MECHANICAL GRIPPER

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This project report attached hereto, entitle "Mechanical Gripper" prepared and submitted by BERNARD CHIA KEOW YEE in partial fulfillment of the requirements for the degree of Bachelor of Engineering with honours in Mechanical Engineering and Manufacturing Systems in hereby accepted.

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MECHANICAL GRIPPER

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Dedicated to my beloved family.

Especially to both of my brothers.

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Abstract

The project report presents the process of designing a mechanical gripper that is able to grip objects from a range of weight and of various sizes and shape. The proper documentation will have to begin from the setting of the parameters for the gripper that include the size, shape and weight of the objects and the materials to be use. Then detailed designs of the gripper with the various components are produced according to the parameters that have been set earlier. Then the machining processes and assembly techniques are analyzed for producing the mechanical gripper. The function, integration and limitation of each of the components of the gripper are studied and presented

Abstrak

Laporan projek ini memperihalkan proses untuk mereka satu tangan mekanikal yang menpunyai keupayaan untuk memegang objek yang mempunyai satu julat berat dan juga saiz dan rupa bentuk yang berbeza. Dokumentasi yang harus diikut bermula dari penentuan parameter untuk tangan mekanikal yang termasuk saiz, rupa bentuk dan berat objek yang hendak dipegang dan juga bahan yang akan digunakan. Ini diikuti dengan penghasilan lukisan jitu untuk tangan mekanikal yang juga termasuk komponent lain berdasarkan parameter yang telah ditentukan di peringkat lebih awal. Ini diikuti dengan analisi proses permesinan dan teknik perhimpunan komponen untuk menghasilkan tnagan mekanical. Fungsi, integrasi dan had keupayaan setiap komponen dalam tangan mekanikal dikaji dan dipersembahkan.

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Chapter 1

Introduction

Presently, the word "robot" are being used intensively. The robotic technology has come a long way before reaching this advanced level. The field of study of robot, which is robotic, has attracted a lot of scientists to perform further research on the mechanical machine that are able to perform human movements and ability such as decision making and sensing the surrounding. But the main course behind the rapid improvement in the robotic technology is due to its important presents to the industrial sector. In order to understand more about robot and robotic technology applications, limitations and also the mechanism that moves this mechanical man, the definition, the forming of the concept of, a robot is an essential first step in the study of robot.

1.1 Definition

There are been several definitions for robot and robotic technology used at this present moment. The origin of the word "robot" comes from the Slavic origin in Russia, which was known with the word paδota (robota). The present meaning of robot was introduced by Czechoslovakian dramatist Karel Capek (1890 –1938) in the early twentieth century in a play entitled R.U.R (Rosum's Universal Robots) where in the play it created automated

substitutes for human workers, having human outlook and capable of "human" feeling [Ben-Zion Sandler, 1991]. But as the robot technology developed further, the definition have differed to more specific area than the initial definition. This progress has risen a word, "Robotic" which was the contribution of Isaac Asimov when he first used the term robotic in his work in 1939 [Asimov and Frenkel, 1985].

But in the last two-decade, robotic research and progress have really been on the fast move. A lot of applications have started to implement robot in the process. Robot has been now been part of our life and according to the Oxford dictionary, robot is a machine that can perform the action of a person and which can perform automatically or is controlled by a computer. But robot has a totally different meaning in the engineering world particularly in the industry sector. So varies national bodies throughout the world have defined robot according to their understanding and application. The Robotic Industries association of America (RIA) has defined robot as [Gordon 1988]:

> A programmable, multifunctional manipulator designed to move material, parts, tools and specialized devices through various programmed motions for the performance of a variety of tasks.

Another leading country in robot technology, Japan has defined a robot as "any device which replaces human labor" [Sosoka, 1985]. But the Japanese Industrial Robot Association (JIRA) has classified robot into six categories from manual manipulator to intelligent robots [Schlussel, 1985]

Robot understandings are actually arising from the concept of creating a machine that is as identical as possible to our capability of doing a particular task. Although robot at this present time seems to head towards

only to industry purposes, it will still move towards the goal of creating a substitute that will represent us. Thus study of robots which is called robotic have been stressed by various country as to emerge as the leaders in the robotic technology. But in the engineer's perception robotics is the intelligent connection of perception to action [Brady, 1985]. Future research may reach a position, which if is within the reach of science will demonstrate how limited our knowledge us.

1.2 History

For centuries, human has built mechanisms to imitate parts of the human body. Machines which moves under their own power have fascinated humankind since the beginnings of recorded history. It all started with the concept of moving certain part of statues powered by human to create movement that are believe by the peasant that are only capable to be done by god at that present time. The Egyptians and Greeks started this believe using human power and hydraulic powered statues to rules their citizen [McKerrow, 1991].

As time and knowledge progresses, people started to implement mechanisms movement machines powered by burning fuel or electricity. This new breakthrough have brought human to a new level in science technology, as this has sparked the beginning of the industrial era where food and other products are produce in a large quantity not just to cater for a certain but to a larger coverage area. With the help of these machines, workloads, which were impossible to handle, could now be done.

But progress didn't just stop there as more sophisticated robots are introduced to meet the demand. Programmable robots have been invented

which could perform more difficult tasks. More complex and quality products are produces using programmable robots to provide the demands. Presently, robots with artificial intelligent technology are introduced. These robots have the ability to choose the wanted decision, sense and also be very flexible conducting it's given tasks.

Although robotics technology has a long history record, intensive development only took place in the middle of the twentieth century. For the last 50 years machines knowledge have progress to programmable and artificial intelligent robot. All these are due to the connection between robots in the industrial sector. Researchers of artificial intelligence have finally developed ways to emulate human information processing with electronic computers. Generally the rise in robotics are due to industry revolution and also human interest to create something that can represent them.

1.3 Robotics Technology

The emphasis of robotic have made it a discipline that are currently a specialize collection of new topics. Since every body and country from all around the world have their own definition and knowledge, the development of robotic must then be brought up by a unified body of knowledge. This unified of body must be able to group the research and study to a few main categories to provide a standard guidance for the scientist. So every participant country has agreed to group the robot system to the following major subsystem to provide better understanding for everybody. The subsystems of the robotic system are as follows [Hunt, 1990]:

I. Manipulator system

This is the study of the mechanical arm mechanism. This area usually consists of series of joints and linkages for it to perform the motion by moving the end effector tooling through the space. Apart from the links at the arm, it also emulates the characteristic of a human arm where it consists of a base, shoulders, elbow and also wrist. Other then all the parts that joints, moves, hold and link the manipulator, the workspace of a manipulator is also one of the important criterion in this area [Ardayfio, 1987]. But recently, due to the demands of a flexible and movable manipulator, mobile robot has been a hot topic in recent researches [Sun, 1996].

II. Actuator power drive

This is the power needed to move the arm or robot to move from one point to another. This motion of the joints and links that the robot performs will require a motor or actuator to move it. Even the act of holding and letting go of an object by the robot needs actuation power and drive mechanisms. One of the non-traditional method of actuation, used only experimentally, is the application of heat and cold to 'memory-metal' wire causing it to expand and contract to provide actuation force [Kuribayashi, 1986]. But presently, the three primary sources of actuation power drive for industrial robots are electric, hydraulic and pneumatic. Electric actuators usually are less power than the other types but have good accuracy and repeatability. It is usually driven by stepping motors or dc motors. Electric actuators are more expensive then the rest but more quiet and use less space. They are the most used power

drive actuators. The simpler types of the power drive are the hydraulically driven robots. They are suitable for heavy-duty robots as they have both the physical strength and also high speed. Hydraulic robots can have high repeatability and accuracy as it uses hydraulic servo valve and analog resolvers for control and feedback, digital encoders and modern resolvers. The final power drives is the pneumatic that caters for limited-sequence activities, such as pick and place where speed and precision are not that important. Pneumatic apply the compressed air to drive the robot and tend to be lightweight, fast, least expensive and simple to keeps the reliability and maintenance cost down. It can only be used where there are available a source of compressed air.

III. End-effectors tooling

These tools are the parts that are needed to perform the robot's intended production tasks. Grippers are the parts in the robot that will perform the desired work wanted. As tooling consists of a variety of peripherals that must be reviewed as they are important and unique for any installation [Hunt, 1990].

IV. Fixture and tooling accessories

These area covers all the accessories or tools that integrated the robot system with the production tasks. All these tools are created to assists the robots in performing their tasks. It is important for the robot to protect other object from being damage by the robots by providing a fix and safe work place in doing their work. It also allows calibration of the

robot with the system to have a smooth and also desired performance. The accessories tools usually use are templates, tool storage and also jigs.

V. Controller or computer

Computer or controller is needed to control the robot according to the task specification. It is responsible to start and stop the motion of the manipulator in the desired point, store position and sequence data in memory and to interface with other advanced manufacturing technology system. The issues involved in the controller field include stability, accuracy and reliability of the robot control system such as PID, CTM, adaptive control, and force control [Meghari, 1992]. The power of a controller and the ease with which it can be programmed are determined by the operating system, the programming language and the programming language environment. It is important in the robot language design is that there are three classes of robot programmers [Cox et al, 1988], each with the different requirements, expectations and abilities. To control the robot, it have lead to the development of robotics programming language such as VAL from Unimation, AR-BASIC from American Cimflex and AML developed by IBM. The latest robot programming is Off-Line Programming Systems (OLP) which is a robot programming language which has been sufficiently extended, generally by means of computer graphic, where the development of robot programs can take place without access to the robot itself [Craig, 1988].

VI. Sensor

Sensors for the robot are to provide independently unique information about the environment while working together in the real world and also providing action for each sensor information. Sensor will monitor the desired physical arrangement such as in the robot joint and also will provide feedback to the control system to analyze [Craig, 1989]. The use of sensor will affect the programming aspects of the robot workstation by setting boundary for the robot's manipulator. Sensors used in a robot workstation fall into several categories:

I. Proximity sensors

II. Range sensors

III. Tactile sensors

IV. Acoustic sensors

V. Machine Sensors

With these six major group elements of a robotic system, it will provide better guidelines in understanding robotic technology. Although there are still some country of body than still haven't participated to standardize the grouping of the robotic system, progresses have taken place to improve this situation. As for the future, a better system will be developed to monitor the advancement of this very important technology.

1.4 Robot Application

The creation of robot by human has been used in many applications that will help to speed up the load of work that were needed to be done. Since each application has its own set of parameter's problem, it needs to have it own set of robot to perform it. But the main applications of robot are still to

fulfill the demand from the industry sector. Robot are created to take over dangerous and repetitive work need to be done by human to increase safety and also productivity due to is accuracy and continuous services in performing the tasks. Various industrial applications of robots include:

I. Material Handling

In material handling task, the robot must be able to move to a prescribed location, grip or hold the required object, move to the next prescribed location and finally let the object down to the desired location. Material handling robots are usually use when the working environment is unpleasant or the tasks are highly repetitive and hard work such as in metal casting industry. With the installation of material handling robot, it will be safer, higher productivity and better quality of the product produce for both the worker and owner of the company as shown in Figure 1.1.

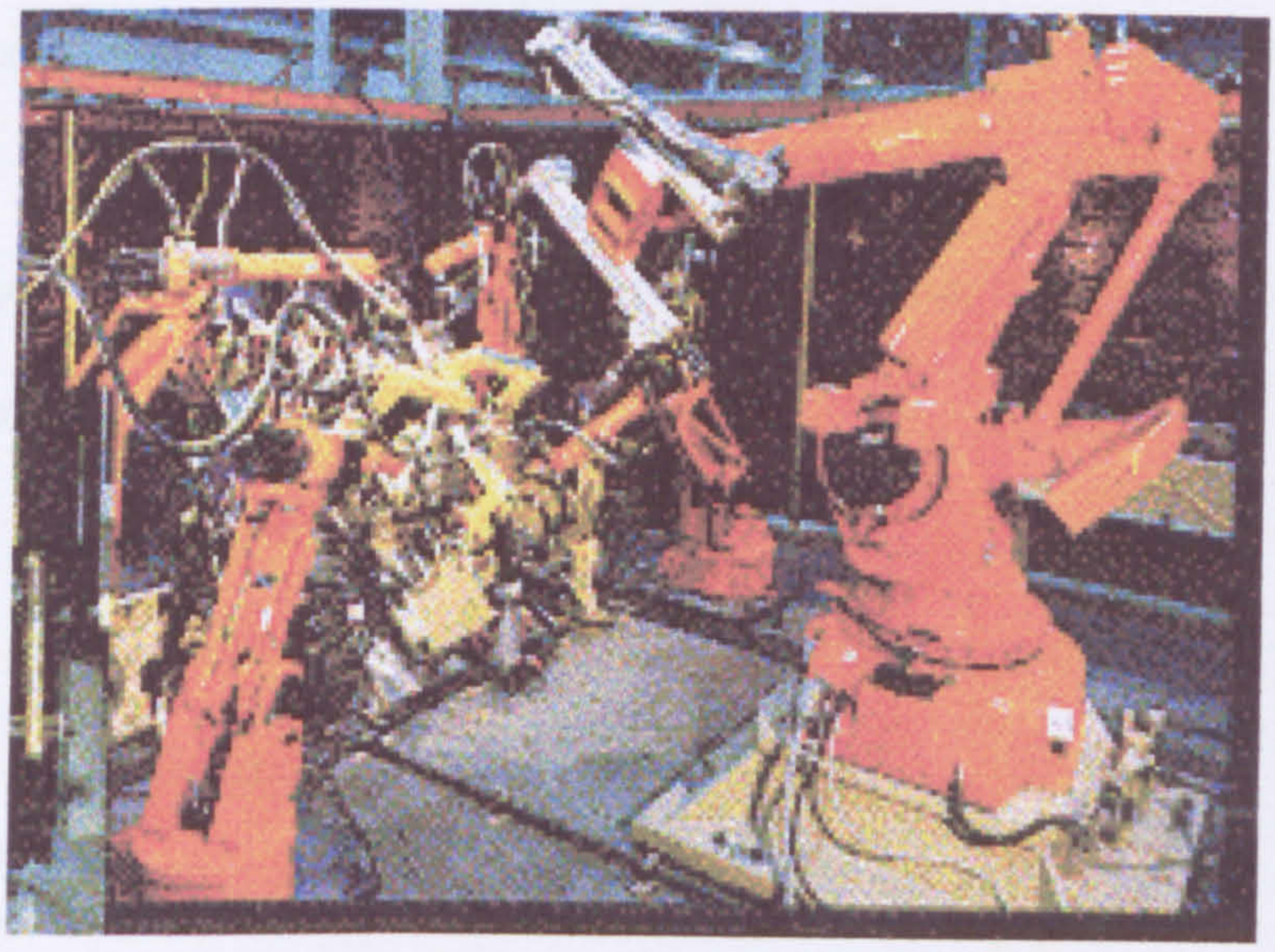

Figure 1.1 Material Handling
(Source: Demmer Equipment Profile)

II. Welding

Welding is a process that joint metal together by fusing both metals with electrode by the present of electricity. Welding is a job, when done by human, requires considerable training, skill and concentration. Welding also is a task that is not only dangerous but also must be able to tolerate tough working condition. Welding robot are introduced to assist human in performing the work. Two of the most common welding technique that robots have been successfully used is arc welding and spot welding.

Arc welding

Arc welding is a continuous welding process. The two pieces of metal that are required to be weld are place along a joint and a metal rod is provided to supply high electric current needed to established the arc. The arc between the welding rod and the metal parts to be joint produces temperatures that are sufficiently high to form a pool of molten metal to fuse the two pieces together. And since accuracy is a important element, sensor such as preview sensing, through-the-arc sensing and direct sensing are use [Hanright, 1984]. The basic process elements in performing arc welding are:

a) Align parts to be welded.

b) Heat parts at seam by generating an arc between welding electrode and workpieces.

c) Apply filler material as needed.

d) Monitor weld for bead width, penetration depth, seam filling.

Spot welding

Spot welding is a process in which two sheet metal parts are fused together at localized points by passing a large electric current through the parts where the weld is to be made (see Figure 1.2). Electric current will result large heat at the two contact areas to fuse the two metal parts that finally produce weld. Spot welding robot is usually programmed for the weld to be performing at a fixed spot. The basic elements for a robot to perform in spot welding are:

a) Align pieces to be joined.

b) Clamp pieces between welding electrodes.

c) Heat pieces at weld point by passing a high current between welding electrodes.

Robot for welding must have a few unique characteristics. It must be able to withstand high temperature, high accuracy and also good repeatability.

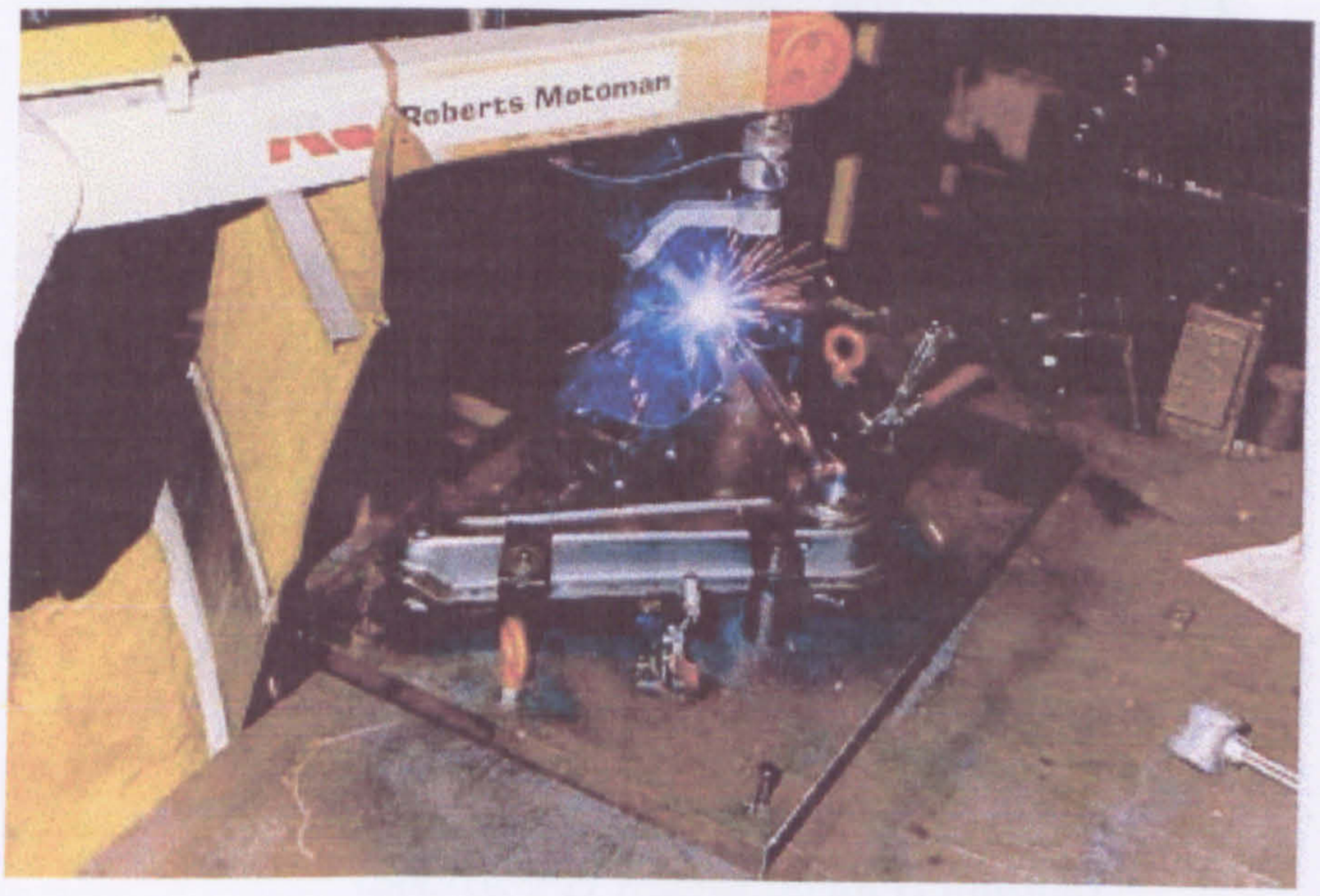

Figure 1.2 Spot Welding
(Source: Demmer Equipment Profile)

III. Assembly

In assembly process, the robots are required to identify all the parts and assemble it to become a finish product. This robots are installed to improve productivity and also quality. Since the robots have to be flexible, it is also attached with sensors to provide the feedback needed. The development of sensors and their integration into robots is the fundamental importance in the application of robotics to assembly [Sanderson and Perry, 1983]. The most common used assembly robots are Unimation Puma, Selective Compliance Assembly Robot Arm (SCARA) and ASEA IRB 1000 as shown in Figure 1.3.

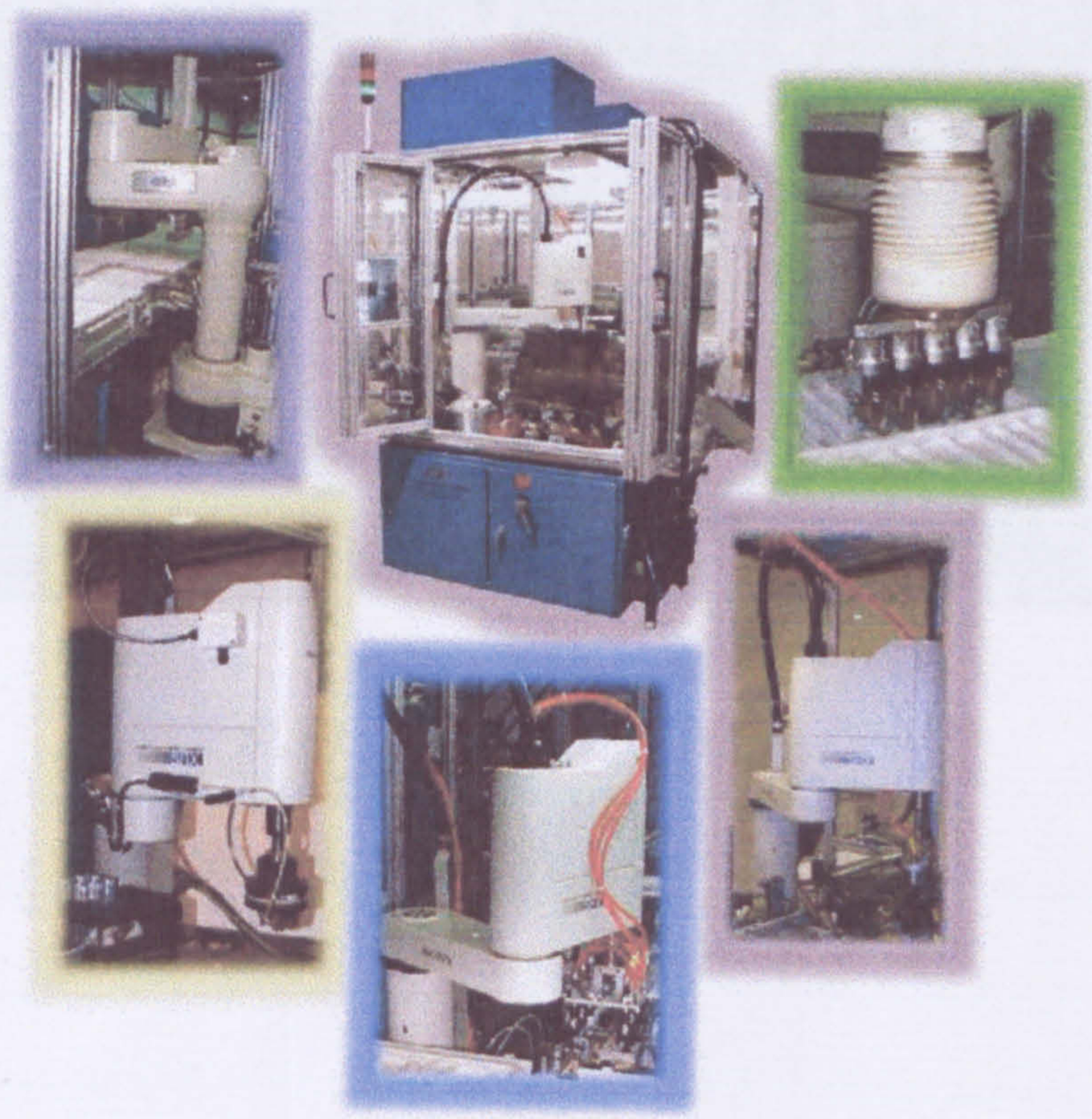

Figure 1.3 Assembly Process
(Source: FTI International Handling)