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# AREA OF FIGURES

# ABSTRACT

The students' task is to count the area of figures (rectangle, parallelogram, rhombus) by using the robot. The robot is equipped with a line sensor. There is a table with the robot speed expressed in cm/s.

# **DIDACTIC OBJECTIVES**

To know different geometric figures and know the area and perimeter of each of these.

STEM Subject: Science

Technology ⊠

Engineering

Mathematics 🖂

Education Level:

12-14 years⊠

14-16 years  $\Box$ 

# **PROBLEM STATEMENT**

#### **First version**

mBot counts the area of figure bounded by a black tape. Students use data from activity "Speed of robot". The idea is to use formula s= v\*t

#### Second version

Students use ultrasonic sensor to measure the distance.

mBot will help the students to calculate distances, as well as the areas and perimeters, since it will ask the student to place him in the ideal position to be able to perform the operation independently.



# BOM (Bill of Materials Needed)

➢ mBot => Ref. 90054



✤ Me LED Matrix 8 × 16:



✤ Me Line Follower:



✤ Me Ultrasonic Sensor:





- ✤ 3D figures or draw in a paper.
- ✤ A cardboard that acts as a stop to calculate the distance.

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



# **ACTIVITY DESCRIPTION**

#### First version.

Students will get paper sheets with a geometric figure. The students' previous activity was to construct a robot that calculates the pasage time in black sections. There is a table with robot speed:

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

The robot shows the passage time through sections. These results are entered into the program to count the area of figure.









The robot speed is showed in the 'counting the figure area' program. The speed of the robot is constant for every passing. You can read the robot speed from the table. After that we give the passage time on both sides of the rectangle. Time is used to calculate the stretches length. We count the area of figure according to the formula and display it.

Height or diagonals are used for rhombus and parallelogram. Students are allowed to place/stick the missing pieces of the figure.





The program to count the time you can find below. Upload it to the mBot board.

Black line tracking program. White color means stopping the robot.

There is time of passage displayed on LED screen

mBotProgram
run forward T at speed 0
wait until on board button pressed
wait until on board button released
reset timer
set see to line follower Port2
repeat until (see) = 3
if see 1 then
set motor M1 speed 0
set motor M2 speed 255
else
if see = 2 then
set motor M1 speed 255
set motor M2" speed 0"
else
if (see) = 0) then
set motor M1 speed 150
set motor M2 speed 150
set motor M1 speed 0
set motor M2 speed 0
set time to timer
show face Ports number time

when p v key pressed	
say The area of rectangle	X: -
ask Give the speed [cm/s] and wait	y.
set V 🔻 to answer	
ask Give the time of passage on first side and wait	
set a 🔻 to answer	
ask Give the time of passage on second side and wait	
set <b>b</b> to <b>answer</b>	
set ad v to a * v	
set bd v to (b) * v)	
say ad * bd	

Counting rectangular area program.

This program is running on PC. To put the data use keyboard.

Other programs have the same code. The final formula/design and descriptions in the ask block are changed.



# Second version

First, we connect the ultrasonic sensor and led matrix to mBot:



Now, we start to program the code. First, we program the square code, so it is the easiest:

when clicked show face Dort? x: 0 y: 0 characters: set led on board () red () green () blue (50) set area edge? to 0 set area TOTAL to 0 Question_Edge define Save Answer EDGE	define Question_Edge set led on board II red 0 green 0 blue 150 set xPos_text to 10 forever show face Port# x: xPos_text y: 0 characters: How many cm measures the edg ? change xPos_text by 0 wait 0.0005 secs if xPos_text < 18 then Save Answer EDGE
set led on board () red (255) green () blue () forever if ultrasonicsensor Dork? distance > 350, then show face Port? number () else show face Port? number () if on board button pressed then set area edge to ().25 * ultrasonicsensor Port? distance () calculate_Area	define Calculate_Area set led on board lip red () green 150 blue 150 set xPos_text to 10 forever show face Port4 xx xPos_text y: () characters : The area of square if change xPos_text () () wait ().000-secs if xPos_text <=13 then Answer 
define Answer set led on board IIP red O green O set area TOTAL to (area_edge * ar forever show face Port? number{ area_TO	ea_edge)



To make this, we need three variables and four blocks.

Data&Blocks Robots
Make a Variable
area_TOTAL
area_edge
▼ xPos_text
set xPos_text V to 0
change xPos_text V by 1
show variable xPos_text V
hide variable xPos_text 🔻

- area\_TOTAL => it uses for show the value of all the area
- area\_edge => it uses for save the value of one edge.
- xPos\_text => it uses for the text that display on Led Matrix can be move.



- Question\_Edge => this block it uses for the mBot ask us to calculate the distance of an edge.
- Save Answer EDGE => together with the "area\_edge" variable, this block it uses for save the value that mBot calculate.
- Calculate\_Area => it uses for to announce the total area of the square.
- Answer => it uses for alculate the area and shows on Led Matrix the result of calculate the area.

Next, we explain the different blocks of the code:





When we click in the green flat, the program will be start. We initialize the variables to 0 and mBot will ask the question:

define Question_Edge																
set led on board all red 💽 gree	an OT	Ы	ie 🖸	50												
set xPos_text to 10		ч 	х х	· · ·												
forever																
show face Port4 x: xPos_text	y: 🕻	) ch	ara	ter	low	ma	ny	cm	me	eas	sur	es	the	2 60	dg	?
change xPos_text by -1	* *					. *	. 1		•							
wait 0.0005secs																
if xPos_text < -180 then																
Save Answer EDGE																

We initialize the "xPos\_text" to 10 because the first letter of the question appears to right.

Every 0.0005 the letters will be moving through the matrix of Leds.

When the whole question has been visualized, we will move on to the next block.

define Save Answer EDGE
set led on board all? red 255 green 0? blue 0?
forever and a second
if ultrasonicsensor Port3 distance > 390 then
show face Port4 number 0
else
show face Port4 number 1,25* ultrasonicsensor Port3 distance
if on board button pressed then
set area_edge* to 1,25 * ultrasonicsensor Port3 distance)
Calculate_Area
🔁 📕 🖉 🖉 🕹 🗠 a series de la companya de la comp

To avoid possible confusions, the mBot when it does not detect anything shows in the array of LEDs 400, therefore, to avoid it, we indicate that if the distance is higher than 390, it shows 0.

When the distance is less than 390, we can save in the "area\_edge" variable the distance that is being calculated at that moment. To do this, press the button on the board.



**Note**: As you can see, the distance that the ultrasound sensor calculates is multiplied by 1.25. This is because the ultrasound sensor has a desviation, so by applying this correction factor, we get the calculation to be correct. In "More Information" section, we explain this more detailed.

a second
define Calculate_Area
set led on board all' red 0' green 150 blue 150
set xPos_text to 10
forever the second seco
show face Port4 x: xPos_text y: 0 characters: The area of square is
change xPos_text by -1
change xPos_text by -1
change xPos_text by -1 wait 0.0005secs
change xPos_text by -1 wait 0.0005secs
change xPos_text by -1
change xPos_text by -1 wait 0.0005secs
change xPos_text by -1 wait 0.000 secs if xPos_text < -130 then
change xPos_text by -1 wait 0.000 secs if xPos_text < -130 then

mBot display on the Led Matrix: "the area of square is:"

	'									
define Answer	1.1									
set led on board	all	rec	0	) gr	eer	0	ы	ue	150	
set area_TOTAL	to <b>(</b>	are	a_e	edge	•	a	ea	_ed	ge	
forever	1			1			1			
show face Por	t47) n	ium	ber	ar	ea_	то	TAL			
							1			

Since the area of the square is the a<sup>2</sup>, we perform this calculation and the mBot will show the result obtained.

For calculate the perimeter, is the same, but in the "Answer" block, the edge will be multiplied by 4.





To calculate the area of the triangle, the mBot first will ask us to calculate the base and then the height, and it will determine the area.

when /= clicked	define Question_Area_Base
show face Port4 x: 0 y: 0 characters:	set led on board all red 07 green 07 blue 150
set led on board all' red 0' green 0' blue 150	set xPos_text to 10
set area_base to 0	forever
set area_height to 0	show face (Port#) x: xPos_text y: 0 characters: How many cm does the base measures?
set area_TOTAL to 0	change xPos_text by 1
Question_Area_Base	wait 0.000 <sup>5</sup> secs
	if <pre>xPos_text &lt; -21</pre> then the
	Save Answer BASE
	nen <mark>- Eller</mark> in enen en enen en en en en en en en en e
define Save Answer BASE	
set led on board all red 255 green of blue of	
forever	define Question_Area_Height
if ultrasonicsensor Port3 distance > 390 then	set led on board all red 0 green 150 blue 0
show face Port4 number 0	set xPos_text to 10
else else else else else else else else	forever a statistic to the second statistic to the sec
show face Port4 number 1,25* ultrasonicsensor Port3 distance)	show face Port4 x: xPos_text y: 0 characters: How many cm is the heigh ?
if on board button pressed then	change xPos_text by -1
set area base to 1,25 * ultrasonicsensor Port3 distance)	wait 0.000 secs
	if xPos_text < -160 then
Question_Area_Height	Save Answer HEIGHT

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define Save Answer HEIGHT set led on board III red 255 green () blue () forever if ultrasonicsensor Port3 distance > 390 then show face Port4 number () else show face Port4 number (1.29 * ultrasonicsensor Port3 distance) if on board button pressed then	define Calculate_Area set led on board all red 0 green 150 blue 150 set xPos_text to 10 forever show face Port x: xPos_text y: 0 characters: The area of triangle I: change xPos_text by 1 wait 0.000 secs if xPos_text < -15 then
set area height to 1.25 * ultrasonicsensor Port3 distance	Answer
define Answer	
set led on board all?	red 💽 green 💽 blue 150
set area_TOTAL to forever show face Port47 nu	area_base * area_height / 2

And for calculate the triangle's perimeter, mBot will ask you how many cm measures each edge and then it calculate the total perimeter:

when 🎘 clicked	define Question_Perimeter_Edge1
show face Port4 x: 0 y: 0 characters:	set led on board all red 0 green 0 blue 150
set led on board all red 0 green 0 blue 150	set xPos_text to 10
set perimiter_edge1" to 0	forever to the test of test
set perimiter_edge2 to 0	show face Port47 x: xPos_text y: 0 characters: How many cm measures the first edge?
set perimiter_edge3 to 0	change xPos_text by -1
set perimeter_TOTAL to 0	wait 0.0005secs
Question_Perimeter_Edge	if <b>xPos_text &lt; -22</b> then had a ball a ball of a ball
	Save Answer EDGE1
define Save Answer EDGE1	
set led on board all? red 255 green () blue ()	
forever sector and the sector of the sector	define Question_Perimeter_Edge2
if ultrasonicsensor Port3 distance > 390 then	set led on board all? red 0? green 150 blue 0?
show face Port4 number 0	set xPos_text to 10
else de la constant d	forever the second s
show face Port4 number 1,25* ultrasonicsensor Port3 distance	show face Port4 x: xPos_text y: 0 characters; How many cm is the second edge?
if on board button pressed then	change xPos_text by -1
set perimiter_edge1 to 1.25 * ultrasonicsensor Port3 distance)	wait 0.000 secs
Question_Perimeter_Edge2	if xPos_text < -16 then a substantial substant
na <mark>luzza de constante de</mark>	Save Answer EDGE2
define Save Answer EDGE2	
set led on board all red 255 green 0 blue 0	define Question_Perimeter_Edge3
forever forever the second	set led on board all? red 07 green 150 blue 07
if ultrasonicsensor Port3 distance > 390 then	set xPos_text to 10
show face Port4 number 0	forever
else de la companya d	show face Port47 x: xPos_text y: () characters; How many cm is the third edg ?
show face Port4 number 1.25* ultrasonicsensor Port3 distance	change xPos_text by -1 wait 0.0009 secs
if on board button pressed then in a sub-statistical statistical statis	
set perimiter_edgeZ to 1.25 * ultrasonicsensor Port3 distance)	if xPos_text < -16 then
Question_Perimeter_Edge3	Save Answer EDGE 3
and a second	









# First version

Program to count the area of rectangle





Program to measure the time of passing









# STUDENT'S EVALUATION

#### First version

Students can use the formula to calculate the road when they know the time and speed. Students write the program for calculating the area of other figures such as trapezoid or deltoid.

#### Second version

For evaluate the student's competence, first, the teacher should teach different geometric figures, and how the area and perimeter of each one is calculated, then make those figures in 3D or printed on a paper, and with the help of mBot, put into practice the theory given by the teacher.

After all this process, it would be best to perform a practical exam, without the help of mBot, to check that the student has understood the geometry



#### SCALABILITY

The scalability of this activity, would consist of programming different geometric figures increasingly complex.

#### MORE INFORMATION

With the help of a meter, we realized that the ultrasound sensor measured less than the real measurement, so we decided to make a table with the real measurement and the measure calculated by the mBot, in this way we could calculate a correction factor to make the measure of the mBot as accurate as possible.

Real Measure (cm)	MBOT measure (ultrasonic sensor)	Difference
10	8,5	1,5
20	15,1	4,9
30	23,4	6,6
40	30,8	9,2
50	39,6	10,4
60	46,9	13,1
70	53,4	16,6
80	62,6	17,4
90	70,3	19,7



Real Measure

