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Industry Intelligence Program



Consumer Electronics



Industrial Robots: Technology, Business Opportunity and Patent Analysis

Abstract

Industrial robots have been widely applied in a broad range of fields such as assembly, production, electric welding, spraying and painting, food packaging, and component installation. Recent years, several companies have seen aggressive investment in related technologies or M&A activities, including Fanuc, ABB, KUKA, Yaskawa, Mitsubishi, Hitachi, Sony, Toyota, Honda, and Samsung. Even Foxconn has jumped on the bandwagon. This report provides an overview of the industrial robot technologies and thorough patent data mining results that reflect major vendors' patent deployments and technology trends. Also included are the outlook for the industrial robot market and opportunities for perspective entrants.

by David Chen

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1 Technology Development

1.1 Type of Technology

The IFR (International Federation of Robotics) has defined industrial robots as an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes and may be used in industrial automation applications.

The IFR has further categorized industrial robots into six types based on their mechanical structures: articulated robots, Cartesian/linear/gantry robots, SCARA (Selective Compliance Assembly Robot Arm) robots, cylindrical robots, parallel robots, and others.

1. Articulated robots: consisting of five to seven rotary joints. Various processing tools can be attached to the joints depending on user needs. The robots are designed with similar functions to a human arm and are used for loading, unloading, paint spraying, surface processing, testing, measuring, arc welding, spot welding, packaging, assembling, cutting machines, fixation, and operating, forging, and casting of special equipment.

2. Cartesian/gantry/linear robots: Cartesian robots are also known as gantry or linear robots. They make linear movements in three axes (X, Y, and Z) which are at right angles to each other. Servo and stepping motors are the fundamental units for driving the single-axe arm while balls-crew actuators, belts, and gear wheels along with gear racks form the transmission system.

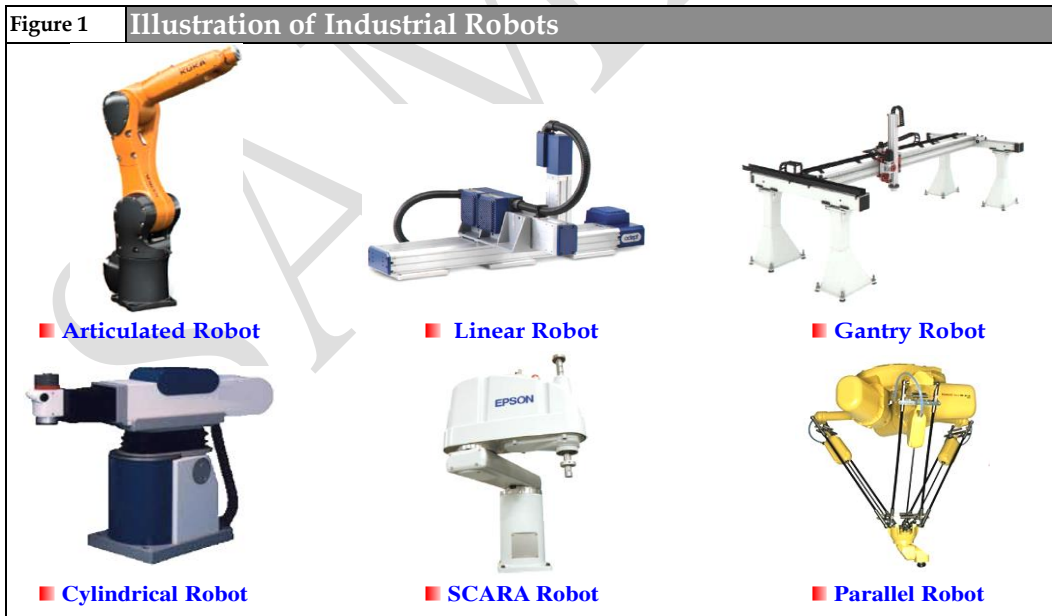
3. SCARA robots: the robots contain two parallel rotary joints and one linear joint. The axes are parallel to each other and allow position and orientation in the horizontal plane. With a simple structure and quick reaction, this kind of robot is faster than other joint robots by several times. Therefore, SCARA robots are ideal for horizontal positioning or vertical assembly operations. SCARA robots, mainly used for carrying components and assembly, have been widely adopted in the plastic, automobile, electrical & electronic, pharmacy, and food industries.

4. Cylindrical robots: the robots consist of a motion axis which is capable of moving up and down and an arm that can be connected to an extendable axis and move in and out. The arm can rotate about the motion axis to achieve a cylindrical work area.

5. Parallel robots: also known as quadrilateral robots, this kind of robots get their name from their parallel arms. With a higher moving speed and better positioning result as well as higher repeat positioning accuracy, parallel robots have been widely used in streamlined production such as food packaging and component assembly operations.

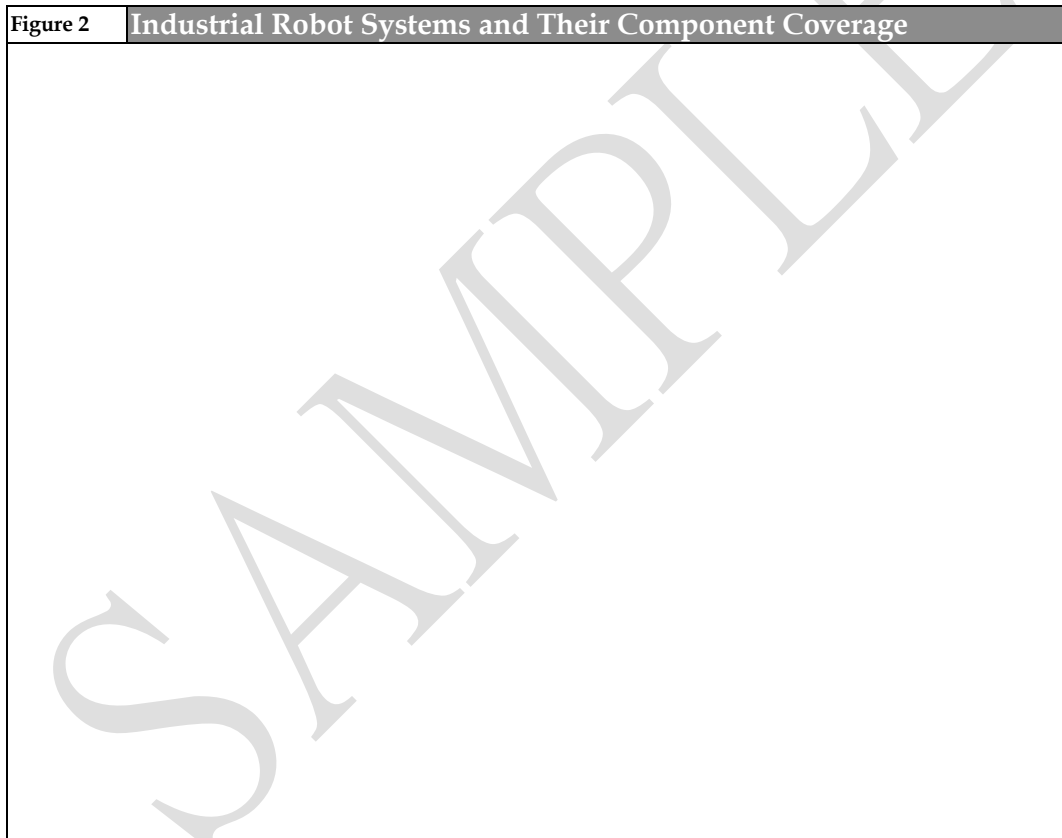
Table 1 Industrial Robot Category and Types	
Category of Robots	Types
Industrial Robot	Articulated Robot
	Cartesian/Linear/Gantry Robot
	SCARA Robot
	Cylindrical Robot
	Parallel Robot
	Other

Source: MIC, February 2015



Source: Respective companies, compiled by MIC, January 2015

1.2 Component Systems



Source: Respective companies, compiled by MIC, January 2015

2. Patent Mining

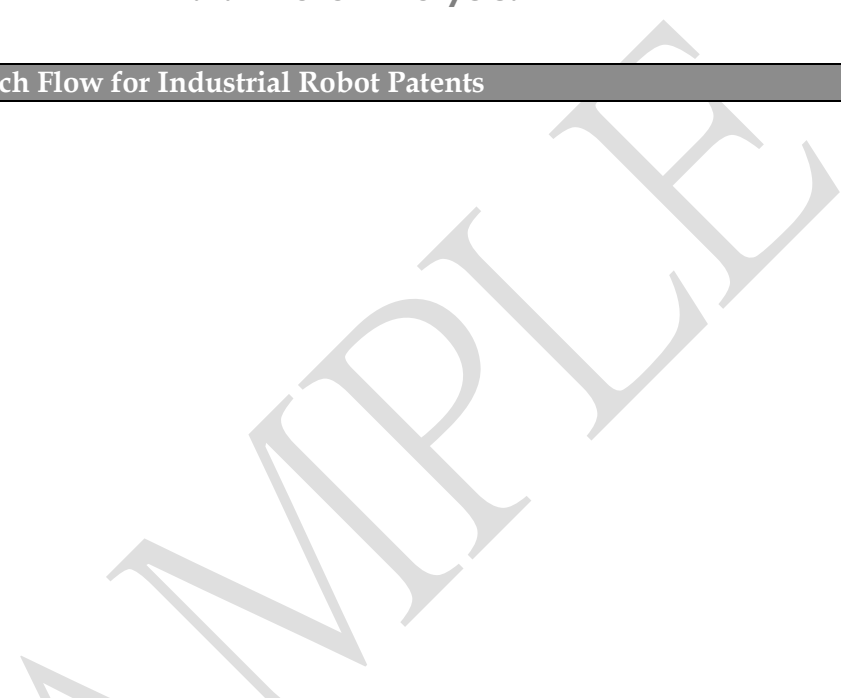
2.1 Patent Search

2.1.1 Selecting a Patent Database:

2.1.2 Identifying Search Keywords:

2.1.3 Data Selection:

2.1.4 Data Analysis:

Figure 3	Search Flow for Industrial Robot Patents
	

Source: MIC, January 2015

Table 2	Key Technology Fields Identified By Text Mining
Code	Search Keyword
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41	
42	

Source: MIC, February 2015

2.2 Trend Analysis

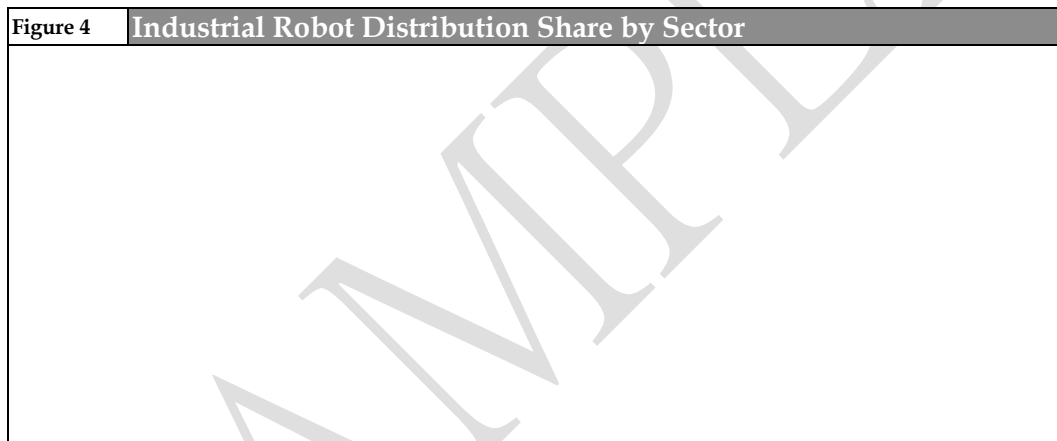
2.2.1 Text Mining

Table 4					
Technology Keyword Ranking by Number of Patents					
Number	Technology	Patents	Number	Technology	Patents
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

11					
12					
13					
14					

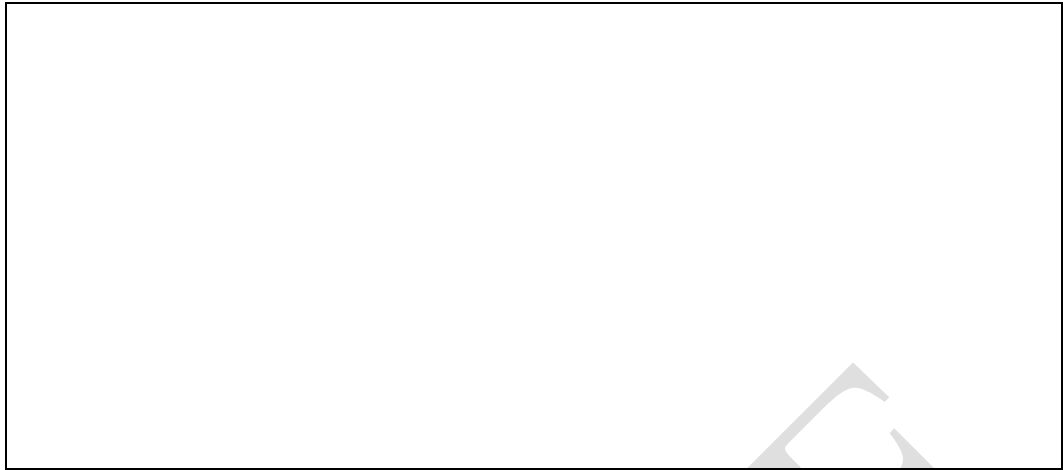
Source: Respective companies, compiled by MIC, February 2015

2.2.2 Data Mining



Source: MIC, February 2015





Source: MIC, January 2015

2.2.3 Relative R&D strength

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Table 5		Top 30 Assignees in the Field of Industrial Robot with Detailed Profile						
Assignee	Number of Patents	Citations	Self-Citations	Inventors	Nationality	Ave. Patent Age	Year(s) since the First Patent was Filed	R&D Strength Ranking
Fanuc								
ABB								
Yaskawa								
KUKA								
Mitsubishi								
Hitachi								
ASEA								
Sony								
Kawasaki Heavy								
Fujitsu								
Siemens								
Matsushita								
Honda								
Toyota								
Stäubli International AG								
Seiko Epson Corp.								
Tokico								
Yamaguchi								
Unimation, Inc.								
Kobe Steel								
Panasonic Corp.								
Samsung								
Denso Corpo.								
Sick Ag								
Comau								
Nachi-Fujikoshi Corp.								
Hongfujin Precision								
Toshiba								
Foxconn								
Canon								

Source: MIC, February 2015

2.2.4 Results of Patent Index Analysis

Table 6		Top 10 Industrial Robot Patents	
No.	US Patent No.	Title	Assignee
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Source: MIC, February 2015

Table 7		Matrix Analysis of 10 Most Important Industrial Robot Patents									
No.	Patent Number	Sector						Patent Generality Index	Filing Date	Issue Date	Assignee
		Electrical Engineering	Mechanical engineering	Instruments	Other Fields	Computer technology	Electrical machinery, apparatus, energy				
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

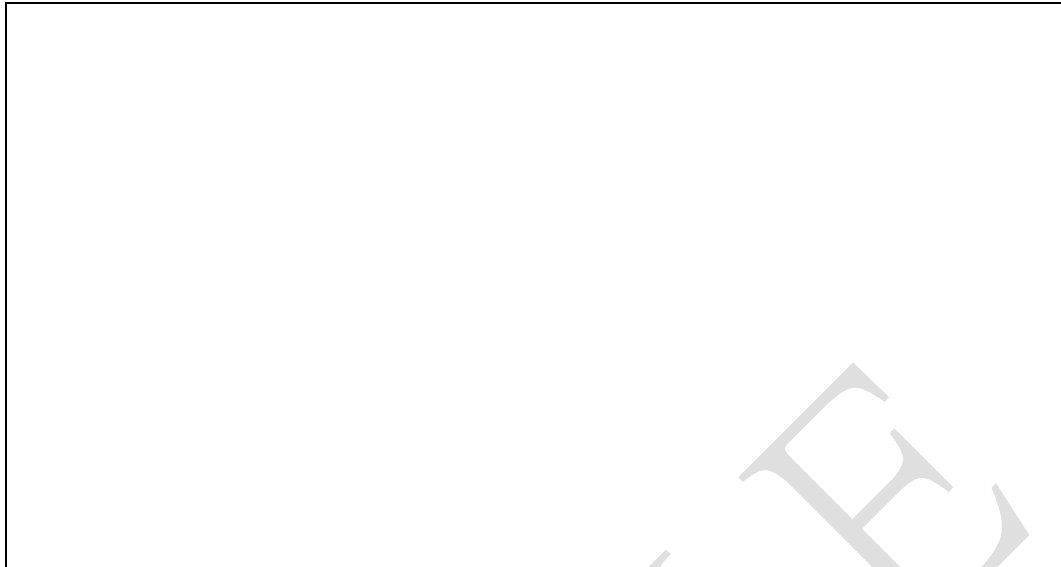
Note; CIT is short for California Institute of Technology and RRC is short for Robotics Research Corporation

Source: MIC, February 2015

3. Market Outlook



Figure 6 | Worldwide Industrial Robot Market Volume, 2010 - 2016



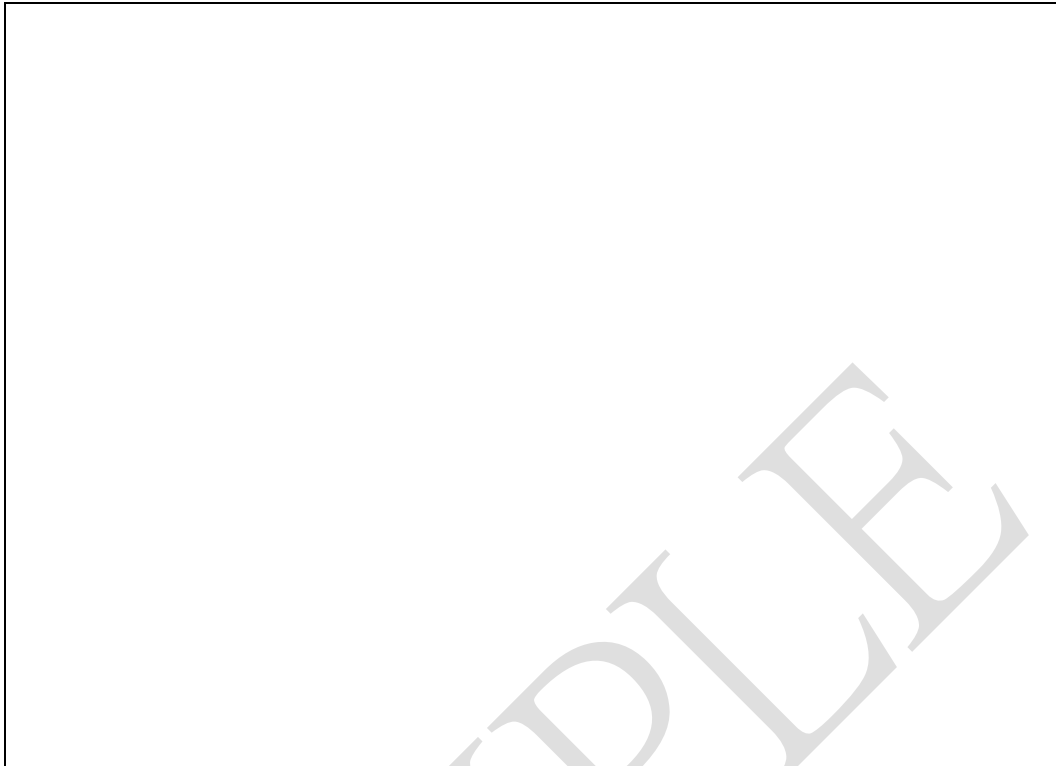
Source: MIC, February 2015

Figure 7 | Worldwide Industrial Robot Market Volume Share by Application



Source: IFR, compiled by MIC, February 2015

Figure 8 | Worldwide Industrial Robot Market Volume Share by Sector



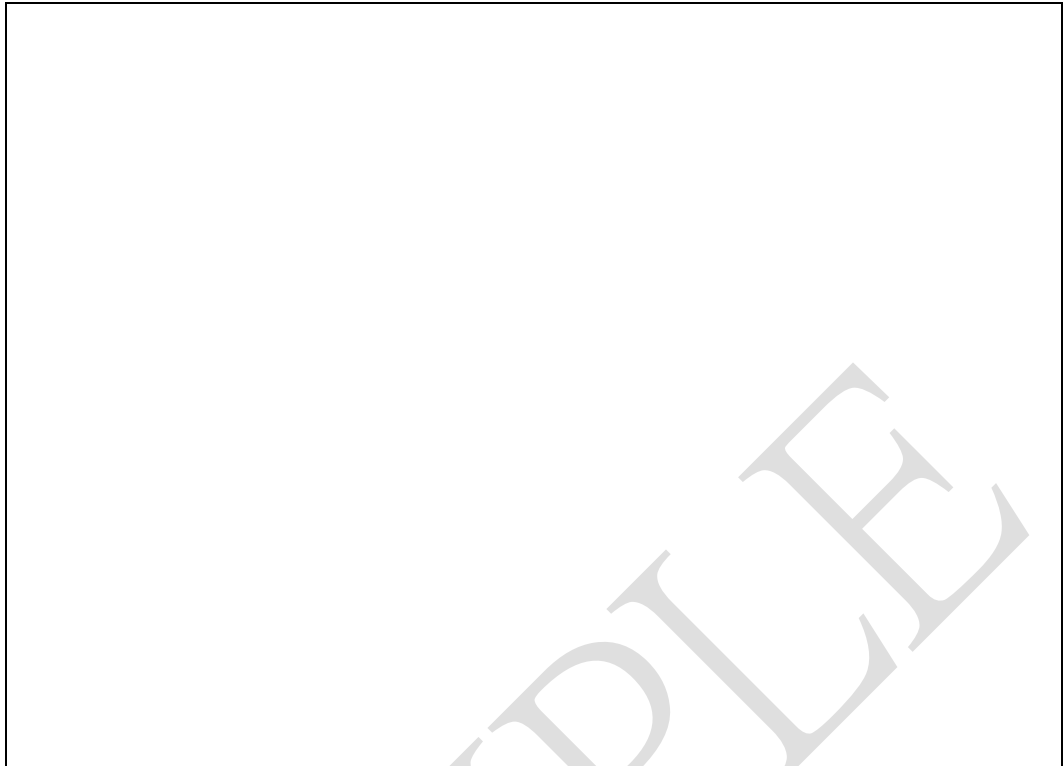
Source: IFR, compiled by MIC, February 2015

Figure 9 Worldwide Industrial Robot Market Volume Share by Robot Type



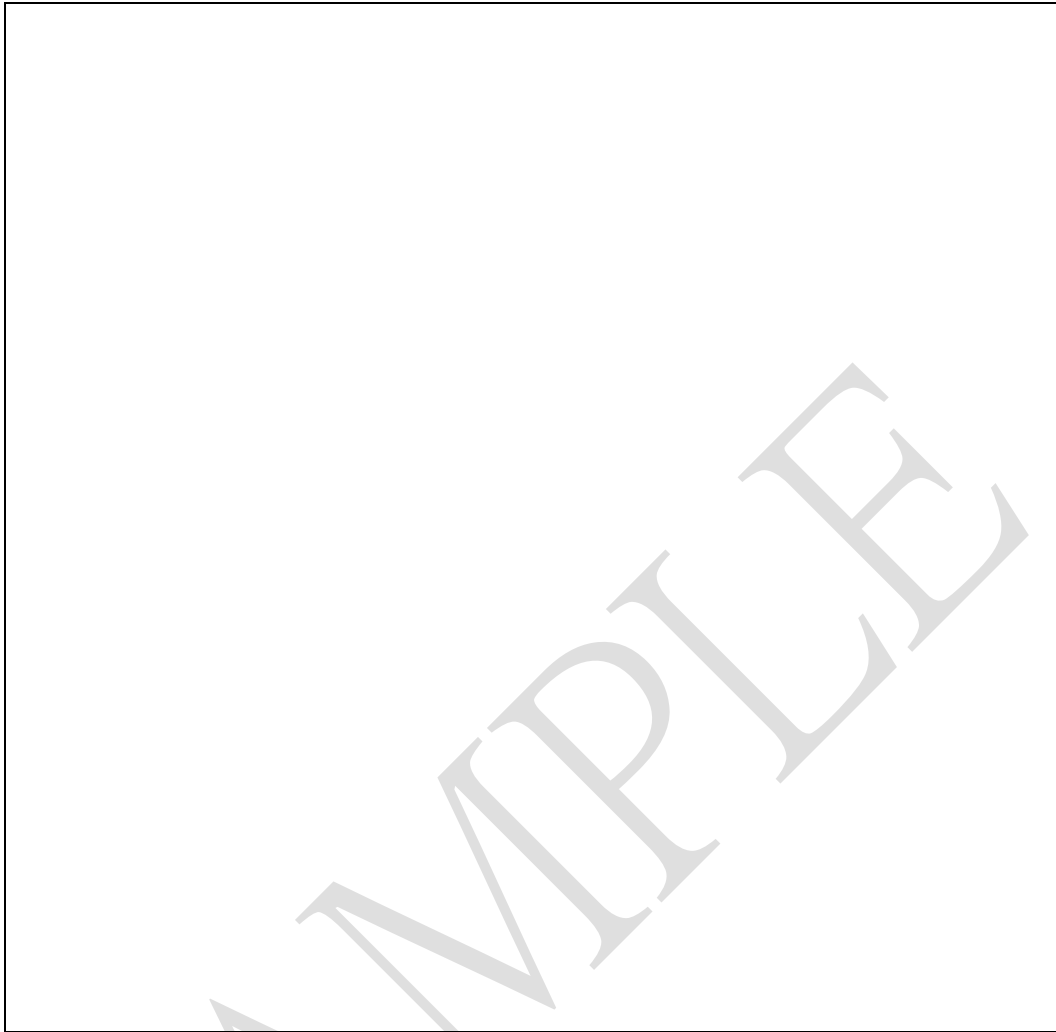
Source: IFR, compiled by MIC, February 2015

Figure 10 Industrial Robot Market Adoption Intensity by Country



Source: IFR, compiled by MIC, February 2015

Figure 11 Chinese Industrial Robot Market Volume by Sector and Application

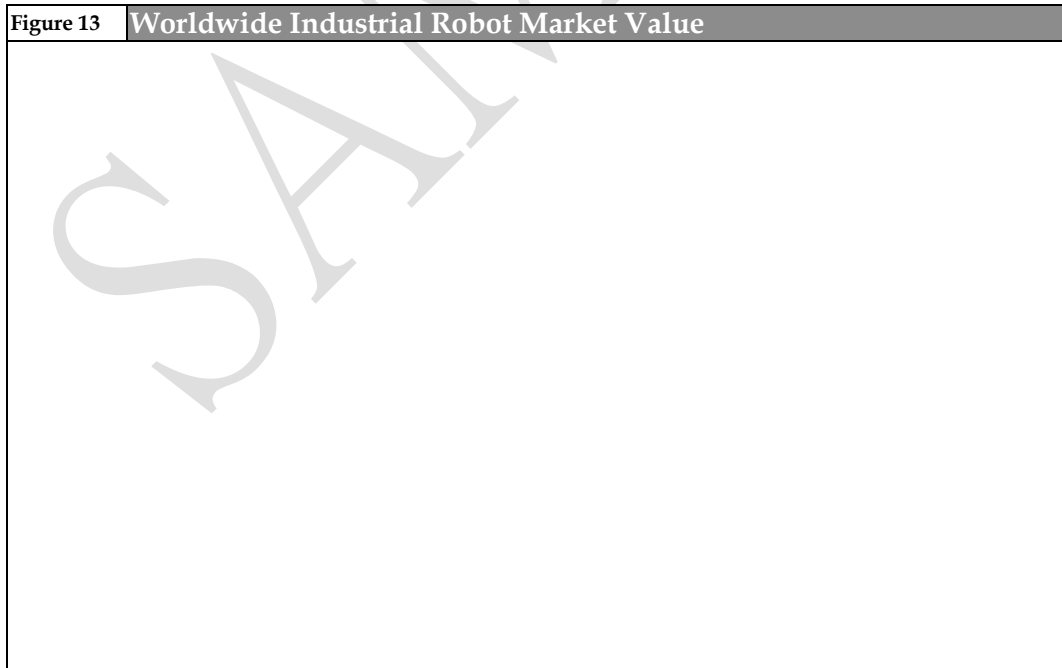


Source: IFR, compiled by MIC, February 2015

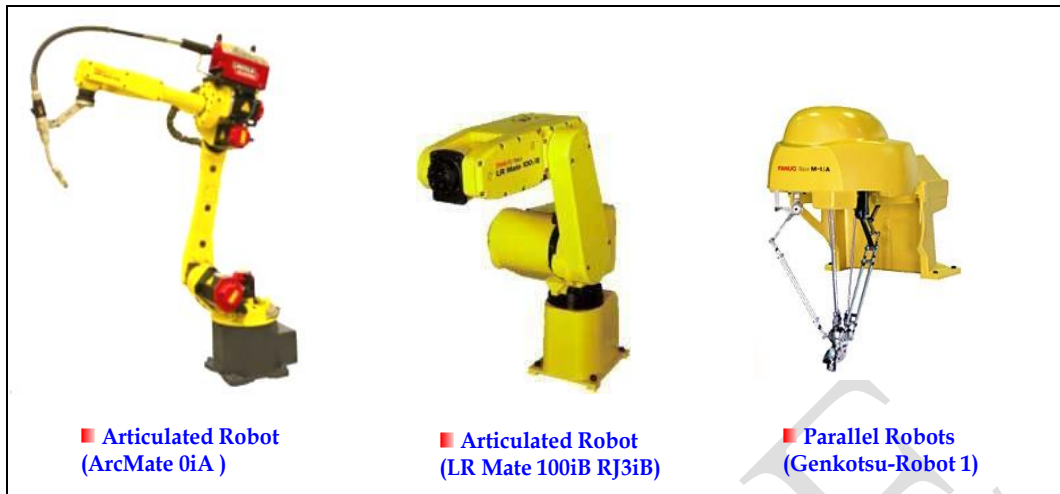
Figure 12	Taiwanese Industrial Robot Market Volume by Application and Robot Type
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Source: IFR, compiled by MIC, February 2015



Source: IFR, compiled by MIC, February 2015



Source: Fanuc, compiled by MIC, February 2015

Figure 16 Illustration of Industrial Robots by ABB



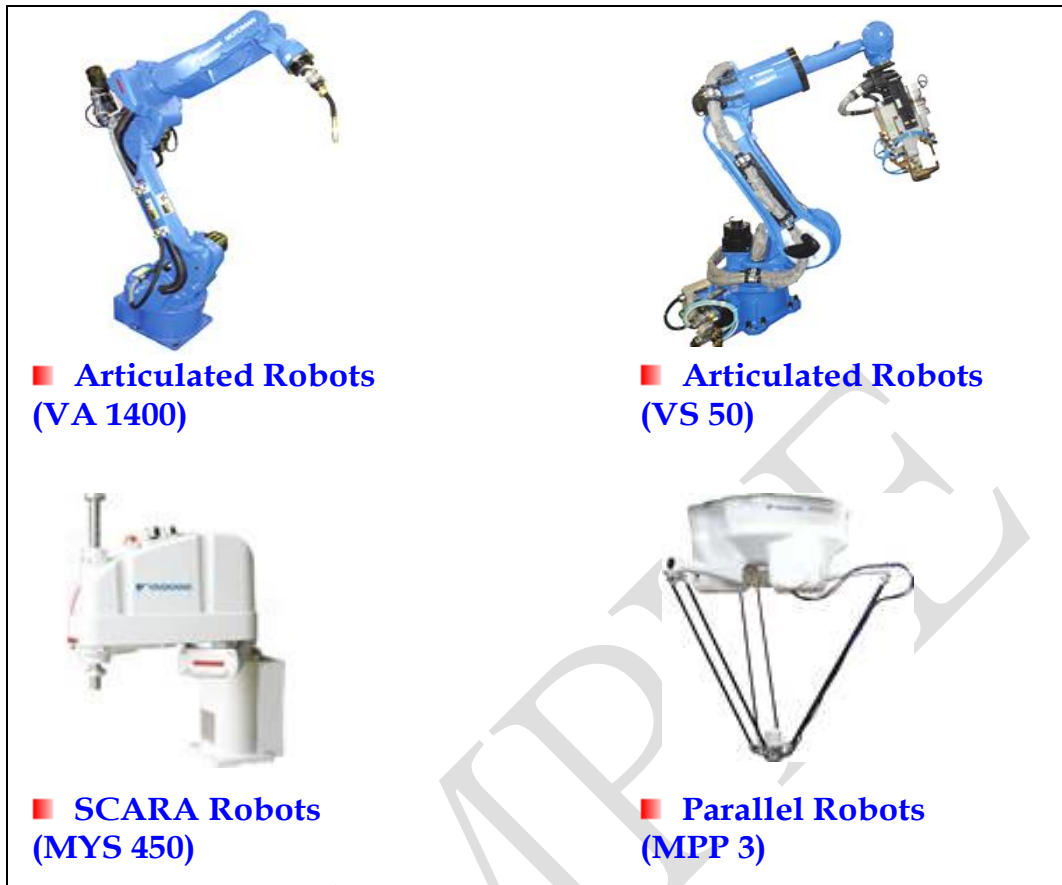
Source: ABB, compiled by MIC, February 2015

Figure 17 Illustration of Industrial Robot by KUKA



Source: KUKA, compiled by MIC, February 2015

Figure 18 | Illustration of Industrial Robots by Yaskawa



Source: Yaskawa, compiled by MIC, February 2015

MIC Perspective

Patents Focused on Control, Handling, Machinery, and Computing Technologies with Key Applications in Transport, Semiconductor, Food, and Chemistry

Deteriorating Labor Market Conditions to Drive Demand for Industrial Robots

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Appendix

Research Scope

This research focuses on the development of technologies and patents with regard to industrial robots, providing analysis on technical papers, product demonstration, patent analysis, patent index, key vendors, market scale, and business opportunities.

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Glossary of Terms

CAGR	Compound Annual Growth Rate
IPC	International Patent Classification
PCT	Patent Cooperation Treaty
SCARA	Selective Compliance Assembly Robot Arm

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List of Companies

ABB
ASEA
California Institute of
Technology
Canon
Comau
Denso
Dynalog
Fanuc
Foxconn
Fujitsu
Hitachi
Hiwin
Honda
Hongfujin Precision
Kobe Steel
KUKA
Mitsubishi
Nachi-Fujikoshi
Panasonic
Robotics Research
Samsung
Seiko Epson
Sick Ag
Sony
Stäubli
Tokico
Toshiba
Toyota
Unimation
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Yamaguchi
Yaskawa

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