How to make a wind turbine

Introduction

This worksheet describes the process of building a simple wind turbine which produces a voltage that can be measured in Scratch. The simplest way of doing this is to attach a pinwheel to a small electric motor and use the ExperiSense Board in conjunction with an Arduino to directly measure the voltage generated in ScratchX. For more information on the ExperiSense Board and ScratchX please refer to warwick.ac.uk/scratchresources.

Materials needed

1. Paper
2. Scissors
3. Blu Tack
4. ExperiSense Board
5. Crocodile clips
6. Arduino board
7. (Double sided) Tape or glue
8. Small electric motor

Building the Wind Turbine

1. Cut out a square section of paper around 10 cm in length and draw a diagonal line across the paper joining the corners.
2. Cut along each diagonal line from the corner to roughly 2 cm away from the centre.
3. Fold one side of each corner towards the centre and secure it with tape or glue.
4. Finally attach the pinwheel to the motor using Blu Tack.

Safety: Please note that you use these resources at your own risk. Correct use of some components requires care.
How does it work?

Electric motors contain a series of coils made from copper wire, which rotate in a stationary magnetic field. When a current is passed through the coils a force (the Lorentz force) is felt by the electrons as they move in the wire, resulting in a turning motion. Here we are using an electric motor as a generator, as the pinwheel spins, the coils inside the motor are also rotating and again a force is felt on the electrons in the wire but this time the force is acting to push the electrons around the wire producing a current.

Measuring the Voltage

Connect one of the wires to ground (GND) and the other to EXT1 using the crocodile clips. The “voltage on EXT1 (V)” block will now return a value equal to the voltage in Volts and can be used like any variable.
Plotting a Graph of Voltage Against Time

Now you have a variable which varies as a function of the voltage produced, this can then be used in Scratch in any number of different ways. In this worksheet we will look at how to plot the voltage measured against time on a graph.

Step 1: Drawing and labelling the axes. Draw your axes on the background using the line tool. Take note of the x and y position of the ends and zero point of your axes (if you hover your mouse over a point the x and y positions are shown at the bottom right corner of the stage). If you want to program a sprite to draw your axes for you see the back page.

Step 2: Plotting the data. We will use a sprite and the pen function to plot the data, it doesn’t matter what the sprite looks like because it will always be hidden. The y position of the sprite will depend on the voltage and the x position will just change by 1 after each measurement. An example script is shown below.

Note: My x-axis ranged from -200 to +200 and was at a y-position of -150. Insert the numbers that are relevant to your axes.
**Step 3: Scaling.** This step scales the graph so that it takes up a larger portion of the screen. My wind turbine can generate voltages up to around 1 V which corresponds to a 1 coordinate point move on the graph. To increase the vertical range of the graph just multiply the voltage value as shown below. You can then add a quantitative scale along your voltage axis if you wish. In the case shown below 0 V is at -150 and 1 V is at +150, so 30 points on the coordinate system corresponds to 0.1 V.

Note: Here I have multiplied the voltage by 300 but it is not necessarily the best value for you. You want to be able to use up as much of the screen as possible without going off the edge.
Extension Tasks

- Try and find a way to reduce the effect of noise on your graph.
- Try to create a race car that is powered by the wind turbine so that the more electricity generated the faster the car moves. Example can be found on our webpage: warwick.ac.uk/scratchresources.
- Try experimenting with different wind turbine designs and sizes. Which design produces the most energy?

Tips

- Blu Tack the bottom of the motor to the table so you don’t have to hold it.
- If you are tired of blowing on you wind turbine a fan can be used instead. A fan also helps if you want a standardised wind speed for comparing turbine designs.
- Want to keep things simple? Plot your graph without axes, just skip step 1.

Using a Sprite to Draw Axes

This is an elegant solution to drawing axis at specific coordinates on the stage. This is particularly helpful when trying to create a more qualitative graph as it allows you to easily chose the lengths and positions of the axes. A script for drawing a vertical axis from -150 to +150 and a horizontal axis from -200 to +200 is shown on the right.