Europe, Japan join forces to map out future of intelligent robots

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The field of robotics could be poised for a breakthrough, leading to a new generation of intelligent machines capable of taking on multiple tasks and moving out of the factory into the home and general workplace. The great success of robots so far has been in automating repetitive tasks in process control and assembly, yielding dramatic cuts in production, but the next step towards cognition and more human-like behaviour has proved elusive.

It has been difficult to make robots that can truly learn and adapt to unexpected situations in the way humans can, while it has been equally challenging trying to develop a machine capable of moving smoothly like any animal. There is still no robot capable of walking properly without jerky slightly unbalanced movements.

But significant progress has been made over the last few years, and the stage was set for a push towards a new generation of intelligent machines at a conference bringing together young scientists in both Europe and Japan, which both have a strong history of robotics development. The event, jointly organized by the European Science Foundation (ESF) and the Japan Society for the Promotion of Science (JSPS), and held in Japan, was targeted at young researchers actively working in the fields of cognitive science and robotics.

The difficult problem of making robots capable of moving elegantly was discussed in two presentations, with Professor Florentin Worgotter from Gottingen University in Germany pointing out that Russian physiologist

Nikolai Bernstein had anticipated the difficulty of mimicking animal movements in 1930, because this required a complex combination of mechanics, neuronal feedback, and instantaneous adaptability. However Worgotter suggested that with greater understanding now of how animals coordinate their movements, the same principles could soon be transferable to robots, even if it will be some time before this problem is solved completely.

Meanwhile Dr. Shuuji Kajita from Japanese research group AIST demonstrated biped robots with new walking techniques based on the Zero-Moment Point principle, which is essentially designed to ensure that any top heavy system such as a humanoid robot can walk without losing balance or imposing too great a stress on its points of contact with the ground. Such robots move considerably better than earlier machines, with scope for further improvement.

Enabling robots to be adaptable and learn from their mistakes in their operating environment was another major focus of the ESF/JSPS conference. Professor Yasuo Kuniyoshi from the University of Tokyo admitted that traditional approaches based on artificial intelligence techniques developed over the past 25 years had not succeeded in making adaptable robots. Such techniques involve breaking down events that a robot has not been programmed to expect into smaller parts in an attempt to analyse them. The problem with this is that the robot has no context in which to decide how to act, and an alternative approach now being tried involves imposing constraints on the robot's interactions, from which more intelligent behavior can emerge.

Then Dr. Ales Ude from the Jozef Stefan Institute in Slovenia introduced the new concept of 'object-action complex' (OAC), which has recently been proposed to help robots learn actively through manipulation in an attempt to perform specific tasks. This can be combined with imitation and coaching, resembling more closely the way

people learn new tasks.

No matter what approach is adopted to teaching robots, there has to be some form of communication with humans, and so this was another major focus of the conference. Professor Aude Billard from the Swiss Federal Institute of Technology in Laussane reported recent progress developing natural means of transmitting human knowledge about tasks and skills to robots. Her work exploits various methods of human-machine interaction, in particular the ability to imitate. Up to now, giving robots the ability to imitate even simple gestures has proved sufficiently complex to occupy the research community for many years. But very recently, it has become clear that the way forward lies with enabling robots to interpret the user's intention and predict the user's actions. Billard's group has progressively added complexity to its algorithms (computerised procedures) for learning by imitation, taking inspiration from various stages of learning in children. This starts from reflexive imitation of body motions and builds up to informed and selective replication of goal-directed tasks.

The future of cognitive robotics lies in combining the techniques discussed at the ESF/JSPS conference to develop true humanoid machines capable of assisting in homes, offices, and public places. For example a humanoid butler could assist disabled people at home, while humanoid porters could carry heavy bags in airports or train stations.

Source: European Science Foundation