# Robots Like Us: Robots That Work With or Beside People

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## ABSTRACT
On 24 June, 2011, US President Barack Obama announced the National Robotics Initiative with a budget of $US70 million. This initiative focuses on developing robots that work with or beside people to extend or augment human capabilities, taking advantage of the different strengths of humans and robots.

## Categories and Subject Descriptors
I.2.9 [**Computing Methodologies**]: Robotics – *Commercial robots and applications, Kinematics and dynamics, Manipulators, Operator interfaces, Propelling mechanisms, Sensors, Workcell organisation and planning*

## General Terms
Performance, Design, Human Factors, Autonomous, Humanoid.

## Keywords
Robotics, Autonomous Humanoid robots, National Robotics Initiative, Geminoid


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ABSTRACT
On 24 June, 2011, US President Barack Obama announced the National Robotics Initiative with a budget of $US70 million. This initiative focuses on developing robots that work with or beside people to extend or augment human capabilities, taking advantage of the different strengths of humans and robots.

INTRODUCTION
Often when we think of robots, we think of the popular imagery of our youth – such as C-3PO& R2D2 ("Star Wars"), or The Terminator, and Robocop. They have two arms and two legs, a torso, and a metallic head (see Photo 1). But real world robots have failed to live up to expectations. Factory assembly arms and planetary rovers (see Photo 2), designed for work that is highly dangerous to humans, or is a far cry from the Asimovian androids like Sonny in I, Robot (see Photo 3), that we had come to hope for (Wright, 2012).

Photos 1, 2 and 3 – from left to right – "Star Wars" characters R2D2 and C-3PO, factory assembly arms and a planetary rover, and Sonny the robot from Asimov's I, "Robot".

THE NEW INITIATIVE
The purpose of the National Robotics Initiative (NRI) program is to develop the next generation of robotics, to advance the capability and usability of robots, and to encourage existing and new communities to focus on new and innovative areas for the use of robots. The initiative is to address the whole life cycle from basic research and development to manufacturing and deployment. Developers are to particularly carry out the research required to gain a better understanding of the long term social, behavioural and economic implications of robots across all areas of human activity [National Science Foundation (NSF), 2012].

THE PROBLEM
While roboticists have had considerable leaps forward in near-humanoid robotic development, such as Honda's ASIMO robot that employs a breath-taking array of sensors to detect and respond to external stimuli (Honda, 2013), people and robots just don't seem to mix, according to UK roboticists Dr Tony Belpaeme [cited in Wright, 2012].



Figure 1. The uncanny valley: a the region of negative emotional response towards robots that seem "almost human". Movement amplifies the emotional response.

According to Belpaeme, robots still have trouble assessing and responding to human's behaviour and humans feel uncomfortable around robots. In a project he's been working on in a children's ward in a hospital in Milan, Belpaeme says that while children are less discerning of the robots' structure, adults are more sensitive to their build and would only briefly see them as entertaining, then recognize them as machines (Rivas, 2012).

The phenomenon is called the "uncanny valley" (See Figure 1) – coined by Japanese robotics professor Masahiro Mori, which holds that when robotic features look and move almost, but not exactly, like natural human beings, it causes a response of revulsion among human observers. If a robot looks sufficiently non-human, its human characteristics will be noticeable, generating empathy. However, if the robot looks almost human, the non-human characteristics will be noticeable, giving the human viewer a sense of strangeness. A robot stuck inside the "uncanny valley" is no longer being judged by the standards of a robot doing a passable job of pretending to be human, but as instead being judged by the standards of a human doing a terrible job of acting like a normal person (Wikipedia, n.d.).

HYPOTHESIS
Professors Hiroshi Ishiguro, director of the Intelligent Robotics Laboratory, at the Department of Systems Innovation at Osaka University, made a robot, called a Geminoid, that was a dead copy of himself in 2005 (Guizzo, 2010). Ishiguro followed this up by two more – a female made as a copy of a young 20- something woman, the other was constructed in 2011 to look exactly like Associate Professor Henrik Scharfe of Aalborg University in Denmark (Ackerman, 2011). The Geminoids (see Photo 4) have been built to test Ishiguro's theories of "emotional affordances" in human-robot interaction, as well as to study the perception of robots between different cultures (Parke, 2011).


Photo 4. Professor Hiroshi Ishiguro (centre, standing), the uncanny Japanese model (left, standing) and Associate Professor Henrik Scharfe (right, standing) with the three Geminoids sitting in the front row.

CHALLENGING THE "CLUTTERED MIND"
Hanson et al (2012) experimented with real-looking robots against real people subjects (only the faces of the robots were visible – "heads on a stick") and a range of facial expressions were tested. Two robots were used in the test – "Eva" and "The Pirate" (see Photo 5). 65% found both robots appealing, 8% said that the humanoid robots did/a bad them and 35% said the robots looked lively – showing no sign of the reputation that defined Mori's uncanny valley. There no longer appears to be any valley.


Photo 5. Eva and "The Pirate" – testing faces.

CONCLUSIONS
In Hanson's experiments, the robots closely demonstrated that realistic robots can be seen by humans as appealing. This conclusion maintains that rendering the social human in all possible detail into the robot can help us to tackle understand social intelligence, both scientifically and artistically – and fully comply with the National Robotics Initiative.

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## 1. INTRODUCTION
Often when we think of robots, we think of the popular imagery of our youth – C-3PO& R2D2 ("Star Wars"), Robby ("Does not compute!" from "Lost in Space"), The Terminator, and Robocop. They almost always had two arms and two legs, a torso, and a metallic head (see Photo 1). Real world robots, however, have largely failed to live up to these expectations. Factory assembly arms and planetary rovers (see Photo 2), although designed for work that is either highly dangerous to humans or require a high level of technical work, are a far cry from the Asimovian androids like Sonny in Asimov's I, Robot (see Photo 3), that we had come


to hope for [7].

*Photos 1, 2 and 3 – from left to right – "Star Wars" characters R2D2 and C-3PO, a planetary rover, and Sonny the robot from Asimov's I, "Robot".*

## 2. THE NEW INITIATIVE
The purpose of the National Robotics Initiative (NRI) program is to develop the next generation of robotics, to advance the capability and usability of robots, and to encourage existing and new communities to focus on new and innovative areas for the use of robots. The initiative is to address the whole life cycle from basic research and development to manufacturing and deployment. Developers are to particularly carry out the research required to gain a better understanding of the long term social, behavioural and economic implications of robots across all areas of human activity [4].

## 3. THE PROBLEM
While roboticists have had considerable leaps forward in near-humanoid robotic development, such as Honda's ASIMO robot that employs a breath-taking array of sensors to detect and respond to external stimuli (Honda, 2013), people and robots just don't seem to mix, according to UK roboticists Dr Tony Belpaeme [cited in 7] According to Belpaeme, robots still have trouble assessing and responding to human's behaviour and humans feel uncomfortable around robots. Describing a project he has been working on in a children's ward in a hospital in Milan, Belpaeme says that although children are less discerning of the robots' structure, adults are more sensitive to their build and would only briefly see them as entertaining, then recognize them

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as machines [6] Roboticists call this problem, or phenomenon, the "uncanny valley" (See Figure 1) –

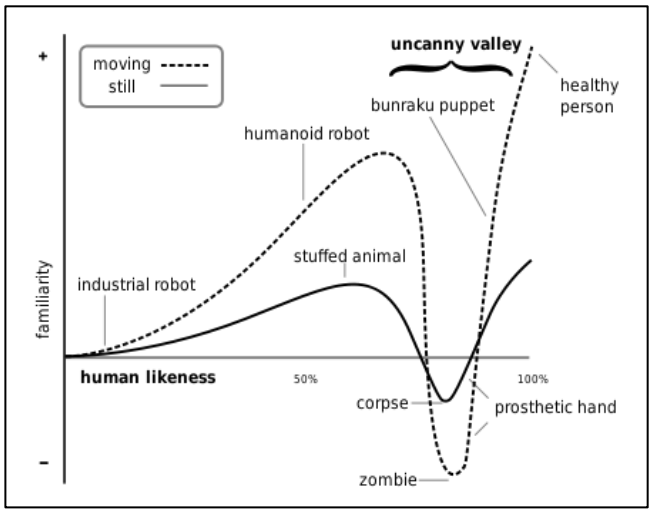


*Figure 1: The uncanny valley is the region of negative emotional response towards robots that seem "almost human". Movement amplifies the emotional response.*

the hypothesis, created by Japanese roboticist Masahiro Mori, which holds that when robotic or animated human features look and move almost, but not exactly, like natural human beings, it causes a response of revulsion among human observers. If an "entity" (robot) looks sufficiently nonhuman, its human characteristics will be noticeable, generating empathy. However, if the "entity" (robot) looks almost human, the nonhuman characteristics will be noticeable, giving the human viewer a sense of strangeness. A robot stuck inside the "uncanny valley" is no longer being judged by the standards of a robot doing a passable job at pretending to be human, but is instead being judged by the standards of a human doing a terrible job at acting like a normal person [8].

## 4. HYPER-REALISM

Professor Hiroshi Ishiguro, director of the Intelligent Robotics Laboratory, at the Department of Systems Innovation in the Graduate School of Engineering Science at Osaka University in Japan, made a robot, called a Geminoid, that was a direct copy of himself in 2005 [2] This was soon followed by two more – a

*Photo 4: Professor Hiroshi Ishiguro (centre, standing), the un-named Japanese model (left, standing) and Associate Professor Henrik Scharfe (right, standing) with the three Geminoids sitting in the front row.*

female made by Ishiguro as a copy of a young 20-something woman; the other was constructed to look exactly like Associate Professor Henrik Scharfe of Aalborg University in Denmark and built by Ishiguro along with Japanese company Kokoro in 2011 [1]. All these Geminoids (see Photo 4), as Ishiguro calls them, have been built to test his theories of "emotional affordances" in human-robot interaction, as well as to study the perception of robots between different cultures [5].

## 5. CHALLENGING THE "OLD" THINK

Hanson [3] experimented with real-looking robots against real people subjects (only the faces of the robots were visible – "heads on a stick") and a range of facial expressions were tested. Two robots were used in the test - "Eva" and "The Pirate" (see Photo 5). 73% found both robots appealing, 0% said that the humanoid robots disturbed them and 85% said the robots looked lively – showing no sign of the repulsion that defined Mori's uncanny valley – that Ishiguro is taking into account in his modern work. According to Hanson, there no longer appears to be any valley.

*Photo 5: Eva and "The Pirate" - the Hanson humanoid robots*

Hanson believes that is it important to push the science of the art as well as the art of the science. He further believes that for realistic robots to be appealing to people, robots must attain some level of social responsiveness and aesthetic refinement – and integration of artificial intelligence, robotic engineering and art.

## 6. CONCLUSIONS

In Hanson's experiments, the robots clearly demonstrated that realistic robots can be seen by humans as appealing. This conclusion maintains that rendering the social human in all possible detail into the robot can help us to better understand social intelligence, both scientifically and artistically – and fully comply with the National Robotics Initiative.

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