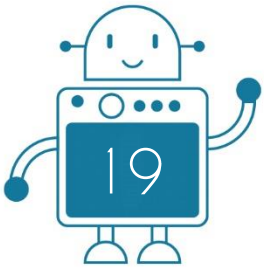

COLOUR SENSOR

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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COLOUR SENSOR

ABSTRACT

This activity is a playground to explore both colour recognition techniques and servo motors controls. Both the direct use of a newly released colour sensor and light reflection measurements are discussed. In the former case the traffic light is realized with a led shield, while in the latter one mBot, equipped with servo control, stands still and acts as the traffic lights by rotating a coloured disk. The main robot, instead, reads the traffic light colour and move forward or stop accordingly.

DIDACTIC OBJECTIVES

While playing the activity you will learn about:

- Physics: Light spectrum and Light measurements in reflective geometry.
- Technology: the servo motor control and the colour sensor.
- Computer Science: conditioned actions.
- Engineering: Automatic driving, simulating the recognition of a traffic light.

While implementing the code you will learn about:

- Computer Science: algorithm development.
- Mathematics: rotation angles

STEM Subject: Science☒ Technology ☒ Engineering☒ Mathematics☒

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

PROBLEM STATEMENT

Some students do not know the composition of the colors, which with the primary and secondary colors.

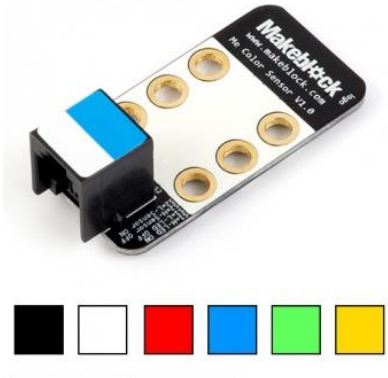
A robot runs along any given path, reads the traffic light colour and move forward or stop accordingly. In one setup (configuration a) the traffic light is a Arduino led shield and the colours are detected through a colour sensor. In configuration b, instead, one mBot, equipped with servo control, stands still and acts as the traffic light (by rotating a coloured disk) and the colour detection is performed through optical measurements in reflective geometry.

BOM (Bill of Materials Needed)

- mCore of mBot

- mBot Ranger

- Colour Sensor



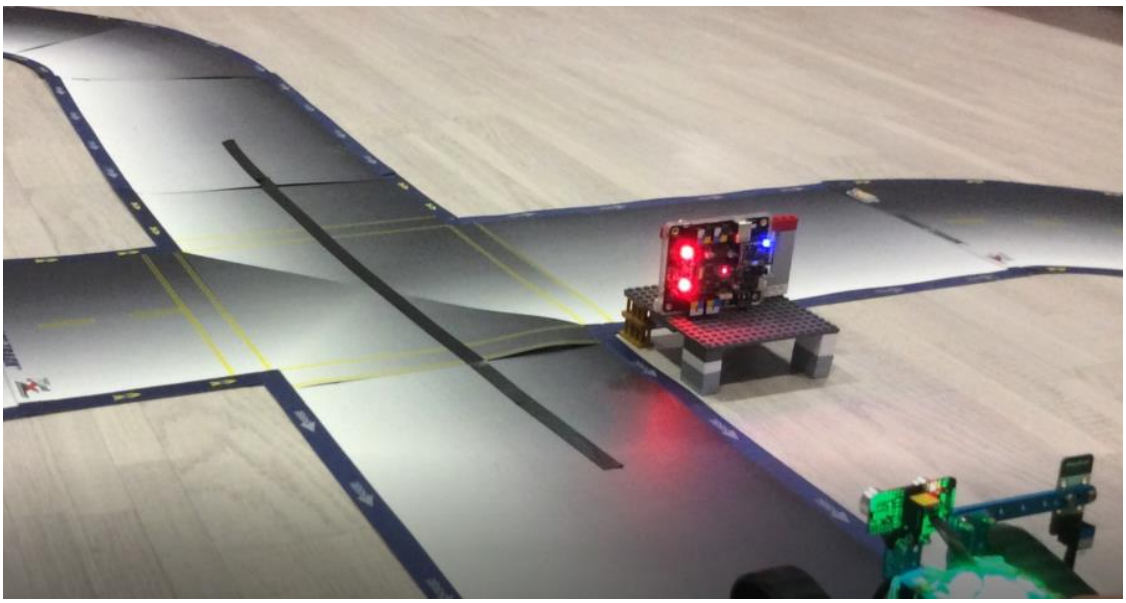
- Line Follower

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 RJ 25 adapter	Y																		
	B																		
	Bl																		
Mini Pan-Tilt kit It has 2 servos. We have to connect the servo to a RJ25 adapter																			
Mini Gripper We have to connect the servo to a RJ25 adapter																			
Me 7-Segment serial display	B																		
Me Led Matrix 8x16	B																		
Me Ultrasonic sensor	Y																		
Me Temperature Sensor - Waterproof	Y																		
Me Line Follower	B	(1)	1		B														
Me Flame sensor	Bl																		
Me PIR Motion sensor	B																		
Me Sound sensor	Bl																		
Me Touch sensor	B																		
Mini Fan Pack	B																		
Me Color Sensor	B	(1)	1					B											
Me Temperature and Humidity sensor	Y																		
Me 130 Motor Fan Pack	B																		
RJ25 cables			2																
Structures and beams																			
Laptops																			
Attrezzo (not essential)																			

ACTIVITY DESCRIPTION

First version

The activity consists of drawing a circuit with black tape, create a traffic light with a mCore shield and thanks to the colour sensor, when the robot detects the red light it will stop, with the yellow light it will considerably decrease its speed and when it detects the green light will continue the speed or will be launched.



The colour is the property possessed by an object of producing different sensations on the eye as a result of the way it reflects or emits light.

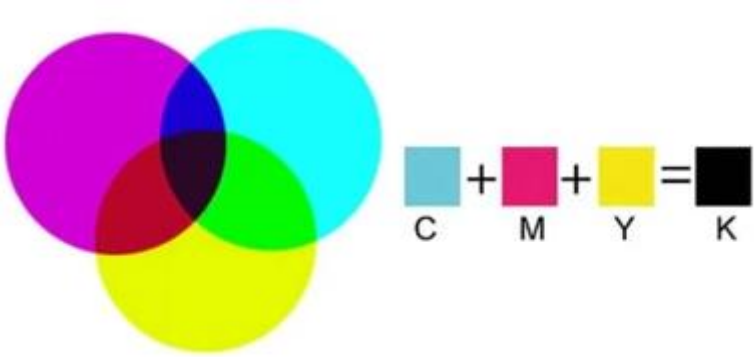
The White light when decomposing organites the 7 colours of the visible spectrum: **red**, **orange**, **yellow**, **green**, **blue**, **cyan** and **violet.**

The colour and light are related and there are 2 theories that explain that relationship:

1. Substractive Synthesis:

   - We treat colour as pigment and the primary colours are:

- If these colours are mixed the black colour is obtained:



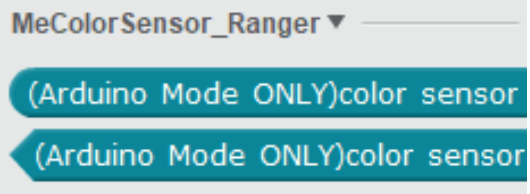
2. Additive Synthesis:

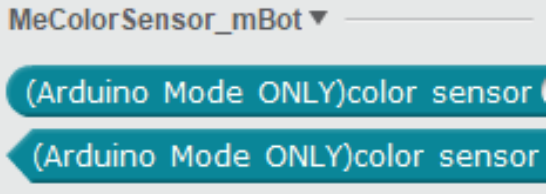
- The primaries in light colour are:

- With these three colours, white is obtanied:

Next, the new colour sensor is detailed:

- It is a sensor that has recently come to the market.
- It is capable of recognizing up to 6 colours:
  Black, White, **Red**, **Blue**, **Green** and **Yellow.**
- We need to install the library on mBlock:

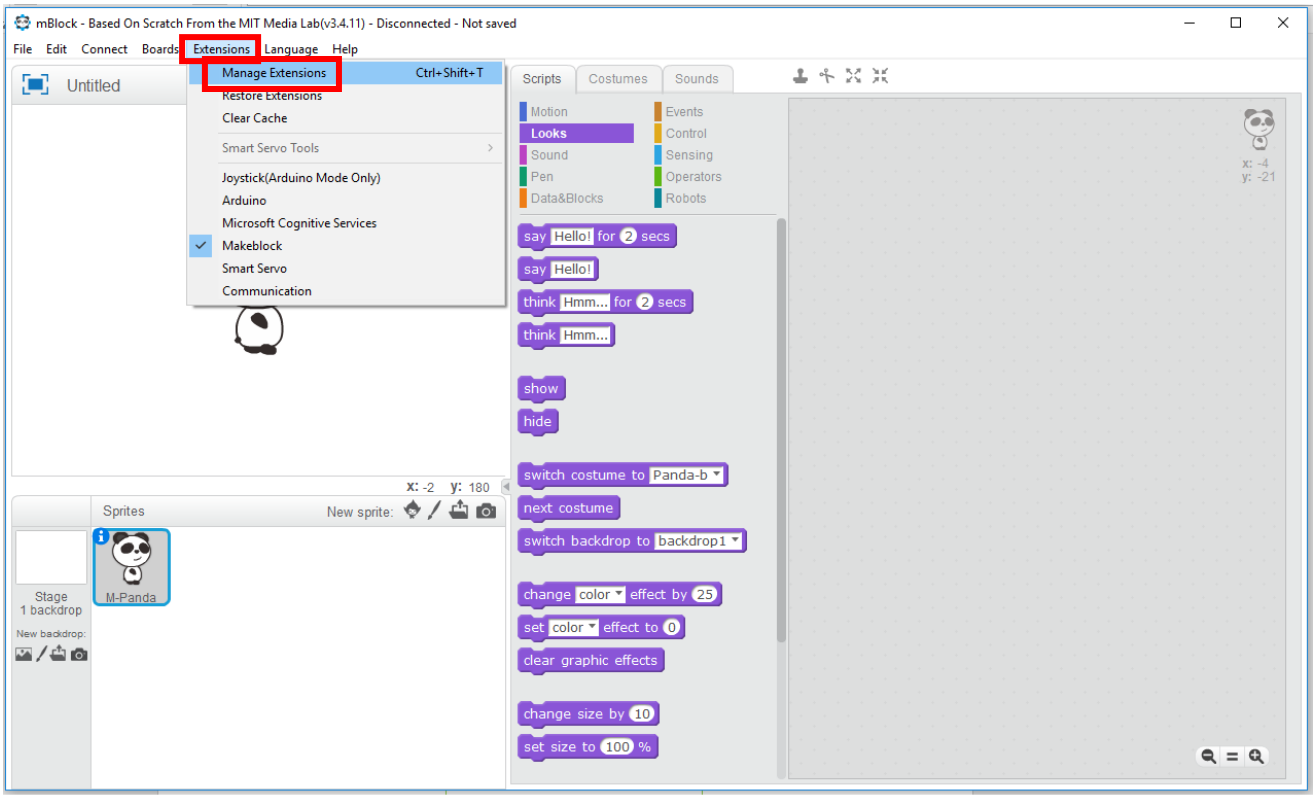




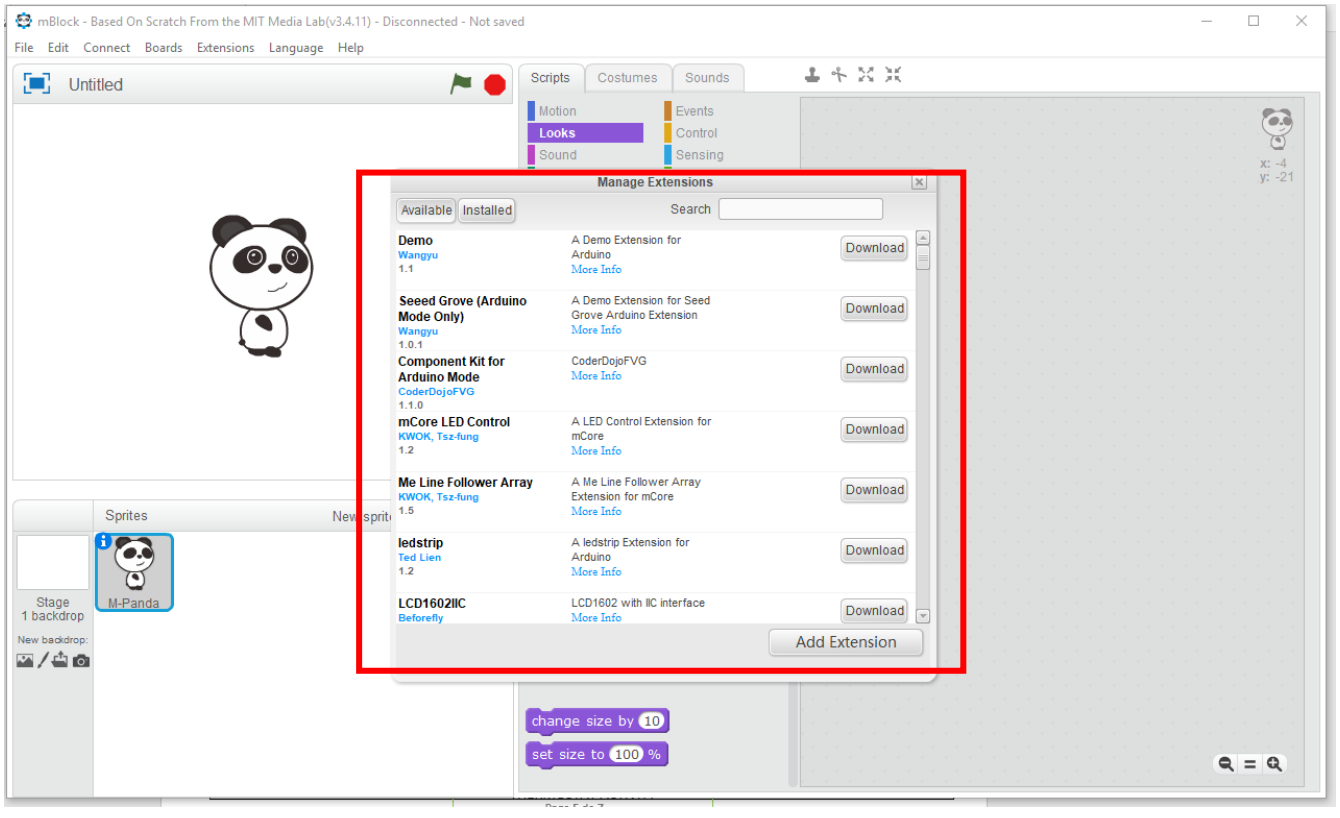
- **Nowadays, it only works if we upload the code on the board.**

For install the colour sensor library, we follow the next steps:

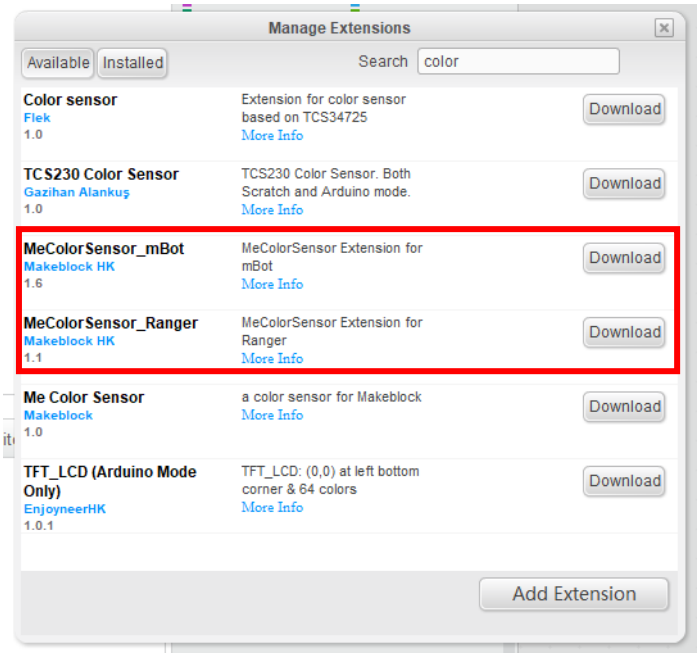
1. Start the mBlock software and go to “Extensions” => “Manage Extensions”:



2. A new window will appear:

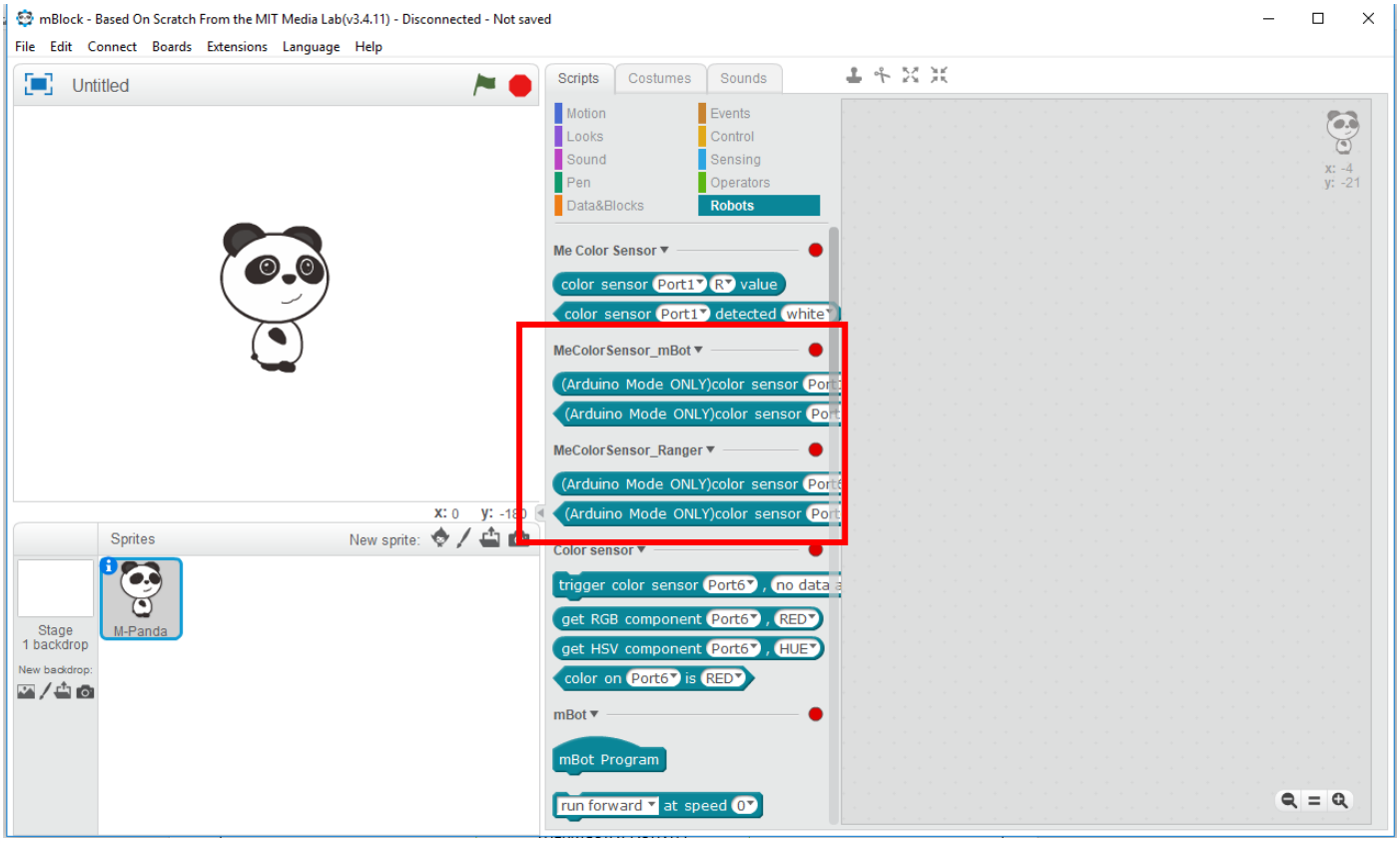


3. Insert the “color” word in the searcher:



4. The “MeColorSensor_mBot” and the “MeColorSensor_Ranger” will appear. Now, click on “download”.

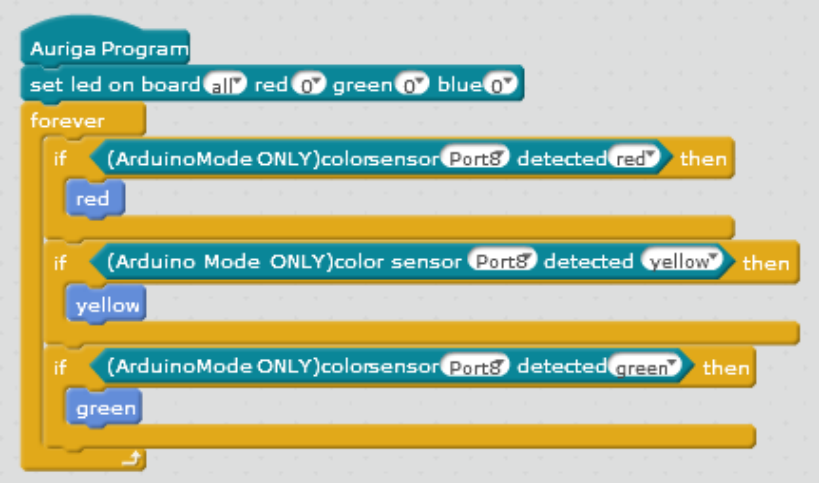
5. If everything went well, the installed libraries will appear in the "robots" section.

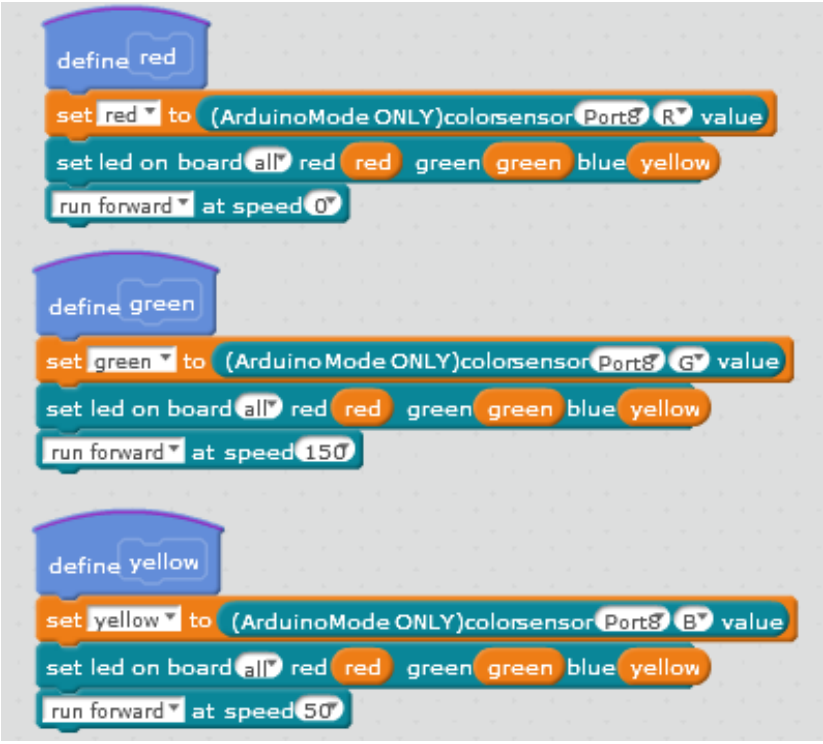


Now, we develop the traffic light code for the mCore shield:

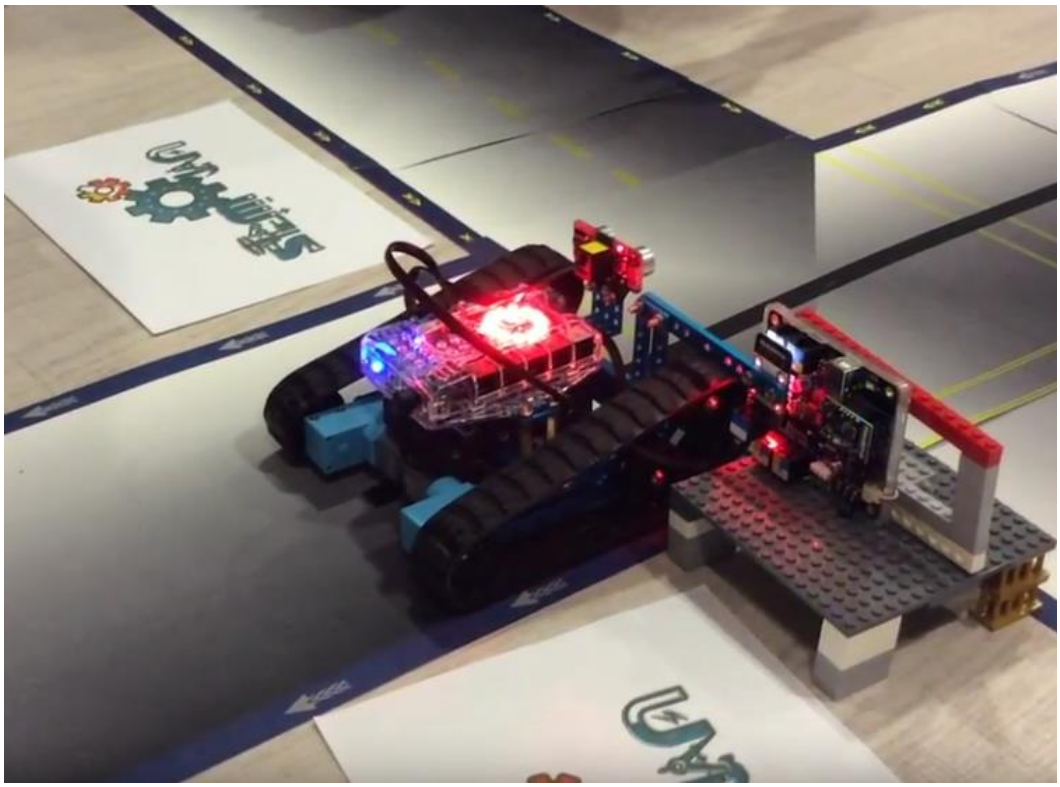
To finish, we will program the mBot Ranger to detect the colour.

When it detects the red colour, the Ranger will stop; when it detects the yellow light its speed will decrease and when the green light is active it will advance.

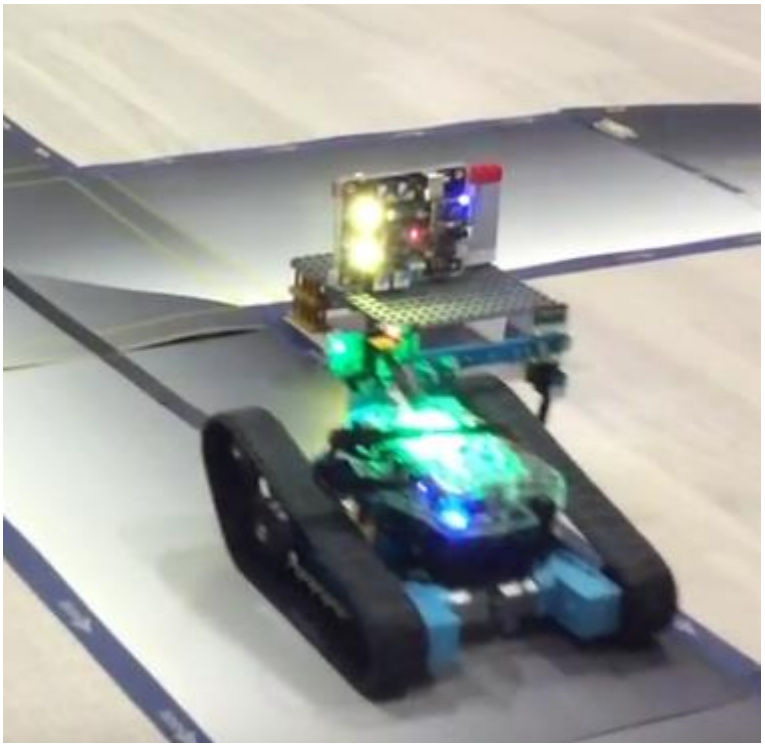




When Ranger detects the red colour it stops.



And if the colour is yellow its speed is lower and if the colour is green the mBot Ranger will be continue.



Second version

In the following, we list the simple steps needed to play the activity, discuss the colour detection technique and illustrate the algorithm and code.

Through the text, useful tips leading to better results are mentioned and highlighted in orange colour.

Experimental Procedure

1. Set up the "road": a track of black tape the mBot can follow.
2. Set up the Traffic Lights:
    a. Install the Arduino Led shield on a proper support.
    b. Choose one mBot to act as the traffic light. Mount on it the RJ25 adapter and the micro servo control. In our case, we installed the servo facing downward. Prepare a paper disk approximately 15 cm in diameter, divide it into three coloured sectors: yellow, green, red (or just two, discarding yellow). Make a hole in the disk center and mount it securely on the servo control.
3. Upload the code to the mBot(s)/mBot Ranger acting as the car(s) and to the traffic lights (mbot or shield).
4. Play the game! When the mBot reach the traffic light and if it is…

    GREEN it will continue to run forward.

    YELLOW it will slow down its speed, but continue to run forward.

    RED it will stops at the traffic lights and it will continue to detect colours, in order to start again when the traffic lights turn green.

Light and Colour detection in reflective geometry (configuration b)

In physics, we speak of *a scattering experiment* when a given radiation (eg. light, as in our case) is sent to the investigated sample/surface and the scattered radiation intensity is measured. This can be done either in: *Transmission geometry*, where one measures the radiation that has gone through the sample and has emerged on the other side[1]; or *Reflective geometry*, where one detects the radiation that is reflected by the sample and comes back almost in the same direction of the incident beam. This configuration is also known as *backscattering*.

If we recall the mechanism of our colour vision, it is easy to understand that Colours can be detected by light backscattering: an object appears for example green, because it reflects green light and absorb blue and red light.

[1] with respect to the incident beam

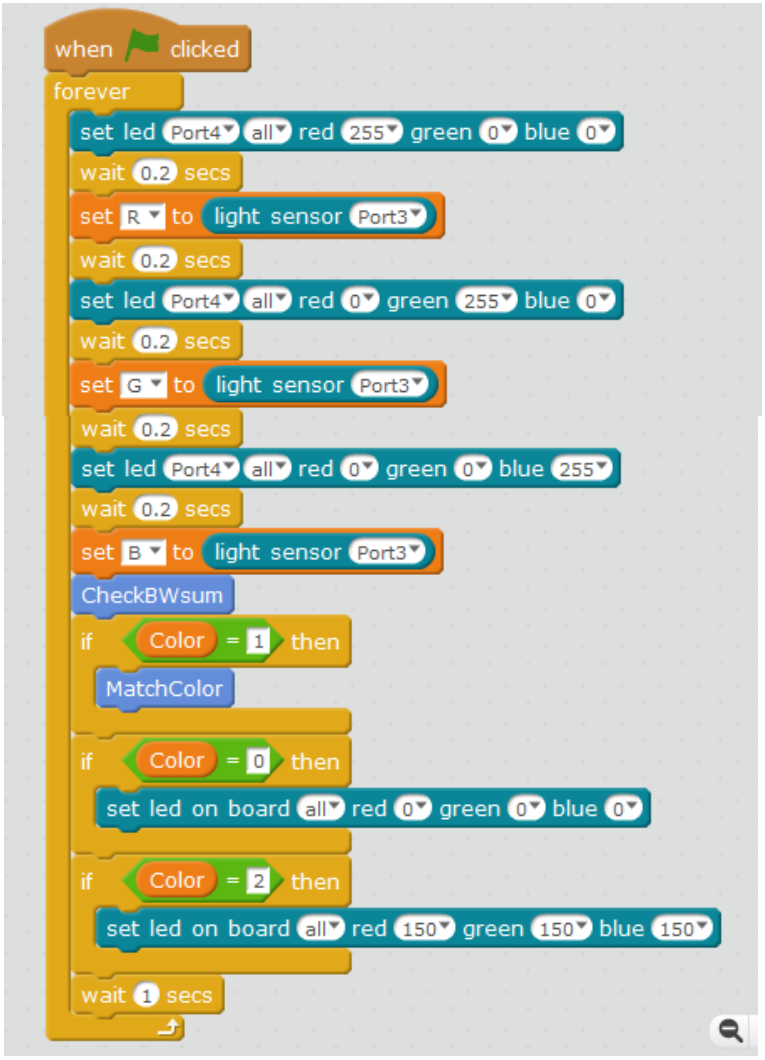
Therefore if we hit the object with red light, we will have a low reflected intensity, while if we use green incident radiation we will get an high scattered intensity. More in general each colour will reflect mostly light of the same colour; in case of a white object all colours will be reflected with high intensity, while a black object would absorb most radiation.

To perform the colour measurement, we turn on alternatively red, blue and green light on the led module and with the light sensor module we detect the reflected intensity for each colour. The software then elaborate the results.

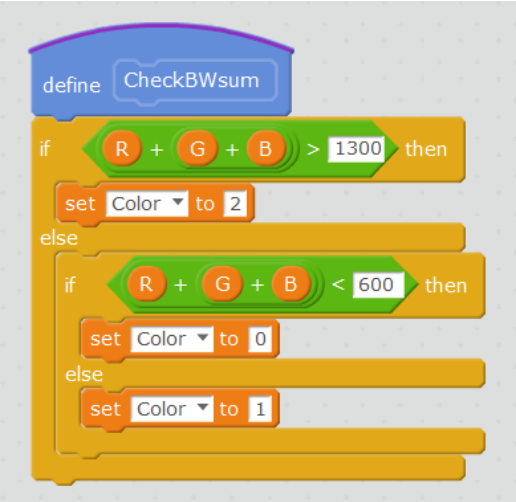
For the measurement to work properly, it is necessary to embrace the light sensor into a small black tube (we used standard heat shrink tubing for electrical wires) in order to reduce the noise coming from the environment (eg. sunlight).

mBlock scratch Code for Colour Recognition

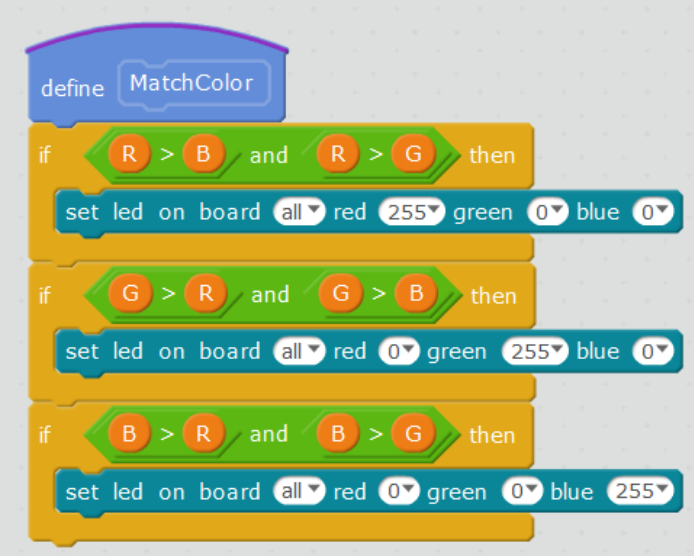
The following code control the Led and Light Sensor modules to perform the optical reflection measurements.



The CheckBWsmu function check if the total intensity is below or above certain thresholds, in order to detect Black and White respectively. These thresholds were calibrated during the experiment and might need (slight) recalibration for one's own experimental setup.

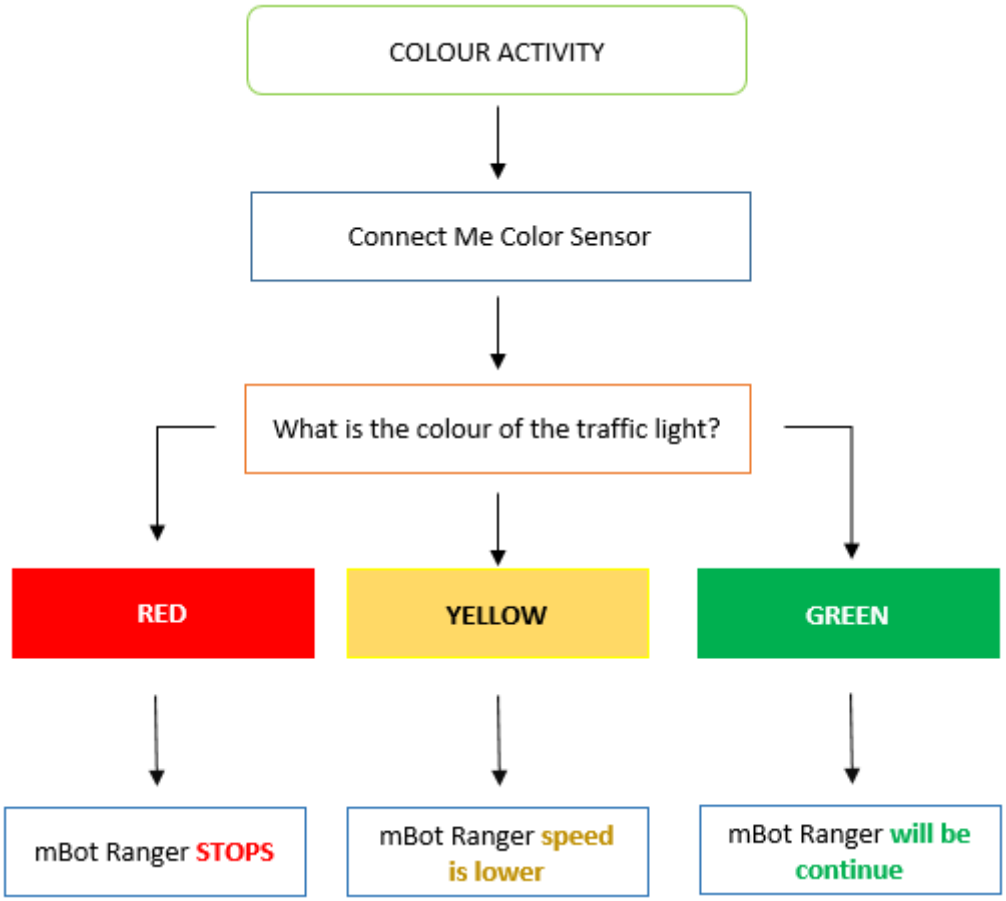


While the MatchColor function is the one which actually compare the measured intensities and output the final result by turning on the onboard led to the detected colour.



FLOW CHART

Schema of the First Version activity:



STUDENT'S EVALUATION

Indicators for student evaluation may include:

- Physics: She/He performs laboratory measurements with care and accuracy.
- Physics: She/He is able to understand and compare experimental results.
- Physics: She/He properly understand the principles of light scattering.
- Physics: She/He recognizes.

BIBLIOGRAPHY

https://www.makeblock.es/productos/sensor_color/

[1] Me Led module description http://learn.makeblock.com/me-rgb-led/

[2] Me Light sensor description http://learn.makeblock.com/me-light-sensor/

SCALABILITY

The activity is suitable for students aged 10 or higher.

The principles of optical spectroscopy (configuration b) and increasing details on the code alghoritm might be explained only to older students (15-16 years).