



## Learning notes

For teachers

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### Modelling radar or lidar in the classroom

Main Article: [How do cars see? Satellites: getting the big picture on Climate Change](#)

Both radar and lidar use the principle of sending out pulses of electromagnetic radiation, and measuring the time taken for the signal to be received by the sender. Knowing the speed of the waves we can work out the distance to the object. This could be used to measure changes in the sea level or the distance to a pedestrian on a road.

We can model this in the classroom using sonar. An example of its use for satellites is given in this video [www.youtube.com/watch?v=ZuedbXIO3vA](http://www.youtube.com/watch?v=ZuedbXIO3vA) but this equally applies to the principles used in lidar for self-driving cars.

#### Learning Task:

Ultrasound sensors, sometimes called motion sensors, are a commonly available piece of hardware, available from educational suppliers. They measure the time taken for pulses of high frequency sound to be reflected from an object. Associated software available with the sensor will then allow settings for time, distance, velocity or acceleration.

To enable students to understand the process of measuring the distance to an object using radar/lidar/sonar it is best for them to use the sensor to measure the time taken for the pulse to be received. By using a value for the speed of sound (approx. 340 ms<sup>-1</sup>), then can use the speed/distance/time equation to calculate the distance. They must be careful to divide the time taken by two, so they are calculating the distance to the object, rather than the round trip that the pulse has made.

They can create their own surfaces, with books or building blocks, and then compare their calculations to measured distances with a ruler. The sensor should be held in a clamp and moved laterally over the surface so that changes in distance are due to the surface only and not vertical movement of the sensor. An example is given in this [video](#).

#### Take your learning further:

Very accurate distance measurements are also used in GPS. These activities from the STEM Learning Quantum Ambassador Programme help students understand the principles behind satellite positioning systems.

Quantum Tech Student Activity GPS and Trilateration: [www.stem.org.uk/rxfktn](http://www.stem.org.uk/rxfktn)

#### Take your learning further still:

To measure very small changes in distance, interferometry can be used. This principle was used in the Michelson-Morley experiment, measuring the speed of light, in 1887. Now this principle has been used to directly detect gravitational waves. Start from 6:07 in this video to hear how interferometry is used in the Laser Interferometry Gravitational-Wave Observatory (LIGO).

Mini lectures: gravitational waves: [www.stem.org.uk/rxeuem](http://www.stem.org.uk/rxeuem)

## **To find out more:**

There are some great resources and information available to support GCSE and A'Level curriculums: Geography, Physics, Maths and Careers.

### **Radar: seeing the unseen**

This activity booklet uses the real-life context of air traffic control using radar signals to identify the position of an aeroplane. It provides students with an opportunity to use their knowledge of waves and speed = distance / time to calibrate and calculate the distance a plane is from the radar. [www.stem.org.uk/rxh2o8](http://www.stem.org.uk/rxh2o8)

### **Anna Hogg - Glaciologist**

Anna works at the University of Leeds. She uses satellite data to look at glaciers at the poles of the Earth using optical and radar data to track ice movement. She explains how she went to Greenland and Antarctica for field trips to obtain more data for her research. Anna explains how we need to study ice sheets since melting can cause sea levels to rise that will impact many of us across the globe. [www.stem.org.uk/rxfr65](http://www.stem.org.uk/rxfr65)

### **Radar Refractivity: Using Science to Help Forecast Thunderstorms**

A Catalyst article explaining how weather forecasts can help keep the public safe in extreme situations by providing advance warnings: for example, airline pilots rely on accurate information about the development of thunderstorms to help them decide which routes might be at risk from lightning or violent downbursts of air. Likewise, people on the ground need timely forecasts of such events as they are vulnerable to flash flooding and hail. This article describes how meteorologists measure the humidity of the atmosphere. [www.stem.org.uk/rxuts](http://www.stem.org.uk/rxuts)

### **Self-driving cars debate kit**

This pack has all you need to facilitate a structured debate on the controversial topic of whether a town centre ought to be for self-driven cars only. The structure shows students how to build a discussion and back up their opinions with facts. This activity is ideal for enhancing useful employability skill sets. [www.stem.org.uk/rxg85w](http://www.stem.org.uk/rxg85w)