EasyChair Preprint

№ 12870

Robotics

Viplesh Viplesh, Manju Kaushik and Satendra Kumar

April 2, 2024

ROBOTICS

Viplesh[1] and Manju Kaushik[2] and Satendra Kumar[3]

Author Affiliations

[1]*Research Scholar, Amity University, Jaipur, Rajasthan, India*

[2]*Research Guide, Amity University, Jaipur, Rajasthan, India*

[3]*Research Co-Guide, Department of Computer Science & Engineering, MIT Moradabad (U.P), India*

Author Emails

a) *viplesh86@gmail.com*

b) *mkaushik@jpr.amity.edu*

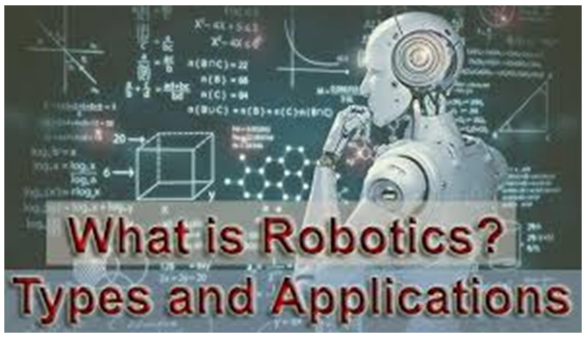
c) *satendra04cs41@gmail.com*

Table of Contents

Abstract

Over the past ten years, the robotics sector has added millions of jobs, driven mostly by the electric vehicle and consumer electronics industries. By 2020, the robotics sector is expected to reach $100 billion in revenue, matching the size of the tourist sector. For instance, the market for rehabilitation robots increased tenfold between 2010 and 2016 as a result of developments in wearable robotics, active prostheses, exoskeletons, and rehab/therapy robots. In summary, robotics will play a crucial role in many applications over the next ten years, and when combined with artificial intelligence (AI), robots will be able to execute complicated tasks and pick up knowledge from people, which will lead to the rise of intelligent automation. As a result, we attempt to illustrate in this work the direction and application domains of such a significant sector of future markets, and scientific research.

Introduction



The goal of robotics research over the past 45 years has been to address the technological requirements of applied robotics. The sophistication and development of application domains have shaped study issues in the robotics sector. The needs of humans have shaped this evolution. Industrial robots were introduced into factories during the early 1960s industrial revolution to relieve human operators of dangerous and hazardous work. More flexibility and intelligence in industrial robots were needed as a result of the subsequent integration of these machines into various kinds of production processes.
The field of robotics combines science, engineering, and technology to create devices, or robots, that mimic or replace human behavior. Robots are perfect for sectors like manufacturing because they are more accurate and efficient than humans at basic, repetitive jobs. Nonetheless, the integration of artificial intelligence with robotics has enabled robots to manage progressively intricate scenarios across multiple sectors.

What Constitutes a Robot?

A robot is an automated device that may be programmed to do a task; the term robotics refers to the field of study concerned with creating robots and automation. Every robot is autonomous to varying degrees. These tiers go from totally autonomous bots that execute tasks without the intervention of humans to human-controlled bots that execute tasks.

The word "robot" comes from the Czech word robot, which meaning "forced labour," according to etymology. The term initially arose in the 1920 drama R.U.R., referring to the characters' lack of imagination as mass-produced labourers.

Robotics Features

Mechanical Establishment
A robot's mechanical component enables it accomplish tasks in the environment it was intended for. The Mars 2020 Rover, for instance, has wheels made of titanium tubing that are independently motorized to assist it grip the rough terrain of the red planet.

Electrical Parts
Electrical parts are required by robots in order to power and operate their gear. Basically, most robots require an electric current to function—a battery, for instance.

Programmed Software
Robots are at least somewhat computer programmed. A robot would be nothing more than another piece of basic machinery without a set of instructions from a set of

codes. A robot can be made to know when and how to do a task by programming it.

What Constitutes a Robot's Major Parts?

Management Framework

All of the parts that comprise a robot's control system, sometimes known as its central processing unit, are included in computation. Similar to how the human brain transmits signals throughout the body, control systems are configured to teach a robot how to use its specialized components in order to perform a task. These robotic operations might include everything from assembly line packing to minimally invasive surgery.

Senses

Robots can interact with their environment by using sensors to send electrical impulses that act as stimuli. The controller then processes these signals to make the robot do what it does. Robots frequently have sensors such as microphones that act as ears, photo resistors that respond to light, and video cameras that serve as eyes. With the help of these sensors, the robot is able to perceive its environment, calculate the best course of action given the circumstances at hand, and communicate commands to the other parts from the controller.

Activators

A gadget can only be classified as a robot if its body or frame is moveable. The parts that are in charge of this movement called actuators. These parts consist of motors that work together to accomplish the movement required finishing the given task after receiving signals from the control system. Actuators are generally powered by compressed air (pneumatic actuators) or oil (hydraulic actuators). They can be built of several materials, including metal and elastic, and they are available in a number of configurations to better serve their specific purposes.

Energy Source

Robots require power to function, much as the human body needs nourishment. Robots that are stationary, like those seen in factories, can sometimes be powered by an internal battery, but they also sometimes run on AC power from a wall outlet. Because lead-acid batteries are safe and have a long shelf life, most robots use them; others, however, may use the more compact, but more expensive, silver-cadmium type. When constructing the power supply for a robot, safety, weight, replace ability, and lifespan are all crucial variables to take into account.

Future robotic advancement may also make use of nuclear power, flywheel energy storage, solar power, hydraulic power, compressed gas power, flywheel energy storage, and organic waste digested an aerobically.

End Effectors/Final Effectors

Final Effectors
The actual, usually external parts that enable robots to complete their tasks are called end effectors. Industrial robots frequently use interchangeable tools, such as drills and paint sprayers; surgical robots may be outfitted with scalpels; and other types of robots may be designed with hands or gripping claws to do a variety of jobs, including packaging, bomb dispersal, delivery, and much more.

Robots Functions

Certain robots are built with preprogrammed functions; these robots work in a controlled environment,

performing repetitive, uncomplicated jobs, similar to a mechanical arm on an assembly line for cars.

Some robots are autonomous; they do tasks in open spaces without the assistance of human operators. They employ sensors to sense their surroundings in order to function, and then they use decision-making structures—typically computers—to determine the best course of action based on their mission and data.

Wireless networks can also be used by robots to allow remote human control from a safe distance. These teleported robots typically operate in harsh environmental conditions, including weather and geography. Teleported robots include drones that are used to find landmines on a battlefield and human-controlled submarines that were employed to repair undersea pipe breaches during the BP oil disaster.

Types of Robotics

Human-like Robots

Robots that replicate or appear like humans are known as humanoid robots. These robots typically carry out actions that humans would do, such as running, jumping, and carrying goods. Occasionally, they are even made to resemble humans, down to having human faces and expressions. The Sophia robot from Hanson Robotics and Atlas from Boston Dynamics are two of the most well-known examples of humanoid robots.

Cabots

Collaborative robots, or cobots, are machines made to operate with people. These robots put safety first by slowing down their motions, stopping when they encounter obstacles, and utilizing sensors to stay aware of their surroundings. Usually, cobots carry out easy jobs, freeing up humans to handle more difficult duties.

Workplace Robots

Processes in production settings, such as factories and warehouses, are automated by industrial robots. These robots, which have at least one robotic arm, are designed to move quickly and precisely while lifting large objects. Industrial robots are therefore frequently used in assembly lines to increase output.

Robots for Medicine

Medical robots promote human physical and mental health and help healthcare workers in a variety of settings. These robots can move precisely, explore medical facilities, and communicate with people thanks to AI and sensors. Certain medical robots can even hold conversations with individuals, promoting social and emotional development in people.

Robots for Agriculture

By handling labor-intensive and repetitive chores, agricultural robots help farmers make better use of their time and energy. These robots are also used in greenhouses, where they assist with harvesting and keep an eye on crops. There are many different types of agricultural robots, from self-governing tractors to drones that gather data for farmers to evaluate.

Small-scale robotics

The study and creation of tiny robots is known as micro robotics. Micro robots are typically no larger than a millimeter, though their size might vary depending on

the circumstance. Micro robotics is often used by biotech researchers to track and treat illnesses in an effort to develop more specialized treatments and better diagnostic instruments.

Enhancing Robots

Virtual reality (VR) robots, also referred to as augmentation robots, can either replace or augment human abilities that may have been lost. Science fiction could soon become reality in the realm of robotics for human enhancement, as machines with the capacity to increase human strength and speed could completely redefine what it means to be human.
Robotic exoskeletons that are used to lift large weights and prosthetic limbs are two instances of modern augmenting robots.

Software Bots:
Also known as "bots," software bots are computer programmers that operate on their own. In a technical sense, they are not robots. A chat bot, a computer programmed that mimics online and phone conversations, is one typical use for software robots and is frequently utilized in customer service settings. Chat bots can be more sophisticated digital assistants that learn from user data, or they might be simpler services that respond to queries automatically.

Robotics Applications

Robotics was initially a huge help to businesses and is now a standard technology for an increasing range of industries.

Manufacturing

Industrial robots are capable of welding, sorting, painting, and assembling goods. In a factory or warehouse, they might even be utilized to repair and maintain other machinery.

Healthcare

Medical robots carry out surgery, deliver medical supplies, and provide psychological support to patients undergoing rehabilitation.

Companionship

Social robots can help individuals with dementia and serve as a therapeutic aid for kids with learning impairments. They can also be used for business purposes, such as carrying goods around warehouses and offering direct customer service in hotels.

It's possible that customers are most familiar with Roomba and other robot vacuums. Other home robots, on the other hand, include lawn-mowing robots and personal robot assistants that may assist with household duties, play music, and interact with children.

Pros and Cons of Robotics

Robotics comes with a number of benefits and drawbacks.

Pros of Robotics

- **Increased accuracy.** Robots can perform movements and actions with greater precision and accuracy than humans.
- **Enhanced productivity.** Robots can work at a faster pace than humans and don’t get tired, leading to more consistent and higher-volume production.
- **Improved safety.** Robots can take on tasks and operate in environments unsafe for humans, protecting workers from injuries.
- **Rapid innovation.** Many robots are equipped with sensors and cameras that collect data, so teams can quickly refine processes.

- **Greater cost-efficiency.** Gains in productivity may make robots a more cost-efficient option for businesses compared to hiring more human workers.

Cons of Robotics

- **Job losses.** Robotic process automation may put human employees out of work, especially those who don't have the skills to adapt to a changing workplace.
- **Limited creativity.** Robots may not react well to unexpected situations since they don't have the same problem-solving skills as humans.
- **Data security risks.** Robots can be hit with cyber-attacks, potentially exposing large amounts of data if they're connected to the Internet of Things.
- **Maintenance costs.** Robots can be expensive to repair and maintain, and faulty equipment can lead to disruptions in production and revenue losses.
- **Environmental waste.** Extracting raw materials to build robots and having to discard disposable parts can lead to more environmental waste and pollution.

FUTURE OF ROBOTICS

Robotics' Future

The future of robotics is significantly impacted by the development of AI. AI and robots can be used in factories to create digital twins and design simulations that will help businesses optimize their workflows. Additionally, advanced AI increases the autonomy of robots. Drones, for instance, might deliver packages to clients without the need for human assistance. Furthermore, Chat GPT and other generative AI tools could be installed on robots, enabling more sophisticated human-robot dialogues. Robots' appearances have changed along with their level of intelligence. Humanoid robots are made to look good and interact with people in a variety of contexts. They can also carry goods, navigate places, and sense and react to emotions.

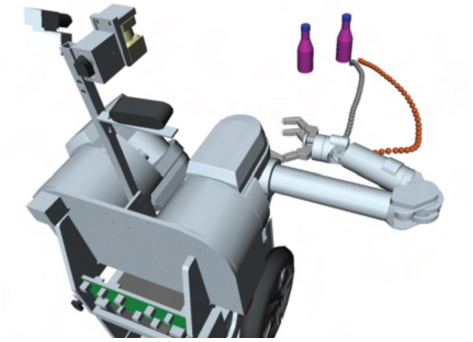
With these shapes and capabilities, robots have the potential to significantly impact a variety of industries, including manufacturing, shipping, healthcare, and customer service.

Although worries about job losses from automation have increased as robotics has become more widespread, robots could only alter the nature of human work. It's possible that humans will work in tandem with robots, delegating repetitive duties to the robots while they concentrate on more complex issues. Either way, as robotics advances alongside other technologies like artificial intelligence and deep learning, humans will have to adjust to their existence.

Conclusion

Robotics research and applications have literally taken off in the last 20 years. It has permeated practically every market now in existence as well as people's imaginations, to the point where we can observe robotics news every day on the one hand and robotics poised to take a market share of $100 billion on the other. We attempted to compile and analyze the most lucrative and promising branches in this paper, along with suggestions for where to search for uncharted territory. In this environment, automation in the industries seems to be leading the way, but a number of applications are beginning to develop or are already solidifying and will likely play a significant part in robotics research and manufacturing. They include, but are not limited to, entertainment, healthcare, surgery, housekeeping, and autonomous cars. We also highlighted certain fields—like humanoids—seem to be losing favor with consumers and researchers and which are gaining traction, such alternatively powered robotics. We think that our analysis can offer a more comprehensive

perspective on the field of robotics and how to approach it going forward.



References

[1] J.J. Craig, *Introduction to Robotics*. Reading, MA: Addison-Wesley, 2nd ed., 1989.

[2] L. Zhenyu, C. Yinglin, and Q. Daokui, "Research on robot calibration," *Robot*, vol. 24, no. 5, pp. 447–450, 2002.

[3] S. Lei, L. Jingtai, S. Weiwei, W. Shuihua, and H. Xingbo, "Geometrybased robot calibration method," in *Proc. IEEE Int. Conf. Robotics and Automation*, pp. 1907–1912, 2004.

[4] O. Khatib, "Real-time obstacle avoidance for manipulators and mobile robots," *Int. J. Robot. Res.*, vol. 5, no. 1, pp. 90–98, 1986.

[5] J.F. Canny, *The Complexity of Robot Motion Planning*, Cambridge, MA: MIT Press, 1988.

[6] J.T. Schwartz and M. Sharir, "On the 'piano movers' problem: 1. The case of two-dimensional rigid polygonal body moving amidst polygonal barriers," *Commun. Pure Appl. Math.*, vol. 36, pp. 345–398, 1983.

[7] J. Bobrow, S. Dubowsky, and J. Gibson, "Time-optimal control of robotic manipulators along specified paths," *Int. J. Robot. Rese.*, vol. 4, no. 3, pp. 3–17, 1985.

[8] J.J.E. Slotine and W. Li, *Applied Nonlinear Control*. Upper Sadlle Rikver, NJ: Prentice-Hall, 1991.

[9] K.J. Aström and K.B. Wittenmark, *Adaptive Control*. Reading, MA: Addison-Wesley, 1989.

[10] B. Siciliano and L. Villani, *Robot Force Control*. Norwelll, MA: Kluwer, 1999.

[11] P.C. Watson, "Remote center compliance system," U.S. Patent No. 4098001, Jul. 1978.

[12] S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach* 2nd ed. Uppper Saddle River, NJ: Prentice Hall, 2003.

[13] R.S. Michalski, J.C. Carbonell, and T.M. Mitchell, *Machine Learning*, Palo Alto, CA: Tioga, 1983.

[14] S.G. Tzafestas, "Fuzzy systems and fuzzy expert control: An overview," *Knowledge Eng. Rev.*, vol. 9, no. 3, pp. 229–268, 1994.

[15] G. Niemeyer and J.J.E. Slotine, "Telemanipulation with time delays," *Int. J. Robot. Res.*, vol. 23, no. 9, pp. 873–890, 2004.

[16] B. Davies, *A Discussion of Safety Issues for Medical Robots*, In R. Taylor, S. Lavallee, G. Burdea, and R. Moesges, Eds. *Computer-Integrated Surgery*. Cambridge, MA: MIT Press, pp. 287–296, 1996.

[17] M. Blackwell, C. Nikou, A. DiGioia, and T. Kanade, "An image overlay system for medical data visualization," *Med. Image Anal.*, vol. 4, pp. 67–72, 2000.

[18] R. Kumar, P. Berkelman, Gupta, A. Barnes, P.S. Jensen, L.L. Whitcomb, and R.H. Taylor, "Preliminary experiments in cooperative human/robot force control for robot assisted microsurgical manipulation," in *Proc. IEEE Int. Conf. Robotics Automation*, pp. 610–617, 2000, San Francisco, CA.

[19] G.H. Ballantyne and F. Moll, "The da vinci telerobotic surgical system: The virtual operative field and telepresence surgery," *Surg. Clin. North Amer.*, vol. 86, no. 6, pp. 1293–1304, 2003.

[20] J. Marescaux and F. Rubino, "The zeus robotic system: Experimental and clinical applications," *Surg. Clin. North Amer.*, vol. 86, no. 6, pp. 1305–1315, 2003.

[21] Y. Kim and A.M. Cook, *Manipulation and Mobility Aids*, In J.G.Webster et al, Eds. *Electronic Devices for Rehabilitation*. London, U.K.: Chapman and Hall, 1985.

[22] H.I. Krebs, B.T. Volpe, M.L. Aisen, and N. Hogan, "Increasing productivity and quality of care: Robot-aided neuro-rehabilitation," *J. Rehab. Res. Devel.*, vol. 37, no. 6, pp. 639–652, 2000.

[23] K. Kiguchi and T. Fukuda, "A 3DOF exoskeleton for upper-limb motion assist—Consideration of the effect of bi-articular muscles," in *Proc. IEEE Int. Conf. Robotics Automation*, New Orleans, LA, pp. 2424–2429, 2004.

[24] L.J. Leifer, "Rehabilitative robotics, the stanford robotic aid," in *Proc. WESCON*, San Francisco, CA, 1981, pp. 4–15.

[25] G. Bolmsjö, H. Neveryd, and H. Eftring, "Robotics in rehabilitation," *IEEE Trans. Rehab. Eng.*, vol. 3, no. 1 pp. 77–83, Jan. 1995.

[26] J. Leonard and H. Durrant-White, *Directed Sonar Sensing for Mobile Robot Navigation*. Norwell, MA: Kluwer, 1992.

[27] R. Simmons and S. Koenig, "Probabilistic robot navigation in partially observable environments," in *Proc. Int. Joint Conf. Artificial Intelligence*, pp. 1080–1087, 1995.

[28] W. Burgard, D. Fox, D. Hennig, and T. Schmidt, "Estimating the
absolute position of a mobile robot using position probability grids," in
Proc. AAAI National Conf. Artificial Intelligence, pp. 896–901, 1996.
[29] S. Thrun, D. Fox, F. Dellaert, and W. Burgard, "Particle filters for
mobile robot localization," A. Doucet, N. de Freitas and N. Gordon,
eds. in *Sequential Monte Carlo Methods in Practice*. New York: Springer-
Verlag, New York, 2001.
[30] A. Elfes, "Sonar-based real-world mapping and navigation," *IEEE J.
Robot. Automation*, vol. 3, no. 2 pp. 249–265, Mar. 1987.
[31] M.J. Matarié, "A distributed model for mobile robot environmentlearning
and navigation," M.S. thesis, Mass. Inst. Technol., Cambridge,
MA, Jan. 1990, MIT AI Lab. Tech. Rep. AITR-1228, May 1990.
[32] H.P. Moravec, "Sensor fusion in certainty grids for mobile robots," *AI
Mag.*, vol. 9, no. 2, pp. 61–74, 1988.
[33] R. Chatila and J.-P. Laumond, "Position referencing and consistent
world modeling for mobile robots," in *Proc. IEEE Int. Conf. Robotics and
Automation*, 1985, pp. 138–145.
[34] J. Leonard, H.F. Durrant-White, and I.J. Cox, "Dynamic map building
for an autonomous mobile robot," *Int. J. Robot. Res.*, vol. 11, no. 4, pp.
89–96, 1992.
[35] J.A. Castellanos and J.D. Tardós, *Mobile Robot Localization and Map
Building: A Multisensor Fusion Approach*, Norwell, MA: Kluwer, 2000.
[36] J.E. Guivant and E. Nebot, "Optimization of the simultaneous localization
and map-building algorithm for real-time implementation,"
IEEE Trans. Robot. Automat., vol. 17, no. 3, pp. 242–257, May 2001.
[37] M. Montemerlo, S. Thrun, D. Koller, and B. Wegbreit, "FastSLAM: A
factored solution to the simultaneous localization and mapping problem,"
in *Proc. AAAI National Conf. Artificial Intelligence*, Edmonton, Canada,
2002, AAAI, pp. 593–598.
[38] F. Lu and E. Milios, "Globally consistent range scan alignment for
environment mapping," *Auton. Robots*, vol. 4, pp. 333–349, 1997.
[39] Y. Liu and S. Thrun, "Results for outdoor-slam using sparse extended
information filters," in *Proc. IEEE Int. Conf. Robotics Automation*, 2003,
pp. 1227–1233.
[40] F. Dellaert, S.M. Seitz, C. Thorpe, and S. Thrun, "EM, MCMC, and
chain flipping for structure from motion with unknown
correspondence," *Mach. Learn.*, vol. 50, no. 1–2, pp. 45–71, 2003.
[41] R. Biswas, B. Limketkai, S. Sanner and S. Thrun, "Towards object
mapping in non-stationary environments with mobile robots," in *Proc.
Int. Conf. Intelligent Robots Systems*, pp. 1014–1019, 2002.
[42] D. Wolf and G.S. Sukhatme, "Online simultaneous localization and
mapping in dynamic environments," in *Proc. IEEE Int. Conf. Robotics
Automation*, 2004, pp. 1301–1306.
[43] S. Thrun, "Robotic mapping: A survey," Tech. Rep. CMU-CS-02-111,
School Comp. Sci., Carnegie Mellon Univ., Pittsburgh, PA 15213, Feb.
2002.
[44] S. Thrun, M. Bennewitz, W. Burgard, A.B. Cremers, F. Dellaert, D.
Fox, D. Haehnel, C. Rosenberg, N. Roy, J. Schulte, and D. Schulz,
"MINERVA: A second generation mobile tour-guide robot," in *Proc.
IEEE Int. Conf. Robotics Automation*, 1999, pp. 1999–2005.
[45] J. Yuh, "Design and control of autonomous underwater robots: A survey,"
Auton. Robots, vol. 8, pp. 7–24, 2000.
[46] D.A. Read, F.S. Hover, and M.S. Triantafyllou, "Forces on oscillating
foils for propulsion and maneuvering," *J. Fluids Structures*, vol. 17, pp.
163–183, 2003.
[47] J. Ayers, "Underwater walking," *Arthropod Struct. Devel.*, vol. 33, no. 3,
pp. 347–360, 2004.
[48] G. Georgidas, A. German, A. Hogue, H. Liu, C. Prahacs, A. Ripsman,
R. Sim, L.A. Torres, P. Zhang, M. Buehler, G. Dudek, M. Jenkin, and
E. Milios, "Aqua: An aquatic walking robot," in *Proc. IEEE/RSJ Int.
Conf. Intelligent Robots Systems*, 2004, Sendai, Japan, pp. 1731–1737.
[49] R.B. McGhee and A.A. Frank, "On the stability properties of
quadruped creeping gaits," *Math. Biosci.*, vol. 3, pp. 331–351, 1968.
[50] P. Gonzalez de Santos, E. Garcia, and J. Estremera, *Quadrupedal Locomotion:
An Introduction to the Control of Four-Legged Robots*, London,
U.K.: Springer-Verlag, 2006.
[51] S.M. Song and K.J. Waldron, *Machines that walk: The adaptive suspension
vehicle*. Cambridge, MA: MIT Press, 1989.
[52] T.A. McMahon, "The role of compliance in mammalian running
gaits," *J. Experim. Biol.*, vol. 115, pp. 263–282, 1985.
[53] M.H. Raibert, *Legged Robots That Balance*. Cambridge, MA: MIT
Press, 1986.
[54] K. Yoneda, H. Iiyama, and S. Hirose, "Intermitent trot gait of a
quadruped walking machine dynamic stability control of an omnidirectional
walk," in *Proc. IEEE Int. Conf. Robotics Automation*, 1996, pp.
3002–3007, Atlanta, GA.
[55] H. Kimura and Y. Fukuoka, "Biologically inspired adaptive dynamic
walking in outdoor environment using a self-contained quadruped robot:

'tekken2'," in *Proc. IEEE/RSJ Int. Conf. Intelligent Robots Systems*, 2004.
[56] S. Hirose and K. Kato, "Quadruped walking robot to perform mine
detection and removal task," in *Proc. Int. Conf. Climbing Walking Robots*,
1998, pp. 261–266, Brussels, Belgium.
[57] K. Nonami, Q.J. Huang, D. Komizo, N. Shimoi, and H. Uchida,
"Humanitarian mine detection six-legged walking robot," in *Proc. Int.
Conf. Climbing Walking Robots*, 2000, pp. 861–868, Madrid, Spain.
[58] P. Gonzalez de Santos, E. Garcia, J. Estremera, and M.A. Armada,
"DYLEMA: Using walking robots for landmine detection and location,"
Int. J. Syst. Sci., vol. 36, no. 9, pp. 545–558, 2005.
[59] P. Gonzalez de Santos, M.A. Armada, and M.A. Jimenez, "Ship building
with ROWER," *IEEE Robot. Automat.Mag.*, vol. 7, no. 4, pp. 35–43, Dec. 2000.
[60] R. Molfino, M. Armada, F. Cepolina, and M. Zoppi, "Roboclimber
the 3 ton spider," *Ind. Robot: Int. J.*, vol. 32, no. 2, pp. 163–170, 2005.
[61] Q. Huang, K. Yokoi, S. Kajit, K. Kaneko, H. Arai, N. Koyachi, and K.
Tanie, "Planning walking patterns for a biped robot," *IEEE Trans. Robot.
Automat.*, vol. 17, no. 3, pp. 280–289, May 2001.
[62] C. Azevedo, P. Poignet, and B. Espiau, "Moving horizon control for
biped robots without reference trajectory," in *Proc. IEEE Int. Conf.
Robotics Automation*, 2002, pp. 2762–2767.
[63] L. Roussel, C. Canudas de Wit, and A. Goswami, "Generation of
energy optimal complete gait cycles for biped robots," in *Proc. IEEE Int.
Conf. Robotics Automation*, 1998, pp. 2036–2041.
[64] M. Vukobratovic, A.A. Frank, and D. Juricic, "On the stability of
biped locomotion," *IEEE Trans. Biomed. Eng.*, vol. BME-17, no. 1, pp.
25–36, Jan. 1970.
[65] J.H. Park, "Impedance control for biped robot locomotion," *IEEE
Trans. Robot. Automat.*, vol. 17, no. 6, pp. 870–882, Nov. 2001.
[66] I. de la Guia, P. Staroverov, M. Arbulu, and C. *Balaguer*, "Fast algorithm
for kinematics problems solving of the low-cost legged robot
LEROI," in *Proc. Int. Conf. Climbing Walking Robots*, 2002, pp. 775–782.
[67] T. Takahashi and A. Kawamura, "Posture control for biped robot walk
with foot toe and sole," in *Proc. IECON '01*, 2001, pp. 329–334.
[68] Q. Huang, Y. Nakamura, and T. Inamura, "Humanoids walk with
feedforward dynamic pattern and feedback sensory reflection," in *Proc.
IEEE Int. Conf. Robotics Automation*, 2001, pp. 4220–4225.
[69] P. Sardain and G. Bessonnet, "Forces acting on a biped robot. center of
pressureózero moment point," *IEEE Trans. Syst., Man, Cybern. A, Syst. Humans*, vol. 34, no. 5, pp. 630–637, Oct. 2004.
[70] K. Hirai, M. Hirose, Y. Haikawa, and T. Takenaka, "The development
of Honda humanoid robot," in *Proc. IEEE Int. Conf. Robotics
Automation*, May 1998, pp. 1321–1326, Leuven, Belgium.
[71] D.G. Caldwell, N. Tsagarakis, P. Artrit, J. Canderle, S. Davis, and G.A.
Medrano-Cerda, "Biomimetic and smart technology principles of
humanoid design," in *Proc. IEEE/ASME Int. Conf. Advanced Intelligent
Mechatronics*, 2001, pp. 965–970.
[72] R. Caballero, T. Akinfiev, C. Manzano, H. Montes, and M. Armada,
"Design of the SMART actuated ROBICAM biped robot," in *Proc. Int.
Conf. Climbing Walking Robots*, 2002, pp. 409–416.
[73] M. Gienger, K. Loffler, and F. Pfeiffer, "Towards the design of a biped
jogging robot," in *Proc. IEEE Int. Conf. Robotics Automation*, 2001, pp.
4140–4145.
[74] K. Nakadai and H. Tsujino, "Towards new human-humanoid communication:
Listening during speaking by using ultrasonic directional
speaker," in *Proc. IEEE Int. Conf. Robotics Automation*, 2005, pp.
1495–1500.
[75] P. Nilas, P. Rani, and N. Sarkar, "An innovative high-level humanrobot
interaction for disabled persons," in *Proc. IEEE Int. Conf. Robotics
Automation*, 2004, pp. 2309–2314.
[76] Y. Chen and W.S. Newman, "A human-robot interface based on electrooculography,"
in *Proc. IEEE Int. Conf. Robotics Automation*, 2004, pp.
243–248.