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HORIZON SCANNING SR007

**HSE HORIZON SCANNING INTELLIGENCE GROUP SHORT REPORT****ROBOT REALITIES****1. Issue**

Intelligent humanoid robots have long been a feature of science fiction. But how far off is the real thing? When can we expect to have robot servants able to take instructions and, more importantly, take decisions, to help us out around the house and in the workplace?

Status: Active Monitoring
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The reality is that these are still some way off. Although there have been huge advances in the development of robots that look and act more like humans, for example Honda's ASIMO<sup>1</sup> and NASA's Robonaut,<sup>2</sup> the development of the artificial intelligence (AI) necessary for the construction of a true android has some way to go. However, there are still many exciting developments in robot technology and the next ten years will see many improvements in robot design and the introduction of robots into areas of industry where they have not previously been used.

**2. Background**

In 2005 the world market for robots was small - \$6 billion a year for industrial robots, according to the International Federation of Robotics (IFR) and the United Nations Economic Commission for Europe (UNEC). It is predicted that 7 million service robots for personal use (that clean, protect or entertain) will be sold between 2005 and 2008 and 50,000 service robots for professional use will be installed over the same period.<sup>3</sup> The author of the UNEC report, Jan Karlsson, cites falling robot prices, an increase in labour costs and continuously improving technology as major driving forces for massive industry investment in robots. There are currently around 21,000 service robots in use worldwide performing tasks such as milking cows, handling toxic waste and assisting surgeons. The report predicts that by the end of 2010 robots will also assist old and handicapped people, fight fires, inspect pipes and hazardous sites.<sup>4</sup> Robots have the potential for future applications within the service industries and also in our rapidly ageing society as potential future carers.<sup>5</sup> Faced with a rapidly aging population and a declining birth rate Japan is viewing robotics as a solution to care for its ageing population (see annex).

Intelligent robots are those capable of recognising sounds and images through sensors and automatically analysing this information to determine their actions. Conventional industrial robots (e.g. used in the automotive industry) require work patterns to be input before they can be operated. Large increases in computer power and advances in sensors, control software and mechanics are allowing robots to gain many more abilities, including walking, talking and manipulation. However AI is lagging behind these developments. Oliver Brook (a robotics expert at the University of Massachusetts) says that we are only now beginning to give robots the ability to work out the right sequence of actions to accomplish a task.<sup>6</sup> AI is growing far more sophisticated, drawing on new information on how the human brain works and exponential increases in computing power. Real world AI applications include voice control systems in cars and on phone lines. In addition, business and industry rely on thousands of AI applications, for example to spot bank fraud and in the development of new drug therapies.<sup>7</sup>

**3. Relevance to Health and Safety and Possible Implications**

<sup>1</sup> <http://www.newscientist.com/article.ns?id=mg18925371.800&print=true>

<sup>2</sup> <http://www.newscientist.com/article.ns?id=mg18925372.100&print=true>

<sup>3</sup> UNCE, IFR 2005 World Robotics Survey, press release ECE/STAT/05/P03, 11 October 2005

<sup>4</sup> [http://www.usatoday.com/tech/news/robotics/2004-10-20-robot-report\\_x.htm](http://www.usatoday.com/tech/news/robotics/2004-10-20-robot-report_x.htm)

<sup>5</sup> <http://www.pinktentacle.com/2006/03/ri-man-revisited/> RI-MAN robot for lifting and carrying humans

<sup>6</sup> <http://www.newscientist.com/article.ns?id=mg18925371.800&print=true>

<sup>7</sup> <http://www.er.uqam.ca/nobel/d362040/article.pdf - search=%22machines%20are%20catching%20up>

More sophisticated pre-programmed robots have been developed that have greater dexterity and flexibility and are able to perform more complex tasks than earlier models. These robots have entered or are entering workplaces that have not previously contained robots, for example:

- the food industry in preparation/packing<sup>8</sup>
- performing surgery<sup>9</sup>
- autonomous fork-lift trucks in warehouses<sup>10</sup>
- milking<sup>11</sup>

These robots are increasingly operating in much closer proximity to workers acting as assistants,<sup>12</sup> e.g. passing a box to a worker, when previously they would have been behind gates or fences. This increases the risk of injury to the worker from the robot (although some are designed to stop when they come into physical contact with a worker). Robots under development will be able to undertake manual handling tasks, office work, industrial cleaning, construction and act as hospital assistants. Sophisticated robots are continually being developed for use in an increasing range of industries.<sup>3</sup> As robot prices continue to fall more companies will be able to afford them and robots in the workplace will be popular because they will eliminate labour costs. However many workers will not be accustomed to interacting with and operating robots, and this could lead to a number of health and safety concerns.

Increasing numbers of robots entering the workplace could present new safety risks, which robot engineers are trying to anticipate and minimise. Autonomous robots use information from a variety of sensors and use on-board intelligence to map the work environment.<sup>13</sup> Research is well developed in UK universities to give robots vision systems<sup>14</sup> and some of these have been designed to recognise a human hand<sup>15</sup>. Robot designers will be responsible for ensuring that the robot is programmed with safe-path and planning strategies for example, to avoid collisions with individuals. Other potential safety concerns could include: what happens if the robot malfunctions or runs out of power whilst carrying a heavy load, would these robots have an automatic shut off switch or do they move with a force that could cause injury, and could cleaning robots constitute a tripping hazard? How susceptible will robots be to interference with their computer systems? (Accidental/malicious or electromagnetic radiation from other sources).

Robots are becoming more 'intelligent' and hence more complex, and the more complex a device becomes, the more difficult it might be to achieve a safe design. Crucially researchers developing these robots do not always have safety as a priority, so safety may not have been adequately considered by the time the robot is available commercially. There has already been some work carried out on robot/human safety; the Japanese Government has commissioned a long-term research programme to establish safety standards for home and workplace robots, the first conference of human-robot interaction was held in the USA in March 2006 and the European Robotics Research Network (EURON) also met in March 2006 to discuss measures to help prevent robots from unnecessarily harming people. But over the next 10 years as robots contain more sophisticated self-learning mechanisms it may be impossible to predict how they might behave.<sup>16</sup>

#### 4. Recommendations

- i. The current use of robots comes under the remit of HSE and is mainly limited to industrial applications where the robot is relatively static, has limited interaction with trained operators and methods of safeguarding against the risks they present are well established. However, the current safeguarding regime would not be suited to more sophisticated robots entering existing and new work areas, operating in much closer proximity to workers.

<sup>8</sup> [http://www.kuka.com/germany/en/pressevents/productnews/NN\\_060322\\_Anuga\\_Foodtech.htm](http://www.kuka.com/germany/en/pressevents/productnews/NN_060322_Anuga_Foodtech.htm)

<sup>9</sup> <http://www.roboticonline.com/public/articles/articlesdetails.cfm?id=2588>

<sup>10</sup> [http://www.still.co.uk/3486.0.0.html?&no\\_cache=1&tt\\_news=1464&no\\_cache=1](http://www.still.co.uk/3486.0.0.html?&no_cache=1&tt_news=1464&no_cache=1)

<sup>11</sup> <http://www.processingtalk.com/news/aau/aau113.html>, [http://www.mackies.co.uk/mackies/robotic\\_milking.html](http://www.mackies.co.uk/mackies/robotic_milking.html)

<sup>12</sup> [http://www.robotics-platform.eu.com/pdf/kuka\\_slides.pdf](http://www.robotics-platform.eu.com/pdf/kuka_slides.pdf)

<sup>13</sup> <http://www.newscientisttech.com/article.ns?id=mg18925396.000&print=true>

<sup>14</sup> <http://svr-www.eng.cam.ac.uk/research/vision/related.html>

<sup>15</sup> <http://svr-www.eng.cam.ac.uk/research/vision/research/visguide.html>

<sup>16</sup> <http://www.timesonline.co.uk/printFriendly/0,,1-1507-2230721-1507,00.html>

- ii. HSE's Horizon Scanning team will continue to monitor these developments, including the likely timescales; working with HSE specialists, key stakeholders and other Government departments.

*Sam Bradbrook, Horizon Scanning Section, HS*