CHAPTER TWO
LITERATURE REVIEW

Overview

In this chapter, the background theory of robot & RFID technology will be presented and also the previous project done by other researchers will be discussed.

2.1 Backgrounds

2.1.1 Robotic:

According to the robot Institute of America, the formal definition of industrial robot is as follows:

A robot is a programmable, multi-functional manipulator designed to move material, parts or specialized devices through variable programmed motions for the performance of a variety of tasks [10].

Nowadays, after the massive developments we may consider a new definition as follows:

A robot is the embodiment of manipulative, locomotive, perceptive, communicative and cognitive abilities in an artificial body, which may or may not have a human shape. It can advantageously be deployed as a tool, to make things in various environments [10].

2.1.1.1   History Of Robotic:

In 1495Leonardo day Vinci designed what may be the first humanoid robot though it cannot be confirmed if the design was actually ever produced. The robot was designed to sit up, wave its arms, and move its head via a flexible neck while opening and closing its jaw [11].

In 18th Century In the 18th century, miniature automatons became popular as toys for the very rich. They were made to look and move like humans or small animals [12].

In 1709Jacques de Vaucanson's most famous creation was undoubtedly "The Duck."This mechanical device could flap its wings, eat, and digest grain. Each wing contained over four hundred moving parts and even today it remains something of a mystery. The original Duck has disappeared [13].

In 1903The first patents were awarded for the construction of a "printed wire" which came into use after World War 2. The concept was to replace radio tube with something less bulky [14].

In 1921 the term "robot" was first used in a play called "R.U.R." or "Possum's Universal Robots" by the Czech writer Karle Capek. The plot was simple: man Creates a robot to replace him and then robot kills man! [15].

In 1937-1938Westinghouse creates ELEKTRO a human-like robot that could walk, talk, and smoke [11]. ELEKTRO was first unveiled at the 1939 world's fair.

In 1960'sOne of the first operational, industrial robots in North America appeared in the early 1960's in a candy factory in Kitchener, Ontario [12].

In 1964Artificial intelligence research laboratories are opened at M.I.T., Stanford Research Institute (SRI), Stanford University, and the University of Edinburgh [16].

In 1965 Carnegie Mellon establishes the Robotics Institute [11].

In 1968The first computer controlled walking machine was created by McGee and Frank at the University of South Carolina [11].

In 1997NASA's Pathfinder landed on Mars. The wheeled robotic rover sent images and data about Mars back to Earth.

In 2001MD Robotics of Canada built the Space Station Remote Manipulator System (SSRMS). It was successfully launched and worked to assemble the International Space Station [11].

In 2005The Korean Institute of Science and Technology (KIST), created HUBO, and claims it is the smartest mobile robot in the world. This robot is linked to a computer via a high-speed wireless connection; the computer does all of the thinking for the robot [11].

2.1.1.2   Advantages of Robot:

There are many advantages of robot, such as paying on people in ways people can't move and from views humans can't reach, they can perform tasks faster than human and much more consistently and accurately, working at places 24/7 without any salary and food .plus they don't get bored. Going far down into the unknown waters where humans would be crushed, Giving us information that human can't get, Going too far away planets, They can capture moments just too fast for the human eye to get, for example the atlas detector in the LHC project can capture~600000 frames per second while we can see at about 60andMost of them are automatic so they can go around by themselves without any Human interference. These are examples but not all advantages [10].

The robot also has disadvantages such as People can lose jobs in factories, it needs a supply of power, it needs maintenance to keep it running, and it costs money to make or buy a robot [10].

2.1.1.3   Components of Robot System:

Mechanical aspect of a robot: mechanical system is a part of any physical system, such as a robot .in general, mechanical system consists of a structure and a mechanism.

Electromechanical Aspect of a robot: it is concerned with Actuation elements and Kinetic-dynamic couplings.

Control system of a robot: it is concerned with altering the direction of motion and Regulation of electrical energy applied to motors. It uses automatic-feedback control.

Information system of a Robot: it is concerned with data processing, storage, communications and microcontrollers & interfacing.

Visual sensory system of a Robot: It is concerned with mathematical modeling of the robot's perception system, CMOS-imaging sensors, CCD-imaging sensors, TV/Video standards and image processing hardware.

Visual perception system of a robot: it is concerned with image processing, feature description.

Decision-making system of a robot: it is concerned with backward-motion planning and qualitative binocular vision [10].

2.1.2 Radio Frequency Identification (RFID):

Radio Frequency Identification (RFID) is a silicon chip-based transponder that communicates via radio waves. Radio Frequency Identification is a technology which uses tags as a component in an integrated supply chain solution set that will evolve over the next several years. RFID tags contain a chip which holds an electronic product code (EPC) number that points to additional data detailing the contents of the

package. Readers identify the EPC numbers at a distance, without line-of-sight scanning or involving physical contact. Middleware can perform initial filtering on data from the readers. Applications are evolving to comply with shipping products to automatically processing transactions based on RFID technology [17].

2.1.2.1   Historic Development of FFID:

The first RFID application was the "Identification Friend or Foe" system (IFF) and it was used by the British in the Second World War. Transponders were placed into fighter planes and Tanks and reading units could query them to decide whether to attack. Successors of this technology are still used in armies around the world [18]. Figure 2-1 shown the fighter planes.

Figure 2-1: shown the fighter planes.

The first commercial RFID application was the "Electronic Article Surveillance" (EAS). It was developed in the seventies as a theft prevention system. It was based on tags that can store a single bit. That bit was read when the customer left the store and the system would sound alarm when the bit was not unset. In the end-seventies RFID tags made its way into the agriculture for example for animal tagging [18].

In the eighties RFID technology got a boost when Norway and several US states decided to uses RFID for toll collection on roads [EZ-Pass]. In addition to toll collection the following decade brought a vast number of new applications, such as ski pass, gasoline cards [Speed Pass], money cards, etc [18].

In 1999 the Auto-ID Center at MIT was founded. Its task was to develop a global standard for item-level tagging. The Auto-ID was closed in 2003 after completing the work on the Electronic Product Code (EPC).At the same time the newly founded EPC global Inc. continues the work [18].

The probably first paper related to RFID technology was the landmark paper by Harry Stockman, "Communication by Means of Reflected Power" in October 1948. The first patent on RFID was issued in1973 for a passive radio transponder with memory [US. Patent 3,713,148] [19].

2.1.2.2   Advantages of RFID:

Basically, the advantage of using RFID technology is the lack of requirement of having line sight with the tag (compared with Infrared system), the ability to work under harsh environment conditions (compared with Ultrasound sensors), faster response time and cost effectiveness, life time and low maintenance [20].

And also it has High data rate, Contact less communication, Non line-of-sight readability, Low cost and long lived [7,8and9].

- **Superior capabilities to barcode**:
1. High speed, multiple reads.
2. Can read and write to tags.
3. Unit specific ID [20].

2.1.2.3   RFID Application:

RFID technology is used in many different applications; such as RFID is used in the Mobil Speed pass system to pay for gas without going into the store, in automobile immobilizer systems to prevent theft by uniquely identifying a key with an embedded chip, in Fast Lane and E-Z Pass toll road systems to automatically pay tolls without stopping in secure entry cards to secure access to buildings, and in the supply chain to manage the flow of pallets, cases, and items [21].

It also used in:

1. Animal Identification

Implantable RFID tags or transponders can be used for animal identification. The transponders are more well-known as passive RFID technology on Microchip implant. *Collar transponders* can be easily transferred from one animal to another. This permits the use of this system within a company. Possible applications are automatic feeding in a feeding stall and measuring milk output [21]. Figure 2-2 shown the place of tag.
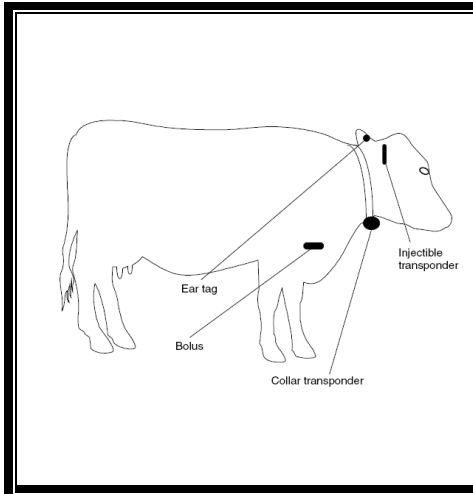
Figure 2-2: show the place of tag.

2. RFID in Libraries

Among the many uses of RFID technologies is its deployment in libraries. This technology has slowly begun to replace the traditional barcodes on library items (books, CDs, DVDs, etc.). However, the RFID tag can contain identifying information, such as a book's title or material type, without having to be pointed to a separate database (but this is rare in North America). The information is read by an RFID reader, which replaces the standard barcode reader commonly found at a library's circulation desk [21].

3. Patient Identification

In July 2004, the Food and Drug Administration issued a ruling that essentially begins a final review process that will determine whether hospitals can use RFID systems to identify patients and/or permit relevant hospital staff to access medical records. Since then, a number of U.S.

hospitals have begun implanting patients with RFID tags and using RFID systems, more generally, for workflow and inventory [21].

2.1.2.4   RFID Components:

RFID consists of two major components, which are the RFID tag and RFID reader. The tag can be classified into passive tag, semi-passive and active tag. The difference between them is: **Passive tags** do not have an internal power source, they receives power from the reader while reading progress. **Semi-passive** has an internal power source that keeps the microchip powered at all times. There are many advantages: Because the chip is always powered it can respond faster to requests, therefore increasing the number of tags that can be queried per second which is important some applications**. Active tag** Like semi-active tags they contain an internal power source but they use the energy supplied for both, to power the micro chip and to generate a signal on the antenna. Active tags that send signals without being queried are called beacons [22].

The RFID transponders (tags) consist in general of:

Micro chip: can store a unique serial number or other information based on the tags types of memory which can be read-only, read-write, or write once read-many.

Antenna: This is attached to the microchip, transmits information from the chip to the reader.

Case.

Battery (for active tags only [22].

The size of the chip depends mostly on the Antenna. Its size and form is dependent on the frequency the tag is using. The size of a tag also depends on its area of use. It can range from less than a millimeter

for implants to the size of a book in container logistic [22]. A RFID tag is shown in figure2-3.
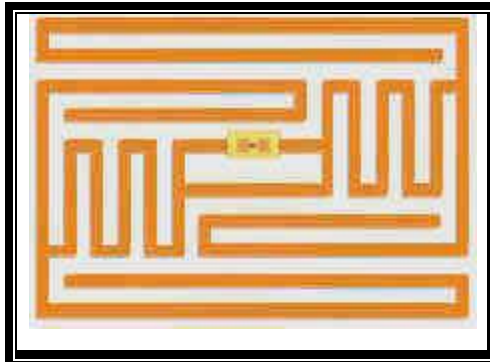

Figure2-3: A passive RFID tag.

A reader uses its own antenna to communicate with tag. When a reader broadcasts radio wave all tags designed to respond to that frequency and within range will respond. A reader also has the capability to communicate with the tag without a direct line of sight, depending on the radio frequency and the type of tag (active, passive, or semi passive) used [22].

Readers can process multiple items at once, allowing for increased read processing times. They can be mobile, such as handheld devices that scan objects like pallets and cases, or stationary, such as point-of-sale devices used in Supermarkets. Readers are differentiated by their storage capacity, processing capability, and the frequencies they can read [22]. Figure 2-4 has shown the RFID reader.

Figure2-4: the RFID reader.

2.1.2.5   RFID Frequencies:

RFID systems operate on different frequencies depending on the application. Ten such frequencies [23]. Are defined and are shown Table 2-1. Four classes of frequencies used in RFID system are: Low Frequency (LF) with frequency range of 30 KHz to 300 KHz, High Frequency (HF) with frequency range of 3MHz to 30MHz, Ultra High Frequency (UHF), and Microwave Frequency above 1 GHz. These frequencies have specific ranges known as industrial-scientific–medical (ISM) or short-range device (SRD) frequency ranges. RFID systems operate on different frequencies so they will not interfere with existing radio frequency system.

Table 2-1: RFID frequency ranges [23].

Frequency Band	Description
< 135 KHz	Low frequency (LF)
6.765 – 6.795 MHz	High frequency (HF)
7.4 – 8.8 MHz	High frequency (HF)
13.553 – 13.567 MHz	High frequency (HF)
26.957 – 27. 283 MHz	High frequency (HF)
433 MHz	Ultra-high frequency (UHF)
868 – 870 MHz	Ultra-high frequency (UHF)
902 – 928 MHz	Ultra-high frequency (UHF)
2.4 – 2.483 GHz	Super-high frequency (SHF)
5.725 – 5.875 GHz	Super-high frequency (SHF)

RFID tags fall into three regions in respect to frequency:

1. Low frequency (LF, 30 - 500 kHz).
2. High frequency (HF, 10 - 15MHz).
3. Ultra high frequency (UHF, 850 - 950MHz, 2.4 - 2.5GHz, 5.8GHz).

Low frequency tags are cheaper than any of the higher frequency tags. They is fast enough for most applications, however for larger amounts of

data the time a tag has to stay in a readers range will increase. Another advantage is that low frequency tags are least affected by the presence of fluids or metal. The disadvantage of such tags is their short reading range. The most common frequencies used for low frequency tags are 125 - 134.2 kHz and 140 - 148.5 kHz [23].

High frequency tags have higher transmission rates and ranges but also cost more than LF tags. Smart tags are the most common member of this group and they work at 13.56MHz [23].

UHF tags have the highest range of all tags. It ranges from 3-6 meters for passive tags and 30+ meters for active tags. In addition the transmission rate is also very high, which allows to read a single tag in a very short time. This feature is important where tagged entities are moving with a high speed and remain only for a short time in a readers range. UHF tags are also more expensive than any other tag and are severely affected by fluids and metal. Those properties make UHF mostly useful in automated toll collection systems. Typical frequencies are 868MHz (Europe), 915MHz (USA), 950MHz (Japan), and 2.45GHz [23].

Frequencies for LF and HF tags are license exempt and can be used worldwide; however frequencies for UHF tags differ from country to country and require a permit [23]. Common frequencies used by passive systems are shown in Table 2-2 [23].

Table 2-2: Common RFID frequencies and passive ranges [23].

Frequency Band	Description	Range
125 – 134 KHz	Low frequency (LF)	To 18 inches
13.553 – 13.567 MHz	High frequency (HF)	3 -10 feet
400 – 1000 MHz	Ultra-high frequency (UHF)	10 – 30 feet
2.45 GHz	Microwave	10+ feet

2.1.3 Components of Project

- **Arduino**

The arduino is a programmable logic controller, which Ryan explained all about a few weeks ago. It's like a little computer you can program to do things, and it interacts with the world through electronic sensors, lights, and motors. In essence, it makes some truly hardcore electronics projects accessible to anyone – so artists and creative types can concentrate on making their ideas a reality. It's the ultimate tinkering tool.

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments[24].Figure2-5 shown the arduino package and the datasheet of arduino is shown in Appendix B.

Figure2-5: The Arduino Package.

- **IR Sensor:**

Infrared detectors are a modern technology used to pick up an area of the light spectrum that the eyes are not capable of seeing. Also known as "thermograph", using infrared detectors has a variety of uses in today's society, including, construction, public service and science [25].figure2-6 shown the IR sensor and the datasheet of IR sensor is shown in Appendix C.
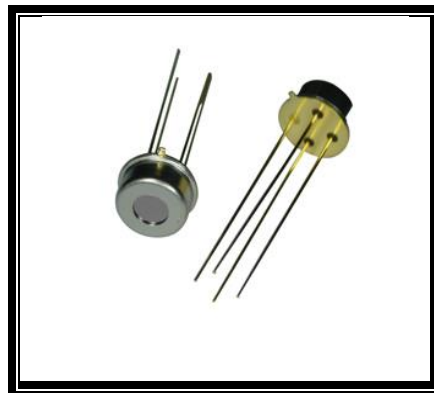

Figure2-6: the IR sensor.

- **Dc Motor**

The DC (or "Direct Current") motor rotates a shaft when you send it an ON signal. It even has a switch to set the direction of rotation. Figure 2-7 shown the dc motor and the datasheet of Dc motor is shown in Appendix D.
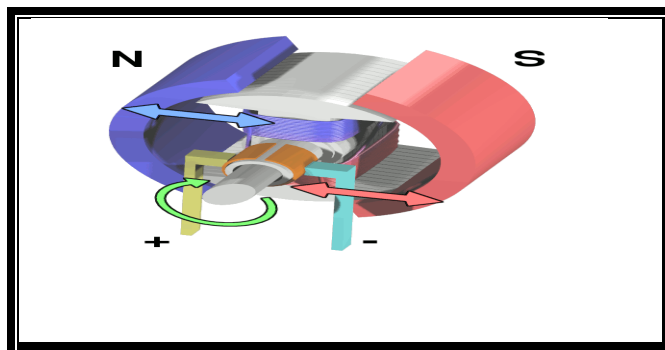

Figure 2-7: the dc motor.

The Advantages of Dc Motor:

Speed control over a wide range both above and below the rated speed, high starting torque, accurate steep less speed with constant torque and accurate steep less speed with constant torque [26].

- **LCD Display**

To use the LCD display, users have to solder 16 pin header pin to the LCD display. LCD used in this projects RT1602C, for other type of LCD, please refer to its data sheet shown in Appendix E. Figure 2-8 shown the 2X16 character LCD.

Figure 2-8: is a 2X16 character LCD.

- **L293D DC Motor Driver**

The main aim of interfacing DC motor with any microcontroller is to control the direction and speed of dc motor. But due to high voltage and current requirement of dc motors, it can be interfaced directly with microcontroller, you need a motor driver. Motor driver is basically a current amplifier which takes a low-current signal from the microcontroller and gives out a proportionally higher current signal which can control and drive motor.l293D is a dual H-bridge motor driver IC. With onel293d IC we can interface two DC motors

which can be controlled in both clockwise and counter anticlockwise direction [27]. Figure2-9 shown the L293D dc motor driver and the datasheet of L293D Dc motor is shown in Appendix F.
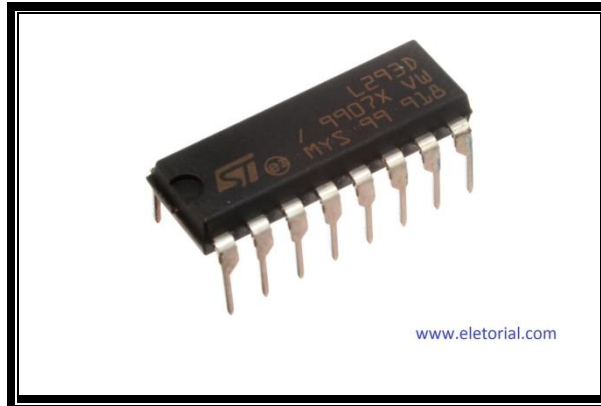

Figure 2-9: the L293D dc motor driver.

- **Forklift**

A forklift is one type of power industrial truck that comes in different Shapes, sizes and forms. A forklift can be called a pallet truck, rider truck, Fork truck, or lift truck. Yet, the ultimate purpose of a forklift is the same - to safely allow one person to lift and move large heavy loads with little effort. For the purposes of this training, a forklift is a small or large industrial truck with a power-operated pronged platform (commonly known as forks); Figure 2-10 shown the forklift.

A forklift operator should be aware of the multiple parts on a forklift in order to safely operate the forklift and be able to detect when an unsafe vehicle needs to be removed from service. Be sure to Familiarize-- yourself with the. Parts on the forklift used within your company [28].
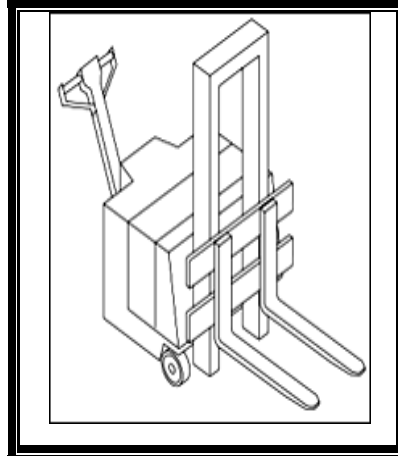
Figure 2-10: the forklift.

- **Servo Motor**

Servo motors have been around for a long time and are used in many applications. It used in radio-controlled airplanes to position control surfaces like elevators, rudders, walking a robot or operating grippers.

In food services and pharmaceuticals, the tools are designed to be used in harsher environments where the potential for corrosion is high due to being washed at high pressures and temperatures repeatedly to maintain strict hygiene standards. Servos are also used in in-line manufacturing, where high repetition and precise work is necessary. Figure 2-11 shown the guts of a servo motor (L) and an assembled servo(R).
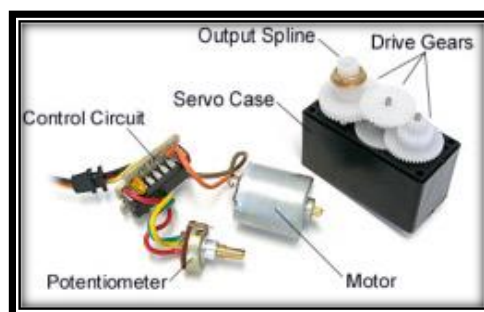

Figure2-11: the guts of a servo motor (L) and an assembled

There are two types of servo motors: AC and DC. AC servos can handle higher current surges and tend to be used in industrial machinery. DC servos are not designed for high current surges and are usually better suited for smaller applications. Generally speaking, DC motors are less expensive than their AC counterparts. These are also servo motors that have been built specifically for continuous rotation, making it an easy way to get your robot moving. They feature two ball bearings on the output shaft for reduced friction and easy access to the rest-point adjustment potentiometer. The datasheet of Servo motor is shown in Appendix G.

The advantages of servo motor are:

- Small in size.
- Have good power for their size.
- Have built in control circuitry [29].

2.2 Related Work

Loh Poh Chuan, Ayob Johari, Mohd Helmy Abd Wahab, Danial Md. Nor, Nik Shahidah Afifi Md. Taujuddin, Mohd Erdi Ayob [1] from Universiti Tun Hussein Onn Malaysia they build an autonomous robot with RFID application. They use RFID reader and PIC microcontroller as the main components. RFID robot uses the line follower module for navigation and locomotion. It is able lift up the item at certain height by generating PWM signal to servomotor. The whole programming operation was carried out by assembly language using MP Lab 7.3. The robot has the ability to identify the items by reading the tag on the items. The robot will pick up the item and navigate to prescribed destination using line follower module to

store the item at the appropriate place and location. A small white platform with black line is built for demonstration and testing.

Yinghua xue and Hongpeng liu [6] from Shandong university of finance and Shandong meteorological science & technology service center they improving the storage/retrieval efficiency in the warehouse. Firstly, they used RFID system to locate the target roughly and to obtain the attributes of the target .Then the vision mounted on the robot is used to recognize and locate the target precisely. Finally, the teaching mode and remote mode are used flexibly to assist robot to grasp the target. This had the advantage the combination of the two modes can not only reduce the Complexity of robot control, but also can make full use of the results of image processing. The experiments demonstrate the feasibility of the system.

Dr.Masoud Fathizaded and Mr.Joseph Edward Cody [2] from Purdue university they represents the result of a senior design project which is a done as pilot project in collaboration with industry. The students who participated in this project learned new hardware and software tools and applied the math and science principles learned in previous year. This project is a true example of experiential learning. A mobile robot with wireless control has been built. The robot has the capability of identifying RFID tags for each item and finding the dedicated location of the item in the warehouse. The robot uses a tracking system for the inventory. Tracking system can collect data on daily basis and perform routines operations. This information can be used both for quality control as well as improving processes and logistics.