The Future of Humanoid Robotics

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Abstract

Albert Einstein once said "imagination is more important than knowledge. For while knowledge defines all we currently know and understand, imagination points to all we might yet discover and create." These words apply also to humanoid robotics; although there is a basic structure it took Honda's team of engineers a lot of imagination to create it's humanoid robots. Walking biped robots have been developed only recently, much less research attention has been focused on developing complete global navigation strategies for biped robots[1]. First developed was walking and this came with a set of problems such as programming balance, but Honda's team didn't stop there. Their aim was to build the first humanoid robot; therefore they wanted their robots to have arms too. They achieved this with their P1 robot, but the hardware of the time was limiting. This meant that to get a robot that could truly act like a human they would have to push the boundaries again, and with P2 and P3[2] they did. They were the first to have wireless control; this made them look more human like and was the beginnings of ASIMO, a robot that doesn't rely on the workstation. With wireless connections the Honda team realised that they would one day be able to have a robot that could interact with the human world, however the limitations of P2 and P3 meant that ASIMO would be the first robot to achieve this. Now with ASIMO coined the "Friendly Robot"[2], being lent out to offices already to carry out light administration work, and the i-WALK, which is said to be more efficient and human like than P3's walking style that was slow and awkward, Honda has moved onto their new project of Inelegance, they're not the only ones. With the introduction of the iCubs, a fascinating project that involves many different subjects, from human development to robotic itself, are we on the cusp of humanoid robots with near human intelligence?

The E Projects

The robotic walking project was started in 1986, with the E projects, standing for experimental model.

Project E0	
E 0 developed	1986[2]
Results of E0	Develop a bipedal robot, but took 5 seconds between steps
E1-E3 developed	1987 to 1991[2]
Results ofE1 and E2	Faster walking, E2 walked fluid enough to mimic the human style of walking
Results of E3	E3's walking speed was close to that of a human at 3 km/h[2]
E4-E6 developed	1991 to 1993[2]
Results of E4	The knee length was increased to 40 cm[2] to increase speed to 4.7 km/h[2]
Results of E5 and E6	The first autonomous models, E6 controlled balance and also able to go up/down stairs and walk on uneven surfaces.

With these projects having successfully advanced robotic bipedal walking the Honda team moved on to more advanced robotic problems.

The P Projects

P stood for prototype model, with bipedal walking having been successfully developed to an adequate stage, the Honda team started to work on a humanoid robot. The P projects were the "first man like models with upper limbs and body" [2].

Projects P1 to P3	
Developed	1993 to 1997[2]
Results of P1	Could carry out commonplace tasks.
Results of P2	Able to act wirelessly allowing independent operation
Results of P3	The size was reduced by decentralizing control system, this meant that P3 was better suited for use in human environment.

Asimo

In 2000 Honda started developing Asimo (Advanced Step in Innovative Mobility)[2], which they have coined the friendly robot. The size of Asimo was specifically designed to be compatible with the home and office environment, for example Asimo is able to push trolleys and place things on the table, however Asimo's height is in no way threatening, this was important to Honda.

What made Asimo so advanced was it walking style, P3 used a walking style that would seem jerky as it would have to stop temporarily between turning. This was because in order for P3 to change direction it would have to combine programmed angles , for example, to turn 30° P3 would have to use a combination of 20° and 40°[2] which were pre-programmed in. However Asimo uses a walking style known as the i-walk. The i-walk allows Asimo to predict its next movements in real-time and shift its centre of gravity to compensate, giving Asimo a turning circle. This meant that Asimo style of walking was more fluid and humanlike than the world had ever seen, "ASIMO is the closest robot yet to replicating the natural walking motion of humans" [5].

Honda's AI Program

The recognition of moving objects

This uses two cameras mounted on Asimo's head, the cameras assess movement, distance and direction. Asimo is also able to recognise multiple moving objects. Asimo can assess its immediate environment, avoiding obstacles. This makes Asimo capable of dealing with the non-static world.

Interpreting body language and sound

Asimo uses information gathered by the cameras, it is able to interpret gestures and movement of humans this means that not only can Asimo respond to voice commands but also reacts to the commands given naturally by body language such as pointing. "ASIMO recognizes human gestures based on statistical analysis, using spatiotemporal variance of three- dimensional (3D) positions of the face and hand. It is able to distinguish 10 kinds of gestures and postures on left and right sides" Asimo can distinguish between voices and background noise.

Facial Recognition

Asimo is capable of recognising approximately 10 different people and can do this while moving, this is useful in offices. When Asimo recognises a face it will greet them by their name, and relay any messages or guide them to a certain destination. This is useful in the office and home environment as human forgetfulness will not interfere with message delivery.

Network Integration and Internet Access

Network integration is particularly useful in office environments, the point of connecting Asimo to the user networks is so that Asimo could perform basic office duties, this included greeting visitors and informing employees by transmitting messages and pictures, Asimo was also able to guide visitors to a predetermined location. Asimo is also connected to the Internet, the point of this was so that Asimo could provide news and weather updates.

The iCubs

In 2004 a new project was created - the iCubs - they are a European wide collaboration, funded by the European Commission. "What distinguishes the iCub from its cousins worldwide is that it is the result of collaboration among 11 European universities and institutions." [7] There are currently 20 iCubs that have been made and are being worked on. The iCubs are open source, this means that anyone can work on them."The iCub robot stands at just over three feet high, or about the size of a three-year old child. It's face has just a hint of a nose and mouth, and it's big eyes allow it to see and track objects in it's environment. Sensors allow the robot to feel, and some iCubs can speak."[8] This is because the project focuses on learning. The main goals of the iCub is "to create a new advanced humanoid robot – the iCub – to support Community research on embodied cognition, and to advance our understanding of several key issues in cognition by exploiting this platform in the investigation of cognitive capabilities."[9]

We will definitely be seeing humanoid robots in our day to day lives very soon, whether at work or in the home, the intelligence has become so advanced that robots will be a viable option.

1 Joel Chestnutt, Manfred Lau, German Cheung, James Kuffner, Jessica Hodgins, and Takeo Kanade 2005 Footstep Planning for the Honda ASIMO Humanoid
2 Honda's website: http://world.honda.com/ASIMO/ (all pictures, apart from Asimo found from this site)
3 press release http://www.hondauk-media.co.uk/release/?release=1145 2009 (Asimo Picture)
5 Honda press release September 9, 2003, Asimo makes public debut in Europe, Frankfurt motor show
6 Gesture Recognition Algorithm for Understanding of Man-Machine Interaction and Its Adaptation for New ASIMO by HIGAKI NOBUO(Honda R & D Co., Ltd.) YOKOYAMA TARO(Honda R & D Co., Ltd.) FUJIYAMA KIKUO(Honda R&d Americas, Inc.)
7 The Times March 8 2010
8 Physorg.com
9 RobotCub: An International Project on Humanoid Cognitive Systems, funded by the European Commission, www.RobotCub.org, September 2006

This poster was prepared for the BCS Woman's Lovelace Colloquium 2010