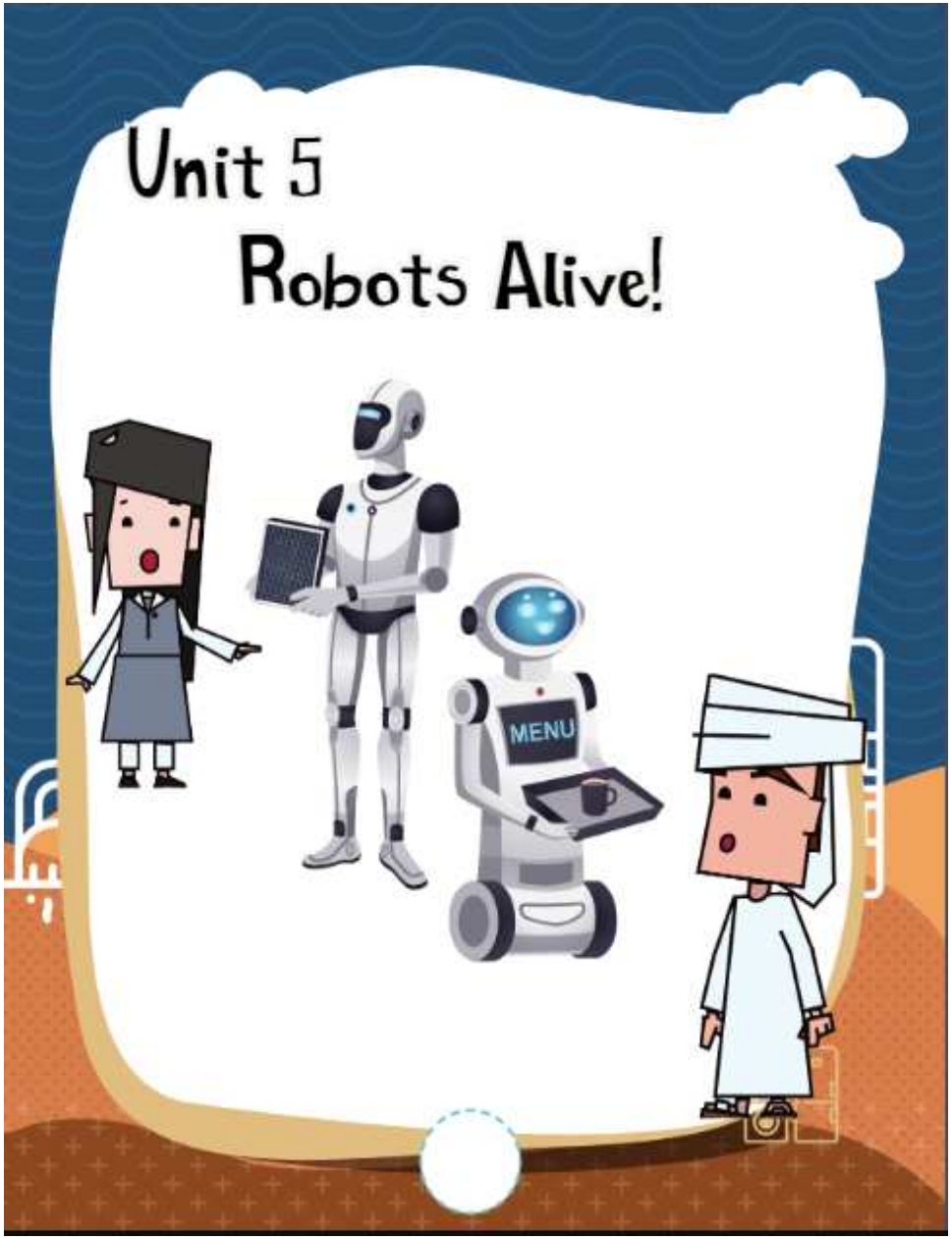
Unit 5
Robots Alive!



What is a Robot?

A **robot** is a machine that can do the work of a human.

Robots can be *automated*, or computer-controlled to do many different tasks.

Robots are a part of everyday life. Most robots today are used for jobs that repeat the same task. Robots are used for:

- fun and entertainment, like in playing computer games
- building machinery like cars
- carrying heavy items from one place to another

They can also be used in the military, in space exploration and for medical applications.

Here are some images of different types of robots.





Robots are like humans; they can ***sense*** things and respond to their senses.

They can sense light and sound, the way your eyes and ears do.

This means a robot can be ***programmed*** to '*think*' on its own.

Robotics is the science that studies the design, construction, operation, and application of robots. Robotics would not be possible without electronics.

The most important electronic part of a robot is its brain.

It allows the robot to interact with things around it. It is where all its '*thinking*' happens.

Input is when the robot senses things around it. In a robot, the **sensors** are the **inputs**.

Output is how the robot acts on what it senses.

Programmable 4 wheel drive robotic car

For example, a robot can turn its lights on, or make a sound if it senses danger.

It can also play music, follow a line and avoid obstacles.

Here is an example of inputand output.

You have been inside all day.

When you go out it is very bright, your eyes start to close, they are sensing the brightness (**Input**).You put your sunglasses on and can now see much better (**output**).

Robot's Brain

The microcontroller is the main control unit of any automatic system or device.

These systems and devices have:

- an **input unit** for collecting signals or sensing the signals from an environment
- a **control unit** for processing the received signals
- an **output unit** for sending out signals or controlling an output device

Programming Robots

To teach a robot to understand its **input** and to control its **output**, you need to use a set of commands or instructions.

The set of commands or instructions is called a **program**.

Worker programming a robot with a laptop

The robot's brain has programs that allow it to make decisions and *think* for itself.

The most amazing thing is that YOU get to write your robot's programs!

You can tell your robot how to think, behave and act in its environment.

To have full control of any robot, you need a programming tool.

Some tools use picture blocks to build a program and some tools use text code.

It is up to you to choose which tool you like or find eas y.

Picture blocks being used to program a robot

In *visual programming* , you can use blocks to create programs.

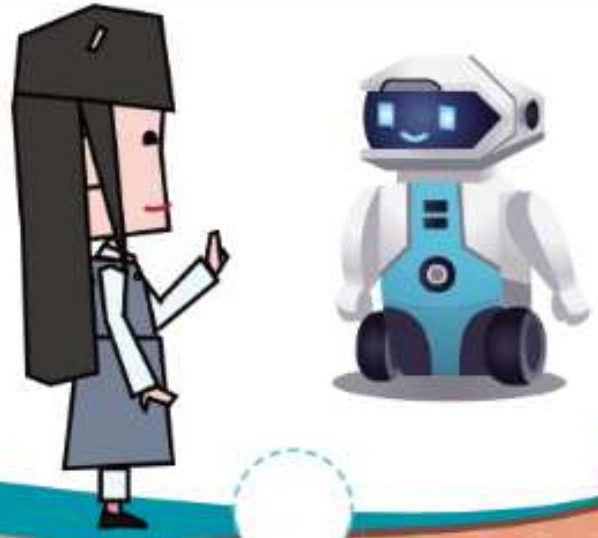
Behind each block of your program, there are tens or even hundreds of lines of code.

You can also drag and drop program elements, click, use menus, forms and dialogue boxes.

This type of programming helps you understand programming easily.

You will learn about these programming blocks, how to put them together and how to transfer them from your computer to the robot.

This is called, programmingthe robot. You will find out that programming the robot is very easy.



What Can Robots Do?

Robots can do many tasks. You can program a robot to:

- Track lines
- Follow light
- Avoid obstacles
- Sumo wrestle
- Bounce in borders
- Respond to your voice, music or sound
- Pick up objects

Getting Started

Usually before you can program a robot, you need to:

1. Know the robot's parts. You need to know where to find its sensors and what action the robot can do. There are many kinds of robots and they can do different tasks.

2. Get the robot ready to be used. For example, put in batteries that are suitable to the robot. Make sure that the batteries are in the correct way.

3. Learn the programming software that is used to program the robot. If you are not sure about something in the software, use the help guide that usually comes with the software. It has everything you need to know about software and sometimes with examples.

4. Check that your computer is programming and that the robot is working by downloading a test program.

Seeing in the Dark

Electromagnetic Waves

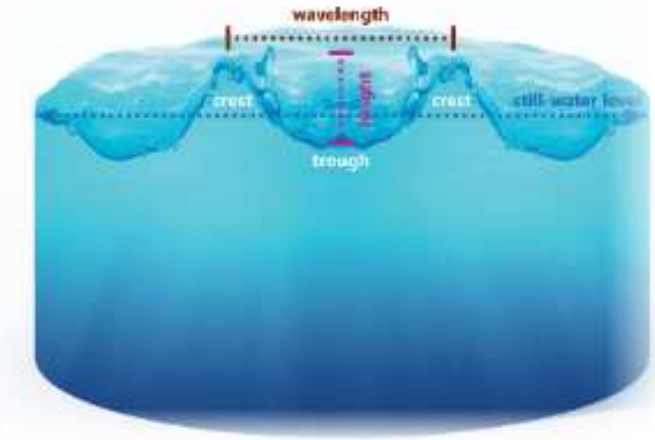
Have you listened to the radio, or used a microwave oven? Have you seen the X-ray machine in airports or hospitals? All of these devices use electromagnetic waves.

An *electromagnetic wave* is a stream or flow of photons.

A photon is a bundle of energy. Photons are always in motion and can transfer energy.

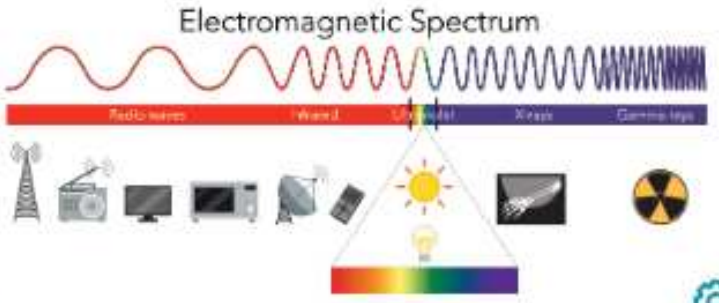
Just like an ocean wave, an electromagnetic wave has crests and troughs.

The wave length is the distance between one crest to the next crest.



Although radio waves, microwaves and X-rays are examples of electromagnetic waves, light is the only wave we can see.

Light travels in straight paths called light rays.



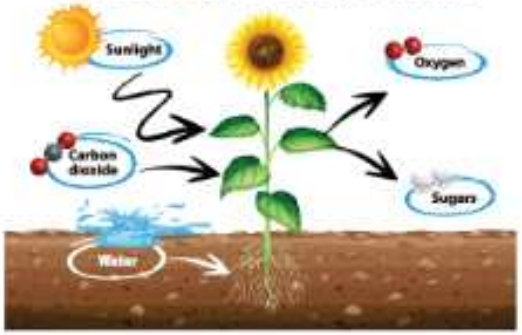
What is light?

Light is a form of electromagnetic *radiation* and represents energy transfer from the source to the receiver. Light is essential for lif e on Earth.

It lets us see the things around us.

Light gives energy to plants that change the energy to chemical energy through photosynthesis. Plants grow, produce oxygen and food for living creatures.

Process of Photosynthesis



Did you know?

Light rays can bend as they pass from one medium to another. This is called refraction of light. You can see this when you put a drinking straw in a glass of water, the straw seems to bend, but when to take it out it is straight. The straw looks bent because the light rays bend as they move from the air into the water and change direction.

When light rays pass through drops of water or a ***prism***, the light bends. As a result, the different colours that make up white light become separated.

This happens because each colour has its own ***wavelength*** and each wavelength bends at a different angle. When this happens in nature you see a rainbow.

The Speed of Light

The light from the sun takes about eight minutes to go 149 million kilometres to Earth. If you could drive to the sun at 100 kilometres per hour, it would take you 177 years to get there.

Did you know?

The speed of light in a vacuum is 299,792 kilometres per second, and in theory nothing can travel faster than light. If you could travel at the speed of light, you could go around the Earth 7.5 times in one second.

When scientists measure long distance space travel, they do not talk in kilometres but in ***light years*** because of the vast distances in space.

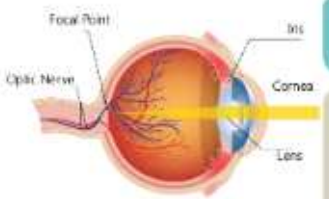
Light and the Human Eye

Have you ever wondered, how you are able to see things around you? How do your eyes work?

When light rays fall on the eye, they pass through the pupil of the eye.

The iris changes the size of the pupil depending on the amount of light.

It increases when there is less light and shrinks when there is more light.

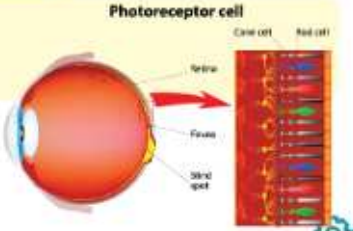


But what happens at the back of the eyeball?

A lens behind the pupil focuses the image onto the retina. The image is upside down, but the visual cortex in the brain helps you i dentify the image.

The retina is filled with *light-sensitive* cells called rodsand cones.

- **Rods**identify shapes.
- **Cones**identify colour.



Light Sensor

An ambient light sensor is used to detect light or brightness, just like the human eye does.

It can detect the light of its surroundings and nearby objects.

How Does It Work?

A light sensor is a sensor that measures the brightness of light based on its intensity. It converts the light intensity to an electrical value that can be measured. If the light intensity is high, the sensor gives a high value. If the light intensity is low, the sensor gives a low value. Light sensors come in different shapes and sizes.

Ambient light sensors are in many products and devices, like laptops and cell phones.

They sense the environment lighting conditions.

A screen's brightness needs to increase as the ambient light increases.

They can adjust the backlight of the screen to a comfortable level for the viewer, depending on the room's light.

When the light is low, it should decrease the brightness for comfortable viewing and to save battery life.

Light sensors are used to detect when it gets dark, and automatically turn on streetlamps.

Other light sensors are used to read the numbers from swiped credit cards.

Some robots have many light sensors on top of them

You can program the robot to take actions based on the value measured by each light sensor.

For example, you can program the robot to beep if its light sensor detects light, or to drive towards the brightest light source.

Application: Follow the Light

The light-following program is one of the most interesting programs that robots do.

The robot is programmed to read two light sensors, one on the right and one on the left and it then finds the difference between them.

Based on the difference value, the robot can drive toward or away from the light source.

Does this behaviour remind you of anything?

Did you know?

Phototropism is a behaviour normally found in plants. It is when plants growtowards the sun.

You can try this experiment at home using seedlings and a light source or put your plants on a window ledge. You can research examples of experiments on the internet.

Did you know?

Al Bahr Towers are two 145m high towers located in Abu Dhabi City. This building is special because it has a protective skin. It has 2000 glass parts shaped like umbrellas. These parts open when it is very sunny and close when it is not.

Flash LED Lights!

An LED is a light source that is different from the original light bulb invented by Thomas Edison. Most light bulbs use a filament or a special wire that shines when electricity passes through it, but LEDs do not.

LEDs are used everyday in many locations and for multiple purposes.

Did you know?

L.E.D. stands for Light Emitting Diode.

LEDs use advanced semiconductor material, the same material found inside computer chips.

Here are some everyday examples of LEDs being used.

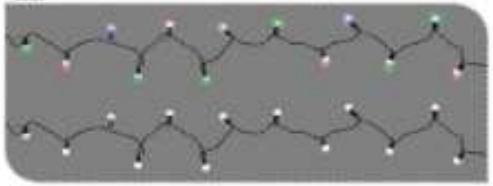
Why Use LEDs?

LEDs are better than ordinary light bulbs because they last longer, they do not break easily, and they use much less power.

How to Control an LED?

The LED light can be ON or OFF.

To control an LED, you need first to choose which LED you want to control and then choose if it is to be ON or OFF.



Staying on Track

Line Sensor

The line sensor, which is usually placed at the bottom of a robot, reads the ***reflected*** light.

The sensor shines light on the surface from an LED and then measures the amount of light that is reflected.

White reflects a lot of light, giving a high light reading and black reflects very little, giving a low light reading.

This sensor is different from other light sensors which read the ambient light level.

Application: Follow the Line

Line tracking is very important in the world of robotics as it gives the robot a precise, and easy to use ***navigation system***.

A line following robot is defined as a machine that follows a line, either a black line on a white surface or a white line on a black surface.

Some warehouses use these robots to move items around.

To do that, they use lines or markers on the ground to guide the robots to their destination.

Did you know?

Amazon bought a robotics company called Kiva Systems in 2012 for $775 million.

Kiva's robots automate the picking up and packing process at large warehouses to help Amazon become more efficient. Amazon now has 45,000 robots in its warehouses.

How Amazon Triggered a Robot Arms Race, June 30 2016, Bloomberg – Kim Bhasin & Patrick Clark

The line follower robots can also be used in restaurants to serve food.

These robots stop when their sensors detect someone reaching for food.

Others can respond to basic voice commands or be controlled by touch screens.

These robo-restaurants can be found in Japan, South Korea, China, and Thailand.

Many robotics competitions promote the line tracking concept, by adding lines on the playground for the robot to follow.

Sometimes, the only purpose of the competition is to race with other robots, following a line along a track.

Did you know?

"RobotChallenge is an international championship for self-made, autonomous, and mobile robots. It takes place annually in Vienna, Austria. Since 2004, more than 2,000 robots from all over the world have taken part in the competition."

www.robotchallenge.org

The line follower allows a robot to navigate a line-marked path by itself.

The idea of a line follower robot is simple.

The robot turns right to get on the line when it is off the line and turns left to get off the line when it is on it.

This means the robot moves from side to side on the edge of the line.

How Does It Work?

A line tracker is mostly made up of an infrared light sensor and an infrared LED. It works by shining the infrared light on a surface. The sensor then picks up the reflected infrared radiation and, based on its intensity, determines the reflectivity of the surface. White reflects a lot of light, giving a high light reading and black reflects very little, giving a low light reading.

You can create your own line to follow using black electrical tape on a white surface or using a black marker pen.

Application: Robot-Sumo

Robot-sumo is a sport in which two robots attempt to push each other outside the arena.

The arena is usually a circle like the sport of sumo.

There are two main challenges for the robots; to stay inside the arena and to find the opponent robot, and then push it outside the arena.

The two robots are placed inside the ring and started at the same time.