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Service Robots

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Robotic Roadmaps: **Korea** and **Taiwan**

Selected Robot Awards: RoboCoaster : Passenger carrying industrial robots and ARMin: Robot-Assisted Neurorehabilitation of the Arm

Selected research labs in service robotics: CEA, LIST, France

Standardisation and Safety in Service Robotic by Theo Jacobs, Fraunhofer-Institute for Manufacturing Engineering and Automation (IPA), Stuttgart

Public perceptions of robots by Bjoern Juretzki, European Commission

Robotics and Ethical, Legal and Social Challenges by Pericle Salvini and Cecilia Lasci , The BioRobotics Institute, Scuola Superiore Sant'Anna, Pisa, Italy

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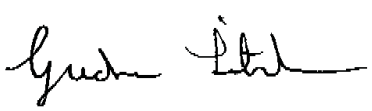

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4.1 R&D Strategy for Korean Intelligent Robots

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The following roadmap has been extracted from the planning report “Strategy for Industrial Convergence Original R&D”, Working Group on Intelligent Robotics, Korea Evaluation Institute of Industrial Technology, Aug. 2011.

4.1.1 Concept and Characteristics

4.1.1.1 Concept

- Refers to robots with autonomous mobility and manipulation through perception of external environments and cognition of situation on its own.
- Developed into robotization concept generating intelligent service through convergence of various areas such as education, medical, silver (=elderly care), defense, construction and ocean with robot technology.
- Scope of intelligent robot industry:
  - **(Narrow Sense)** Industry including manufacturing, distribution of robots and related parts and materials, robot software and service contents
    - Personal service robots, professional service robots, robots for manufacturing industry (IFR).
  - **(Broad Sense)** Includes industries deriving into robotization in other areas through convergence of robot technologies.
    - New industries such as Unmanned Ground Vehicles, Unmanned Aerial Vehicles, IT/BT/NT manufacturing equipment and robotization of other industries such as welfare, education, culture, and art through expansion of robot-based services.

4.1.1.2 Characteristics

- Intelligent robot is a representative end user product of the 21st century since automobiles and PC.
  - Robots are in the process of evolution from an alternative means of simple labor to service realization, e.g. coexisting with humans. Development from industrial society to knowledge-based society, and forecast to grow into an economic scale of several hundred billion dollars as a single item in a near future by professional futurists and innovative entrepreneurs.
- Robots are the best solution responding to megatrends.
  - The demand for robots are on the rise mainly in response to the increase in income levels, the arrival of an aging society, pursuit of well-being, etc. Today’s robot technologies provide a range of new services reflecting trends of intelligence, sensitivity, personalization, and mobile conversion.
- Growth potential of robot industry for Korea is at its optimum level worldwide.

  - Key industries with a high utilization for robots, advanced IT infrastructure, standardized living environment, a nationally high acceptance rate for advanced technologies, etc. qualify us as the best candidate for the expansion of our robot industry. As the establishment of the global market for intelligent robots is still at its early stages, securing a leading position will only be possible if our domestic growth potential is inherently solid.

- The original technology for the intelligence-based robot will provide a foundation for transforming the entire industry since IT.
  - Manufacturing robots that led productivity innovation already are a “killer application” of the industry, and capable of generating high added values through providing diverse services replacing humans by convergence with such industries as education, medical care, construction, defense, disaster prevention, etc. other than manufacturing industry in the future.
- Multi value chain type of industry capable of generating diverse related businesses
  - A representative industry where formation of multi-structured industry value chain enabling generation of diverse related businesses such as design, production, distribution of completed products as well as parts, robot application software, production and operation of service/contents is possible, requiring consilience approaches.

4.1.1.3 Technology Classification System

Intermediate Division	Subdivision	Essential Technology
Mechanism	Manipulation	• Redundancy/precise manipulation/direct teaching/collision avoidance technology • Flexible grasping technology, superfine object manipulation technology • Facial muscle adjustment technology, eyeball motion technology • Precise position manipulation technology, surface condition transmission technology
	Work	• Handling, welding, assembly, painting technology • Building cleaning, human rescue, military support technology • Cleaning, living support, education/recreation/information support technology • Intrusion detection and alarm, locomotion/manipulation fusion technology
	Mobile mechanism	• Omnidirectional wheel mechanism, staircase overcoming mechanism, caterpillar optimal design, transmission design • Biped/multiped apparatus design, biped walking motion control technology • Flight control mechanism, micro aerial vehicle design • Fine motion technology, screw movement technology • Wall adsorption movement, movement mechanism technology in live organs

Intelligence	Decision	• Reinforcement learning, deductive learning, evolution learning technology • Recognition, sensing/perception, sociality/emotion technology • Problem solving, conversation and communication technology
	Recognition	• Face detection, face recognition, Action/situation understanding and 2D object recognition, 3D object recognition, Environment recognition technology • Speaker recognition, voice recognition, sound source detection and tracking, place recognition, place situation recognition, tactile sensing technology • Map building, artificial/natural sign base recognition, sensor (USN) based recognition technology
	Action	• Facial expression display, gesture motion display technology • Obstacle avoidance, target tracking technology • Agent technology
Parts	Sensor	• Stereo camera sensor, low illumination intensity camera sensor, omni-directional camera sensor, etc. • Microphone/artificial ear sensor, multi-axial force/torque-sensor, pressure sensor, texture sensor technology • Multi-axial gyro sensor, acceleration sensor, velocity sensor, ultrasonic sensor, 3D laser scanner, encoder, temperature sensor, smell sensor, moisture sensor, taste sensor, magnetic sensor technology
	Material	• Plastic, metal, artificial skin related technology • Marker, infrared reflection plate • Heat resistant, durable, chemical resistant technology
	Actuation parts	• Motor, reduction gear, driver, converter related technology • Amp sensor, charging apparatus technology • Fuel cells, lead battery, lithium-series battery technology
	SoC (System on Chip)	• CAN communication, power cable communication, mobile communication technology • Hearing processing, run processing, image processing, multi-axial control technology
System	Platform	• Embedded system design technology, control board design technology • Input/output apparatus per design technology, SoC design technology • Robot software component technology, real-time support software technology • Environment and robot modeller, robot software development tool technology
	Network	• Large-capacity data real-time transmission, multiple agent networking and real-time control technology • Sensor network, industrial fieldbus, technology related to interactive real-time contents service
	System Engineering	• Simulation, modular design technology • Performance evaluation technology, control performance prediction and standardization technique • Human-friendly appearance design, biomimetic apparatus design technology

4.1.2 Vision and Strategy

< Vision >

Korea among 3 greatest robot powers by 2013
The robot leading nation by 2018

< Goals >

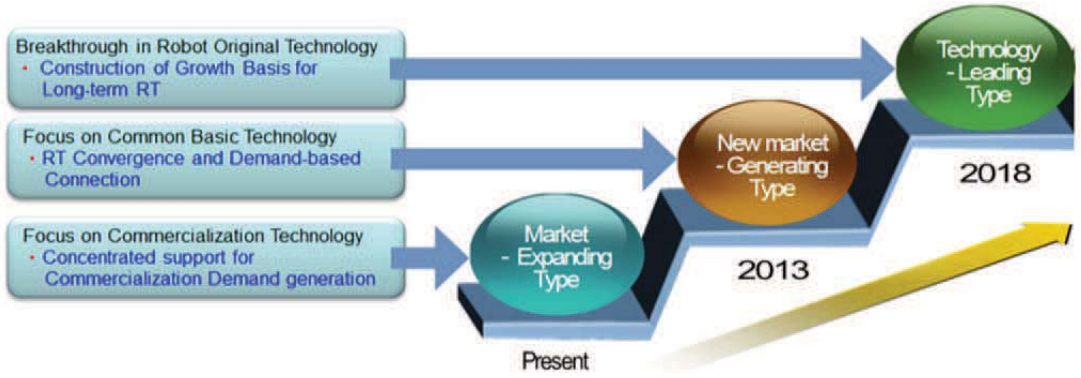
- Achievement of robot world market share of 17% and export of US$ 3.2 billion by 2016.
- Achievement of domestic production of ₩10 Trillion and fostering of 380 robot specialized firms by 2016.
- Fostering of 5 strategic product groups, securing of 4 original technologies and robot platform technologies.

<Implementation Strategy>

Construct growth basis by reinforcement of support for robot original technologies	Support future promising areas and international joint R&D for securing technology competitiveness	Articulate outcome-oriented R&D goals, implement project planning according to upward adjustments
• Construct a growth basis by reinforcing support for original/common technologies - Reinforce support for robot original/common technologies essential for industrialization of robots such as a breakthrough technology of Human robot interaction[HRI], locomotion, operation and platform technologies • Reinforce support for robot parts development - Reinforce a basic stamina through support for development of parts such as robot controllers critical for robot commercialization	• Construct a basis for technology preoccupancy by reinforcement of planning for future promising new industry areas - Reinforce planning for cloud robots, medical robots with expectations for drastic growth in the market • Globalize R&D - Explore and support international joint R&D projects for technologies impossible to secure with domestic competence alone	• Articulate clear R&D goals and implement project planning according to upward adjustments - Specify project goals in challenging, concrete numbers for derivation of results on a global level • Contribute to market expansion with support for outcome-oriented, demand-based commercialization - Derive growth engine projects with focus on areas with high industrial spread effects and a high possibility of market generation

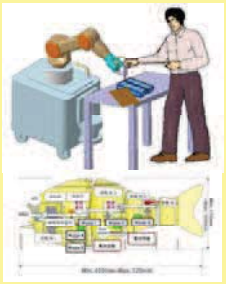
<Industry Fostering Strategy>

Select 3 Product Groups as per market formation period and concentrate on tailored promotion policies"



- Market-expanding type: Support with focus on commercialization technologies for product groups with the market already formed, commercialization & demand generation.
- New market-generating type: Simultaneous securing of technology and market through implementation of strategy connected with tech./demand generation/ infrastructure for product groups with a growth possibility into main products 5 years later.
- Technology-leading type: Breakthrough in original technologies and reinforcement of industry basic stamina for function realization with product groups aimed at a market 10 years later.

Product Group	Market-expanding Type	New market-generating Type	Technology-leading Type
Market Formation Period	**Present**	**3 years later ('14)**	**7 years later ('18)**
Main Product Group (Example)	Manufacturing	Education, cleaning, surveillance, reconnaissance	Medical care(surgery), Traffic/transportation, silver (elderly care)
New Product Group (Example)	Education, Cleaning	Medical care (surgery), traffic/transportation, fire and disaster prevention, "silver", agriculture	Housekeeping, wearable, underwater/aviation biomimetic robot
Project Lead	Industry	Industry/research institute	University/research institute
Technology Development	Cost reduction, reliability securing, short-term investment in commercialization tec.	Mid- to long-term investment in common basic technologies such as part and module, platform technology	Long-term investment in original technologies such as bio interface, intelligence technology
Demand Generation	Dissemination & escalation, demonstration projects	Public purchase	—
Human Resource Training	Field workforce/retraining	Convergence workforce	High level specialized workforce
Standardization, Certification	Construction of certification system	Standardization and activation	Leading in international standards
Regulation, System	Support of robot supply	Robot introduction in public areas	Expansion of robot research staff

Classification		2012	2013	2014	2015	2016
Major Annual Goals (Outcomes)		Collaboration Robot Underwater Environment Monitoring Robot	Dual arm Packaging Robot Emotion/Walk Assist Robot for the Elderly/Disabled	Dual arm AssemblyRobot Minimally Invasive Surgery Robot	Robot for Nuclear Powerplant, Swarm Robot	Interventional Procedure Robot Multipurpose VTOL
						
Standard		Real-time path planning technology based on multiple sensor fusion, Reliability evaluation technology for extreme environment robots, HRI tech for edutainment.				
		High-reliability robot S/W platform technology, Visual/tactile/audio/ emotion-based recognition and identification technology, etc.				
		Surgery robot user interface technology, etc.				
Manufacturing Support	Innovative Product	Dual arm collaborative robot for IT product cell manufacturing				
		Parallel robot for high-speed handling of workpieces				
		Robos for human-robot collaborating work	Explosion proof type of painting robot technology for painting processes			
	Original Technology	Active/passive compliance control technology	Autonomous movement type of multi-arm manipulation technology			
			Mixed-initiative interaction technology for dependable coworker			
		Direct teaching technology	Remote operation manipulation technology for extreme environments			
		Multiple-induced driving module technology	Precision, high reduction flat panel decelerator for robot driving modules			
Medical Care Service	Innovative Product	Minimally invasive surgery robots for laparoscope and otolaryngology/neurosurgery				
			Orthopedic surgery robot, fracture treatment/Active driving mini robots for digestive organ diagnosis			
				Eyeball fine surgery robot		
	Original Technology	mini high DOF surgery robot technology for surgeons	Microscopic surgery robot technology for incisionless, non invasive fine operations			
		Surgery robot technology for image registration-based biopsy/RF-Ablation/interventional procedure				
		Affected area/robot registration and calibration technology	Real-time medical information augmented reality convergence technology			
		Driver and sensor technology for high radiation environments			Driver and sensor technology for ferromagnetic environments	
Social Security	Innovative Product	Underwater environment monitoring and management robots			Multiple robot control and surveillance robot	
		Information collection robot for nuclear power plant/ Unpiggable pipe inspection robot				
		Airport security management robot system based on multiple robots				
	Original Technology	Autonomous running technology capable of simultaneously using indoor and outdoor spaces				
		Technoloy for remote-controlled robot for automatic check of live wires / robot for blade maintenance in wind power generation				
		Crowd environment/control/intelligence and system integration technology				
			Collaboration type multi-purpose vertical takeoff and landing mini aviation robot technology			
Edutainment	Innovative Product	Minimalism UCR		Performing robot based on media interaction		
		Ecology link type of contents authoring tool / Smart robot companion service				
		Early childhood education helper robot for institutional use			Teacher assisting robot for institutional use	
	Original Technology	Technology for open type robot controller with flexible structure and portability				
		Actor and stage apparatus integration control tech	Synchronization technology for multimedia and robot motion			
Home Service	Innovative Product	Emotion sharing & walk assist robot for elderly & disabled		Robot for emotion/action recognition and medical care support		
		Cleaning robot	Mobile robot for low-speed swarm running			High-speed boarding robot
		Arrangement/organization cleaning robot			Housekeeping assistance robot	
	Original Technology	Real-time open-type robot platform technology based on cloud robotics				
		Real environment situation recognition and decision-making/expression technology with recognition sensor convergence (HRI key technology)				
		Standard object manipulation based on visual/tactile sensing (Reliability 90%)	Non-standard object manipulation based on visual/tactile sensing (Reliability 95%)		Non-standard object arrangement/organization based on visual/tactile sensing (Reliability above 99%)	
			Polymer-based driver technology with tactile sensing function / Mobile robot performance evaluation technology			

4.1.3 Expected Effects

4.1.3.1 Technological Expectations

- Securing key original technologies for the future core growth engine.
  - To establish a globally leading nation in key growth areas of robotics through development of original technologies for intelligent robots and commercialization

    -> Leading to 4 original technologies for intelligent robots along with 5 commercialization technologies.
- Expansion of new convergence industries which spread into other industries
  - Overcoming technological limitations and improving technological competence through convergence of diverse advanced technologies such as machinery, electrical and electronics, S/W, control, communication, and materials.

    - > Expansion of applications of related technologies through technology convergence and applications in each area and leading developments.
- Expansion of companion growths in the industry with a spread of robot technologies throughout overall related industries such as automobile, home appliance, smart home, shipbuilding, etc.

  -> Developed original/common technologies to be utilized for intelligent conversion in other industry areas, spreading across the overall industry.

4.1.3.2 Economical Expectations

- **Achieving to be one of the top 3 leading countries in the area of intelligent robots worldwide by 2012** followed by the realization of producing ₩ 20 trillion worth of intelligent robots and exporting US$7 billion by 2018.
  - Generating a diverse service robot industry supporting and cooperating with humans and penetrating other industries such as medical care, defense, education, etc. outside the traditional manufacturing industry.

    -> Forecasts to achieve ₩8 trillion in domestic productions along with US$2.2 billion in exports by 2015.
  - Creation of new jobs through fostering specialized businesses in development, manufacturing, and production areas related to robots.

    -> Forecast to achieve developing 330 robot-specialized businesses and generating employment of 35,000 workers by 2015.
- Generation of value-added industries through spread effects for various front/rear industries by providing a new convergent foundation for transformations.
  - Pushing the development of new industries through convergence with industries such as IT/BT/NT and other industries such as welfare, education, culture, art.
- Effects on small- and medium-size businesses.
  - Forecast: about 70% of the total market to be occupied SMEs, start-ups.
  - Providing diverse business opportunities in the areas of production and manufacturing of robot products and related parts, robot-dedicated S/W, etc.

    -> Large corporations to provide support to the industry by leading large-scale development and demonstration projects, while small- and medium-sized businesses can get successfully established and develop their core competence.