Are Robots Our Friends?
Current and Future Trends in Robotics

Case Studies Assignment 2*
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Abstract

In his "Robot" series of novels and short stories, the science fiction writer Isaac Asimov portrayed an optimistic vision of robots in society in which more or less humanoid robots served their human masters. In Asimov's stories, robots were rendered incapable of harming human beings by having the famous "Three Laws of Robotics" hard-wired into their machine intelligence. In this paper, I look at current and future trends in robotics to see to what extent (if any) Asimov's vision is being realised in the way robots are being deployed and in the roles being planned for them in society. I examine a number of areas of robotics research and development in both the civilian and military domains, and assess whether the impact of these developments is likely to be benign or threatening to human beings and to society in the near future.

1 Introduction

Over the period since he wrote "Robbie", his first short story about a robot in 1939 [1], the science fiction author Isaac Asimov constructed a largely benign vision of societies in which robots, in many cases constructed in human-like forms, were dedicated to serving human individuals and society at large. In this vision, robots were precluded from harming or acting against the interests of their human masters by the "Three Laws of Robotics", which were encoded deep within each robot's "positronic" brain [2]:

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 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.*

2 Robots in Early 21st Century Society

Asimov did not expect to see robots become a reality in his lifetime [3], but over a half a century after his first robot stories were written, the field of robotics (a term first coined by Asimov) has become a well established technology and robots are attaining an ever-growing presence in industrialised society, although often in forms very different to the android or humanoid forms imagined by Asimov. As of

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the end of 2005, there were 923,000 industrial robots in operational use worldwide, with a population density of one robot per ten workers in the motor vehicle industry [4]. The International Federation of Robotics predicts that the number of personal service robots sold between 2005 and 2008 will reach 5.6 million units [4]. Personal service robotics applications currently include domestics robots (e.g. robotic lawn mowers and vacuum cleaners) and entertainment and leisure robots.

2.1 Robots in space

As well as in the industrial and personal domains, robots are making significant contributions to many areas of scientific research, and play a particularly important role in space exploration. Since the ending of the Apollo lunar exploration program in 1974, the presence of humans in space has been confined to low earth orbit, while NASA currently operates over 60 robotic missions reaching throughout the entire solar system [5], such as the Mars Exploration Rovers [6] and the Cassini-Huygens mission to Saturn [7]. Indeed, many in the space exploration community such as Slakey [8] argue that robots can be used to explore our solar system far more safely and cheaply than sending astronauts on inter-planetary missions, and the spectacular successes of the Mars Rover and Cassini missions support this view.

2.2 The view from Redmond

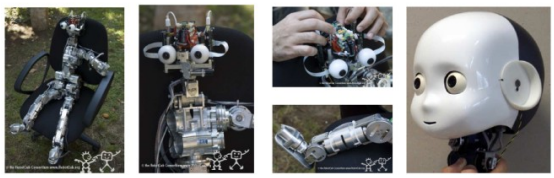
Despite the increasingly active role played by robots in society, the robotics industry is still relatively immature. Microsoft founder and CEO Bill Gates sees the robotics industry as being at the same stage of development as the computer industry was 30 years ago, with a few large companies providing specialised robots for industrial use, a growing number of start-up companies producing toys, gadgets and niche products, and a fragmented, non-standardised set of software tools and hardware platforms available for developing robotics applications [9]. Microsoft is endeavouring to produce a set of software development tools that will make it easy to write robotics applications that will run on a variety of different hardware platforms, in much the same way that computer applications written in C++ or Java can be compiled to run on a variety of different servers and personal computing devices. Gates hopes that Microsoft's robotics toolkit will emerge as a widely-used standard development platform in a manner similar to the way their BASIC language allowed software to be developed easily for different platforms in the 1970s, thus acting as a catalyst for a growth in the number and range of robotics applications available to the general public. This trend is also being followed by White Box Robotics with their PC-Bot platform, which aims to use off-the-shelf, plug-and-play PC components running on the Windows operating system to create inexpensive personal service robots [10].

Interestingly, Gates predicts that in the near future, most robots will bear little resemblance to Asimov's anthropomorphic robots, and will be so embedded into our home and work environments that we may not think of them as robots at all. However, he does see robots in a variety of useful and socially beneficial roles, including care for the elderly, extending the capabilities of industrial and medical workers, handling hazardous material and working in dangerous environments.

2.3 RobotCub

While Gates and others predict that most robots are unlikely to look much like human beings, some researchers contend that in order to be able to develop an understanding of the world that is compatible with humans, a robot must have physical characteristics that are similar to those of a human being, i.e. must be a *humanoid* robot. Sandini, Metta and Vernon espouse an "enactive" approach to cognitive

learning in robots, where the learning process is based on adaptive skill development rather than knowledge acquisition; to test and develop this approach, they have constructed a humanoid robot called the *iCub* in the size and shape of a three year-old child. [11, 12]. iCub crawls about on all fours like a human child and learns about its world and the objects in it by experimentation, manipulation and imitation; because it has the same sorts of body parts as its human teachers, it can imitate how humans manipulate objects by mapping their actions onto its own body. By acquiring manipulative skills in this way, Metta et al. hypothesise that iCub will learn about its environment more successfully and thoroughly than by using more traditional knowledge acquisition techniques, and they emphasise the necessity of having a humanoid embodiment to allow enactive learning to take place. If their theories are correct, then personal service robots in the future may well have the humanoid characteristics that Asimov imagined.



3 Military and Law Enforcement Robots

Unsurprisingly, robotics research and development in the military, security and law-enforcement domains pursues a very different set of perspectives and priorities to those embodied in programs such as the baby-faced iCub. In 2000, the United States Congress mandated that by 2015, one-third of all operational ground combat vehicles should be unmanned [13]. The United States military is investing aggressively in robotics, with programs such as the Defense Advanced Research Projects Agency's (DARPA) Future Combat Systems (FCS) program aiming

> to develop lightweight, *overwhelmingly lethal* (my italics), strategically deployable, self-sustaining and survivable combat and combat support force, systems and supporting technologies for the 2012-2025 timeframe and beyond [14].

The battlefield aim of the FCS program is described by Freeman [15] as providing "effective early entry forces", or in other words, allowing the U.S. to deploy much more potent ground forces much earlier in a military campaign through the use of robotics, thus minimising the risk of incurring massive casualties amongst U.S. troop forces.

3.1 The Grand Challenge

As part of its program to develop an unmanned ground combat capability, DARPA initiated in 2003 a series of "Grand Challenges" competitions in which self-navigating robotic vehicles raced each other across desert or urban settings over distances of up to 200 miles for a $2,000,000 cash prize [16]. The aim of the competition is to encourage robotics companies and researchers to address the challenges of mobile robotics and autonomous vehicle operation, with a view to creating a vehicle that could navigate through a battlefield with minimal supervision, transporting supplies and wounded, but perhaps also taking on an offensive role as a robotic tank [17]. After an unpromising start in 2003 (in which none of the contestants completed more than 7.5 miles of the 200 mile course), subsequent progress has been rapid and impressive; the latest "Urban Challenge" competition in 2007 saw the winning vehicle from Tartan Racing and Carnegie Mellon University successfully complete a 55 mile course through an urban setting, sharing the roads with human drivers and other robots and obeying California driving laws [18].

3.2 Robots and law enforcement

Robotic technology is also increasingly being deployed in the fields of security, law enforcement and counter-terrorism. Initially, the main robotic application in law enforcement was explosive ordnance disposal (EOD), involving remote bomb disposal by a robot operated by a human bomb disposal expert at a safe distance. However, a survey by Nguyen and Bott shows that law enforcement and security professionals envisage several other scenarios in which robots are perceived as being useful, including the inspection of hazardous areas, dealing with barricaded suspects and the reconnaissance of tunnels and storm drains [19]. As counter-terrorism and internal security remain top priorities for many Western governments and as advances in robot autonomy and communications are made, the role of robots in law enforcement and security can be expected to become increasingly diverse and important.

4 Conclusions

In many of the stories and novels he wrote about robots and robotics, Isaac Asimov imagined a future in which robots played a generally benign and helpful role in human society, and were precluded from harming human beings by the "Three Laws of Robotics". However, whilst civilian robotics applications in the present and near future largely fulfill Asimov's peaceful vision, the uses being planned for military robots may well end up being very far removed from the spirit of the "Three Laws", in particular (and most disturbingly) the First Law. The ability to aggressively project military force using robotic "infantry" without incurring the risk of a high "body-bag" count will no doubt be attractive to governments and military planners, but could have profound implications for foreign policy and global political stability. While the iCub and Grand Challenge projects both in their different ways demonstrate how much progress still needs to be made before genuinely autonomous robots come into widespread use in either the civilian or military domains, we must remain aware that, unlike in Asimov's stories, there is neither consensus nor obligation on manufacturers to incorporate rules like the "Three Laws" into modern robots, and we must take the decisions necessary to avoid robots becoming a threat to human society.

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