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Disrupting the Industry with Play

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Abstract

Decades of research into intelligent, playful technology and user-friendly man-machine interfaces has provided important insight into the creation of robotic systems and intelligent interactive systems which are much more user-friendly, safer and cheaper than what appeared possible merely a decade or two ago. This is significantly disrupting the industry in several market sectors. This paper describes the components of the playware and embodied artificial intelligence research that has led to disruption in the industrial robotics sector, and which points to the next disruption of the health care sector. This includes playful robotics, LEGO robots for kids, minimal robot systems, user-friendly, behavior-based, biomimetic, modular robotics and intelligent systems. The insight into these components and the use in synthesis for designing robots and intelligent systems allows anybody, anywhere, anytime to use these systems, providing an unforeseen flexibility into the sectors, which become disrupted with these systems.

Keywords: Playware, user-friendly, modular robots, playful robotics and intelligent systems.

1. Introduction

Over the last half century, most robots have been characterized by being large, squared, metallic and hard objects, which are controlled by fairly complicated control software to the novice user. This led to large robots, for instance employed in the heavy industries in car factories, shipyards, etc. installed by highly skilled engineers. These robots were automatic in the sense that they were self-regulating, but did not make the laws that their regulatory activities seek to satisfy. These laws were given to the robot, or built into the robot. They were done so by engineers with years of training, and experience with control theory and practice. In many cases, the large, squared, metallic and hard robots were kept in a cage to perform their actions in order to screen away human beings for security reason, since being hit by one of the large robots could be deadly to a human being.

Since these industrial robots had their clear place in automating the industry, it became standard to develop and utilize such robots with this approach, and most researchers and roboticists would adhere to this standard.

Nevertheless, decades of research into intelligent, playful technology and user-friendly man-machine interfaces has provided important insight into the creation of robotic systems and intelligent interactive systems which are much more *user-friendly*, *safer* and *cheaper* than what appeared possible merely a decade or two ago, and this is now disrupting the industry.

2. Play and playful robotics

The basis of such disruption of the industry is the quest to create truly user-friendly robotic systems. Since the 1990's, with a bottom-up approach, we have investigated how to create minimal robot systems that are playful to interact with, in order to develop technological systems that anybody can interact with. Play is important, since play is a free and voluntary activity that we do for no other purpose than play itself [1]. We play for the enjoyment. So installing play in the interaction can lead to people interacting with the system out of their own free will and enjoyment. Further, when in play, people performs an ontological shift according to Gadamer [2], and almost become another representation of themselves when they forget about time and place. In such a state of being, i.e. in a play dynamics, people can often perform more than they would normally do [3].

The first playful robot systems were in the form of Khepera miniature robots and LEGO robot prototypes, before we started the collaboration with LEGO on the development of LEGO Mindstorms robots. The development of these robotic systems in the 1990's facilitated the development and practical experimentation of modern artificial intelligence with artificial life experiments, evolutionary robotics, user-guided evolutionary robotics, and user-guided behavior-based robotics.

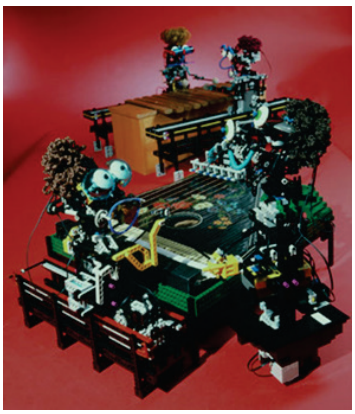

Fig. 2. A robot orchestra that we developed for the LEGO Mindstorms promotion tour in Europe in late 1990's.

Despite of the core research effort in these embodied artificial intelligence themes, all experiments had the underlying focus of creating robotic and interactive systems that anybody – even young children – could interact with and understand within minutes. This focus on the user and understandable interaction for anybody within minutes distinguished the research and development from the traditional robot, automation, and control research.

The experiments resulted in an understanding of how minimal robot systems can result in task-fullfilling behavior guided by the user in different ways. One example is the development of *user-guided behavior-based systems*, in which the engineer develops the primitive behavior modules, and the end-user is allowed to combine the primitive behaviors to coordinate these into the overall behavior of the robotic system. Since the engineer performs the difficult task of handling the details (e.g. reading, interpretation and classification of sensory signals; and complicated motor commands) in the design and debugging of the primitive behaviors, the end-user can work on the higher abstraction level of combining these primitive behaviors with no need of knowledge of the (more complicated) low-level details. This approach of creating user-friendly robot control for any user with user-guided behavior-based systems was developed and verified on LEGO Mindstorms robots for RoboCup Junior [4], for the LEGO Mindstorm Europe launch tour with a robotic orchestra, robot fashion show, and robot art show, for the RoboCup Humanoids Freestyle World Champion 2002 [5]. Further, it became the basis for the development of *user-friendly modular robotic systems* such as the I-Blocks [6], in which each of the primitive behaviors is a module, and the user is allowed to physical build with the modules to create the overall robotic system. Further, this became the inspiration to create other user-friendly modular robotic systems such as the music cubes, MusicTiles MagicCubes, modular interactive tiles [7], and Moto tiles (www.mototiles.com).

3. Disrupting the Industrial Robot Sector

Based on these studies of playful robotics as user-friendly interfaces, our students during a decade went on to form the Universal Robots company to create an industrial robot arm, which should be light-weight, safe, and easily programmable by anybody.

Indeed, the founder of Universal Robots, Esben Østergaard reports that "in the mid 90's, we built robots

with pure ferocity. It culminated in 1998 when we won the football World Cup for robots, which was seen by 50 million people. Football robots could be programmed by children without any technical knowledge, and if children can learn to program robots, then all people can learn it. This approach was one of the fundamental values of our company Universal Robots. We found out that Danish food companies needed to be able to adapt quickly. It was absolutely impossible to do that with the existing robots. So we built a robotic arm that could be reprogrammed easily and without specialist knowledge, and the idea turned out to be pretty good." [8]

Fig. 2. One of the Universal Robots industrial robot arms.

Indeed, Universal Robots created such robotic arms, which suddenly made it feasible for SMEs to invest in robots and automation, since the SMEs could afford the robot arm and could easily adapt the robot arm to new processes. This disrupted the industrial robot industry, the Universal Robots company was sold for 285 million USD to Teradyne, and most other robot companies had to follow up to create similar light-weight, safe and user-friendly robotic arms. A good example is Rodney Brooks' Rethink Robotics company and their Baxter robot. Like the Universal Robots company did, also Rethink Robotics tries to develop user-friendly robots that anybody can control by allowing the factory worker to grab the robot arm and show the robot what to do by moving it around while the robot learns what to perform and with which objects.

Further, crowdfunding sites such as Kickstarter are seeing several projects funded to build low-cost table-top robotic arms for personal use, e.g. for the maker movement and light manufacturing.

In our case, the lessons learned were that long-term focus on play and user-friendliness can lead to disruption of an industrial sector such as the industrial robot sector, where the growth now is characterized by the development and sales of such low-cost, user-friendly robots. The development of such robots was based upon the extensive knowledge gained in playful robotics, LEGO robots for kids, minimal robot systems, user-friendly, behavior-based, biomimetic, modular robotics and intelligent systems.

Fig. 3. Robots from Rethink Robotics and Universal Robots.

4. Disrupting the Health Sector

One of the next sectors to experience a similar disruption may be the health sector. In many areas of the health sector, patient compliance to the treatment is important. This is the case in prevention and rehabilitation, for instance, in which the subject is asked to perform a certain series of actions at regular intervals. But unfortunately compliance to the protocol is often low, due to little intrinsic motivation to perform those actions that may be viewed as tedious and repetitive.

Also here, play and playware may disrupt the sector by providing new technological opportunities that radically changes the way such practices in prevention and rehabilitation is performed. Play as a free and voluntary activity, which is performed for the personal enjoyment, may result in highly motivated patients, if the technology can mediate such playful engagement. At the same time, it may be possible to observe the *collateral effects of play* in the form of quantifiable health effects that exceeds the effects measured with traditional health intervention methods [9].

Therefore, we developed modular playware in the form of the modular interactive tiles called Moto tiles (www.mototiles.com). The Moto tiles activates the user to perform playful interaction with play and games on the tiles that light up in different colors and registers when users step on them. The Moto tiles are connected

to a tablet with the ANT+ radio protocol. On the tablet, the user can select between numerous games that challenge both the physical and cognitive abilities of the user. Further, the tablet shows the score in each games, shows statistics for the user, and make automatic documentation of effect.

Scientific studies of effect among community-dwelling elderly who perform group play on the modular tiles once per week show highly statistical significant effect on functional abilities of the elderly. Especially, the balancing abilities of the elderly (avg. 83 years of age) increase by more than 60% after merely 13 training sessions [10]. Also, all other measured functional abilities (strength, mobility, agility, and endurance of the elderly) improved with statistical significant effect.

Qualitative studies suggest that the high health effect from playing with the Moto tiles arises from the fact that the Moto tiles act as a play force, which pushes the participants into a play-dynamics, in which they forget about time and place, and thereby perform more than they would normally do. In play, they may forget about their fears of falling and forget about their perceived physical and cognitive limitations.

Fig. 4. The Moto tiles and the tablet interface.

With such quantifiable health effect results of play, we believe that playware technology may disrupt certain areas of the health sector. Already, the Moto tiles are used in the health sector for the benefit of cardiac patients, stroke patients, elderly citizens at risk of falling, dementia patients, children with cerebral palsy, and in special schools in three continents. As is the case with the disruptive technology for the industrial robot sector, also this disruptive technology for the health sector is based on the possibility for the end-user to easily adapt to different tasks and practices, e.g. for different kinds of patients.

5. Discussion and Conclusion

The developments of disruptive technologies are based on the Playware ABC concept. The Playware ABC concept focusses on the development of technology to be used by anybody, anywhere, anytime based on building bodies and brains, and thereby facilitating that users can construct, combine and create. Indeed, the possibility for anybody to create new interactions with the systems seem to provide new opportunities, as is showcased in the industrial robot sector and health sector. At the same time, the concept leads to solutions that are cheaper, safer and more flexible than previous solutions in the sectors.

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