AREA OF FIGURES

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

Co-funded by the Erasmus+ Programme of the European Union

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☐

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

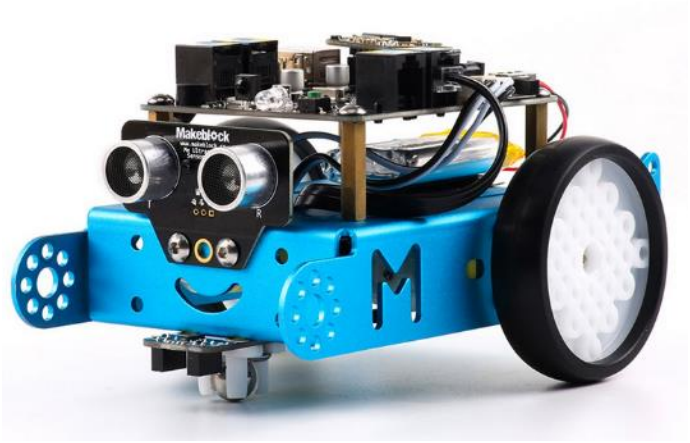
Second version

Students use ultrasonic sensor to measure the distance.

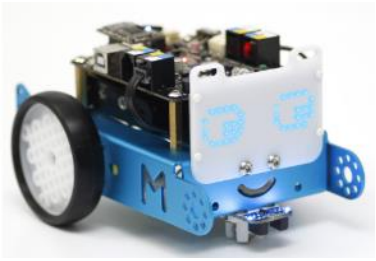
mBot will help the students to calculate distances, as well as the areas and perimeters, since it will ask the student to place him in the ideal position to be able to perform the operation independently.

BOM (Bill of Materials Needed)

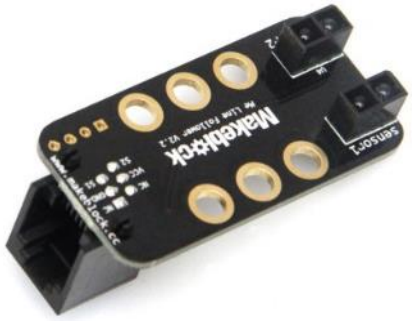
- mBot => Ref. 90054



- 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.

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)																			

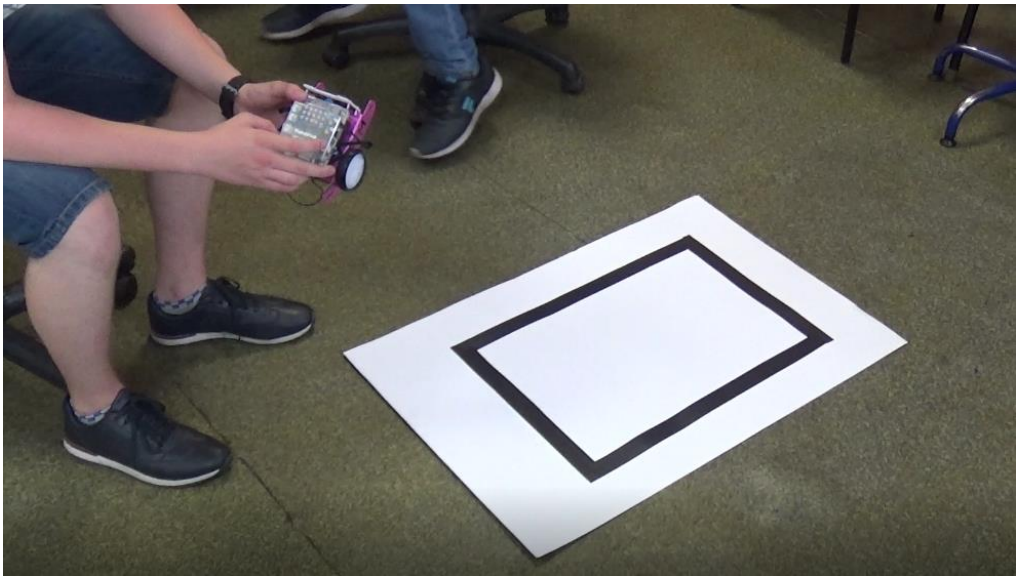
ACTIVITY DESCRIPTION

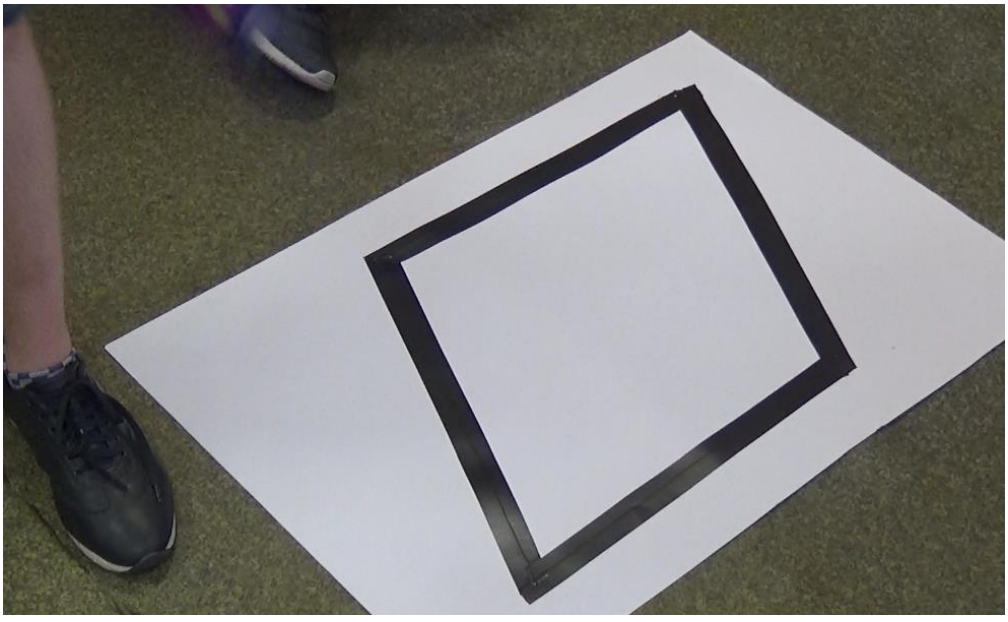
First version.

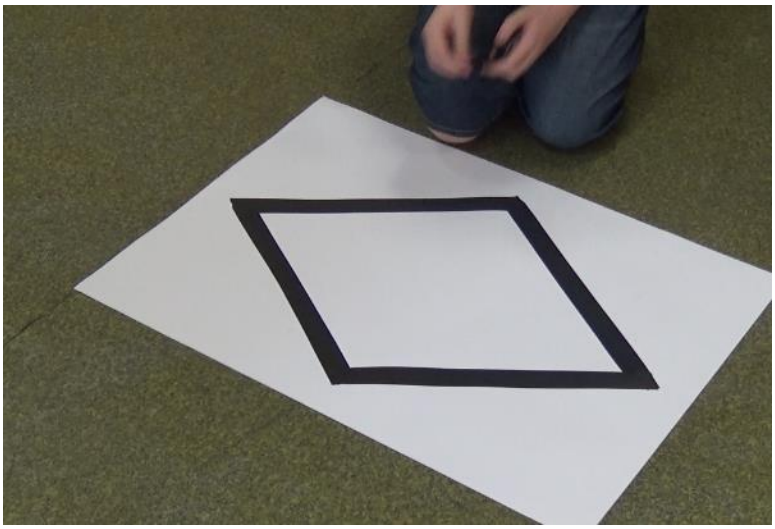
Students will get paper sheets with a geometric figure. The students' previous activity was to construct a robot that calculates the pasage time in black sections. There is a table with robot speed:

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.

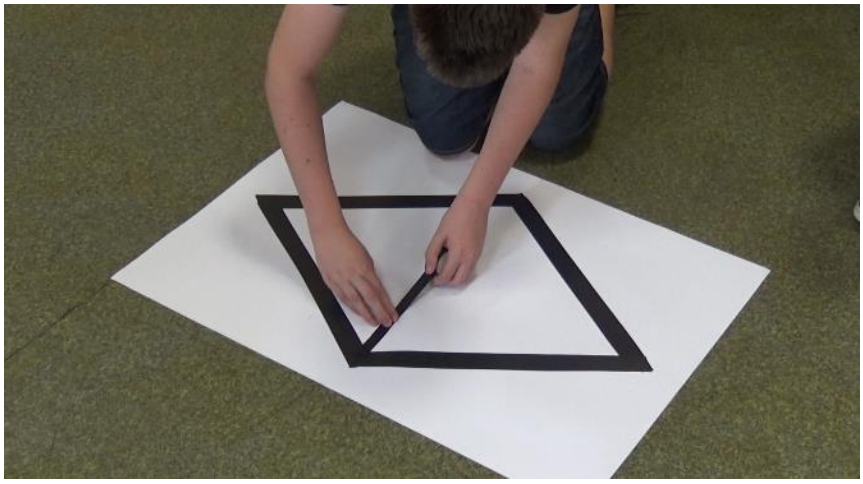


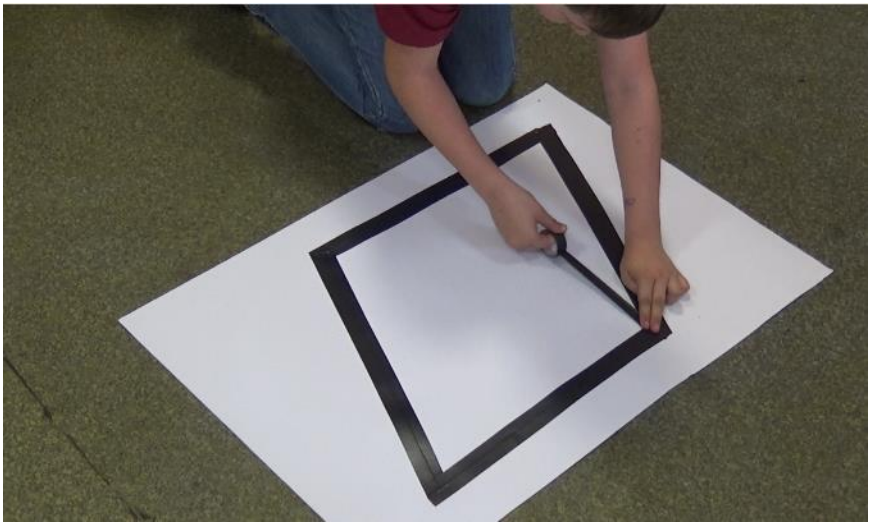




The robot speed is showed in the ‘counting the figure area’ program. The speed of the robot is constant for every passing. You can read the robot speed from the table. After that we give the passage time on both sides of the rectangle. Time is used to calculate the stretches length. We count the area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

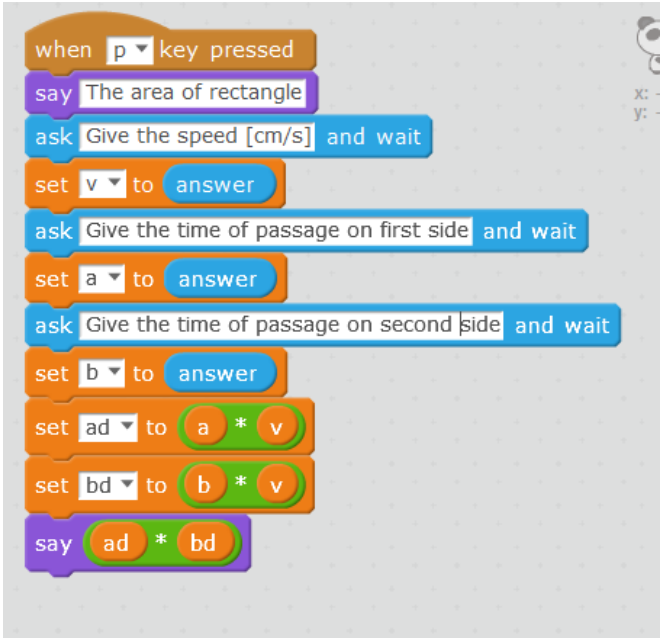




The program to count the time you can find below. Upload it to the mBot board.

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

There is time of passage displayed on LED screen



Counting rectangular area program.

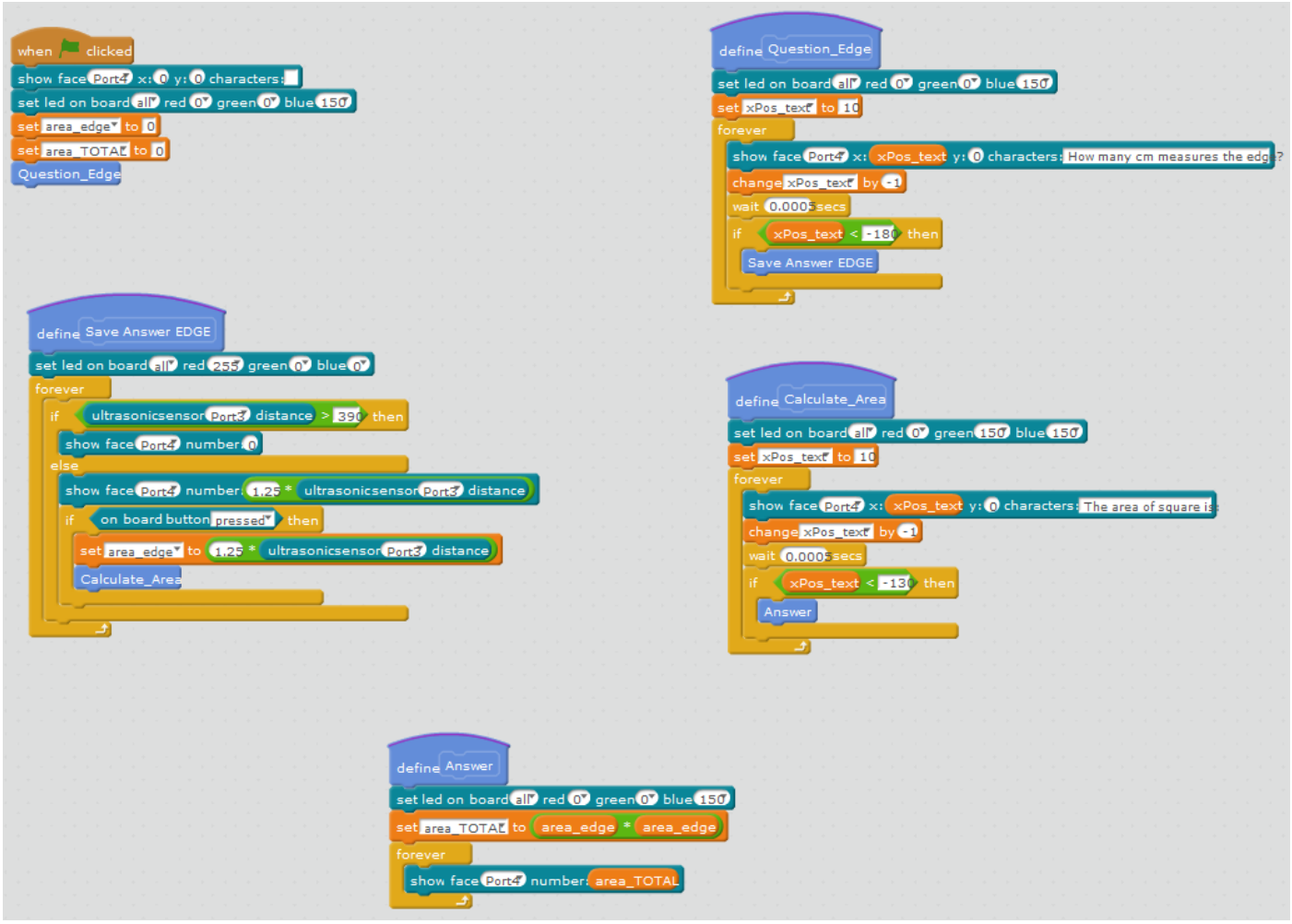
This program is running on PC. To put the data use keyboard.

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

Second version

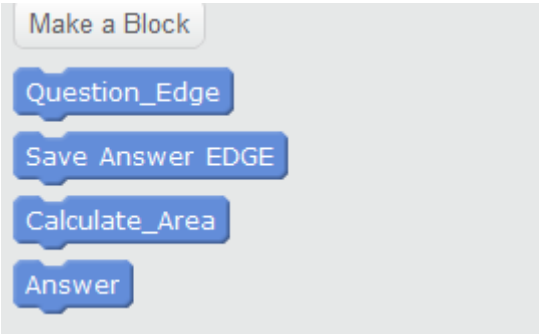
First, we connect the ultrasonic sensor and led matrix to mBot:

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



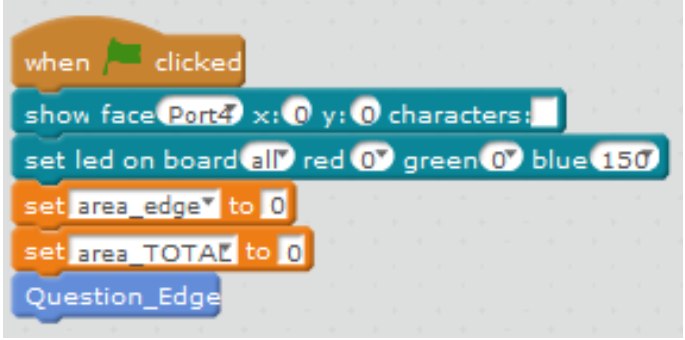
To make this, we need three variables and four blocks.

- 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.

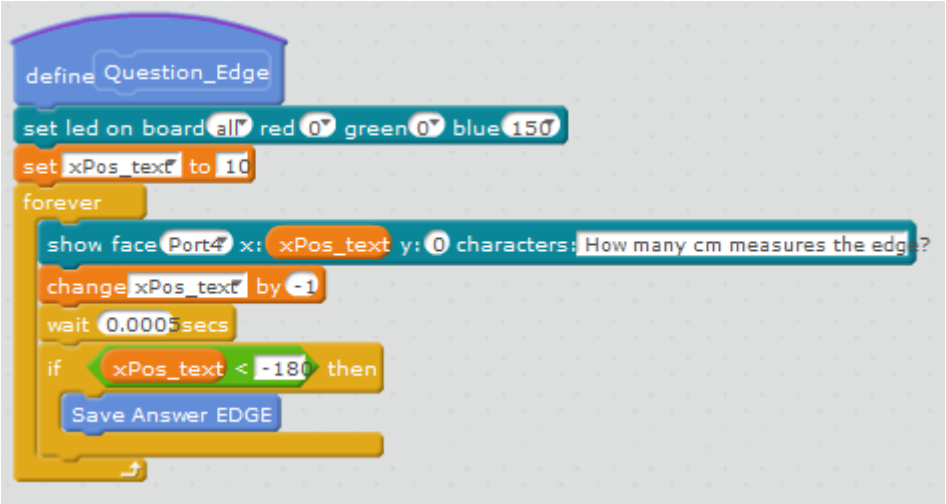


- Question_Edge => this block it uses for the mBot ask us to calculate the distance of an edge.
- Save Answer EDGE => together with the “area_edge” variable, this block it uses for save the value that mBot calculate.
- Calculate_Area => it uses for to announce the total area of the square.
- Answer => 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:



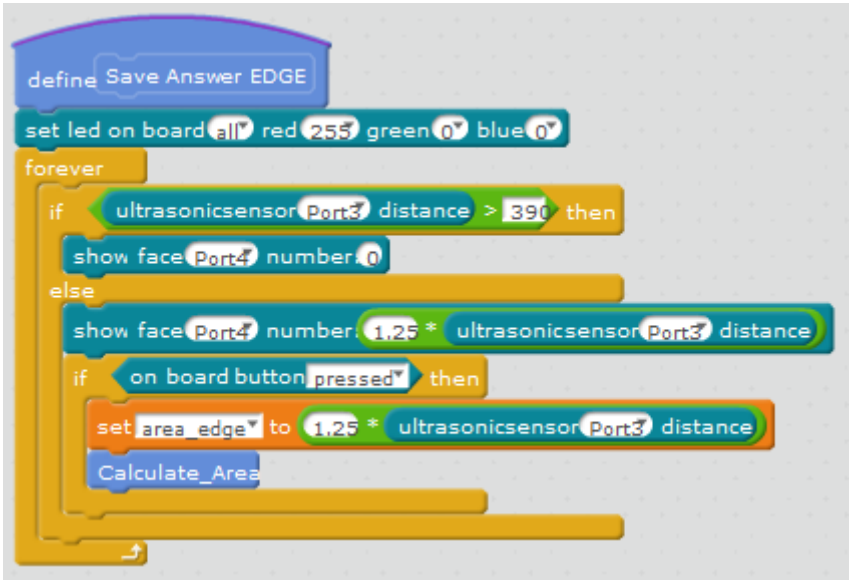
When we click in the green flat, the program will be start. We initialize the variables to 0 and mBot will ask the question:



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.

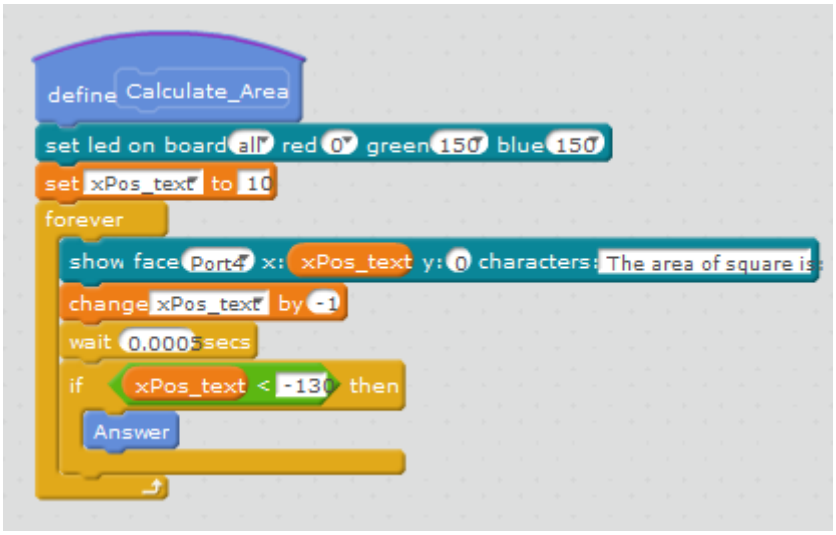
When the whole question has been visualized, we will move on to the next block.



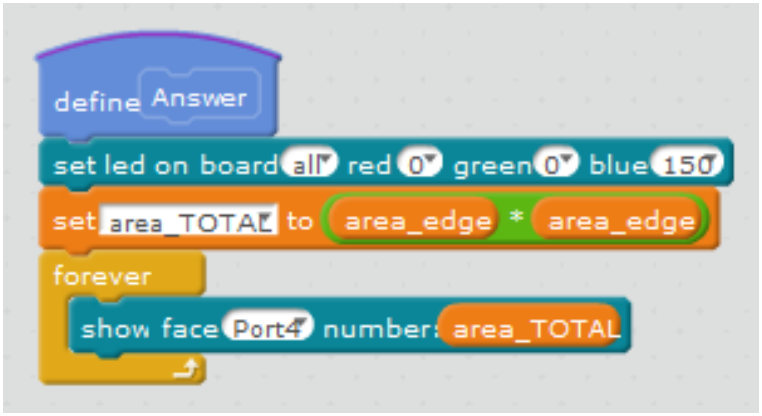
To avoid possible confusions, the mBot when it does not detect anything shows in the array of LEDs 400, therefore, to avoid it, we indicate that if the distance is higher than 390, it shows 0.

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.

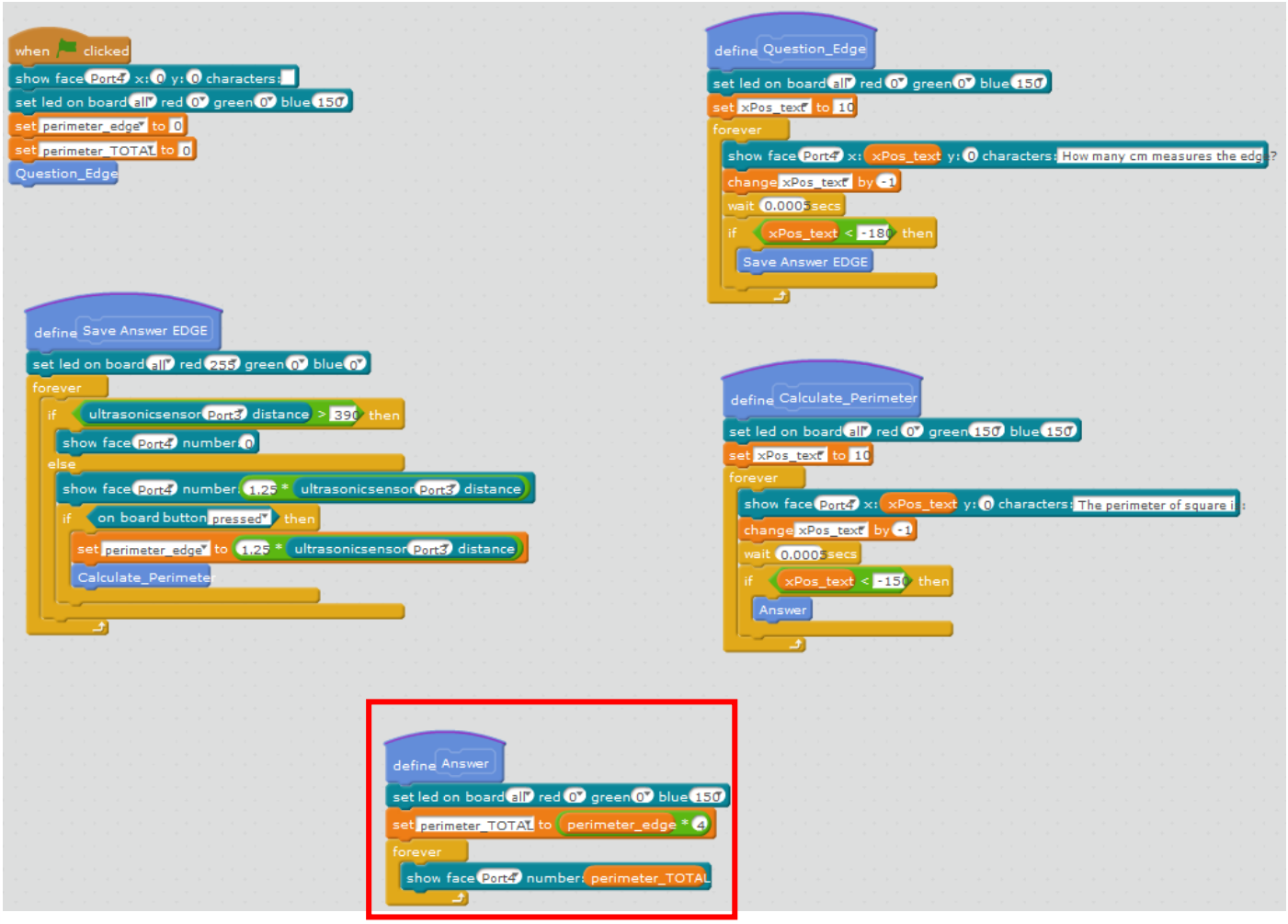


mBot display on the Led Matrix: “the area of square is:”

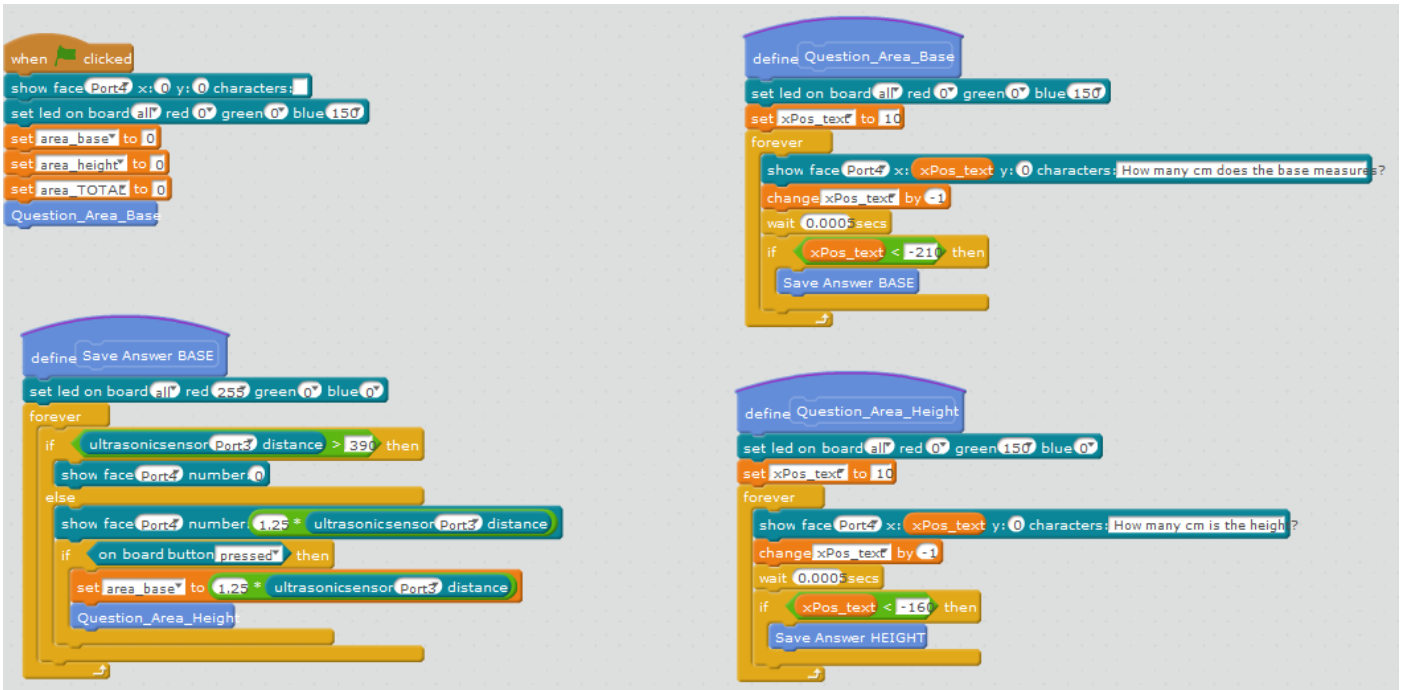


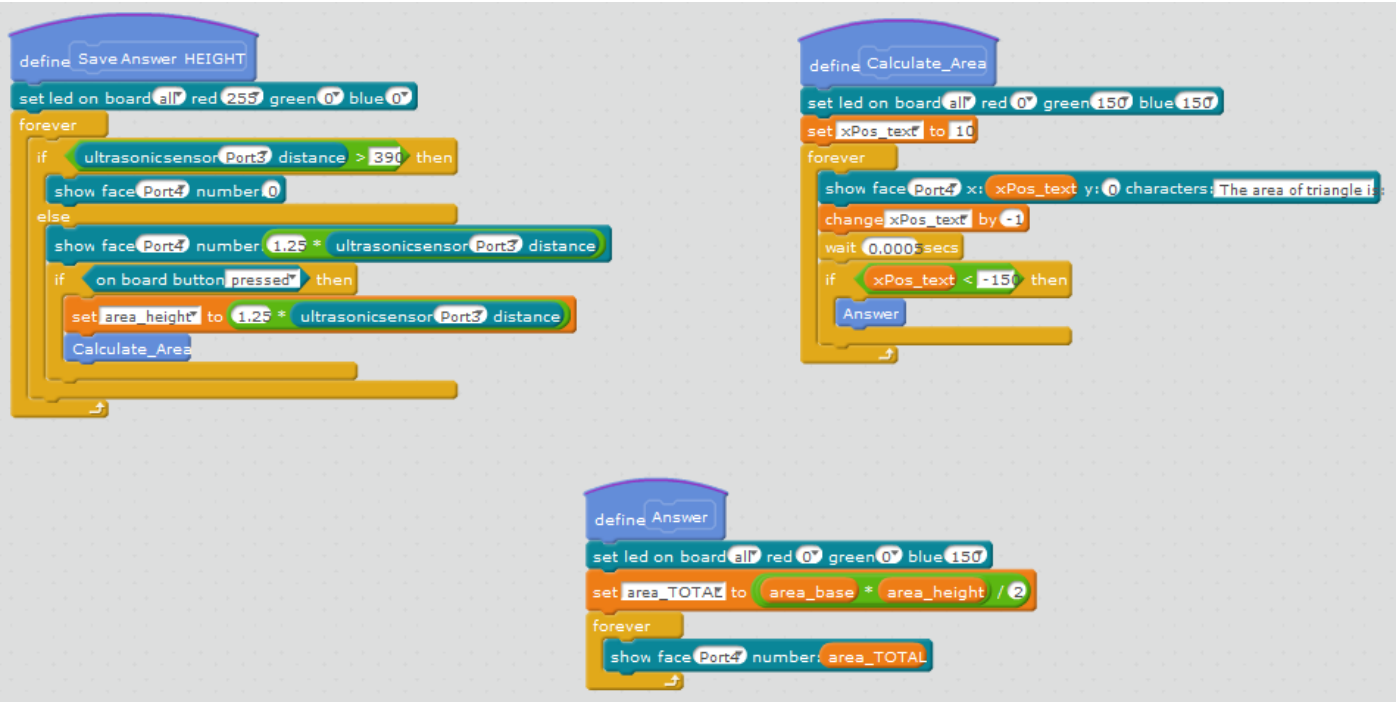
Since the area of the square is the a^2, we perform this calculation and the mBot will show the result obtained.

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

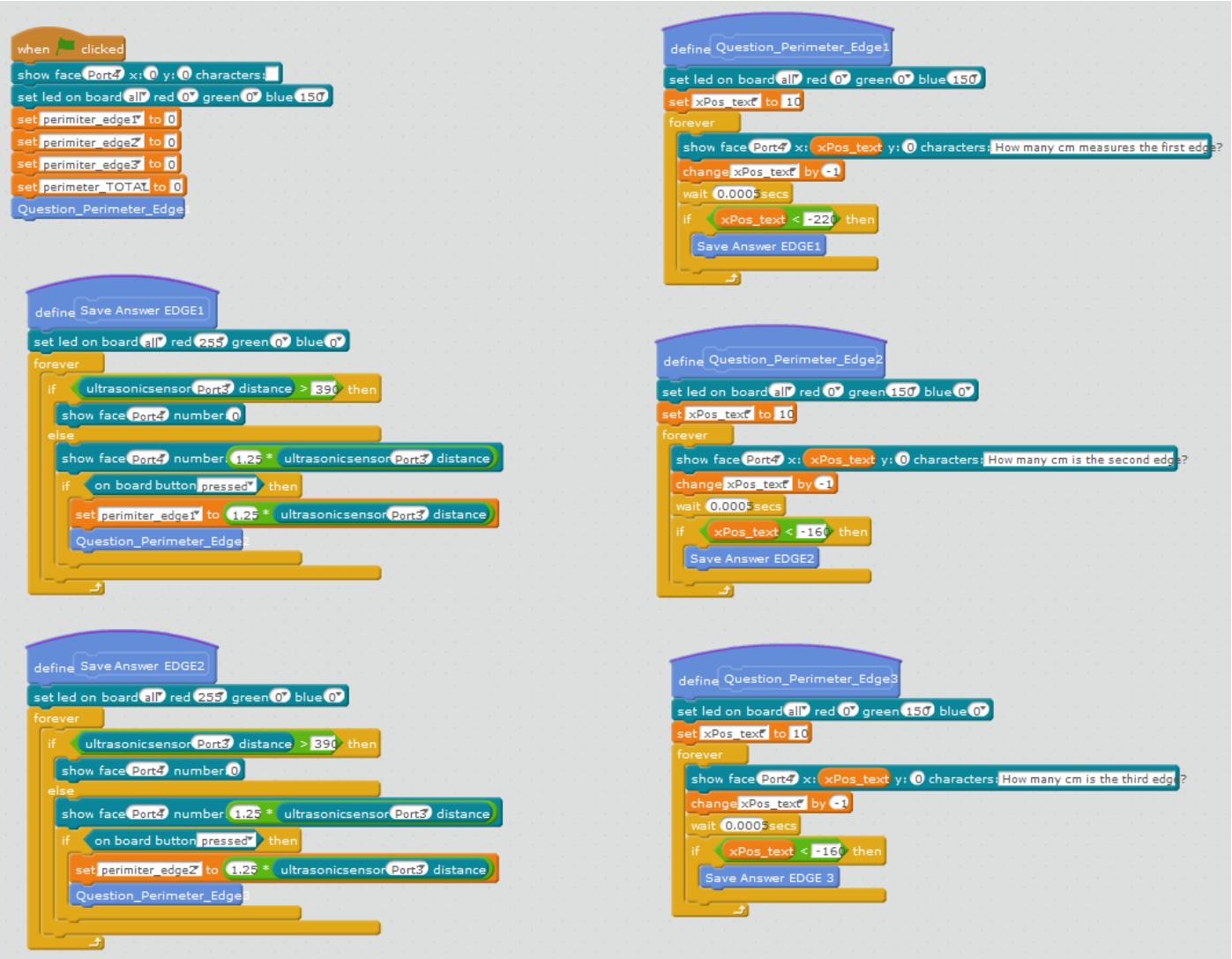


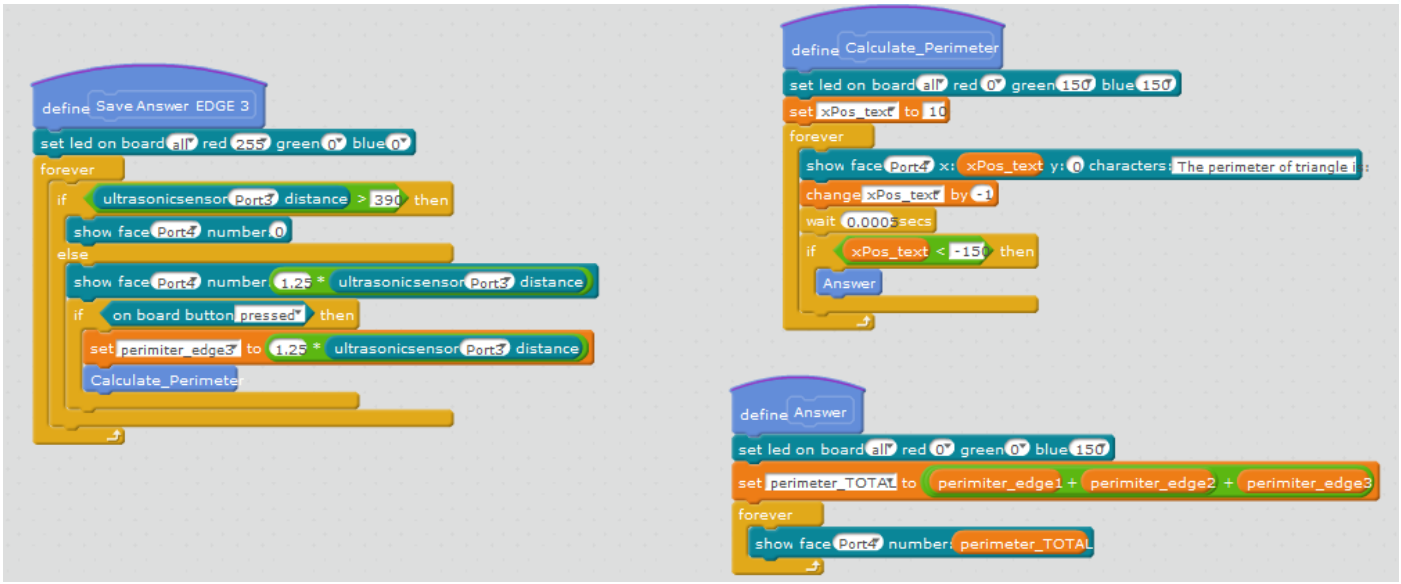
To calculate the area of the triangle, the mBot first will ask us to calculate the base and then the height, and it will determine the area.





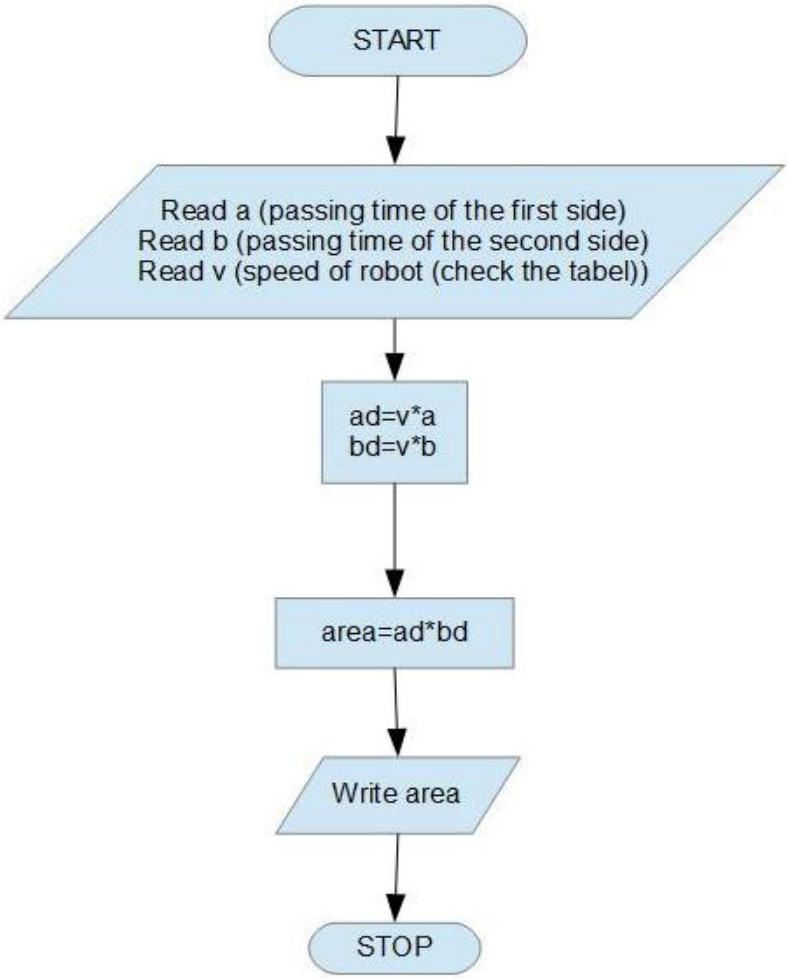
And for calculate the triangle's perimeter, mBot will ask you how many cm measures each edge and then it calculate the total perimeter:



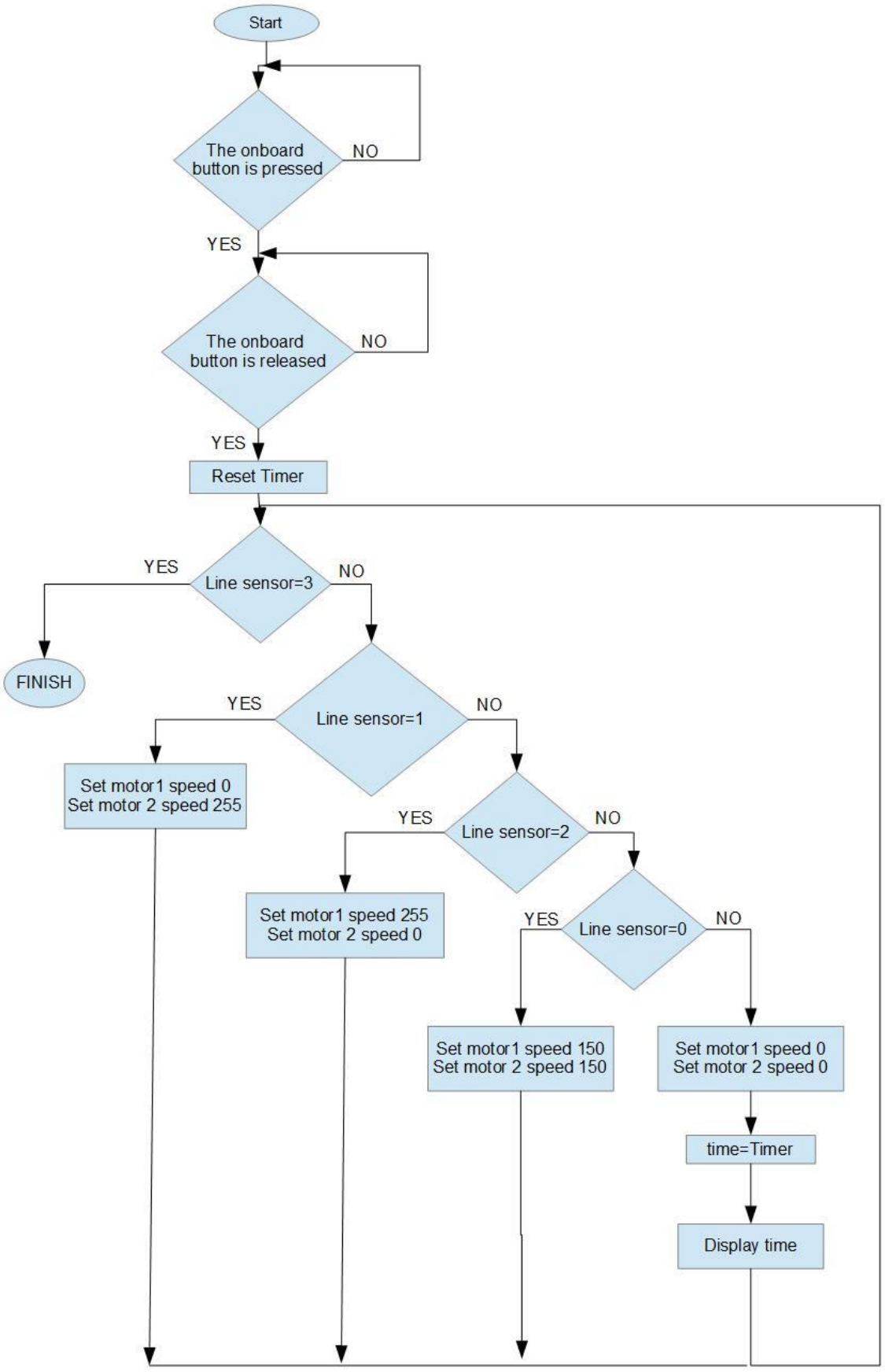

define Save Answer EDGE 3
set led on board all red 255 green 0 blue 0
forever
if ultrasonicsensor Port3 distance > 390 then
show face Port4 number 0
else
show face Port4 number 1.25 * ultrasonicsensor Port3 distance
if on board button pressed then
set perimiter_edge3 to 1.25 * ultrasonicsensor Port3 distance
Calculate_Perimete
define Calculate_Perimeter
set led on board all red 0 green 150 blue 150
set xPos_text to 10
forever
show face Port4 x: xPos_text y: 0 characters: The perimeter of triangle i
change xPos_text by -1
wait 0.0005 secs
if xPos_text < -150 then
Answer
define Answer
set led on board all red 0 green 0 blue 150
set perimeter_TOTAL to perimiter_edge1 + perimiter_edge2 + perimiter_edge3
forever
show face Port4 number perimeter_TOTAL

First version

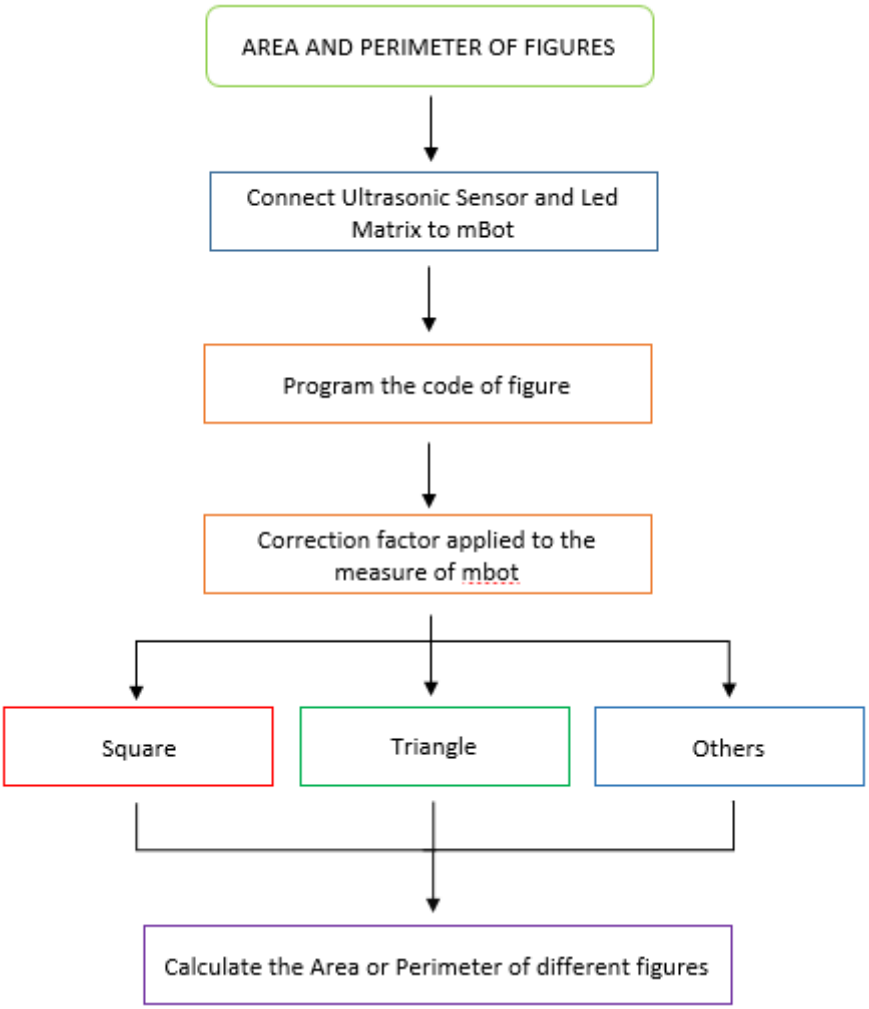
Program to count the area of rectangle



Program to measure the time of passing



Second version



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

BIBLIOGRAPHY

http://www.makeblock.com/

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