

FIREMAN TO THE RESCUE



STEMJAM Teaching Guide

Developing make spaces to promote creativity
around STEM in schools

Acronym: STEMJAM

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FIREMAN TO THE RESCUE

ABSTRACT

The idea is to make aware the students of the huge sensors' utility.

For this purpose, we will design a robot which will be able to find fire. Once the fire is found, the robot will emit an alarm message and will run to a "safe area".

While the robot is running a timer starts, in order to calculate the distance from the fire to the "safe area". The distance value will be shown in the led matrix.

In the meantime, the line follower sensor corrects the direction of the robot's way.

DIDACTIC OBJECTIVES

ENGINEERING & SCIENCE:

- ❖ Flame sensor. Line-follower sensor.
- ❖ Parameters that govern the running of the sensors.
- ❖ Utility of the sensors.
- ❖ Concepts of measurement units: obtaining linear speed (m/s) from angular speed (rad/s).
- ❖ Solving uniform linear motion equations: calculating distances.

TECHNOLOGY:

- ❖ Introduction to computational thinking.
- ❖ Assimilation, creation and programming of algorithms, to decompose complex problems into ordered sequences of simple instructions, which solve it.

STEM Subject: Science Technology Engineering Mathematics

Education Level: 12-14 years 14-16 years

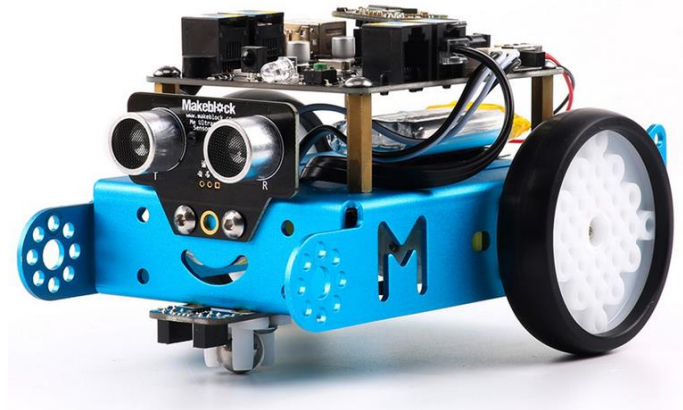
PROBLEM STATEMENT

The mBot robot has to be programmed to detect fire. Later the robot will do some calculations and it will inform about the fire's location.



BOM (Bill of Materials Needed)

➤ mBot => Ref. 90054



❖ Different beams and structures:



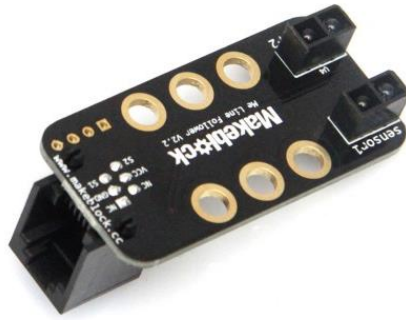
❖ Me LED Matrix 8 × 16:



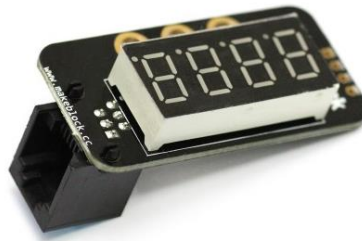
❖ Me Flame Sensor:



❖ Me Line Follower:



❖ Me 7-Segment Serial Display - Red:



❖ Black tape.

❖ Candles (several).

❖ Rest of Attrezzo (not essential).

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*															W*			
Motor 2	W*															W*			
Me 7-Segment serial display	B	Yes	1											B					
Me Led Matrix 8x16	B	Yes	1	B															
Me Line Follower	B	Yes	1					B											
Me Flame sensor	Bl									Y	B	W	Bl						
RJ25 cables			Several																
Structures and beams																			
Laptops																			
Attrezzo (not essential)																			

ACTIVITY DESCRIPTION

The activity consists on programming a mBot assisted by a laptop, whose function will be to detect fire. Later the robot will do some calculations and it will inform about the fire's location.

In order to achieve this goal, students will have to learn the proper functioning of both, the flame sensor and the line-follower sensor. The students will also design a part of the code related to sound and text effects for the activity.

After all these technical tasks, we start with the PROGRAMMING.

1. DEFINITION OF THE MAIN PROGRAM: the mBot follows a straight black line until it finds fire

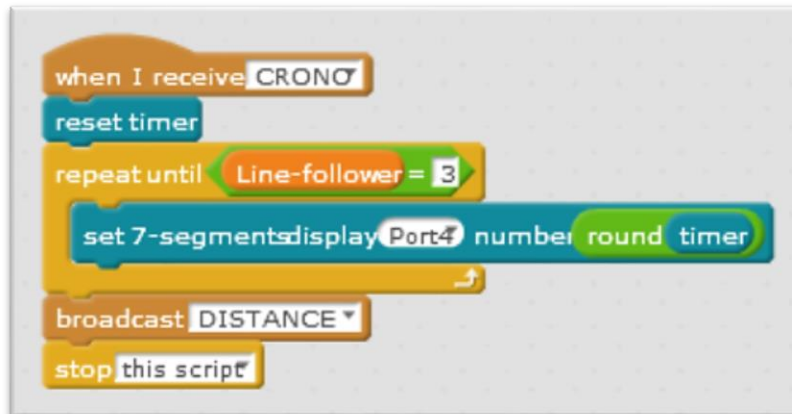
```
when clicked
  set led on board all red 0 green 0 blue 0
  set 7-segmentsdisplay Port4 number 0
  forever
    set Flame to flamesensor Port3
    set Line-follower to line follower Port2
    if Line-follower = 0 and flamesensor Port3 > 40 then
      run forward at speed 90
    else
      run forward at speed 0
    if Line-follower = 1 and flamesensor Port3 > 40 then
      set motor M2 speed 80
      set motor M1 speed -80
    else
      run forward at speed 0
    if Line-follower = 2 and flamesensor Port3 > 40 then
      set motor M2 speed -80
      set motor M1 speed 80
    else
      run forward at speed 0
    if flamesensor Port3 < 40 then
      run forward at speed 0
      FLAME EFFECT
      broadcast RUN AWAY
      stop this script
```

2. FIRE DETECTION: as soon as fire is detected, the “FLAME EFFECT” starts and the “RUN AWAY” message is sent.

```
define FLAME EFFECT
repeat 3
  set led on board led left red 255 green 75 blue 0
  set led on board led right red 0 green 0 blue 0
  play tone on note F6 beat Quarter
  set led on board led left red 0 green 0 blue 0
  set led on board led right red 255 green 75 blue 0
  play tone on note A4 beat Quarter
set led on board all red 0 green 0 blue 0
```

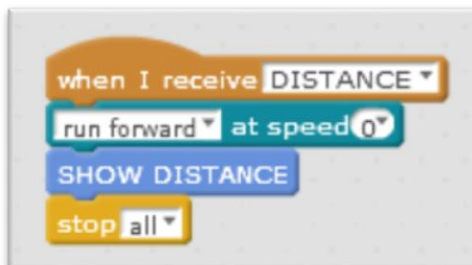
```
when I receive RUN AWAY
broadcast CRON
forever
  set Line-follower to line follower Port2
  if Line-follower = 0 then
    run forward at speed 90
  else
    run forward at speed 0
    if Line-follower = 1 then
      set motor M2 speed 80
      set motor M1 speed -80
    else
      run forward at speed 0
      if Line-follower = 2 then
        set motor M2 speed -80
        set motor M1 speed 80
      else
        run forward at speed 0
```

3. "CRONO MESSAGE": this message is sent and the CRONOMETER starts up.



```
when I receive CRONO
  reset timer
  repeat until Line-follower = 3
    set 7-segments display Port4 number round timer
  broadcast DISTANCE
  stop this script
```

4. "DISTANCE MESSAGE": once this message is sent, the distance calculations begin. Once the robot arrives to the end of the black line, fire's distance will be shown, ("SHOW DISTANCE").

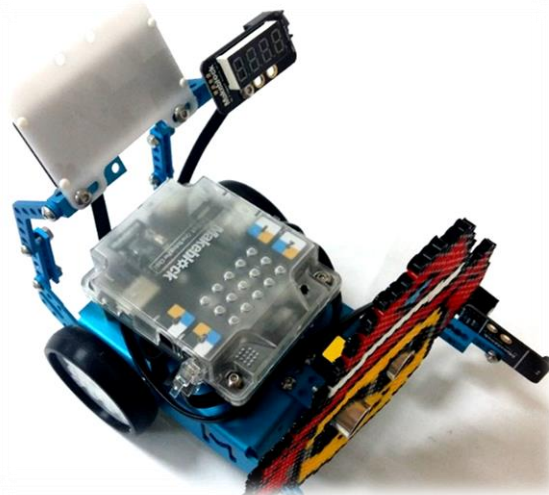
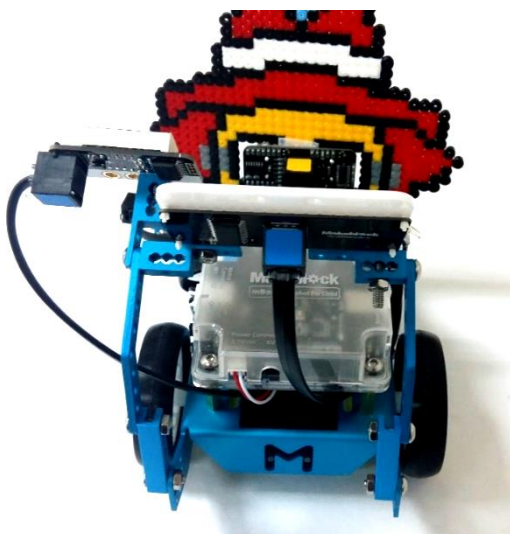
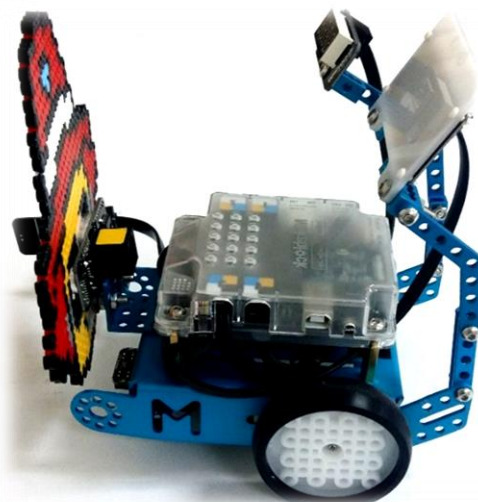
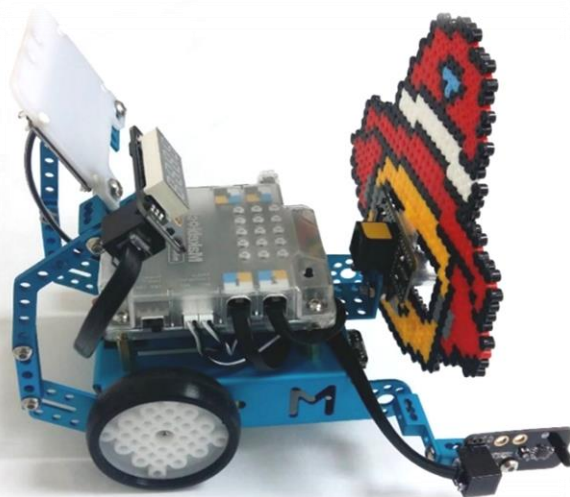
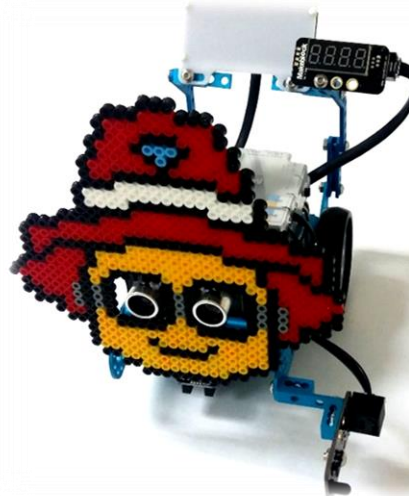
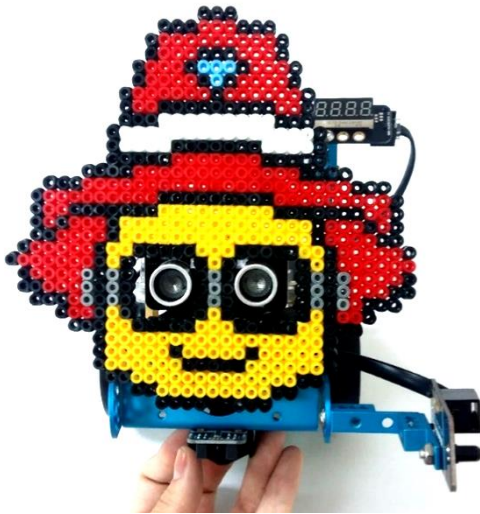


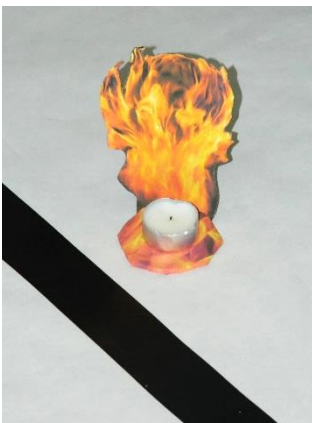
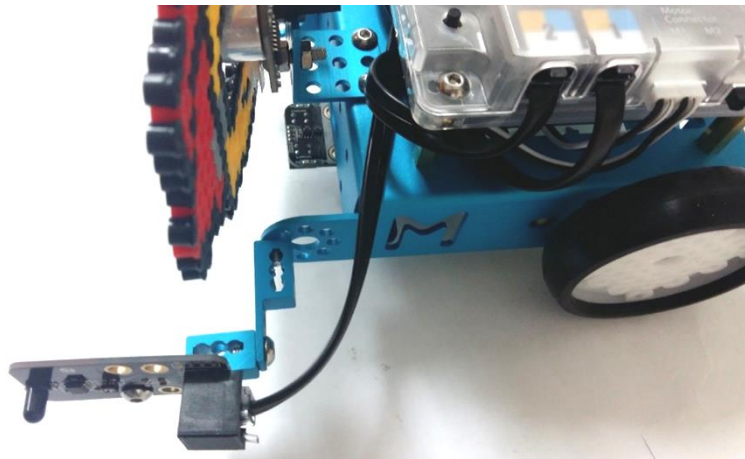
```
when I receive DISTANCE
  run forward at speed 0
  SHOW DISTANCE
  stop all
```



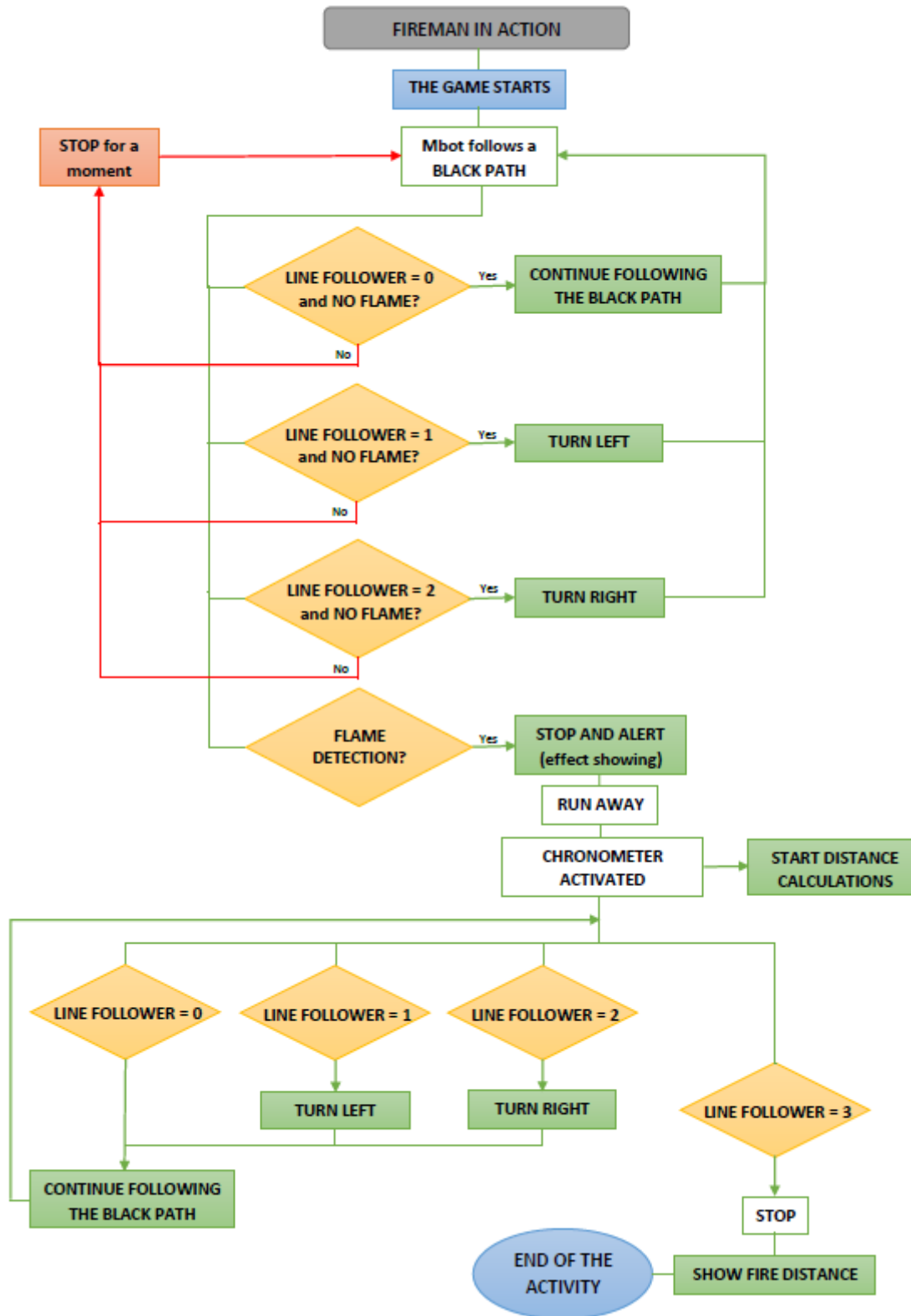
```
define SHOWDISTANCE
  set r to 3.15
  set w to 3.46
  set v to w * r
  set Time to timer
  set e to round v * Time
  set e2 to round e / 1.56
  set text to 20
  repeat until text = -90
    show face Port1 x: text y: 0 characters: Fire was at
    change text by -1
  set text to 20
  repeat until text = -15
    show face Port1 x: text y: 0 characters: e2
    change text by -1
  set text to 20
  repeat until text = -20
    show face Port1 x: text y: 0 characters: cm
    change text by -1
  stop all
```

Once, the programming is finished, we start building up THE STRUCTURE, where all the mechanical elements will be set. Also the electronic elements.





FLOW CHART



STUDENT'S EVALUATION

For the evaluation of the students in this activity, use the Evaluation Rubric designed for this project.



BIBLIOGRAPHY

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“Jugando con MBlock”. Makeblock España.

“Divirtiéndome con MBot”. Susana Oubiña.

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“Curso de Scratch + Arduino”. J. Javier Esquivia Mira.

MORE INFORMATION

DIFFICULTIES:

- **FLAME SENSOR:** flame sensor is highly sensitive to solar radiation. If we want it to work correctly, it has to be used indoors.
- **ULTRASONIC SENSOR:** it was supposed to be used to avoid obstacles, but it also does not work properly when the obstacles are right in front of the mBot. If the obstacle is placed at an angle with the mBot, the ultrasound does not work and the robot can not avoid it.
- **MBOT'S UNUSUAL BEHAVIOUR:** sometimes the mBot has an unusual behaviour. To avoid this, it is recommended to erase the cache memory (found in the "Extensions" section).
- **MOTORS' SPEED:** the speed of the motors depends on the state of the battery, as well as the angular velocity. This behaviour affects the program when calculating the distance to which the flame is. That is why, we must take the result of the calculations, as an approximate value.