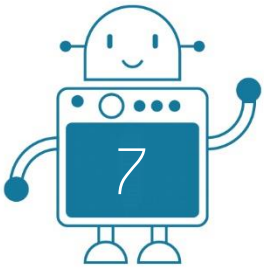

CALCULATION OF SPEED

STEMJAM Teaching Guide

Developing make spaces to promote creativity around STEM in schools
Acronym: STEMJAM
Project no. 2016-1-ES01-KA201-025470

www.stemjam.eu

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CALCULATION OF SPEED

ABSTRACT

The students' task is to write the programe – the robot is to move along the line. The engine speed is determined by specifying a number between 0 and 255. The main aim of the task is to calculate the robot speed and express it in unit m/s or cm/s

DIDACTIC OBJECTIVES

Technology and Physics:

- Monotonous movement, calculating speed.
- Physics: straight uniform motion.
- Identification and evaluation of experimental error.

STEM Subject: Science☐ Technology ☒ Engineering☒ Mathematics☐

Education Level: 12-14 years☒ 14-16 years☐

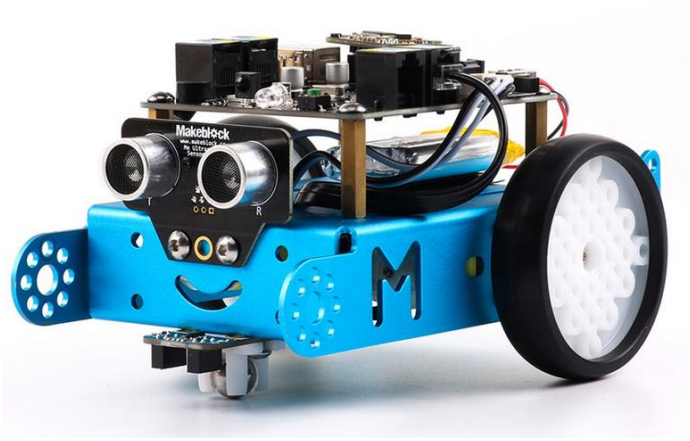
PROBLEM STATEMENT

Measure the robot speed in standard units (m/s) at different motor power (0..255).

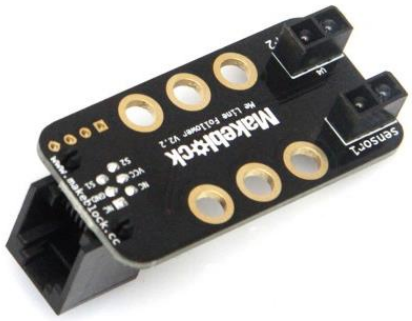
Evaluate the associated error bar on the measurements.

BOM (Bill of Materials Needed)

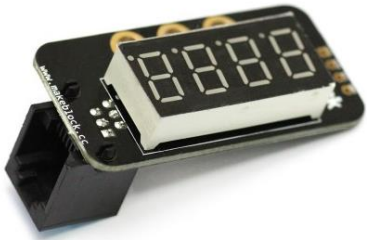
- mBot => Ref. 90054



❖ Me **Line Follower**:



❖ Me **7-Segment Serial Display - Red**:



❖ A board with black straight lines of 1m, 2m, 3m.

ELEMENT	ID	CABLE	AMOUNT	PORT 1	PORT 2	PORT 3	PORT 4	P.MOT1	P.MOT2
				Y B W	Y B W	Y B W Bl	Y B W Bl	W*	W*
Mbot Robot 2´4G			1						
Motor 1	W*		1					W*	
Motor 2	W*		1						W*
Me Led Matrix 8x16	B	(1)	1	B					
Me Line Follower	B	(1)	1		B				
RJ25 cables			2						
Structures and beams									
Laptops		usb	1						
Attrezzo (not essential)									

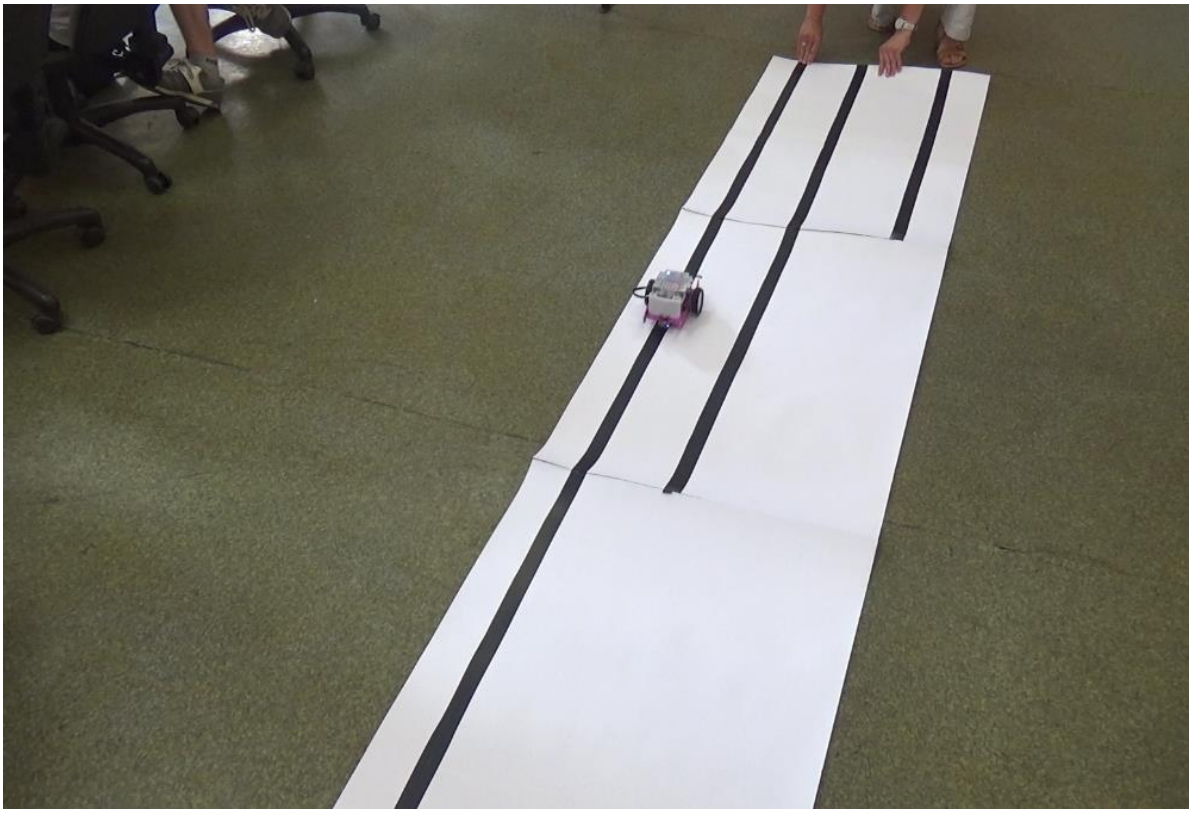
ACTIVITY DESCRIPTION

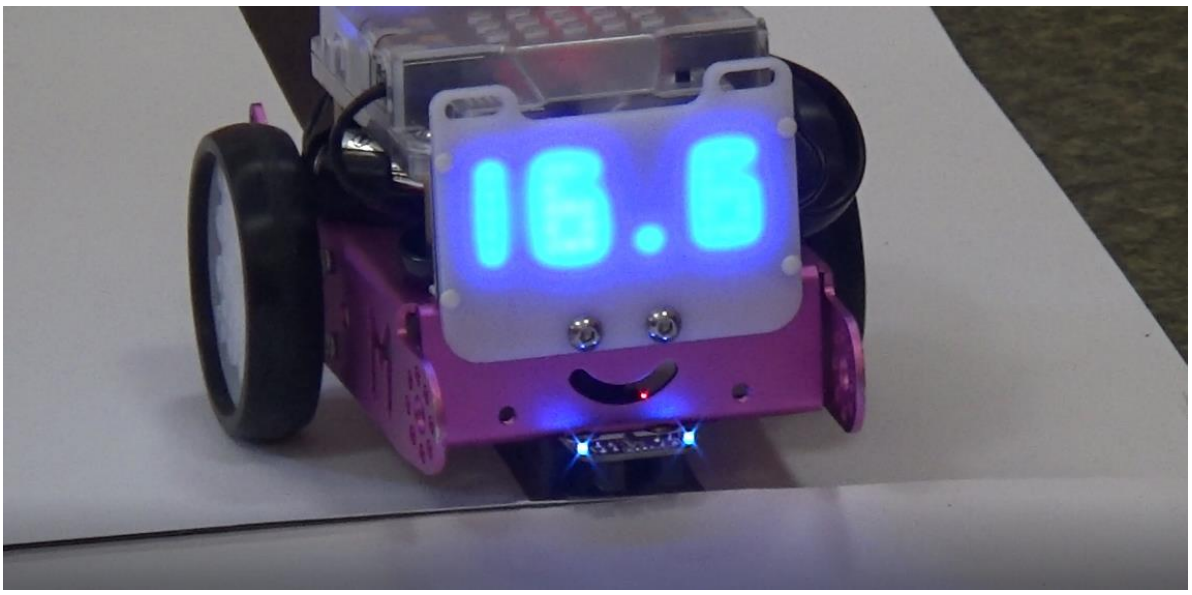
First version

Measure the robot speed in standard units (m/s) at different motor power (0..255).

Read the activity 1 (Line Follower) to be sure, that you understand the line follower sensor.

Students program the robot to follow the black line. The robot is set at the beginning of the black line. The robot is started when the button is pressed and released. It is also the countdown time. Once you reach the goal, that is, when the robot invades the white, the robot should stop and display the passage time on the display.





Students record travel time in seconds in the table:

Engine power	1m	2m	3m
50			
100			
150			
200			
250			

Using the formula, speed = road / time is calculated the speed for each passage

Second version

Evaluate the associated error bar on the measurements.

The measurement is repeated ten times on each track, in order to improve the statistics. Data are recorded in tables similar to the following

Motors power = 75

S [m]	t [s]	v [m/s]
1	10,808	9,252
	10,726	9,323
	10,76	9,294
	10,644	9,395
	10,741	9,310
2	21,501	9,302
	21,526	9,291
	21,538	9,286
	21,517	9,295
	21,478	9,312

$v_{media} = (9{,}30 \pm 0{,}05)\ 10^{-2}$ m/s

Motors power = 150

S [m]	t [s]	v [m/s]
1	5,049	19,805
	5,157	19,392
	4,967	20,131
	5,024	19,903
	4,949	20,208
2	9,94	20,120
	10,043	19,915
	10,229	19,552
	9,966	20,068
	9,877	20,250

$v_{media} = (19{,}9 \pm 0{,}3)\ 10^{-2}$ m/s

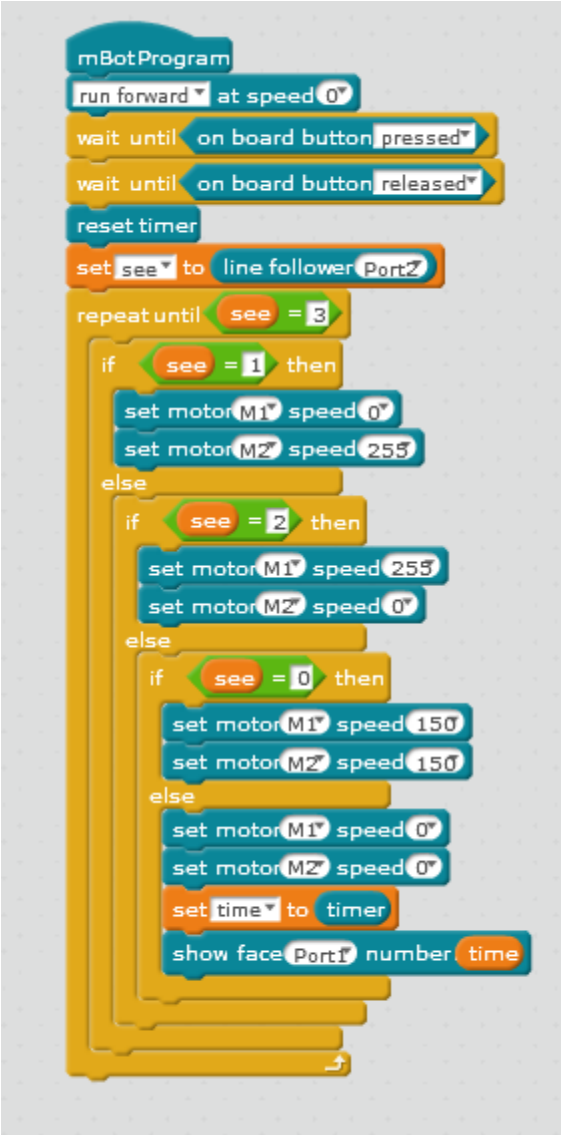
Motors power = 180

S [m]	t [s]	v [m/s]
1	4,328	23,105
	4,424	22,602
	4,357	22,950
	4,284	23,340
	4,163	24,021
2	8,857	22,580
	8,528	23,452
	8,617	23,211
	8,67	23,068
	8,733	22,902

$v_{media} = (23{,}1 \pm 0{,}4)\ 10\text{-}2$ m/s

Students use statistic method to count average speed.

Black line tracking program. White colour means stopping the robot. There is time of passage displayed on LED screen



The table shows the time of passages in seconds:

	time [s]	distance [m]		
		1	2	3
Engine power	50	21,9	37,8	56,5
	100	7,71	15,6	23,3
	150	4,96	10	14,9
	200	3,94	7,99	12,3
	255	3,58	6,86	10,3

Next table shows the speed in m/s

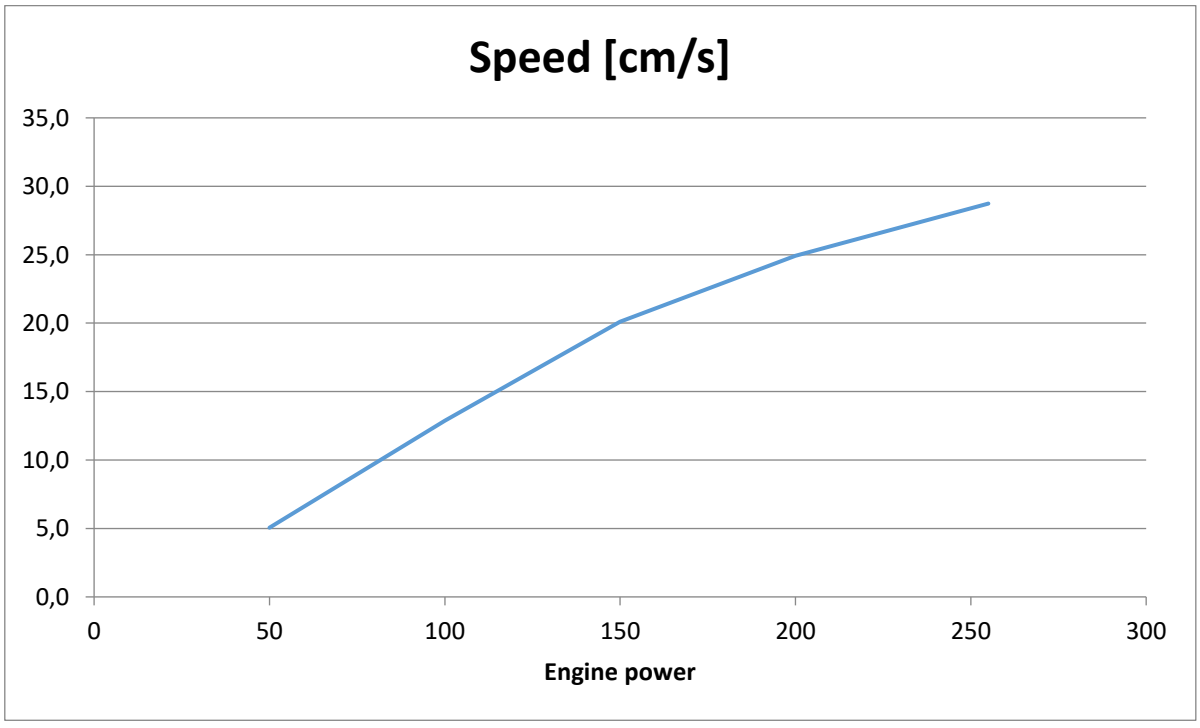
	1m	2m	3m
50	0,045662	0,05291	0,053097
100	0,129702	0,128205	0,128755
150	0,201613	0,2	0,201342
200	0,253807	0,250313	0,243902
255	0,27933	0,291545	0,291262

Average speed m/s
0,050556499
0,128887393
0,200985062
0,249340812
0,287378978

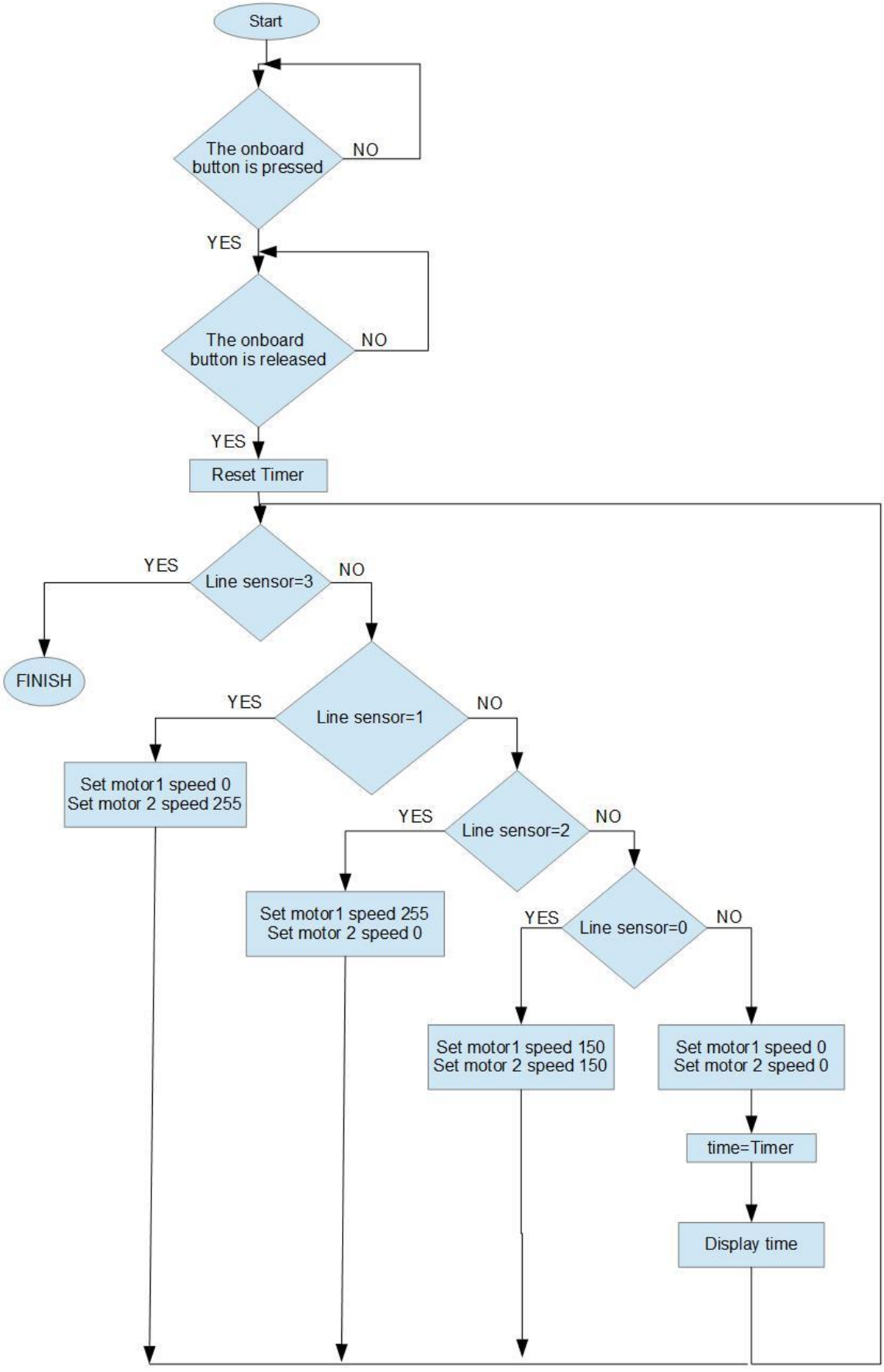
More practical is to use units cm/s:

	1m	2m	3m
50	4,56621	5,291005	5,309735
100	12,97017	12,82051	12,87554
150	20,16129	20	20,13423
200	25,38071	25,03129	24,39024
255	27,93296	29,15452	29,12621

Engine power	Avarage speed [cm/s]
50	5,1
100	12,9
150	20,1
200	24,9
255	28,7



FLOW CHART


Start
The onboard button is pressed
NO
YES
The onboard button is released
NO
YES
Reset Timer
YES
Line sensor=3
NO
FINISH
YES
Line sensor=1
NO
Set motor1 speed 0
Set motor 2 speed 255
YES
Line sensor=2
NO
Set motor1 speed 255
Set motor 2 speed 0
YES
Line sensor=0
NO
Set motor1 speed 150
Set motor 2 speed 150
Set motor1 speed 0
Set motor 2 speed 0
time=Timer
Display time

STUDENT'S EVALUATION

Students will change the program - they change the speed of the mBot. They describe the course of the experience. They can calculate the speed with given time and distance.

The activity is suitable for students who are 12-13 years old, even with no preconditions.

For students (15 years) we also added the estimation of experimental error bars The next step is to extend the measurements to accelerated motion.

BIBLIOGRAPHY

http://www.makeblock.com/

https://www.youtube.com/watch?v=LE-SOkW1xQM

SCALABILITY

The design is based on students with "zero" preconditions