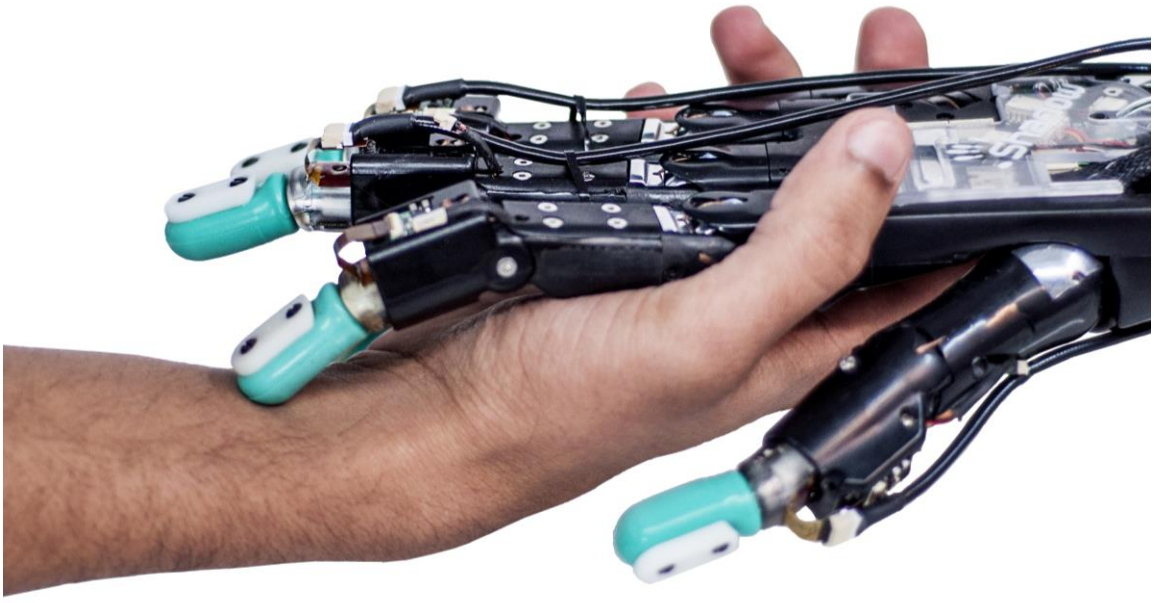

The problem with robots:
If they only had a brain.

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In the 1960s and 70s, a great wave of enthusiasm for artificial intelligence (AI) in computers based on human thought processes crashed against our sheer ignorance of those processes. Engineers mostly stopped talking about "intelligence" and opted for signal processing algorithms and relational databases that appear to perform intelligently but only within highly scripted tasks - e.g. robots. That is why moving robots from the mindless assembly line into the real world usually produces pitiful, sometimes catastrophic results. If a robot encounters an unfamiliar object or even a familiar one in the wrong orientation, it is likely to proceed extremely cautiously or to damage the object or itself by handling it inappropriately. A human worker that inept would be fired immediately.

Good design starts with a clear understanding of requirements. If robots are going to work with humans in the real world, we need to formalize the important human capabilities that we often take for granted. In particular, humans are aware of their surroundings and can draw on a lifetime of experience to help them to identify and interact with other entities.

Awareness requires sensors but also something else. It was relatively easy to replace biological ears with microphones and biological eyes with video cameras, but it has been much harder to achieve useful speech recognition or machine vision, especially to understand context and to interact in real time with a dynamically changing world. Our work on tactile exploration of

objects forced us to confront a general feature of intelligent decision-making - iterative behavior. Humans (and other animals) don't collect all the data in an unbiased way before making a decision. Instead, they start with a contextual guess and try to confirm it as quickly as possible so they can get on with their lives.

In order to obtain tactile information about an object, it must be actively explored. The signals so obtained depend at least as much on the selection of the exploratory movement as on the physical properties of the object. Thus, prior guesses about the object must inform the decision about which movement to make next, whether by a human or a robot. By contrast, human vision and machine vision have evolved very differently from each other. Human high-resolution vision covers only a tiny, central part of the retina, so we move our eyes about 3 times a second as we interpret a complex scene, using the previously obtained information to guide this exploration. A computer with a video camera can receive uniformly high resolution images as long as it happens to be pointed in the right direction. Machine touch will be fundamentally more complicated than machine vision because there is no way to cheat by processing all the sensory information at once.

Machine touch requires both biomimetic sensors and biomimetic information processing algorithms and behaviors. This is the essence of intelligence that we must distill into computer algorithms for what is now called "strong AI".

If robots and humans were both using the same sort of intelligence, both would succeed *and fail* in the same ways. Because humans are always thinking as fast as possible in real time, they are easily tricked by something that seems familiar but is subtly different – the basis of optical and other sensory illusions. Evolution guarantees that these "mistakes" usually lead to functional or at least rapidly correctable behaviors. Computers tend to be more objective but also to fail in laughable ways (for example, crushing a Styrofoam coffee cup because it looks like a ceramic mug). Until we get robots and humans to succeed and fail in similar ways, we will be easily amused by the shortcomings of robots even as we forgive our own illusions and prejudices.

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Image: Shadow® anthropomorphic robotic hand equipped with BioTac® biomimetic tactile sensors (provided courtesy of Jeremy Fishel, Director of Research, SynTouch LLC).

Links:

Machine Touch – www.SynTouchLLC.com

Bayesian Exploration - http://www.frontiersin.org/Neurorobotics/10.3389/fnbot.2012.00004/abstract