Syrian Arab Republic
Ministry of education
National Center for Distinguished

An escort to the future

A Seminar Presented in English literature

By: Ahmad Naser.

Under the supervision of: bayan soufie.

2014-2015

Table of Contents:

- Introduction -

From the beginning of the humankind, humans have always been trying to develop new ways to facility their life and work. Starting from the wheels until the industrial revolution which its goal was to develop tools to help them in work or life by doing things normal people cannot do because the lack of force, endurance or even the repetition.

And this is where robots and machines take place in the informatic revolution. A robot can do things that we cannot do such as rescue jobs dealing with natural disasters. It is very used in the studying sides and it is now commonly used in different researches worldwide. Now it can do so many of the biological processes that human body usually do and even more accurate and frequent but:

What is robots? How robots are controllable? What is their actual ability to live in the reality and to act like humans? In addition, can we replace humans by robots? Yes, no or maybe not yet…. How much this knowledge has developed through the past years? In addition, what are the top robots around the globe now? Let us find out…. :)

- What is robotics ??? -

Chapter 1: Introduction to robotics and engineering.

WHAT IS ENGINEERING?

Engineering can be defined as the application of practical and scientific knowledge to the solving of a problem with a methodical (the orderly or systematic performance of a task) process.

More simply put, at its most fundamental level engineering is problem solving.

The above definition mentions that engineers apply scientific knowledge to their problem solving. Some would say that engineers take scientific knowledge and find a practical application for it to benefit humanity. To be successful, engineers must become familiar with a wide variety of fields, and experts in some specific fields.

The main goal of engineering is to solve different problems in our lives and to develop easier ways to make our lives easier and in this sector of work, engineers usually work in teams or groups because the disciplines of engineering are very various.

DISCIPLINES OF ENGINEERING:

There are many different types of engineers, each specializing in a different field of knowledge, each with a specific set of problems they specialize in solving. There are almost as many fields of engineering as there are fields of scientific inquiry! Some examples are listed below. Keep in mind that this list is not all-inclusive.[1]

- Aerospace Engineering.
- Automotive Engineering.
- Chemical Engineering.
- Computer Engineering.
- Control Engineering.
- Electronic Engineering.

[1] VEX EDR Curriculum – unit 1.

- Energy Engineering.
- Heating, Venting, Refrigerating & Air-Conditioning Engineering.
- Industrial Engineering.
- Materials Engineering.
- Mechanical Engineering.
- Mechatronics.
- Mining Engineering.
- Molecular Engineering.
- Nano Engineering.
- Nuclear Engineering.
- Petroleum Engineering.
- Thermal Engineering.
- Transportation Engineering, etc…

Figure -1-

So many problems takes more than one engineer to solve, take for an example the design of a car, which is a very complicated system that includes hundreds of smaller issues and problems.

Acoustical Engineers might work on minimizing road noise within the car, improve the design of the car's stereo and speaker system, or even work to improve the sound of the car's engine.

Aeronautical Engineers would be involved in improving the aerodynamics of the car to reduce drag and maximize gas mileage.

Automotive Engineers are a specialized type of engineers who utilize the skills of many of the other branches of engineering listed here, and would be involved in most aspects of the car design.

Ceramic Engineers work with inorganic, non-metal materials, and might develop special ceramic composites (combinations of multiple materials) for use in heat shielding, or bearings. Some high-end cars use specially engineered ceramic brakes.

Computer Engineers would be involved in creating the firmware (software embedded in the car's microchips) of the car.

Control Engineers, Electrical Engineers, and Electronic Engineers would work on designing & integrating the car's electrical system, software, and sensors.

Environmental Engineers would be involved in making sure the car meets all emissions requirements.

Heating, Venting, Refrigerating & Air-Conditioning Engineers might be involved in creating the car's heat and air conditioning systems.

Systems Engineers & Industrial Engineers would be involved in the management and supervision of the car creation process.

Manufacturing Engineers would determine how to make the individual components of the car.

Materials Engineers would help create new materials for use in the car construction.

Mechanical Engineers would work on the design of the mechanical aspects of the car; anything from the transmission to the engine to the suspension to the design of the snaps that hold the seats onto the frame.

Optical Engineers work on lenses and other optical instruments. They would design the car's mirrors and windows.

Plastics Engineers would create plastic types for use in the car's construction.

Process Engineers would be required to determine the best way to make the car and to ensure it its built correctly.

Structural Engineers might be involved in the creation of the car's chassis and frame.

Thermal Engineers would work on the complex heating transfer systems, such as the engine cooling and exhaust.[2]

Chapter 2: What is the robot?

According to NASA, Robotics is the study of the robots. Robots are machines that is useable to do jobs. Some robots can do work by themselves. Other robots must always have a person telling them what to do.[3]

The scientific definition of a robot According to VEX EDR Curriculum is "a programmable mechanical device that can perform tasks and interact with its environment, without the aid of human interaction. Robotics is the science and technology behind the design, manufacturing and application of robots".[4]

And "Electronics Teacher" website states that " Roboticists develop man-made mechanical devices that can move by themselves, whose motion must be modeled, planned, sensed, actuated and controlled, and whose motion behavior can be influenced by programming".[5]

Basic Components of a Robot:

According to Electronics Teacher robotics Curriculum, the components of a robot are the body/frame, control system, manipulators, and drive train.

- **Body/frame:** The body or frame can be of any shape and size. Essentially, the body/frame provides the structure of the robot.

[2] VEX EDR Curriculum – unit 1, chapter 2 Engineering/ Design teams.
[3] NASA website – what is robotics 2009.
[4] VEX EDR Curriculum – unit 2, chapter 1- what is robotics?
[5] Electronics Teacher.com – Robotics – What is Robotics.

Most people are comfortable with human-sized and shaped robots that they have seen in movies, but the majority of actual robots look nothing like humans. (Robonaut, will be covered later) They are typically designed more for function than appearance.

- **Control System:** The control system of a robot is equivalent to the central nervous system of a human. It coordinates and controls all aspects of the robot. Sensors provide feedback based on the robot's surroundings, after that they send it to the Central Processing Unit (CPU). The CPU filters this information through the robot's programming and makes decisions based on logic. The same can be done with a variety of inputs or human commands.

- **Manipulators:** To fulfill their purposes, many robots are required to interact with their environment, and the world around them. Sometimes they are required to move or reorient objects from their environments without direct contact by human operators. Unlike the Body/frame and the Control System, manipulators are not integral to a robot, i.e. a robot can exist without a manipulator.

- **Drive train:** Although some robots are able to perform their tasks from one location, it is often a requirement of robots that they are able to move from location to location. For this task, they require a drive train. Drive trains consist of a powered method of mobility. Humanoid robots use legs, while most other robots will use some sort of wheeled solution.

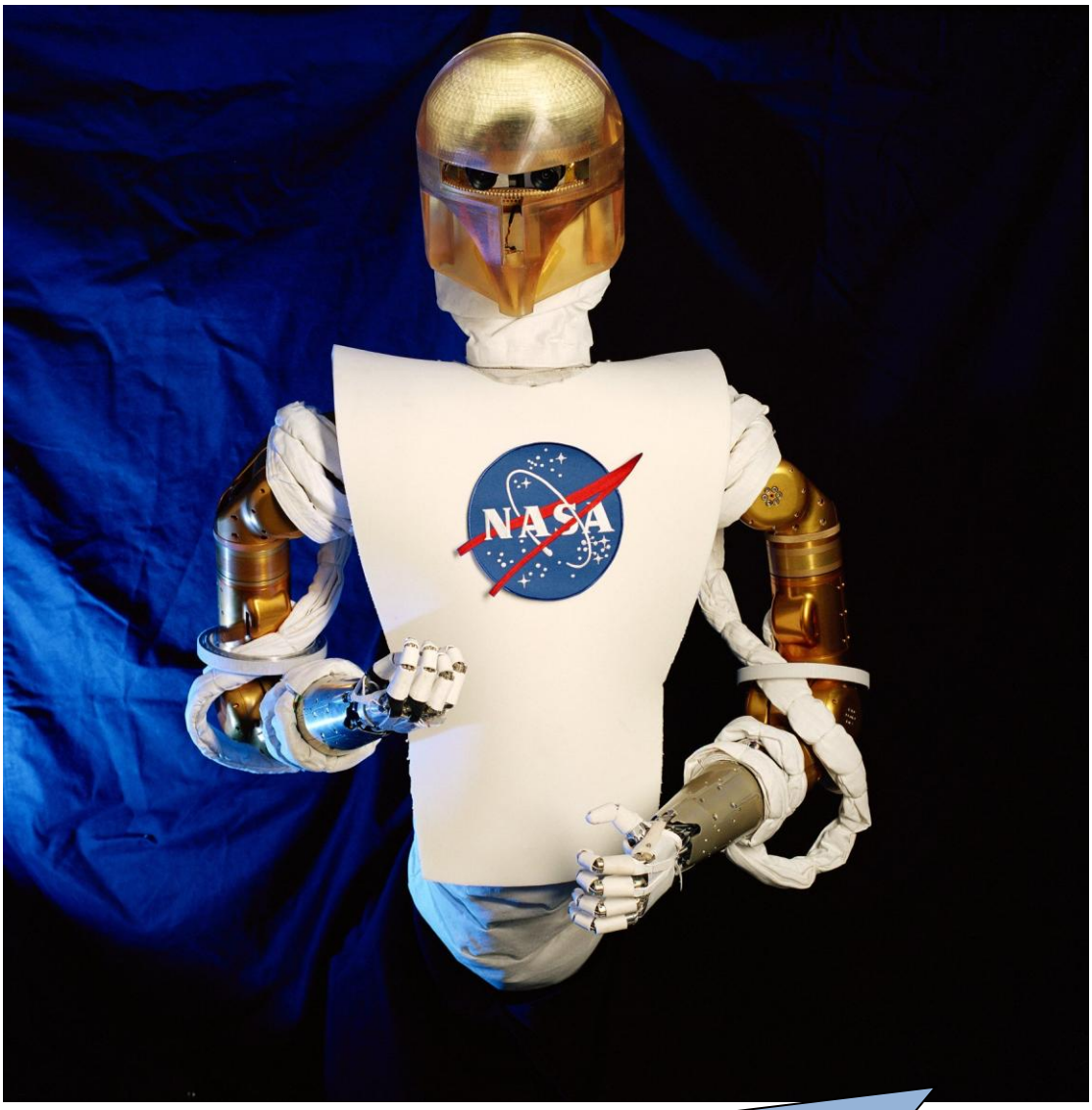


Figure -2- Meet Robonaut, a robot produced by NASA to perform tasks astronauts usually cannot do. It has a body which is very similar to human body.

Chapter 3: History of robots.

Robot Institute of America (1979) demonstrated the original old definition of robots and it states that a robot is "a reprogrammable, multifunctional manipulator designed to move material, parts, tools, or

specialized devices through various programmed motions for the performance of a variety of tasks"[6]

The first person to put the word "robot" in use was the Czech playwright Karel Capek (1890 - 1938) and it was taken from the Czech word for forced labor or serf.

The word 'robotics' was first used in Runaround, a short story published in 1942, by Isaac Asimov (born Jan. 2, 1920, died Apr. 6, 1992).[7]

The long road of robotics started along with the industrial revolution from the idea of making machines that can help us in different fields of life. However, old robots had a lot of problems and disabilities, they were very big and slow besides they did not had the strength or the accuracy to be fully trusted with different tasks such as handling a production line or rescuing someone from a natural disaster or exploring rough terrains like volcanoes… However, this research took an enormous intention and a large worldwide funding and it started to develop very rapidly and specially by releasing the first robot the world had ever seen "**unimate**" which was made by the first robotic company "**Unimation**" by the inventor George C. Devol and the engineer Joseph F. Engelberger which was named "**the father of Robotics**".

Chapter 4: Kinds of robots.

Robots are usually categorized by the way of movement, the general figure and the suitable tasks into different categories:

- ### Mobile robots:

  mobile robots are robots that can move from a place to another by its self. They are usually used to reach remote places that people cannot reach such as the robots that explore Mars or any other planet or maybe rescue someone from fire or natural disasters and they are divided by the way of movement into two kinds :

[6] Electronics Teacher Curriculum– Robotics – Robotics History
[7] Electronics Teacher Curriculum – Robotics

1- *Rolling Robots:* This kind of robots uses wheels to move around. They are quick in moving and searching different areas but their ideal territory is flat areas because rocky areas give them hard times.

Figure -3- This walking robot is called "hexapod". It has six legs and it uses many walking techniques such as 1 by 2 or 1 by

Figure-4- The surface of Mars is almost flat so NASA sent a wheeled robot to explore it because of its speed in movement.

2- *Walking Robots:* This kind of robots is usually used with rocky terrains where wheeled robots have some hard times. They depend on legs in movement and need a lot of work to maintain their balance and especially if they had not many legs like humanoid robots. That is why most of the walking robots have 6 legs or more.

- **Stationary Robots:**

Those robots are used when the task requires an in-position movement and repeated actions such as working in a production line in a factory. The most used form of this kind is robotic arms and they are usually used in moving heavy stuff from a place to another many times. NASA uses this kind of robots in spacecrafts such as the International Space Station because they have an

advanced level of accuracy and a big strength in lifting and moving.

In NASA, the use of the robotic arms is beyond the imagination because NASA uses robotic arms to move large objects in space. The space shuttle's "Canadarm" robot arm first flew on the shuttle's second mission in 1981. The International Space Station is home to the larger Canadarm2. The space shuttle has used its arm for many jobs. It could be used to release or recover satellites. For example, the arm is usually used to grab the Hubble Space Telescope on five different repair missions. The shuttle and space station arms work together to help build the station. The robotic arms have been used to move new parts of the station into place. The arms also can be used to move astronauts around the station on spacewalks. The space station's arm can move to different parts of the station. It moves along the outside of the station like an inchworm, attached at one end at a time. It also has a robotic "hand" named Dextre that can do smaller jobs. An astronaut or someone in Mission Control must control these robotic arms. The astronaut uses controllers that look like joysticks used to play video games to move the arm around.[8]

Figure -5-This robot arm takes a place on the international space station and it is used for maintenance and moving parts.

- Autonomous Robots:

Autonomous robots are self-supporting or in other words self-contained. In a way, they rely on their own 'brains'.

[8] What is robotics – NASA's official website.

Autonomous robots run a program that give them the opportunity to decide on the action to perform depending on their surroundings. In some cases, these robots even learn new behavior. They start out with a short routine and adapt this routine to be more successful at the task they perform. The most successful routine will be repeated as such their behavior is shaped. Autonomous robots can learn to walk or avoid obstacles they find in their way. Think about a six legged robot, at first the legs move ad random, after a little while the robot adjust its program and performs a pattern which enables it to move in a direction. [9]

- **Remote-Control Robots:**

Sometimes there are tasks, which are very complicated. In this case, an autonomous robot would not be the best choice because the human brain would solve or deal with complicated tasks better than the autonomous robot. The autonomous robot has a limited ability of processing and it is possible to make many mistakes. In this case we use Remote-Control Robots or RC Robots which give the ability to control the robot from a safe place and to use the human brain to deal with any situation that occurs with the robot such as rescuing missions or exploring very hard terrains (such as volcanoes…..).

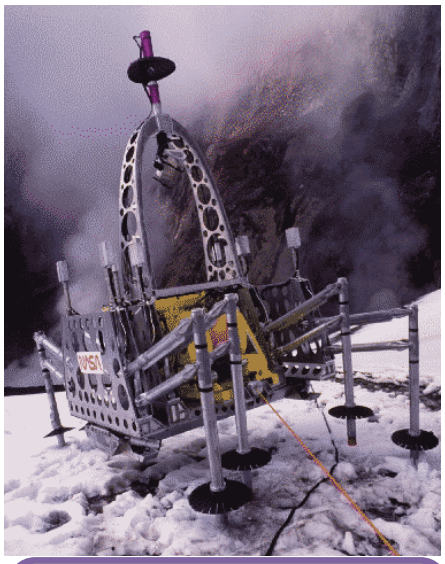


Figure -6- Dante 2: a NASA robot designed to explore volcanoes.

[9] Robotics – Types of Robotics – Electronics Teacher.com

- ## Virtual Robots:

This kind of robots is special because it does not actually exist… virtual robots are special programs that simulate the actual robots. Therefore, you can build robots by the program that has a 3D environment. After you build it, you can test it in most of the programmes (but not in all of them) in a movement simulation mode and you will feel as if the whole thing is real.

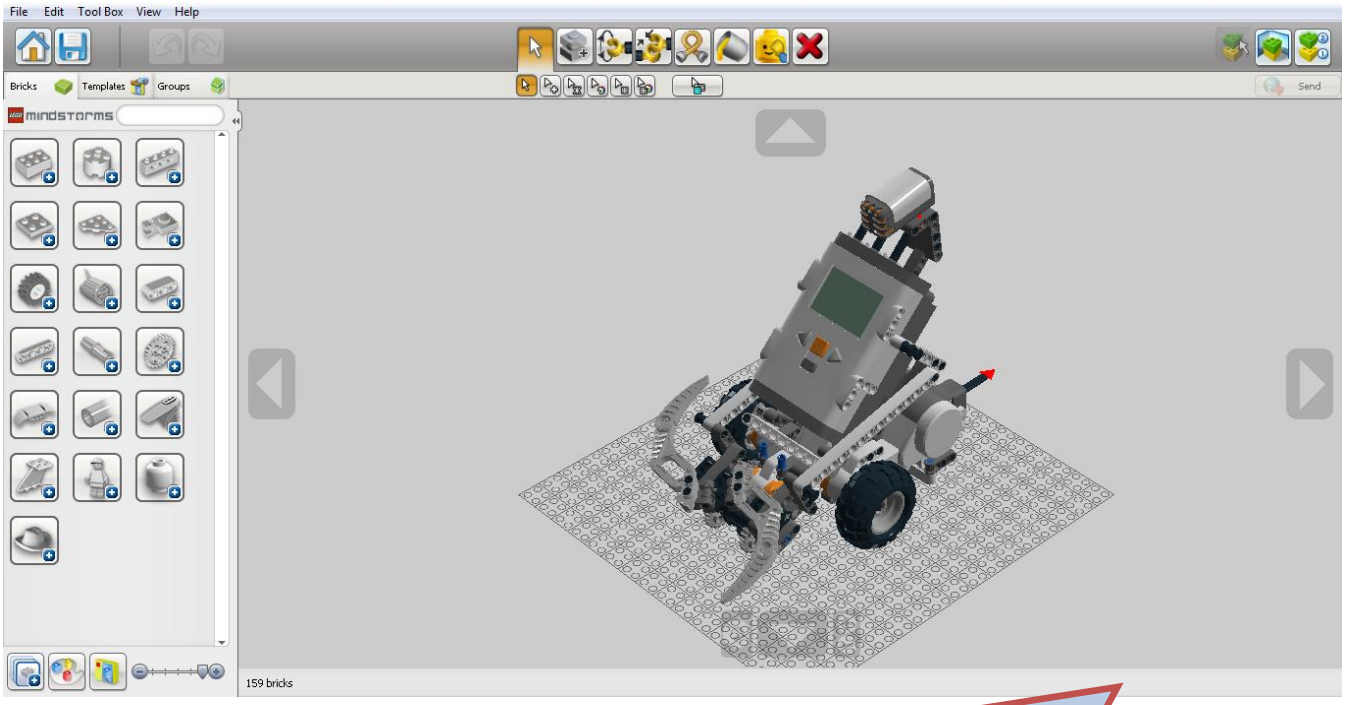


Figure -7- This is a picture of the Lego Digital Designer, a program was produced by Lego Mindstorms and it is specialized for NXT Robot. You can build your robot here but you cannot test it!

Chapter 5: The uses of robots in reality.

Since their beginning, robots started to invade all sectors of life and became the main power of modern technology and now they have different uses in many specialties:

1- Industrial robots:

In modern industries, many tasks need very high degrees of precision, strength and speed. Since a long time ago, humans

were responsible for such tasks and having many problems while doing them but, when robots had entered the picture, the production of any factory raised in an unbelievable way and there was no need for a big number of workers. The only need was for engineers for programming the robots.

Robots were more precise and faster than any number of workers and especially in technical industries such as processers or computers.

Figure -8- These robots can work on this production line forever. It produce more than a lot of workers and only need power and an engineer for maintenance.

2- Robots in research.

Robots are widely used in different sectors of researches. From a long time ago, NASA started using different robots for many tasks such as helping astronauts by "Robonaut"(We covered it earlier) but that was in the beginning of the road because after that robots became the main

Did you know???

By the end of 2014, the International Federation of Robotics predicted that there will be over 1.3 million industrial robots in operation worldwide.

And it that number.

(VEX EDR Curriculum).

workers for NASA in the outer space because they were stronger than astronauts, much faster and more precise.

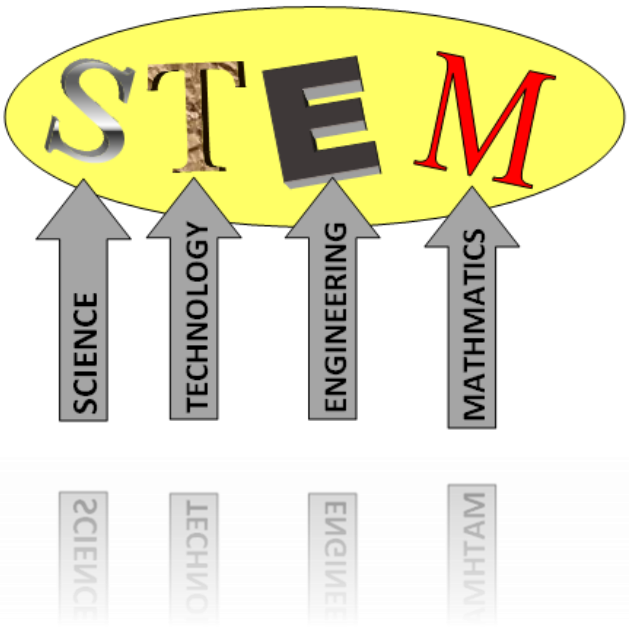
How Do Robots Explore Other Worlds?

Robots help NASA explore the solar system and the universe. Spacecraft that explore other worlds, like the moon or Mars, are all robotic. These robots include rovers and landers on the surface of other planets. The Mars rovers Spirit and Opportunity are examples of this kind of robot. Other robotic spacecraft fly by or orbit other worlds and study them from space. Cassini, the spacecraft that studies Saturn and its moons and rings, is this type of robot. The Voyager and Pioneer spacecraft now traveling outside Earth's solar system are also robots.

Unlike the robotic arm on the space station, these robots are autonomous. That means they can work by themselves. They follow the commands people send. People use computers and powerful antennas to send messages to the spacecraft. The robots have antennas that receive the messages and transfer the commands telling them what to do into their computers. Then the robot will follow the commands.[10]

3- Educational robots.

Few years ago, robots started spreading through the world of education around the world and both of elementary and high schools besides colleges started participating in different worldwide robotic events such as competitions or conferences working by the principle of making



[10] What is Robotics? – NASA official site

the engineers of the future by developing the STEM skills, problem solving, and creativity.

* * * * *

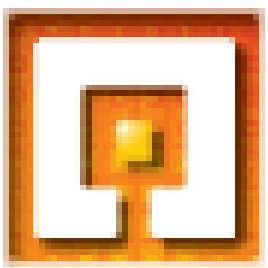
- Developments and Visions of Robotics –

Chapter 1: What is new about robotics?

Robotics had been a big help in many tasks before, but now we can say it became the "backbone" of the industry. Robots became smaller, more powerful, more precise and faster! So now, most of the factories in the world depend on robots in almost every things and does not need any workers except some engineers for maintenance and programming the robots.

Industry was not the only sector that was invaded by robots. The uses of the robots in researches and especially in space sciences; robots are now the main astronauts in NASA because they have an infinite ability of repeating and working. Until now NASA had sent many robots to explore the moon and MARS such as SPIRIT, CURIOSITY and OPPORTUNITY which still on MARS exploring the surface of the planet and sending data and pictures directly to the centers of NASA. NASA used robots in other ways like maintenance and moving things such as the Robots on the International Space Station that includes (robot arms – robot workers – mini drive robots).

Educational Robots were hugely developed and especially in the last five years. Many kinds of robots and robotic kits spreaded through the world and many educational systems adopted robotics as a main subject and especially in USA with VEX Robots, China and Japan with Lego and Europe.



Chapter 2: Top robotic projects around the world.

The fastest legged robot ever existed-CHEETAH:

This robot can run surpassing 29 mph, which is a new land speed record for legged robots. The previous record was 13.1 mph, set in 1989 at MIT (**M**assachusetts **I**nstitute of **T**echnology).

The current version of the Cheetah robot runs on a high-speed treadmill in the laboratory where it is powered by an off-board

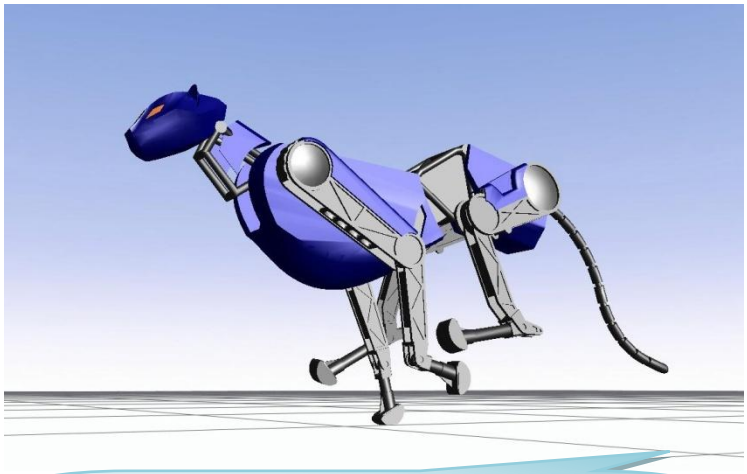


Figure -9- This is a 3D simulation of the robot Cheetah and its movement

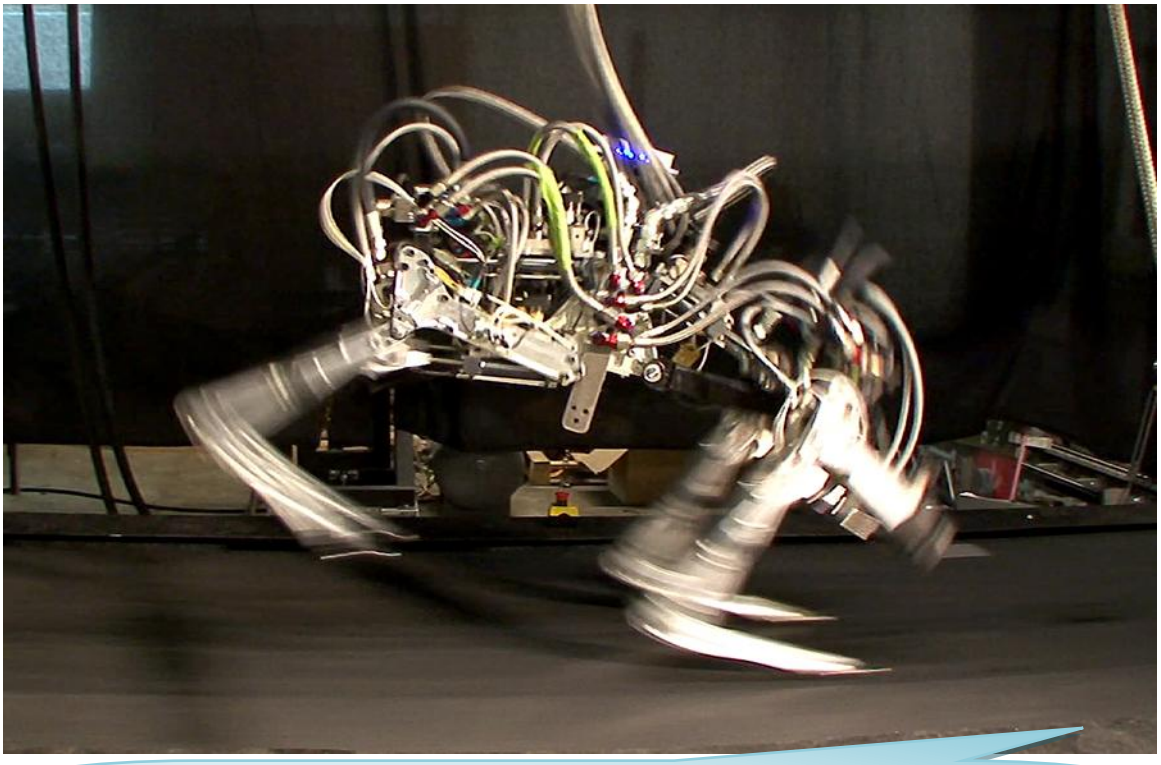


Figure -10- This the robot Cheetah while its first tests in the Boston Dynamics labs.

Hydraulic pump and uses a boom-like device to keep it running in the center of the treadmill. There is a new generation of Cheetah robot called Wild Cat. It is designed to operate untethered.

DARPA's Maximum Mobility and Manipulation program fund cheetah robot development but, the project was designed by Boston Mechanics

The most advanced rough terrain robot on earth – Big Dog:

Big Dog is a rough-terrain robot that walks, runs, climbs and carries heavy loads. An engine that drives a hydraulic actuation system and has four legs articulated as an animal's, and have compliant elements to absorb shock and transfer energy from one-step to the next powers this robot. Big Dog is the size of a large dog or small mule; about 3 feet long, 2.5 feet tall and weighs 240 lbs.

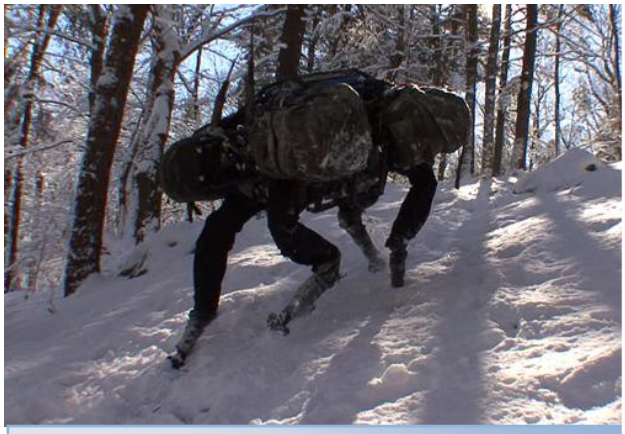


Figure -11- The robot Big Dog while its first outdoor movement tests.

This amazing robot has very tough joints with a huge capability of carrying heavy weights and very complicated locomotion systems with a very complicated balance system ran by powerful microchips and big programming codes. it runs at 5 mph, climbs slopes up to 35 degrees, walks across rubble, climbs muddy hiking trails, walks in snow and water, and carries 340 lb load.

DARPA funds the Development of the original Big Dog robot. Work to add a manipulator and do dynamic manipulation was funded by the Army Research Laboratory's RCTA program.

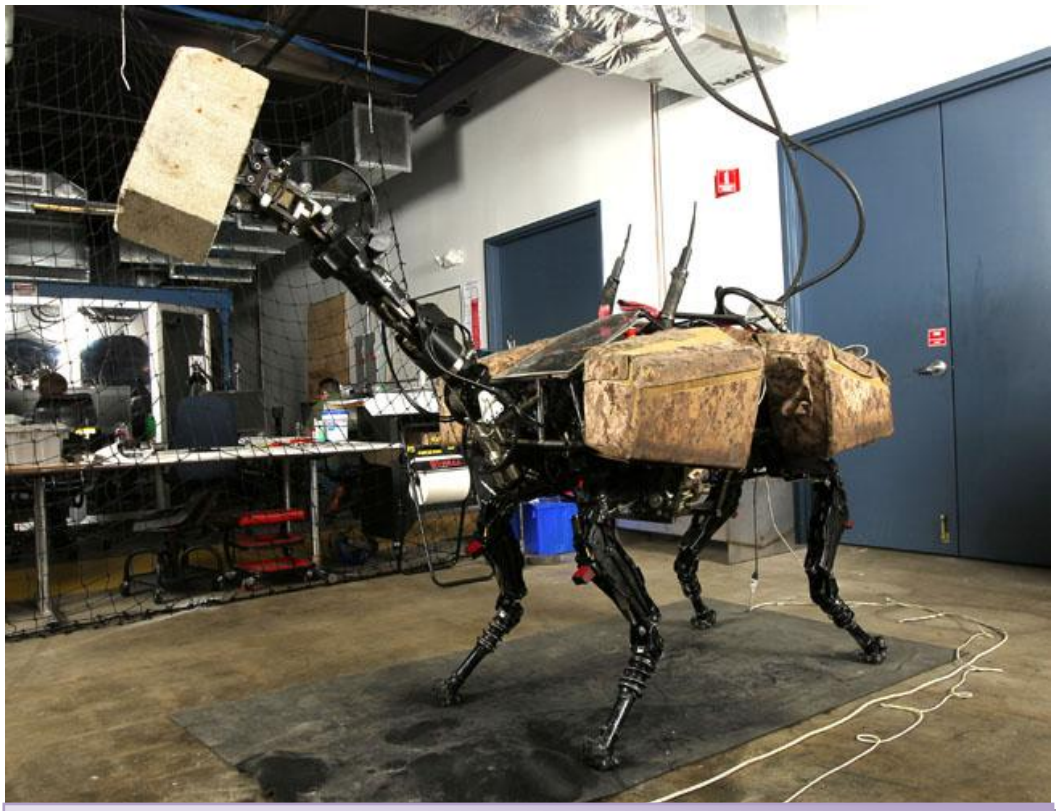


Figure -12- The test of heavy weight carrying capability on the robot Big Dog in the Boston Dynamic labs. This is considered one of the most difficult abilities to equip the robot with.

The agile anthropomorphic humanoid robot-ATLAS:

The robot ATLAS is one of the best and most advanced humanoid robots in the world for the last couple of years. ATLAS is a high mobility, humanoid robot designed to negotiate outdoor, rough terrain.

ATLAS is able to jump, walk and climb effectively. It can perform the basic moves and it has a high ability of sensing and responding by avoiding obstacles.

This robot has a very promising future in the world of humanoid robots its main use is in dangerous jobs that humans cannot do such as rough terrains. It can perfectly work in rough areas.

Figure-13-: MEET ATLAS.

Conclusions

Robotics is a high-leveled science that would take us from scientific evolution to revolution in every field of life starting by the industry... ending by space… This science is developed by the robotics competitions worldwide and the continued researches and builds. Probably in the near future there could be robots in every house, hospital, fire station…

Robots could be trusted to do many works because of their benefits and abilities of precision, strength and speed. However, they are unable to be replaced by humans in any way because, they do not have the required ability of conclusion and learning from mistakes.

Although soon robots with enough intelligent controlling will be produced by the biggest robotic companies in the world such as DAPRA, General Motors and HONDA…

Remember… "Think it, Build it and Solve it".

Recourses and References:

1- VEX EDR Curriculum – unit 2 – chapter 1 - What is Robotics? http://curriculum.vexrobotics.com/curriculum/intro-to-robotics/what-is-robotics
2- VEX EDR Curriculum – unit 1 – chapter 2 – Engineering/ Design Teams : http://curriculum.vexrobotics.com/curriculum/intro-to-engineering/engineering-design-teams
3- NASA official website – What is Robotics? http://www.nasa.gov/audience/foreducators/robotics/home/what_is_robotics_58.html#.VKcL_3sauw0
4- Electronics Teacher official website – What is Robotics http://www.electronicsteacher.com/robotics/what-is-robotics.php
5- Electronics Teacher official website – Types of robots – Robotics http://www.electronicsteacher.com/robotics/type-of-robots.php
6- Boston Dynamics official website – Robots – Big Dog: http://www.bostondynamics.com/robot_bigdog.html
7- Boston Dynamics official website – Robots – CHEETAH: http://www.bostondynamics.com/robot_cheetah.html

Table of the figures: