Executive Summary

Here at Hanson Robotics, we put a lot of work into making the best life-like robots possible. Unfortunately, we have not created the robots that society has dreamed about yet. As major discoveries have been scarce lately and some of the design philosophies are inadequate, we are faced with a situation. To deal with it, this report suggests that a new personal robotics division focused on R&D be opened.

This new division will have many obstacles to tackle. Robots need to be cheap enough for a large number of people to buy them, and public opinion of robots will need to be changed before this will happen as well. There are many technical issues that need to be tacked as well, such as the ability of robots to walk efficiently and the ability to properly handle objects of all kinds. This new division will focus on single-purpose personal robots, as they are less costly to make and are simpler to develop, which will give us a chance to isolate and figure out solutions to some of the current limitations. Development will be focused on improving human-robot interaction instead of problem solving and critical thinking skills. New ideas such as complex intelligence and alternate laws to Asimov's Three Laws must be looked at as well.

Opening up this new division will ensure that new breakthroughs are made in the field while also keeping the company afloat in these uncertain economic times and living up to our motto “We bring robots to life.”

Introduction

This report looks at the past of robotics leading up to the present day. It also analyzes reasons why we have not achieved the advancements of technology that were expected by now. To help solve this problem, a plan has been developed that will increase development by opening a personal robotics division here at Hanson Robotics.

The past of robotics

The foundation of the robot

Mechanical devices that we would consider robot-like have been around since Archytas of Tarentum built a steam propelled mechanical bird in around 350 B.C. The actual term robot did not have its current meaning though until 1921, when Czech playwright Karel Capek introduced the word in the play R.U.R. (Rossum's Universal Robots). In fact, the word robot means compulsory labor in Czech. In the 1940's, Isaac Asimov wrote a series of short stories about robots that are eventually compiled into "I, Robot." In these short stories, he developed the idea of The Three Laws of Robotics:

> 1) A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
>
> 2) A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
>
> 3) A robot must protect its own existence as long as such protection does not conflict with the First or Second Law (qtd. in Isom).

In 1950, Alan Turing published “Computing Machinery and Intelligence” in which he established what will be known as the Turing Test as a way of testing intelligent behavior in robots (Isom).

The old ways are obsolete: the meaning of intelligence and insufficient philosophies

While new discoveries and ideas continued, they eventually slowed down significantly. In the 1990's, computer technology advanced greatly, but mostly in the field of personal computing and the development of the Internet. The worlds “smartest” robots may be able to beat the world's best chess players, but it turns out making a personal robot with functional (walking, seeing, thinking, etc) intelligence is a completely different challenge (“What Became of the Personal Robot”).

As well as a lack of major discoveries, the design philosophies behind robotics are either inefficient or too forward thinking. The Turing test only measures whether the robot has the same intelligence and conversational ability of a human but not other important aspects such as the ability to successfully walk or handle objects smoothly. The Turing test even ignores other demonstrations of thinking such as using a map or playing a musical instrument (“Twelve Reasons to Toss the Turing Test”). Also, Asimov's Three Laws of Robotics think too far ahead in the future: “Asimov’s laws are based on functional morality, which assumes that robots have sufficient agency and cognition to make moral decisions” (Murphy 15). Robots do not have the capacity to correctly implement these laws.

Robotics: Where are we now?

What is a personal robot, and why we haven't achieved the ideal robot

A personal robot is defined as a device that possesses a degree of intelligence and uses sensors to gather data from the environment and act on it, allowing it to perform a specific task or tasks (Ingebretsen 90). Developments in personal robotics are currently not living up to customer and business expectations. There are two main reasons why: they are very expensive and they are not the personal humanoid robots that people dream about and expect. “The ultimate barrier is price tag. . . Personal robots have to be sufficiently inexpensive that consumers will buy them,” said Larry Fisher, research director of NextGen, a research company that has done forecasts of projected sales. Even “simple” robots such as Sony's Aibo that sells for US $2,000 have powerful and, therefore, expensive microprocessors. Software is also costly to develop and maintain; these two factors combine to make most personal robots too expensive for most customers (Ingebretsen 90-91). As well as being costly, robots are a long way from conforming to long-held romantic ideals humans hold. When we think of what we want robots to be (or at least where we expect them to be), we think of Arnold Schwarzenegger walking around with big guns or C3PO waddling around talking to us, not a machine used in a factory or a Roomba zooming around the house, but that is where robotics is right now.

The capabilities of robots are limited

The capabilities of personal robots are currently limited. Walking has turned out to be a very complex engineering problem, and robots cannot efficiently do it. Most robots that move do so on wheels or other methods that do not involve walking. The few that do, such as

Honda's ASIMO, are very precarious and slow moving. Outside of the laboratory, robots are mostly helpless. Most robots cannot handle objects without crushing them. It may seem that robots can see, but it is merely reacting to pre-programmed colors and shapes. Again, in the real world robots would be helpless as they do not actually know what they are looking at. Sight is linked to thinking, as sight is about interpreting and acting upon the world around you. As robots are merely responding to pre-programmed orders when they respond to keywords, they do not actually think yet ("What became of the personal robot?"). Because of current economic conditions, not many companies are focusing on developing personal robots at the moment. For example, Sony had to shut down its robotics decision in 2006, forever closing its Aibo robot-dog project. This is a vicious cycle; robots are limited and expensive because there are no breakthroughs from research, and there is not enough research because robots have limited marketable capabilities and are expensive.

There are some companies still doing research though, and they are making advancements. Honda has made great strides with the development of their ASIMO robot. It can walk at 2.7 kph (1.7 mph) and can run at 6.0 kph (3.7 mph). It can bring objects from place to place by pushing them around on a cart. It can pick up, put down, or hand over a tray. It can turn smoothly without stopping. It can interact with people on a limited basis, responding to predefined keywords or actions, such as a wave of the hand ("FAQ"). ASIMO, as well as other examples such as the Roomba, show that the field is still promising and there are many new developments to be had.

If something is not done, Hanson Robotics will be left behind when the big breakthroughs are made, not fulfilling our motto that “We bring robots to life,” (“Hanson Robotics”).

The future, and how Hanson Robotics can be a part of it

Opening a personal robotics division

We are a long way from achieving the goal of intelligent and functioning personal robots, and there will be many steps in between now and then. The first step is to increase our research and development, mainly by opening up a new division focused solely on personal robotics. While Hanson Robotics has very high quality and human looking robotics, they are prohibitively expensive, with custom made ones running around $130,000 and smaller mass produced ones running about $3,000 for the standard version (Ogando). The current focus of the robots produced here at Hanson is the life-like quality, with Frubber (flesh rubber) and high quality parts combining to make a realistic human face. The focus of the new division would be on the implementation of human qualities to the actions of our robots as well as their looks. This new division will look into different types of single-purpose robots, the attitudes that society holds about robots, and reevaluating development goals and design philosophies.

The single-purpose robot

One tactic the personal robotics division might use is focusing on developing single purpose robots. They have a major advantage in that they are easier and less expensive to make than an all purpose robot. The robots in the Roomba series range anywhere from $159.99

to $599.99 (“iRobot store”). 940,000 vacuum cleaning robots were sold in 2008, which was a 50% increase from the previous year (Ingebretsen 91).

Besides domestic housework functions, another avenue to consider is telepresence, or “the ability to project oneself into a different environment via a semi-autonomous device,” the most common example being drones used by the military. From 2003 to 2008, drone usage in Iraq and Afghanistan has increased from 35,000 hours to over 800,000 hours. Advancements in drone technology will definitely influence personal robotics, as the same techniques used to detect and act upon enemy sightings can probably be modified to detect and act upon in a non-violent way to non-violent people, or even detect and act upon criminals. For example, the Rovio by WowWee is controlled by Wi-Fi and patrols the home to check for intrusions and structural damage (Ingebretsen 91).

As well as the military, there is also the medical field to consider. Robots are already assisting in some surgical procedures, and as the technology gets more efficient robots will be capable of assisting in a larger number of medical procedures. Gecko Systems is developing a robot called the CareBot to be a personal home-care robot. Something similar to the CareBot could be a substitute for assisted living for the handicapped and the elderly. Again, there are many problems to work out , such as the handling of objects (like medicines and food) and understanding commands accurately (Ingebretsen 91). Research into any or all of these fields may lead to marketable products that would help fuel more research, as well as leading to future breakthroughs with the name Hanson Robotics attached to them.

Attitudes towards robots, and how they effect the market

For robots to spark consumer desire and be adopted by the public at large, they will need something they do not have now: to be able to be related to and loved by humanity. The attitudes towards robots in various nations of the world vary differently. The Japanese are perhaps the only nation that is at this point, as they have had a long history of fondness for robots, with some of the major developments coming from researchers there. In Europe on the other hand, robots are viewed merely as a tool to be used to increase industrial efficiency. Any developments there are towards making them more efficient workers, and public opinion is filled with indifference towards them (Duffy).

Opinions on robots in the US is somewhere in between, with people buying robot vacuum cleaners to show off to the neighbors but not ready for wide integration of robots into society like the Japanese (Ingebretsen 91-92). While movies have ensured that the idea of robots is here to stay, it has also brought about the idea that robots in general are evil and will rise against and murder humans if powerful enough. This idea must be countered in the public opinion before robots will be widely adapted (Duffy). This relates to cost of development as well. There is no outstanding open source software for robots at the moment. As robots become more adopted by the population at large, more people will start to try their own hands at modding and developing software to make robots better suit their needs, which can be used by developers like us to decrease costs (Ingebretsen 91).

Back to basics: Reevaluating the way robots are developed

To further along development, some researchers have gone back to basics. Professor Kerstin Dautenhahn of the University of Hertfordshire's human-robot interaction research group says that “For a long time people thought that the summit of human intelligence was our capacity for problem solving, IQ tests and the like. So in developing robots they designed them to do these complex tasks...But now people are saying that its human's ability to deal with complex social relationships that's made us intelligent.”

On the basis of this idea, the research group has moved from a laboratory to a nearby flat, where they develop and test robots and their interaction with humans in everyday life situations. Instead of asking questions about the best way to play chess, they are asking questions about such things as the best way to get the attention of a human in the middle of an activity. People from a variety of different fields, such as sociologists and psychologists, have been brought together along with the engineers and computer scientists to develop a more human robot. Professor Chris Melhuish, who heads a similar project at the Bristol Robotics laboratory, agrees, saying "The dynamics of interactions are incredibly important. It does not have feelings of course, but must have the techniques and wherewithal to appear to have feelings that are sensitive to humans." A robot not only needs to sense that a human is experiencing an emotion, but be able to react to that emotion (Duffy). The new division should make these ideas about robot-human interaction be an important ideal while developing.

Debate over guiding philosophies

There has been debate over two of the major guiding design philosophies behind robotics as well, those of the Turing Test and Asimov's Three Laws. Some AI researchers are more focused on designing robots to perform specific tasks instead of being able to pass the Test. Others, such as Ray Kurzweil, believe we are at the cusp of having computer that could pass the Test, and that "...our intelligence will become increasingly non-biological and trillions of times more powerful than it is today..." (Wang 2-3). There is a new train of thought developing though; it says to consider AI as an independent type of intelligence within cyberspace, separate from human intelligence. Fei-Yue Wang, the originator of this theory, uses the analogy of complex numbers, stating that they are half real and half imaginary. From there, he explains that with new technology our world may become a complex world, or half physical and half cyberspace. In that world, we will need a complex intelligence that is half human and half artificial. With the focus being on investigating the dynamics of cyberphysical interactions, new fields in AI research such as behavioral computing and psychological computing become open (Wang 3).

There has also been some debate over the validity of Asimov's Three Laws, as robots today do not have the capacities that Asimov imagined when he wrote his stories. The first law is already obsolete, as the military already uses robots in warfare. The second law requires that a robot be able to understand and act upon verbal requests, and robots are still struggling with the ability to have natural conversations. Add on to that all the non-verbal forms of

communication such as body language and things get very complicated. The third law, while possible with technology since the 1980s, is rarely fully implemented in robots since it would increase the cost of development. There have been an alternate set of laws proposed, which follow (Murphy 14-16).

Table 1. Asimov's laws of robotics versus the alternative laws of responsible robotics

	Asimov's laws	Alternative laws
1	A robot may not injure a human being or, through inaction, allow a human being to come to harm.	A human may not deploy a robot without the human–robot work system meeting the highest legal and professional standards of safety and ethics.
2	A robot must obey orders given to it by human beings, except where such orders would conflict with the first law.	A robot must respond to humans as appropriate for their roles.
3	A robot must protect its own existence as long as such protection does not conflict with the first or second law.	A robot must be endowed with sufficient situated autonomy to protect its own existence as long as such protection provides smooth transfer of control to other agents consistent the first and second laws.

(Murphy 19)

The alternate laws are designed with feasibility in mind, given the current state of robotics. Also, since robots are not fully autonomous, they emphasize the responsibility of the human controllers. The first law especially is focused on this idea, encouraging designers to be proactive about errors on both the human and robot side of the equation, implementing measures such as training humans on the capabilities of robots and implementing network and physical security in robots before being released. The second and third laws require continuing work in areas like speech recognition, but at least they are feasible somewhat now and will become even more feasible long before robots become fully autonomous. While Asimov's laws focus on functional morality and autonomy, the alternate laws emphasize the ability to be prepared for any situation and being able to adapt to change, as there is a diversity of different

tasks that robots will be doing. Understanding these diversities and having resilience to change will be essential for making good robots (Murphy 14-19).

Conclusion

Robotics is in a precarious position; there have been many advancements in the past but there is still much more to go before we reach the robots society dreams about. Hanson Robotics needs to open up a division for R&D developing personal robots. Breakthroughs in this area may lead to bigger discoveries in the future, as well as bring in money to sustain the company. If we do not help in these discoveries we will be left behind as a company and fail our motto, and if we do then we will be guaranteed to live long and prosper.

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