clip, accompanied by a light show. In the case of a wrong answer, the robot shook its head in a negative side-to-side motion with red light schemes and dissonant music. The test system did not incorporate any intelligent tutoring, offering only encouragement and suggestive criticism.

The undergraduate students working on Woofie learned first hand that the young children would require constant stimulation and instant feedback to keep their attention and interest in the task. The game was not complex enough and the target task quickly became boring in comparison to the robot. The robot was almost too appealing, encouraging the children to leave their seat to play with the robot dog.

Children typically respond better to tactile/kinesthetic feedback than visual or auditory feedback. Touch is the first sense to develop and is the most descriptive[3,4,6-9]. During the excitement of the game, it was very tempting for the children to grasp at the robot. It followed that they also tend to be more forceful and sometimes destructive when interacting with the robot as they tried to heighten the experience. The challenge of building a robot that is rugged, gentle, and interactive is a difficult one. Since the AIBO is not physically robust enough, it could not be used as the source of tactile input for young children.

Human Robot Interface

Woofie needed a more functional and robust interface. We designed and constructed a very versatile kinesthetic robot interface. Strong and robust, the interface addresses the need for a tactile/kinesthetic interface as well as providing a flexible method of delivering visual content to the student [2]. The student stands at the center of an arc of five full color displays mounted at floor level. The robot is positioned on a platform at eye level on the outside of the arc. The student makes responses by stepping on or otherwise pressing the display showing the correct answer. Figure 4 shows the flow of communication.

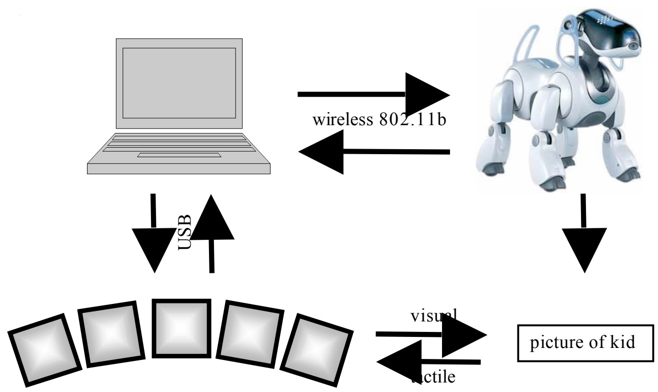

Figure 4: Flow of Communication

The completed system was displayed for preliminary user testing at the Louisiana Children’s Museum in New Orleans, LA. For this testing session where children of multiple ages and skill levels would be passing through, three special gameplay modes were defined. For children younger than four years, the system was set up to display five random animals and their names. When the child pressed the image, Woofie would speak the name of the animal and make its animal noise. For preschool aged children, Woofie would specify an animal by its name and noise and ask the child to choose it from among itself and 4 other animals. For kindergarten and older children, the system played a true game of Simon using the animal noises with no limits on the sequence length.

For these short games where each participant would usually not play more than one round of the game, the intelligent tutoring system remained active, but its presence would not be very visible. To judge its functionality, verbose log files were created during the games, including the players’ responses and response times as well as the intelligent tutoring system’s analyses and decisions.

Within the floor of a shallow platform are five, 15 inch LCD displays that are oriented in portrait style and mounted in an arc and angled slightly upward such that a young child standing at the focus can easily see each of them. Slightly above each monitor and flush with the platform level are heavy-duty acrylic step sensors. The 1/2 inch acrylic steps are each supported by a thin layer of compressible foam. Steps are registered by momentary switches mounted in the frame. A step requires roughly 9 newtons (approximately 2 pounds) of force to register. These switches are fed into the controller from a Microsoft Xbox Dance Dance Revolution (DDR) dance pad. The chip from the controller allows us to register up to 8 simultaneous binary inputs. Xbox controllers are natively USB. Using open-source drivers, the Xbox controller can be read as a standard joystick in Windows. The first version of the tactile interface was the DDR pad with pictures of animals ironed on, demonstrated at the AAAI 2006 robot competition.

Observations

During the day, volunteers helped to observe the behaviors and attitudes of the children as they played the game (Figure 5). An indirect feature of the interface's design is that it implies to the child their role in the interaction with the robot and the game, including where they should be standing. Encouraged by robot's dances, the children were eager to play the game as directed and not one child attempted to cross the interface to touch the robot while playing.

Figure 5: Child playing with robot interface at museum

It was observed that the children interacted with the robot more naturally than they had with the touch screen interface. For most children, the interface required no explanation. Unlike the touch screen, which requires the use of concentration and fine motor skills to operate, our interface allows the children to rely upon gross motor movements, shifting concentration to the game task instead. Over the course of the one day exhibition, 110 children played the vocabulary game with Woofie. Their ages ranged from approximately 1 to 13 years, with the exception of a few parents who took a turn. In total, almost 1300 responses were registered.

Discussion

These projects have been a successful method for teaching AI and robotics. The experience of working on these projects has given students valuable lessons in teamwork and leadership. Having the students learn to educate and interact with the public through their projects greatly increased their confidence.

Also, each project gave presentations and papers at conferences, which are good skills to have for a career in either industry or academia. Several of these students have applied to graduate school and some of the art students decided to minor in computer science. These projects have become the starting points for continued research in HRI.

References

[1] Adams, Julie A. (2002). Critical Considerations for Human-Robot Interface Development. *AAAI Fall Symposium: Human Robot Interaction Technical Report*, FS-02-03. Nov. 2002, p. 1-8.

[2] Ardito, C., De Marsico, M., Lanzilotti, R., Levialdi, S., Roselli, T., Rossano, V., Tersigni, M. (2004). *Proceedings of the Working Conference on Advanced Visual Interfaces*, Gallipoli, Italy. p. 80-84. New York, NY: ACM Press.

[3] Bartlett, B., Estivill-Castro, V., Seymon, S., Tourky, A. "Robots for Pre-orientation and Interaction of Toddlers and Preschoolers who are Blind" (2003) *Proc. of the Australasian Conference on Robotics & Automation.*

[4] Cooper, M., Keating, D., Harwin, W., and Dautenhahn, K. (1999). Robots in the Classroom - Tools for Accessible Education. In Buhler, C. and Knops, H., (Eds.), Proc. *AAATE Conference 1999, The 5th European Conference for the Advancement of Assistive Technology, November, Dusseldorf/Germany*, p. 448-452. IOS Press.

[5] Coursey, K. 2004, Living in CyN: Mating AIML and Cyc together with Program N, Available: http://www.cyc.com/doc/white_papers.

[6] Gertner, A. S., and VanLehn, K. ANDES: A Coached Problem-Solving Environment for Physics. In Intelligent Tutoring Systems: Fifth International Conference, ITS 2000, eds. G. Gautheier, C. Frasson, and K. VanLehn, 133–142. New York: Springer, 2000.

[7] Kahn, P. H., Jr., Friedman, B., Perez-Granados, D. R., Freier, N. G. (2004, April). Robotic Pets in the Lives of Preschool Children. *CHI '04 extended abstracts on Human factors in computing systems*, Vienna, Austria. p. 1449-1452. New York, NY: ACM Press.

[8] Katz, L.G. (1993). *Dispositions as educational goals*. Urbana, IL: ERIC Clearinghouse on Elementary and Early

Childhood Education. ED 363454. Available: http://www.ericdigest.org/1994/goals.htm.

[9] Koedinger, K. R., Anderson, J. R., Hadley, W. H., and Mark, M. A. Intelligent Tutoring Goes to School in the Big City. Journal of Artificial Intelligence in Education, 1997. 8(1): 30–43.

[10] Eric Normand and Sheila Tejada, Virtual Synergy: An Interface for Human-Robot Interaction. In the *Proceedings of IJCAI-2003, Acapulco, Mexico 2003*.

[11] Sheila Tejada, Shahrukh Tarapore, Andrew Cristina, Priscilla Goodwyne, and Ryan O.Hara. Mixed-Initiative Interface for Human, Robot, Agent Collaboration in Urban Search and Rescue Teams. *Proceedings of the World Automation Congress, Seville, Spain, June 2004*.