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ROBOTICS, INDIA AND THE FUTURE

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The Robotic Age

The world around us is constantly evolving in unprecedented ways, at an unimaginable speed. The robotic age, something we're used to reading about in science fiction is finally becoming a reality. The result? Hopefully, a robot in every house. Robots have a long history, from fictional characters (Isaac Asimov's novels and motion pictures), to industrial robots and mobile robots.

Industrial robots have taken a long stride and are well established, but newer domains and research has got most of the limelight. Roboticists are now taking the robots out of their fixed base (industrial applications) and are imparting mobility and intelligence. There are a number of mobile robots deployed in the real world.

Robotics is an exciting, multi-disciplinary area that integrates intelligent control, communications, computer vision, mechatronics, sensor fusion, design and many other aspects on a single platform. Although the vast majority of robots today are used in factories, advances in technology enable robots to automate many tasks in non-manufacturing industries such as agriculture, construction, health care and other services.

India is now emerging as a destination for the production of industrial robots. In fact, the size of the Indian robotics market is large with sales figures hovering around Rs. 3,500 crores. Most of this (around 70 per cent), is in the automotive industry. The robotics industry in India is expected to grow substantially in the years to come. Several new players are venturing into this space. The Indian manufacturing arena is poised to grow larger in the coming decades, thereby increasing the demand for robotic solutions. As far as the industry is concerned, India contributes significantly as far as research / intellectual property (IP) generation to converting LISP codes to C codes for industrial robots is concerned. A large volume of work centred around these domains is outsourced to India. Being an agrarian society, our nation has opportunities in automating agricultural related activities.

Industrial robotics is mature as a technology, and is well established. However, the mobile robotics space is expected to witness significant growth in the coming

years along with social / interactive, consumer and medical robots.

Mobile robots are utilised in industrial, military and security environments. There are several consumer robots meant for entertainment purposes, and some designed to perform certain domestic tasks such as floor cleaning. Autonomous robots with reasoning capabilities and the ability to move around freely will be in demand in the coming decades. Designing autonomous mobile robots in any meaningful degree has become possible only with the recent surge in computational, communications and sensing technologies. Teams of smart micro-robots could do regular maintenance in nuclear power plants and other hazardous environments.

Personal robots will change our lifestyle altogether by assisting us in our disabilities and nursing us in sickness. Artificial dogs or robot-pets with emotions can soothen many, especially children, and the aged and disabled.

While all this is exciting to experience, behind the scenes, there are several issues that crop up – where am I (positional information), where should I go (situation awareness and target identification), what should I do (target identification, object manipulation and reactive capabilities). These are issues that should be addressed.

When it comes to real-world operational conditions of mobile robots, the level of accuracy is also important. The most advanced species on this planet (humans) perform well out there with less precision and accuracy. Of course, it is desirable to have mobile robots that are capable of pin-point accuracy, which will depend on the application areas. Human capabilities around "tracking" and "following" are commendable, though precision and accuracy are not major concerns as we are comfortable in continuously adjusting our actions. There is a long way to go in bringing robots to the level of human-like capabilities.

Humanoids

We have built the environment that is suitable for two-legged systems. It is predicted that robots will be with us in our daily life sharing our space and resources (power, bandwidth and space). Nature has shown the way where the most successful species on this planet has two legs. And, the robots that may have to live with us in due course of time should preferably be two legged, or else, we'll have to redesign our living space to suit wheeled robots.

The most challenging issue with humanoids is balancing on two legs. Humans are capable of doing all kinds of acrobatics with two legs. We have muscles to assist us in coordinating various activities and the body is flexible. Research along material science (flexible body, muscles, actuators), nano technology (smaller and lighter sensors and actuators), computational intelligence (fuzzy logic, neural-networks, learning – genetic algorithms, evolutionary algorithms), should be assimilated into and mastered to design better systems.

GENUS

This 21 degrees of freedom humanoid robot is marketed by Robhatah Robotic Solutions, Bangalore. A single DSP-based controller board drives the servos. A camera, accelerometer and digital compass are connected to the DSP board for sensory feedback. The on-board accelerometer is used as a tilt sensor that allows the robot to detect a fall or dive and autonomously recover back into an upright standing posture. Trajectory-based gaits for the humanoid is generated in real time by reading predefined joins data and interpolate using cubic polynomial trajectory planning.

The CREO

The Mechatronics and Automation laboratory of National University of Singapore developed this humanoid robot, and supports a wide range of research in robotics, including intelligent system, image processing, kinematics and dynamics, real-time control system, wireless communication and energy efficiency in biped locomotion. CREO stands tall at 540 mm with 26 degrees of freedom.

A double knee joint configuration based on closed kinematics is utilised. The actuators can be configured with different response profiles to fully maximise motion efficiency and effectiveness. The actuators use the daisy chain network topology. The humanoid sparks an open architectural platform in which the processors can be customised. It is armed with a 1.3-MP camera and an inertia measurement unit consisting of a three-axis accelerometer and two-axis gyro.

Robots (and humans) enjoying a game of soccer

Traditionally, humanoid robots are often built with a lower centre of gravity (for better stability performance) and larger foot. CREO has a foot-body ratio closer to that of the humans and higher centre of gravity. A great deal of studies can be conducted in CREO on generating motion similar to that of a human in terms of dynamics, control and stability performance since the physical system is now closer to that of a human (ratio and weight distribution aspects).

Cooperative robotics

Cooperation / coordination among members was so much the need of the hour,

Check out the Robots in Love album in the DVD by Bertycox which explores the world from the eyes of a robot

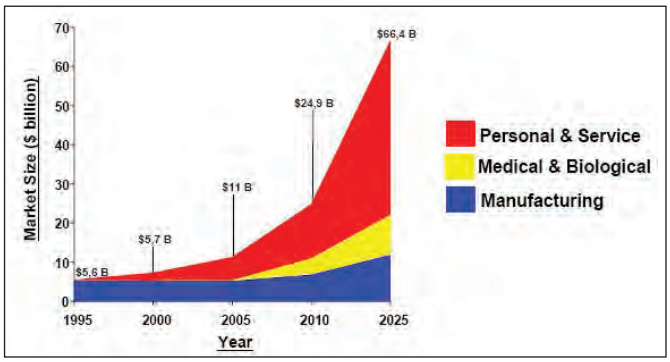
Kevin Warwick
The Cybernetics professor who calls himself the world's first cyborg, with computer chips implanted in his left arm

as they had to compete with other (hostile) communities. Present industrial systems are more complex and multiple mobile robots are increasingly preferred. Multiple mobile robots are not spatially constrained and performance benefits are manifold. Robots/agents equipped with knowledge, motivations, reasoning and planning capabilities may communicate each other and, share data and information. Cooperation protocol by distributed control, effective communication and fault tolerance while having efficiency of cooperation, adaptation and robustness are some of the research directions associated with multi-robot / agent systems.

Robot soccer

The robot soccer platform serves as a test bed to study and research on the issues pertaining to cooperative mobile robots. A robot team needs to coordinate its actions while competing with another team. The robot soccer system also has an explicit performance measure, the match score. Cooperation, decision making, planning, modelling, learning, robot architecture, vision tracking algorithm, sensing and communication are some of the directions of study. Organisations such as FIRA (www.fira.net) are promoting robot soccer as a competitive platform to push technology. In robot soccer, teams have to coordinate and compete while chasing an indivisible resource (the ball). Robot soccer, therefore, is a benchmark problem to study various issues along coordination / cooperation and competition, giving insights into problems in social / life sciences.

International robotic competitions have played an important role in pushing technologies leading to a number of technology starts ups. The FIRA Robot World Cup and Congress Bangalore 2010 (www.fira.in) is expected to act as a catalyst in these directions where the advancements in robotics will be showcased. FIRA India aims to propagate and popularise robotics and international-level robotic competitions across India. The objective of the competition is to promote the spirit of science and technology among the younger generation. It serves to bring together skilled researchers and students from different backgrounds to challenge one another in developing better robots for technologies of the future.



Due to the restricted growth in recent times, robotics, as a sector is expected to witness an exponential growth rate

Robotic soccer competitions have emerged as benchmark problems for the integration of several technologies required to build sophisticated autonomous robots. These competitions are meant to stimulate research and serve as a platform for the exchange of ideas for the researchers involved. We've set 2050 as our target to pitch a team of humanoids against humans to play the game of football. Although many of us are sceptical of this deadline, primarily because technology is yet to reach the needed threshold for this to materialise. What these deadlines do, is help us work towards its accomplishment and push ourselves.

The path ahead

We expect robots will be utilised in the 21st century for household applications. This will pave the way for advanced robotic technologies to dominate in the 21st century. Some day, personal robots will be as popular as personal computers!

There are opportunities in industrial robotics space for further development specific to Indian requirements and expansions along manufacturing. Mobile robotics is relatively new, and has higher potential growth in the coming decades, where a variety of applications right from consumer products to medical robotics are expected to usher in avenues.

Higher education in India is often neglected and as a result, there's an acute shortage of skilled man power in specialised areas, especially in the robotics and intelligent systems industry. The number of institutions imparting courses related to robotics design is limited in India. According to a recent NASSCOM study, 75 per cent of Indian engineers are not employable and IT firms reject about 90 per cent of Indian graduates. The employability of graduates is directly related to the quality of education, availability of state-of-the-art facilities and the assessment methodologies adopted. Timely reforms in the educational sector can assist India to ride the robotics wave and to position better. Japanese and Korean domestic robotic markets are able to sustain their growths from within. Governmental support and push along niche areas of research in interactive and intelligent robotic systems can help India to position itself better and to tap into the immense potential that lay ahead.

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