

Give your Maths Lesson a 'Wow' by using Robots.

Lesson Plan for Using a Datalogger on an Autonomous Physical System and Analysing the Data produced on a Graph

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Aim of Lesson Users to program and run a prebuilt EV3 Lego robot to autonomously move, use a data logger with sensor to detect objects then interpret the data produced on a Graph.

Using Dataloggers Autonomously

Background

Robots today are roving Mars, collecting data in dangerous environments, hoovering our floors, lifting patients in hospital, building cars and entertaining us in films along with uses in surgery, in military surveillance and drones.

Driverless cars are being developed that are capable of sensing its environment and navigating without human input. The Workshop looks at similar technology, all be it on a simplified level, to detect objects, dark lines and sounds with sensors attached to a moving robot.



Diagram to show the path of a Google Self-Drive Car as it maps out the objects that are surrounding it.

Resources

- Prebuilt Lego EV3 Robot
- Ultrasonic sensor
- Light sensor
- Training mat
- EV3 Mindstorms Software

Extension activity. Add another sensor – colour/light and sound

Learning Path

1, Program robot to move forward and calculate distance to travel

2, Program robot to use Datalogger.

3, Download, run and upload the results of the Datalogger program

4, Produce Graphs from the Datalogging. Interpret and Analyse the main findings of the Graph.

Continuous testing, debugging, testing and debugging should occur to ensure that the robot completes the objective at every stage.

National Curriculum Coverage

- Design, write and debug goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts
- Use sequence, selection and repetition in programs, work with variables and various forms of input and output
- Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs

First discuss EV3 Mindstorms and give the basics of using the program (see Appendix 1)

STEP 1 Program robot to move forward and calculate distance to travel



Program the Robot to move forward along the mat for ONE rotation and measure the distance (cm).

Measure the total distance that the Robot is required to move. The number of rotations can be calculated by dividing the 'Total Distance' by 'Distance moved in ONE Rotation':



'Move Steering Block' showing Rotations

$$\text{Total number of Rotations} = \frac{\text{TOTAL distance (cm)}}{\text{Distance moved in ONE Rotation (cm)}}$$

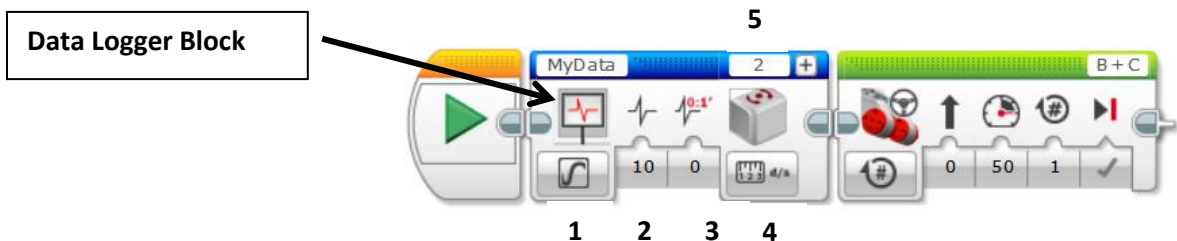
In Mindstorms, change the number of Rotations to the calculated number, amend and run the program. Check and debug if necessary. NB The EV3 Robot is more accurate if the speed is kept fairly slow (approx. 20% power).

Step 2 Program robot to use Datalogger

Using Mindstorms, add the data logger block from the blue (advanced) tabs and select:

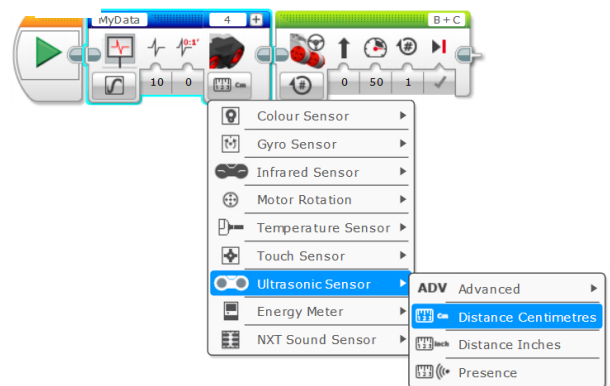
1. Oscillator On
2. Sample rate of 10 per second
3. Code 0 means rate per second
4. Sensor – Ultrasonic (or Colour/Light)
5. Port – where the sensor is plugged into the EV3

The data collected will be called **MyData**



Introduce outputs and inputs (see Appendix 2). Sensors are inputs and plug into the number ports on the EV3 and Motors are outputs and plug into the letter ports.

Select Ultrasonic Sensor in Datalogging Block and distance (cm).



Selecting Ultrasonic Sensor in Data logging Block

Finally add another Data Logging Block and select Stop in Oscillator Mode to give the following sequence to program the EV3 Robot.



Final program for Data logging with Autonomous Robot

STEP 3. Download the Datalogging program, run against a background with and without objects in the way

Download the Datalogging program onto the brick. With an ultrasonic sensor plugged in, run the program for the total distance as calculated in STEP 1 against a background approx. 35cm away from sensor.

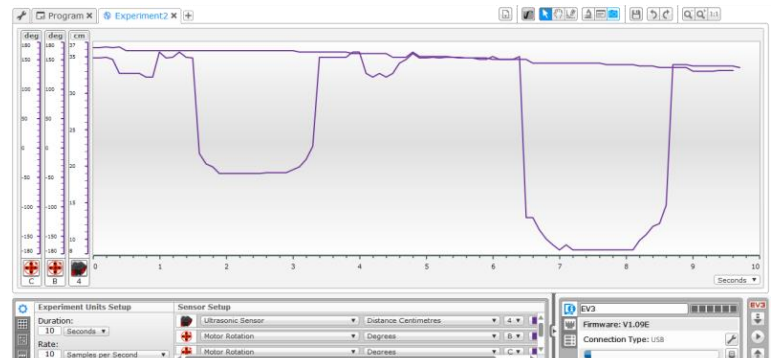
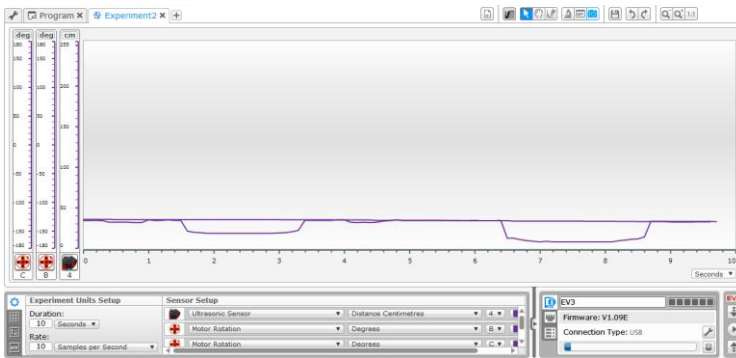
Upload the program from the brick by:

- On the programming tab bar, select the + sign and the choice of New Program or New Experiment appears
- Select New Experiment
- In the bottom right hand corner, select the upward arrow to upload.
- List of projects appears, select project and the submenu MyData and import



Run the program again and put two objects between the background and the robot. Measure the distance of object away from sensor to help predict. Upload the data again.

4. Produce Graphs from the Datalogging. Interpret and Analyse the main findings of the Graph



*Graphs to show the TWO experiments conducted by the Robot using the Ultrasonic Sensor.
(LHS non-magnified and RHS magnified)*

Firstly, the top line detecting the background and secondly, the bottom line, detecting two objects placed between the background and the sensor.

Students can interpret and analyse the graphs in many ways:

- The background measurement is a constant and shows as an approx straight line with the sensor 35cm away
- There were TWO objects placed between the ultrasonic sensor and the background at 17cm and 9cm

Other graph observations:

- Time to run program. X vs Y axis
- Time between objects
- It is possible to predict the outcome of the experiment by measuring distances and objects.
- Discuss possible limitations of equipment and measurements – need solid objects, the sensor on the ultrasonic fans out.

In addition, other sensors such as light/colour and sound can be used at the same time with datalogging experiments.

In Summary

Using the datalogging with Robots can enhance the analysis and interpretation of graphs in mathematics by pupils.

The Robot with datalogger makes graphs interactive, interesting and a real life future scenario.

APPENDIX 1

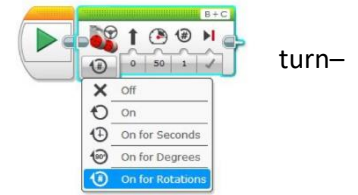
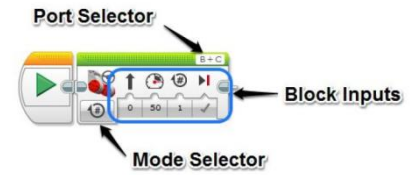
Basics of EV3 Mindstorms program

- **Move Steering Motor**

To make the robot move, instructions are sent to the motors which in turn drives the wheels. The Move Steering Block is used for this purpose

as this can change several parameters :

- **Mode** selects how you control the duration the wheels will On, Off, Time in seconds, Degrees OR Rotations

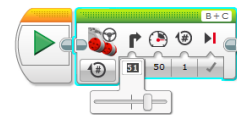


- **Steering direction**

Keep the steering on '0' to go straight ahead

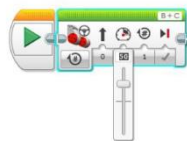


Adjust to steer at an angle



- **Power (speed)**

Set the power to 50% forward (-50 would be backwards)



Set the Rotations to '2'



- **Distance** - specifies how far the wheels will travel and is visible depending on the Mode selected

- Save the program by going to File > Save Project As and save with a short relevant name
- Downloading the program onto the EV3
Plug download lead into EV3 and click arrow in bottom right hand corner
- Running the program on the EV3



Select the program on the brick by clicking on the second icon on the screen. Go down the list of files until you find your program. Select then go down to submenu and run 'program'.

APPENDIX 2

Inputs and outputs

Definition

INPUT: An input is data that a computer receives. (Ref: BBC Bitesize)

OUTPUT: An output is data that a computer sends. (Ref: BBC Bitesize)

The ultrasonic sensor is an Input device as it receives information to enable a response. The motors are the Output as they react by turning as a result of the EV3 brick sending it information.