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ixi-Play, a robot buddy for young children

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ABSTRACT

Current tablet computers are so easy to use, that even children can operate them. But is a virtual environment operated by a touch screen really the optimal form for a child to develop new skills? In this paper, WittyWorX describes ixi-Play, a robot buddy for young children to play physical games with in the real world. This buddy can see, listen, feel, show emotions and move life like enabling young children to explore and play games in the physical world we live in. Communication with the ixi-Play platform takes place by speech recognition, image recognition and touch. ixi-Play not only offers rich interaction, the character also shares time and space with the child offering a higher level of engagement than screen based media.

Author Keywords

Education; Robotics; Personal Robotics; Social Robotics; Children; Gaming; Human Machine Interaction

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

The ongoing development in semiconductor technology has enabled cheap microprocessors and sensors propelling the market of computer technology. Nowadays desktop computers and laptops are accompanied and in many cases replaced by smartphones and tablet computers. In combination with powerful operating systems e.g. Android™ or iOS™ that can be controlled with only your fingertips, these devices have become the new way of how we interact with computer technology. In fact these devices are so easy to use, that even children can do it. This incentivized many developers to develop children's Apps opening a whole new market for tablet- and smartphone-based games. So using tablet computers and smartphones has literally become child's play.

Parents love to see their toddlers master these devices, believing it will boost their child's IQ so they will become geniuses. Research however has shown that the opposite is true. Frequent screen use can have several negative side effects e.g. sleep disorder [1], attention disorder and delayed language learning, whereas the potential positive effects are low to non-existing. That is why the American Academy of Pediatrics advised to avoid screen-based media below the age of two [2].

Research has shown that we learn better and faster if we combine cognitive with physical interaction [3]. Tablet computers and smartphones offer only audiovisual feedback and interaction via a touch screen by tapping and swiping. The images on screen may represent a real character, but lack the physical detail of their real life version. They remain a 'picture behind glass' and that is one of the reasons why people still buy action figures and plush toys of their favorite characters. Even though they cannot move or interact at all, children are often more attached to them than to the virtual character.

ROBOT TECHNOLOGY

What if we could bring characters to life with robot technology? Although robots have been around for decades, they have not seen the tremendous development that computers have. Of course with the development of sensors e.g. camera modules, microphones or accelerometers, and advanced mobile operating systems e.g. Android™ and iOS™ supporting speech recognition and image recognition Human Machine Interaction has improved [7]. The missing element for natural interaction is natural motion. Most robots move 'robotic' i.e. simple linear motion, one joint at a time while making a buzzing noise. This limits convincing human interaction and that is why WittyWorX has developed a motion module that enables fast, smooth, silent and agile motion in six degrees of freedom [4].

Another reason why robot technology has not seen the same development as computers is because of their price. Advanced robots like Asimo™ and NAO™ can do complex operations, but are far too expensive for large-scale adoption by consumers. The reason for this is that they use high-end modules and components e.g. motors and gearboxes. Toy robots are affordable, but because they use low-end modules they are mostly noisy or slow and have limited functionality. Therefore they do not offer the same user experience as advanced robots. Mechanical components do not scale the same way as electronic components, because they do not become faster and cheaper by making them smaller. The way to develop an affordable robot is by further integration, designing out the noisy or expensive components and leaving out the unnecessary elements.

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IXI-PLAY PLATFORM

This motion module forms the basis for ixi-Play, an intelligent platform that can bring characters to life (figure 1). Ixi-Play holds a camera for image recognition, two microphones for hearing, a multitouch sensor for feeling touch, two small color displays for showing eye animations, a flexible body for lifelike motion, two speakers for music, speech and sound effects. The platform also offers WiFi and Bluetooth for wireless communication with other devices and the Internet.

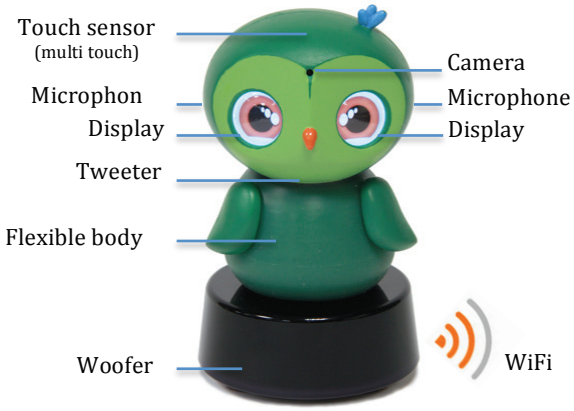

Figure 1. ixi-Play platform with sensors

The ixi-Play platform holds a powerful computer capable of doing on the fly image recognition e.g. face detection, color or card recognition. This enables ixi-Play to recognize objects in the real world. The platform runs Android™ operating system making it easy to program. It also allows other devices e.g. tablet computers to interface even if they run a different operating system e.g. iOS™ or Windows™.

EMOTIONS AND EXPRESSIVENESS

Ixi-Play's motion module together with the flexible body, eye animations and sound effects enables the character to have a high level of expressiveness and show convincing emotions (figure 3). As for animated movie characters, also for physical characters, fluent and silent motion appears to be crucial as it amplifies user experience. Masahiro Mori researched this aspect as published in his Uncanny Valley paper [5]. Figure 2 shows the added value of motion in the perceived affinity of the character versus the user.

In this figure ixi-Play positions itself just before the uncanny valley as it has a higher affinity than a humanoid robot, but is far from resembling a zombie.

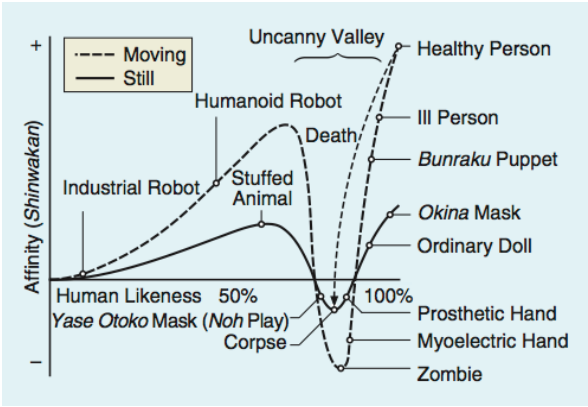

Figure 2. The presence of motion steepens the slopes of the uncanny valley [5]

APPLICATIONS AND ACCESSORIES

An important aspect of Ixi-Play is that it enables children to play games in the real world with physical objects and interaction. This can be both guided and open-ended play. Examples of possible games are: parroting, colors & shapes, animal sounds, storytelling, connect four, music & dancing and dressing up (figure 4). These games can be played together with accessories like flashcards or colored blocks that can be recognized by ixi-Play as well as clothes.

While playing the child learns how to manipulate objects and interact with them. In the mean time ixi-Play acts like a peer, so the child plays the games against or with ixi-Play. Ixi-Play interacts by watching, listening, speaking, moving and making sounds.

Because ixi-Play is not capable of moving objects, the children have to do all the physical operations, which is good because this improves not only their physical skills, but also makes them learn faster. Games can be educational or just fun. The educational content is mainly determined by the game itself. Ixi-Play makes it fun to learn without the need of an adult.

Besides being a game companion, ixi-Play also serves as a baby-monitoring device where video is streamed to a tablet or smartphone via WiFi or as timekeeper. Because ixi-Play runs Android he can speak and recognize over 40 languages, which makes him a great aid for learning new languages. Research by Kanda et. al. [6] has shown that the learning effect improves when the child develops a relationship with the robot.

Figure 3: Examples of emotions of the ixi-Play platform

Figure 4: Examples of games with ixi-Play

UNIVERSITY RESEARCH

Leiden University has used ixi-Play for their research on how children learn [8]. The main goal of the study was to examine whether the robot could be a useful tool in dynamic testing and whether it was able to improve children's performances on a series completion task (Towers of Hanoi) and a complex reasoning task. Their research indicates that the robot can be of additional value for a dynamic assessment. The children were able to learn from the graduated prompts training which was given by the robot. Moreover, they were able to change their strategy to more analytic behaviour. Once the robot is able to register all actions by itself, testing with the robot will be a promising method to have a standardized dynamic test, which will not be a large time consumer for the test leader.

Eindhoven University of Technology has carried out research on the added value of motion to a human interface robot [9]. They measured motivation and attention by looking at verbal and non-verbal communication of the children. Their research showed that movement adds to the user experience, but may also be distracting if the robot is not part of the game. They suggest involving the robot in the game to make use of the attention it draws from the child.

Delft University of Technology has researched if children are able to recognize emotions from a robot by just using eyes, posture and sound [10]. The results were that this is true for all children tested (4-6 years of age). Tests with parents show that even children below 2 years of age can recognize these emotions. Delft's research also showed that interaction with an avatar (virtual representation of the character) is much different from interaction with the real, animated version of the character. Typical behavior with the avatar was that children tried to draw attention by tapping on the screen and shouting, whereas with the real character they had immediate contact by touching the head and talking.

CONCLUSION

With ixi-Play WittyWorX has developed an interactive platform that is affordable and easy to use offering a level of engagement that outperforms tablets or smartphones by enabling children to play games in the real world with tangible objects. University research has shown that this platform contains the necessary elements to do effective and efficient research on both Human Machine Interaction and child learning.

Future work contains adding games and accessories to the platform as well as improved image recognition and intelligence. Furthermore the platform needs to be tested in a broader setting to verify the long-term effects and benefits on children.

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