MOWAY'S
BEGINNER MANUAL

Index

1. Prologue

The dawning of a new era; the era of the minirobots. Increasingly more mobile robotics applications enter our daily life. We can currently find robots which help us with simple tasks like cleaning household floors, mowing the lawn or keeping the swimming pool clean. As technology keeps improving, these small devices which blend mechanics, electronics and software are performing more and more complex tasks*. They are slowly introducing themselves into our lives in a useful manner and reducing the burden of unpleasant jobs.

It's not too far-fetched to think that the revolution which took place in the IT or telecommunications fields will be repeated with robotics in the next decade. Enough technology is currently available to manufacture these devices and society is also ready to receive them in the market. Yet, a specific catalyst is needed to start this revolution. People also need to be ready and prepared to identify in what fields microrobotics may have an opportunity and which new applications may be interesting to implement.

Up till now processors weren't able to move. But today things have changed. Software is one of the fundamental elements in the world of mobile robotics. The main difference between developing a program for these robots and running it with a personal computer is interaction with the environment. The environment isn't changing randomly in PC applications, so decision making and programming are simplified. On the other hand, when running commands for a minirobot application usually the result is unknown, therefore algorithms have to consider situations with a wider range of possibilities, some of them unexpected.

The mOway robots are tools specifically designed for teaching and research. Their purpose is to bring the world of autonomous robots closer to the teaching centers.

mOway's main purpose is to be a useful tool for those who are being introduced for the first time to the world of the minirobots as well as for those who are already experienced and wish to perform complex collaborative robotic applications.

mOway aims to stimulate enthusiasm for this new and exciting branch of engineering in a prompt and enjoyable way through the practical exercises included in this manual.

- An easy and entertaining way to learn.
- This book's purpose: to be mOway's Manual and not a comprehensive book on minirobotics.

This manual has been implemented to assist learning how to use mOway. It provides some basic notions on using mOway and its functions in a quick and clear manner.

This manual is divided in two parts. The first part includes a description of the elements which form part of the robot and their functioning. The second part of the manual includes a series of practical exercises that can be executed with mOway.

2. What is mOway?

mOway is an autonomous programmable small robot designed mainly to perform practical minirobotics applications.

It provides a perfect hardware platform for those wishing to take their first steps within the world of mobile robots as well as for those who have already worked with minirobots and want to develop more complex applications.

The mOway robot is equipped with a series of sensors which aid it to move in a real environment. It also includes a drive unit which allows it to move over smooth terrain commanded by a I2C communications bus. All these peripherals are connected to a microcontroller responsible for governing the robot.

This small robot incorporates I2C/SPI expansion bus options. As an example, a wireless communications module, a video camera or a prototype card can be connected to it as well as any other device considered interesting to perform a certain task.

mOway's external design is very compact, intended to move with grace and style avoiding standstills due to obstacles or corners. This small mobile device has been fittingly called a "pocket robot".

mOway is a perfect tool for those who want to both learn and teach minirobotics. The user will be pleasantly surprised by the speed in achieving results even if this is the first time he/she comes into contact with mobile robots.

3. Robot mOway

This chapter describes each of the parts that constitute the mOway. It is important to highlight that it is not necessary to know the total functioning of the robot to be able to program it, at least not at the level of detail explained here.

The following elements are to be found inside mOway:

- Processor
- Drive system
- Sensors and indicators group
- Power supply system
- An expansion connector

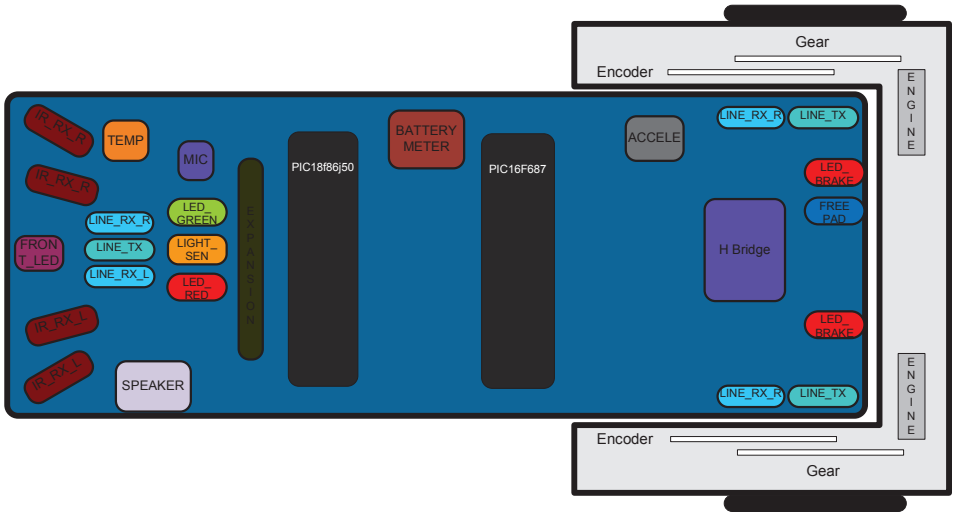


Image 1. Diagram of mOway's parts

3.1. Processor

mOways are governed by a 4 Mhz PIC18F87J50 microcontroller manufactured by Microchip Technologies. All the peripherals distributed throughout the whole robot are connected to its input/output ports. Some of them need a digital input or output, others need an analog input or output and others, instead, are controlled by one of the I2C/SPI communication buses. The table below describes how the microcontroller pins are distributed.

3.2. Drive system

To be able to move the mOway uses a double servo-motor group. It includes both an electronic part and a mechanical one. The electronic part is mainly in charge of controlling the motor's speed and the mechanical part allow the mOway to move unhindered over different terrains with adequate power.

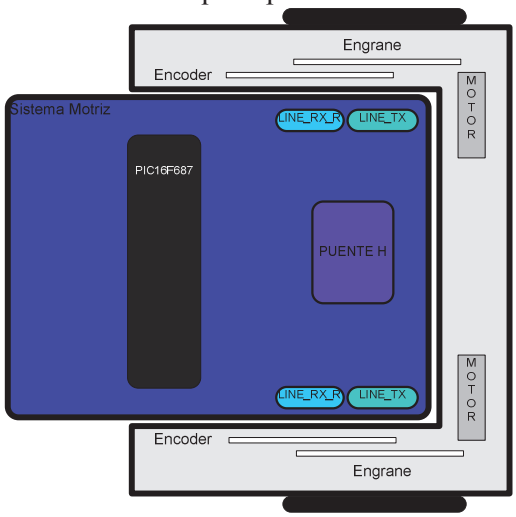


Image 2. Drive system: electronic and mechanical

The servo-motor group includes different features:

1. **Speed control**: controls the speed of each motor.
2. **Time control**: controls the time for each command with a 100 ms precision.
3. **Traveled distance control**: Controls the distance traveled by each command with a precision of 1 mm aprox.
4. **General speedometer**: counts distances traveled since the initial command.
5. **Angle control**: controls the angle when the mOway rotates.

The microcontroller sends the I2C command to the drive system that controls the motors and therefore releasing the main microcontroller so it can carry out other tasks.

Speed control is carried out by means of proportional control with negative feedback from the encoders' signal. The illustration displays the controlling system. The microcontroller feeds the motors through an H bridge controlled by pulse width modulation (PWM) signals. Wheel rotation is monitored by an encoding sticker and an infrared sensor. When the sticker shows its black segment, the logical output shall be 1 and when it shows the white sector the output shall be 0. The microcontroller analyzes these signals (it can determine the exact wheel speed by measuring the pulse width) and

acts on the motors. This way, the mOway will be able to keep the speed constant on any surface.

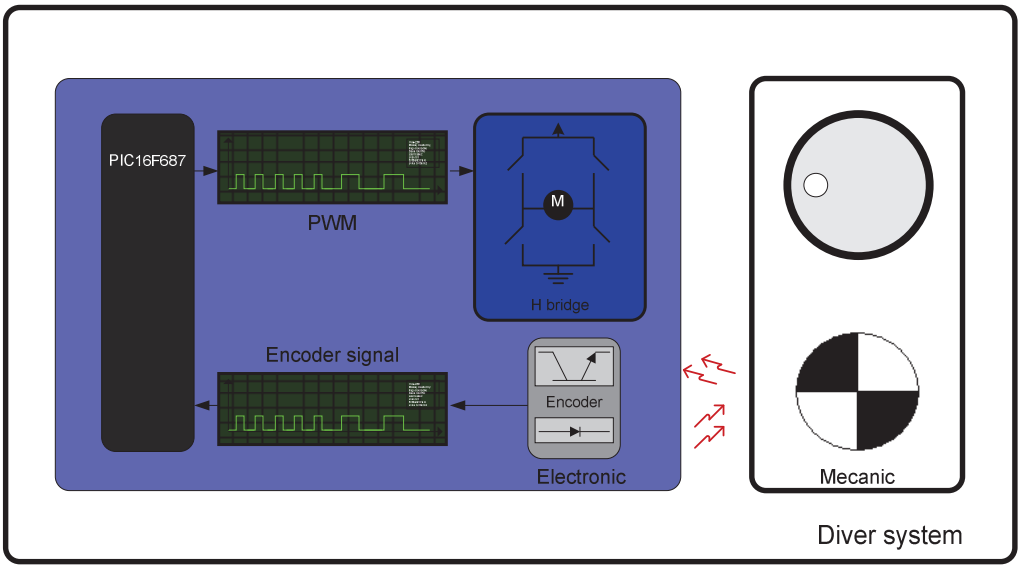


Image 3. Motor control

To send a movement command to the robot, via the main microcontroller, all we need to do is send the movement command parameters. To this end some libraries were designed in assembly and C language to simplify communications through some functions which are responsible for I2C communications. The format for these frames is explained in the motors and drive system library section.

The table below describes connections between the main PCB and the servo-motor unit.

3.3. Sensor and indicators group

This group consists of different luminous sensors and indicators, connected to the mOway microprocessor, through which the robot interacts with the external world:

- Two line tracking sensors.
- Four obstacle detection sensors.
- A light sensor.
- An expansion connector.
- Four LED diodes.
- Temperature sensor.
- Speaker.
- Microphone.

- Accelerometer.
- Battery level.

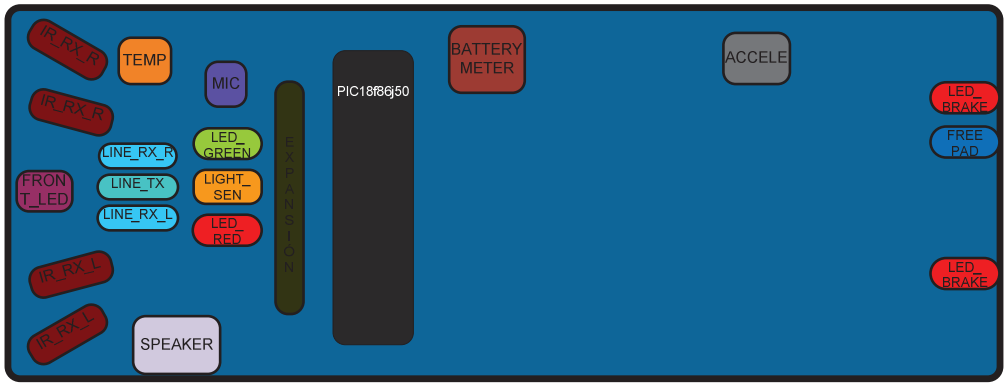


Image 4. Sensors and indicators group

3.3.1. Line sensors

The line tracking sensors are two reflection optocouplers mounted on the top front part of the robot. They use infrared light reflection to detect the color of the terrain at the point where the robot is.

These two sensors are connected to two microcontroller analog ports so strong terrain contrasts, like white lines on black backgrounds, can be detected. They are also capable of distinguishing different tones.

The Vishay CNY70 sensor has a compact construction where the emitting light source and the detector are arranged in the same direction to be able to detect by using the reflective IR beam the light reflected in the terrain.

In the images below the three possible cases can be observed:

1. **Clear surface**: A white surface reflects all the infrared light and therefore we obtain a low voltage reading at the transistor's output when in regular mode.

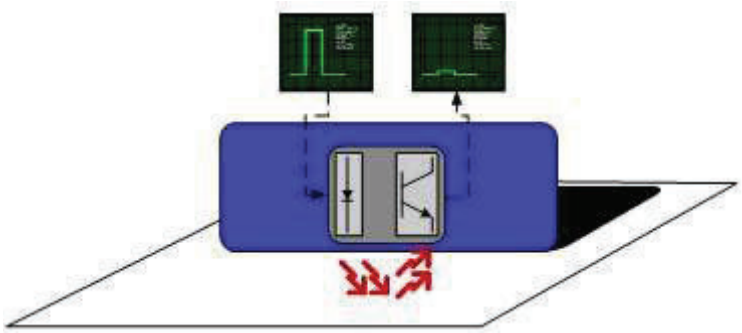


Image 5. Line tracking sensor on a clear surface.

- **Colored surface**: A colored surface reflects part of the emitted light obtaining an intermediate voltage at the microcontroller's analog channel input. This way colors are easily identified[1].

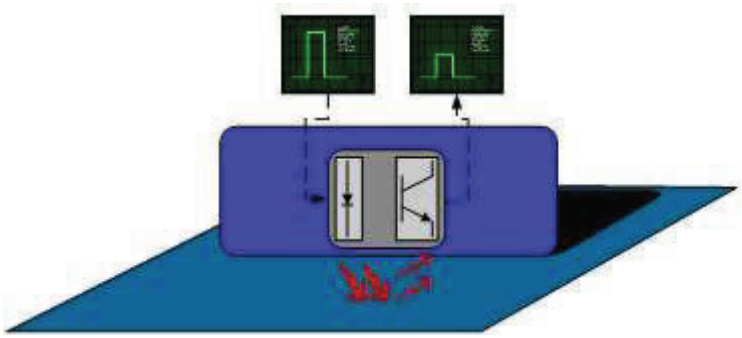


Image 6. Line tracking sensor on a colored surface.

1. **Dark surface**: A dark surface reflects very little light obtaining a high voltage reading at the sensor's output.

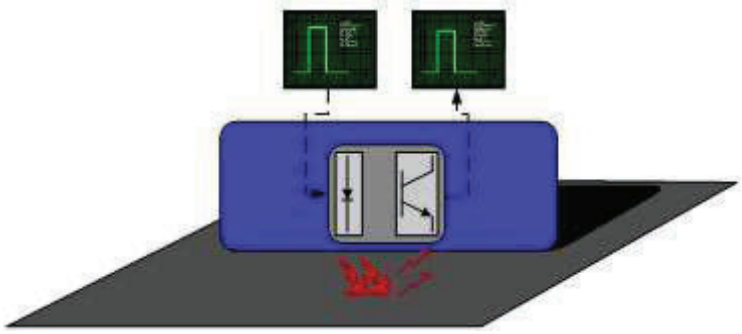


Image 7. Line tracking sensor on a dark surface.

[1] Due to CNY70 tolerance two different sensor can differ.

Image 8. Location of line sensors

3.3.2. Obstacle detection sensors

Similar to line tracking sensors, obstacle detection sensors also use infrared light to detect objects located in front of the mOway. The sensor includes two infrared light-emitting source (Kingbright KPA3010-F3C) and four receivers placed on both sides of mOway.

The output of the Sharp PT100F0MP receivers are connected to the microcontroller's analog inputs so it can detect the presence of any object (digital mode) and also measure how far away it is (analog mode)[2].

The sensor functions similarly to the line tracking sensor. The light emitter generates a 70us pulse which allows the receiver to capture any obstacle using a filtering and amplifying stage. Once the signal is processed electronically, the PIC can measure it by means of the ADC or as a digital input. The digital distance range is close to 3cm and a bright environment is recommended to enhance infrared light reflection.

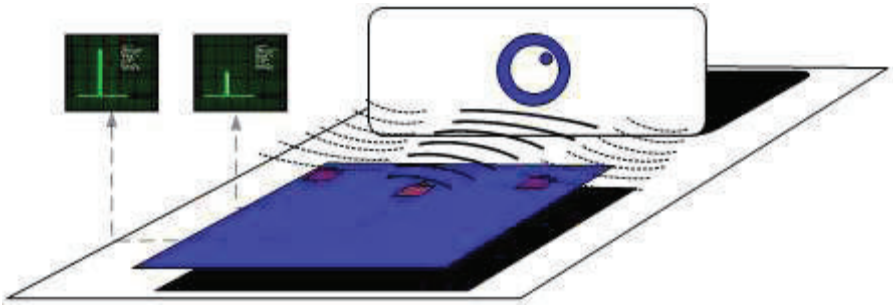


Image 9. Obstacle detection sensor

[2] Due to tolerance two different sensors can differ from each other.

Image 10. Location of Obstacle Sensor

3.3.3. Light sensor

This sensor allows mOway to recognize the light intensity that enters through a small half moon-shaped opening on the top part of the chassis. Since it is facing forward it enables it to detect where the light source is located and to act accordingly.

The output of the AVAGO APDS-9002 sensor is connected to the analog port of the microcontroller so that with a simple reading of the ADC we can register the light intensity level and any change in intensity levels based on the last reading[3].

Image 11. Location of Light Sensor

3.3.4. Expansion connector

This connector allows the mOway to connect with any commercial modules or electronic circuits the user may choose.

As shown in the above table, it is possible to connect commercial SPI devices. On the other hand, the RF BZI-RF2GH4 module available in the market is totally compatible with mOway and with specific libraries. This module enables the mOway to communicate with other robots and with a PC via the RFUsb. With this module it is possible to create complex collaboration applications without having to worry about complicated wireless communications.

[3] Top two-color LED has to be switched off to have a valid measure.

Image 12. RF modules into expansion connector.

3.3.5. Temperature sensor

mOway has installed as a temperature measurer an NTC thermistor from Murata, a semiconductor whose electrical variable resistance decreases as temperature increases. The sensor is located in the front part of the robot, very close to obstacle sensor.

The thermistor is connected to the analog port of the microcontroller so that with a simple reading of the ADC it is possible to get the temperature value in that moment and notice any change in it since the last reading[4].

3.3.6. Speaker

The CMT-1102 speaker from CUI INC directly connected to the microcontroller, is capable to play tones from 250 Hz to 65 KHz.

3.3.7. Microphone

The CMC-5042PF-AC microphone from CUI INC enables the robot to detect sounds from 100 Hz to 20 KHz.

The output is directly connect to an analog input of the microcontroller so that it is capable to detect not only if there is sound or not (digital mode) but also the intensity of the sound with a simple reading of the ADC (analog mode).

[4] Temperature measured by the sensor can be 5ºC higher than external temperature.

3.3.8. Accelerometer

An accelerometer is a device that measures acceleration and the gravity induced forces: the movement and rotation. There are many types of accelerometers, most of them based on piezoelectric crystals, but their size is too big. Because of that, it was tried to design a small device in the field of microelectronics, which might improve the applicability. Then, the MEMS (Microelectromechanical Systems) accelerometers were created.

An easy way to create an accelerometer is measuring changes in a capacitor. Capacitors can work as sensors or as actuators. In the case of mOway, it is a capacitive accelerometer, which consists of two capacitors displaced in differential mode whose electrical capacity changes as the acceleration varies.

By measuring X, Y, Z axes of the MMA7455L accelerometer from FREESCALE Semiconductor, it is possible to know if mOway is correctly positioned, inverted or tilted.

3.3.9. Battery level

The robot has a LiPo cell battery rechargeable. For proper operation of the microcontroller, the battery is connected to one of its analog inputs through a splitter. Thus, with a reading of the ADC battery level can be measured.

3.3.10. Front LED

The front LED is a white LED placed on the front side of mOway. The output of the OSRAM LW A6SG LED is connected to a digital output of the microcontroller.

3.3.11. Top two-color LED

This double indicator and the light sensor share the same opening on the top part of the robot. They are connected to two microcontroller digital outputs[5].

[5] Please note that since they share the same opening as the light sensor it is fundamental to switch them off when wanting to perform a light intensity reading.

Image 13. Robot with Front LED and red LED switched on

3.3.12. Brake LED

The brake LED is double indicator placed on the back side of mOway. The output is connected to one digital outputs of the microcontroller.

Image 14. Brake LED location. Switch on green LED.

3.3.13. Free Pad

mOway has implemented a free Pad to allow expert users to connect their electronics. It is accessible opening the robot and it´s located near brake LED[6].

3.4. Power Supply System

mOway's battery is located inside and accessible only by disassembling the product. It is a small rechargeable LiPo cell.

The battery can be charged via a computer's USB port through the mOway's MINI-USB-B port. There is no need to wait for the battery to be completely discharged, as it can be plugged in any time since these batteries do not have memory effect (also

[6] Advanced users only

known as lazy battery effect). These batteries are a perfect power source for mOway due to their small size, lightness and flexibility.

Battery duration depends to a great extent on the active sensors and the amount of time the motors are used. Charging lasts about 2h.

Power supply system controls two LED located in the back part of the robot[7]. Green LED indicates that mOway is switched on and red LED indicates that the battery is charging. When the battery is full red LED will switch off[8].

Image 15. Charging (red) and switched on (green)

3.5. RF module and RFUsb[9]

RF module allows communicate with other mOways or with PC using RFUsb.[10].

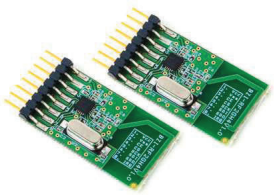


Image 16. RF module

[7] These LEDs can´t be controlled by the user.
[8] This LED can swap between on and off when the battery is fully charge because there is energy consumption when mOway is plugged.
[9] Available in some packs
[10] Available in some packs

RF module is connected in expansion connector and it is very easy to use with mOwayGUI. The best way to start working with the module is using an example project provided in mOwayPack.

Image 17. RFUsb

The **BZI-RF2GH4** radio-frequency communications module is based on the nRF24L01 transceptor manufactured by "Nordic Semiconductors". This integrated circuit has been fitted with all the logic required to establish wireless bidirectional communications with acknowledgement of receipt. Communications with the microcontroller is made via an SPI bus.

The main characteristics of the BZI-RF2GH4 module are as follows:

- Low consumption.
- Working frequency: 2.4GHz,
- Transmitting power between-18 and 0 dBm,
- Transmission speed between 1 and 2 Mbps,
- 128 in transmission channels selectable by the SPI bus.

In addition to the CI nRF24L01, the **BZI-RF2GH4** is also fitted with all the associated electronics for its correct operation plus a microstrip antenna on the same board with the impedance adaptation network. In this way the user can forget completely about the hardware required to implement the radio part of his application.

As interface, the device has four pins available for the SPI bus, two more pins for controlling the module and another two for the supply.

In order to facilitate the handling of the module, a number of libraries have been developed to simplify and shorten the development time of wireless applications with these modules.

3.6. Camera module and Moway Videocap

Thanks to the camera module (**Moway Camera Board**[11]) it is possible to display on the computer what Moway is "watching" . Camera board sends images wirelessly to the video **Moway Videocap**[12].

Image 18. Camera module Moway Camera Board

Camera module is connected in expansion connector and it is very easy to use with mOwayGUI. Video **Moway Videocap** must be connected to an USB connector of the computer.

Camera control is performed by Microchip **MCP23S08 device**, which is an input/output port managed by SPI. A library is provided to make easier for user to develop programs with the camera module. The basic functions are the camera ON and OFF, and the selection of the transmission channel from de camera to the video **Moway Videocap**. User have to select the same channel (from 1 to 4) both in program and **Moway Videocap**. The status of the camera is shown by a LED on camera board.

As interface, the device has four pins available for the SPI bus, two more pins for controlling the module and another two for the supply.

NOTE: Both camera transmission and RF module transmission are in the same frequency band. So that, when camera is active, RF module reception distance decreases.

[11] Available in some packs
[12] Available in some packs

4. First Steps

4.1. mOway Pack installation

In mOwayPack (available in the webpage or in the installation CD) you will find the software, mOway´s libraries, test programs and documentations.

Following setup steps you will have all the resources:

- Beginner's and User manual.
  - Beginner's manual includes all you need to start working with mOway.
  - User manual contains detailed description of the robot.
- mOwayGUI software.
  - This software controls all aspects of the robot: program download, battery charge control, radio control, RFUsb[13] management and C or assembler programs download.
- Reference projects in assembler and C.
  - Example projects to start working with mOway easily.
- RFUsb Driver
  - Driver for RFUsb[14] that allows the communication between robots and PC.
- Moway Videocap Driver
  - Driver for Moway Videocap [15] that allows to grab images from Moway camera to display on PC.

If a security warning message appears during installation, please click on "install driver anyway".

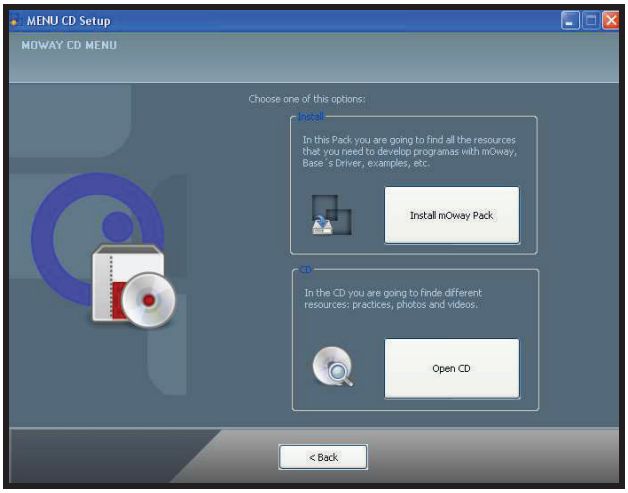


Image 19. CD

[13] Module not available in all kits
[14] Module not available in all kits
[15] Module not available in all kits

4.2. Download a program to mOway

Download process is always executed in mOwayGUI. This application can download to the robot mOwayGUI, assembler (compiled with Mplab o gputils) and C (C18 compiler) projects.

Steps to download a program to mOway:

- Connect mOway to the PC through USB. The robot doesn´t need any driver.
- Open mOwayGUI application.
- Open or create a project in mOwayGUI, or import a .HEX file from assembler or C project.
- Click download bottom. If a .HEX file has been imported the download progress will start automatically.
- Disconnect the robot and check the project.

mOwayPack provide 8 compiled projects: 3 to check sensors, 3 to check the drive system and 2 programs that are explained in the next section.

4.3. RFUsb instalation

- This is a device that allows to communicate the PC and mOway.

A driver that it´s included in mOwayPack is required:

- The first time the RFUsb is connected, the PC will detect it as a new device and an "Assistant for new hardware found" message will be displayed. Select the *No,not this time* option.
- In the following window select the recommended option: Install software automatically.

Image 20. Driver installation Wizard

- Now the installation process will begin.

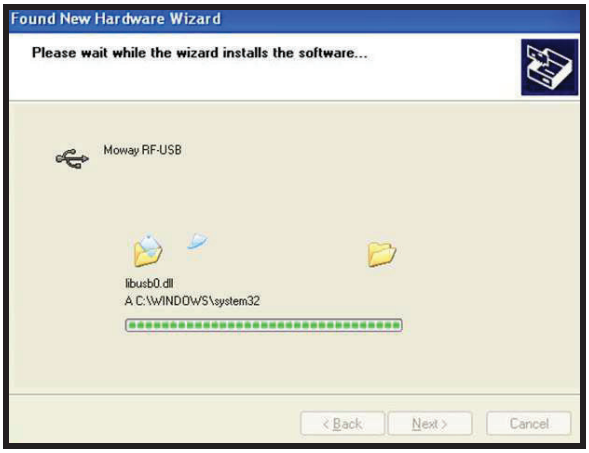


Image 21. Windows xp driver installation

- Assistant will then indicate that the hardware is installed.

Image 22. Driver installed in Windows xp

- Check if Moway's software has detected the RFUsb

4.4. RF modules

RF modules are very useful tool to introduce RF concept.

These are the steps to start working with them:

- Connect RF modules into the expansion connector. Check that the module is fully connected.
- Connect the robot to the PC through the USB cable.
- Open mOwayGUI.

- Open *mOway_RF_send* project included in the pack.
- Click the Program bottom.
- Disconnect and switch the robot on.
- Configure RFUsb module using RF window of mOwayGUI with cannel 0x00 and address 0x01.
- Check receiving data in mOwayGUI.

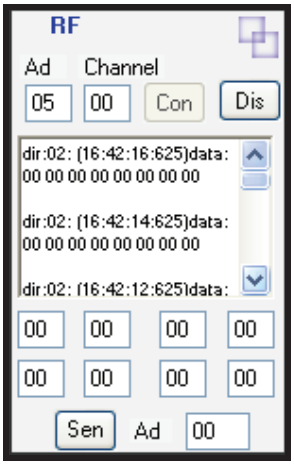


Image 23. RF window

4.5 Moway Videocap drivers installation

As with RFUsb device, a driver that it´s included in mOwayPack is required to use video capturer:

- The first time the **Moway Videocap** is connected, the PC will detect it as a new device. Driver installation runs automatically. If it doesn´t, an "Assistant for new hardware found" message will be displayed. Select the *No,not this time* option.

- In the following window select the recommended option: Install software automatically.

- Now the installation process will begin.

- Assistant will then indicate that the hardware is installed.

- Check if Moway's software has detected the **Moway Videocap.**

5. mOwayGUI programming

5.1. Creating a Project

The only thing you have to do is to click on the new project icon.

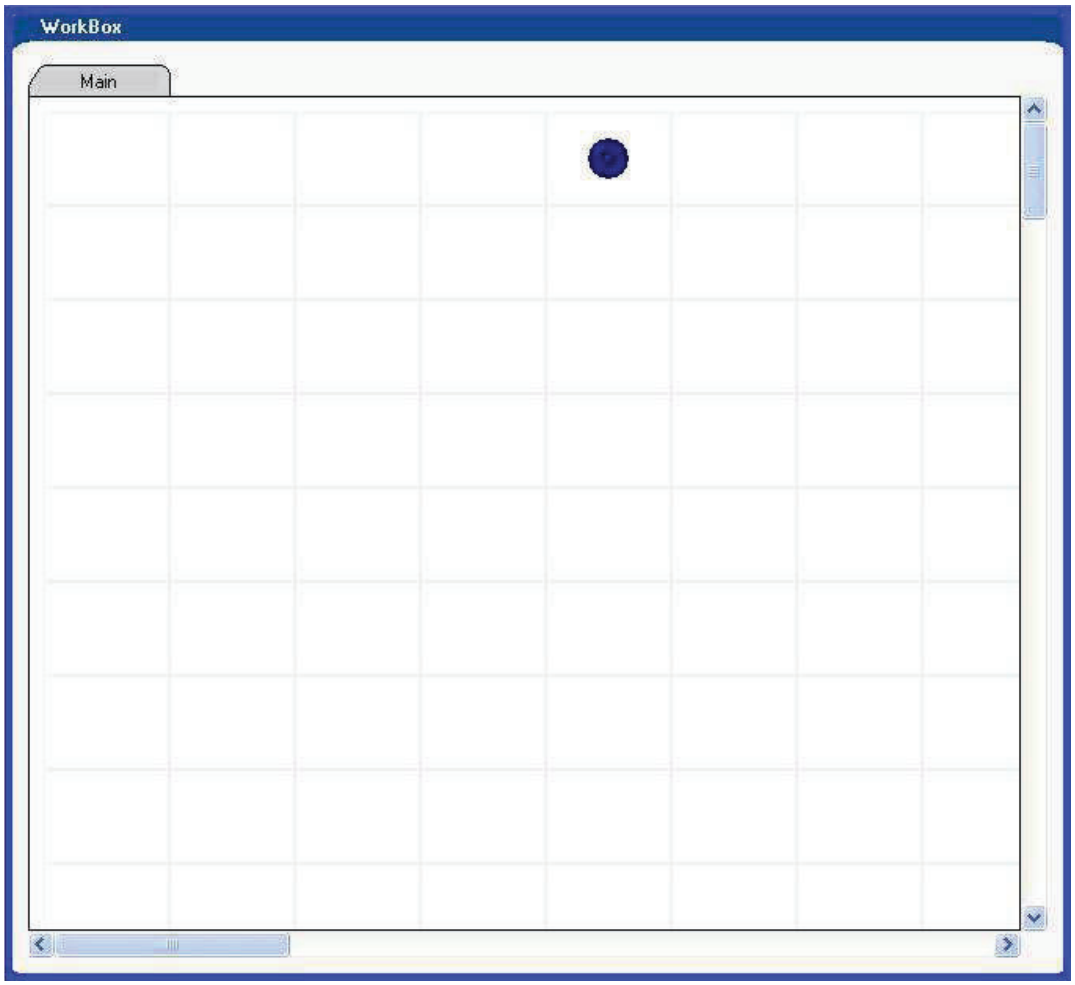


Image 24. mOwayGUI screen

5.2. First programme in mOwayGUI

In order to develop your first programme, first you must create a project (previous chapter). This first basic programme will make mOway avoid obstacles.

1. Next step is to add a 1-second delay: delay_ms(1000). Just add a module and double click in order to configure it. The *Pause* option is selected and configured as may be seen in the following image.

2. The command to make one of the LEDs blink is added. This is another module with the following configuration:

Image 25. Pause and LEDs configuration

3. The end of the program is added so that the application can be compiled.

4. The program is compiled and recorded into the robot by means of the record button in the menu.

5. Test the program and check that after waiting 1 second the green LED lights up.

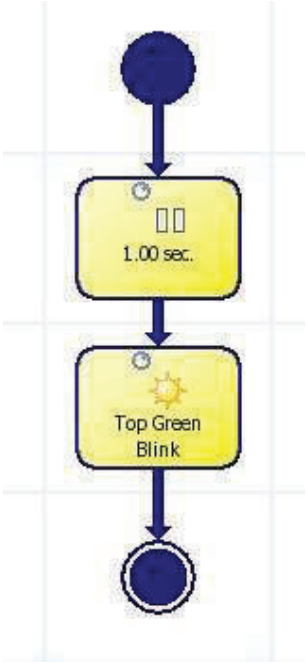


Image 26. First mOwayGUI program: Pause and blinking

6. In order to detect obstacles, the *Condition* modules are configured to check both sensors individually.

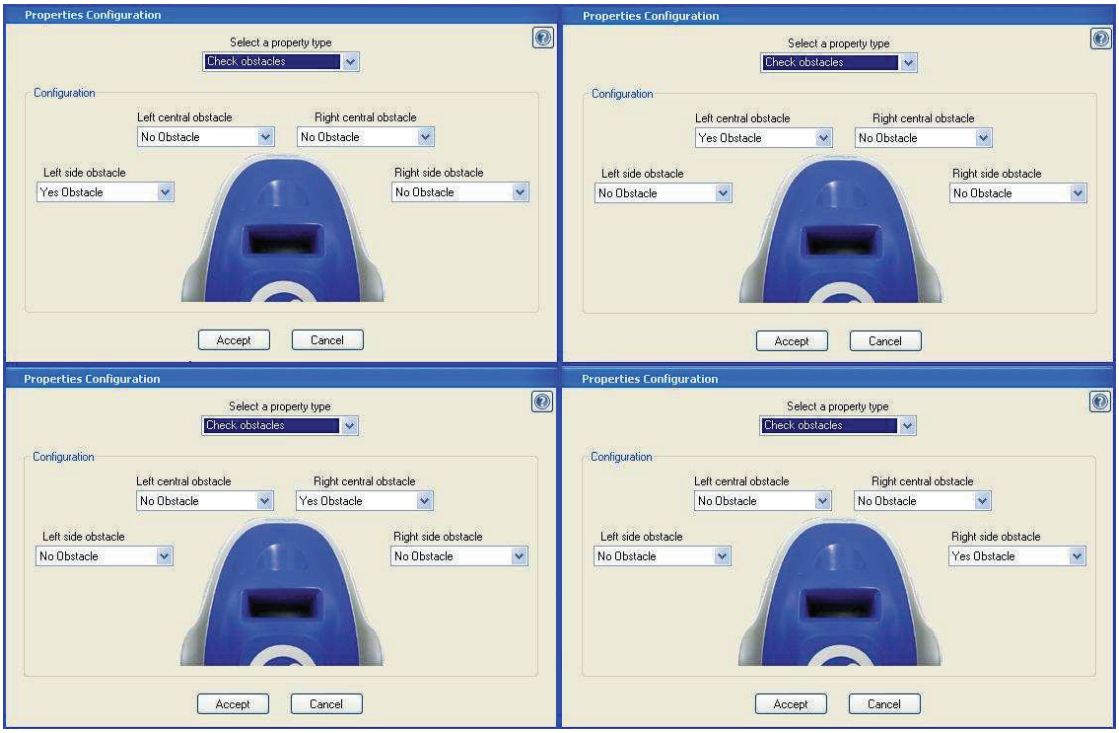


Image 27. Check obstacles configuration

7. Condition modules have a true output and false output. If the condition is true (obstacle detected) the corresponding LED lights up, otherwise it remains off.

8. Test the program and check that the front LEDs light up when an obstacle is detected.

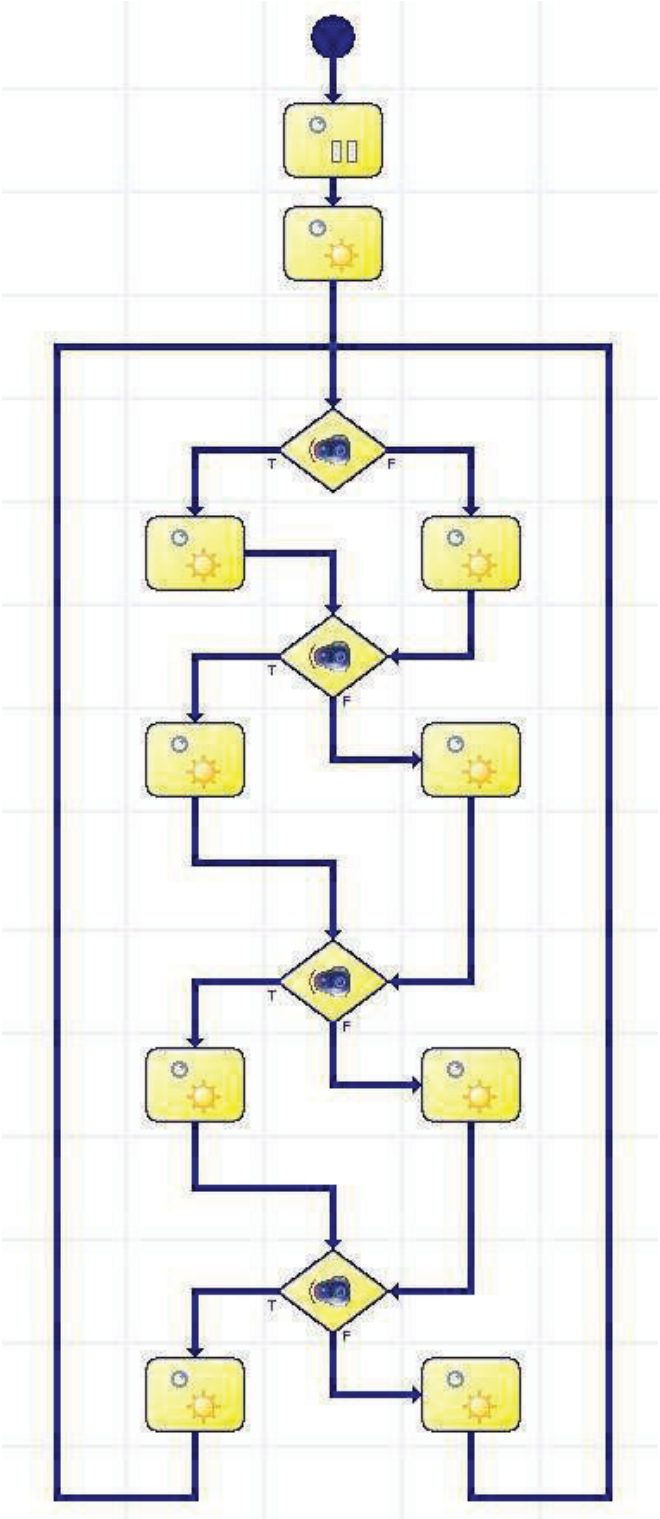


Image 28. First mOwayGUI program: obstacle detection

9. We add movement to the robot: straight on indefinitely until an obstacle is found.

10. When an obstacle is found, a command is sent to the robot to rotate 180º. The robot will continue to move in a straight line when the rotation is completed.

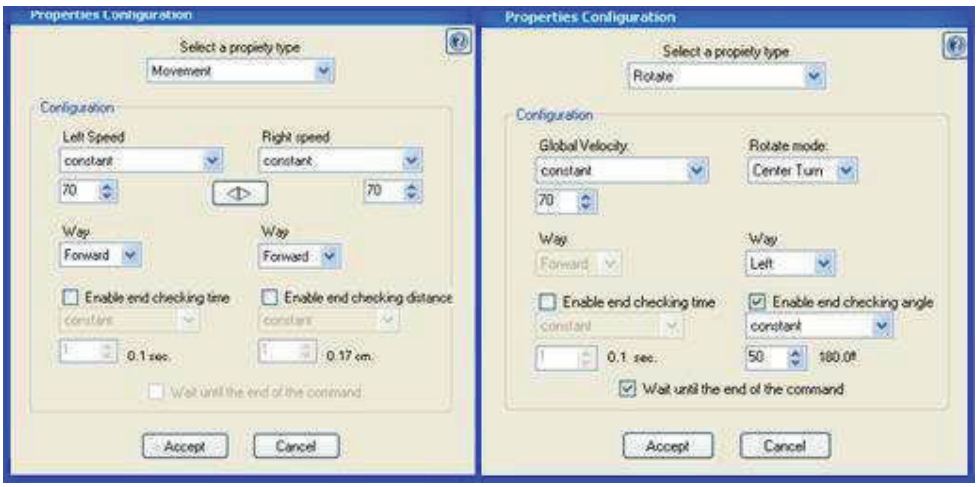


Image 29. Movement and Rotation configuration

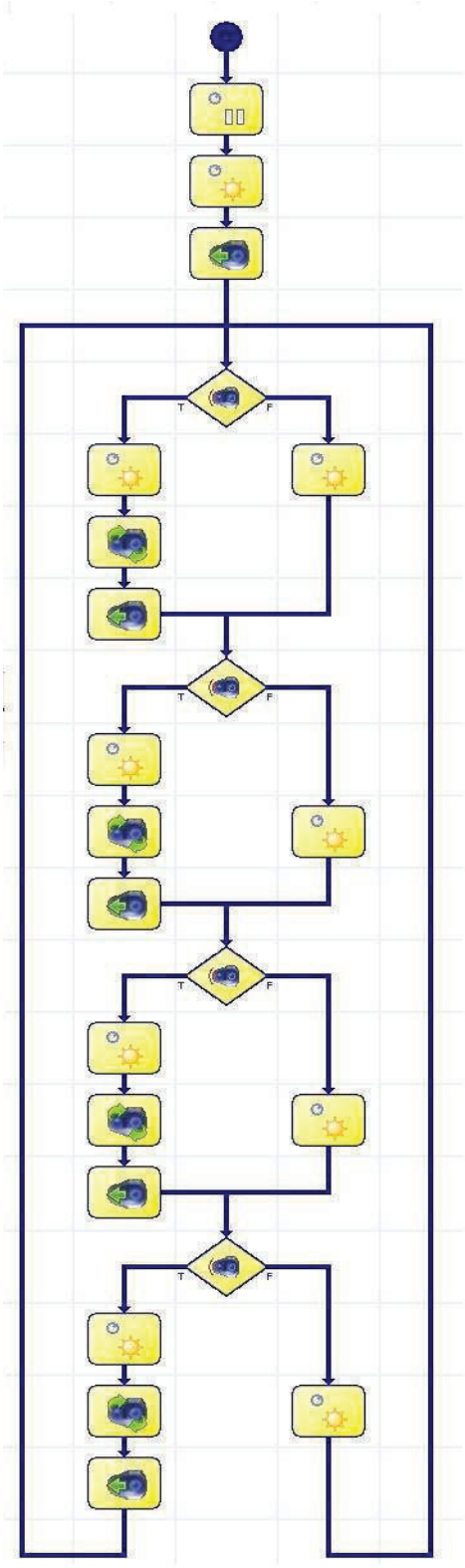


Image 30. End of first program in mOwayGUI

5.3. mOwayGUI

5.3.1. Modules

Modules are actions in which the output is unconditional: turn on a LED, send a movement command, etc. With modules, the following actions can be carried out:

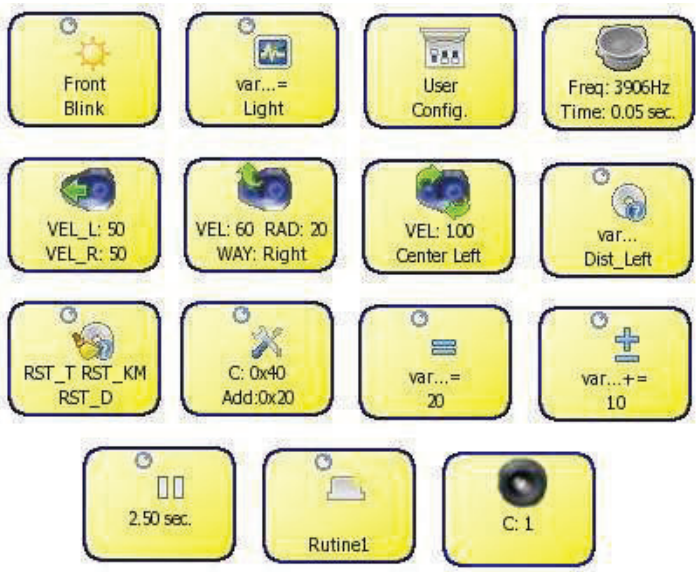


Image 31. Set of mOwayGUI modules

SENSORS

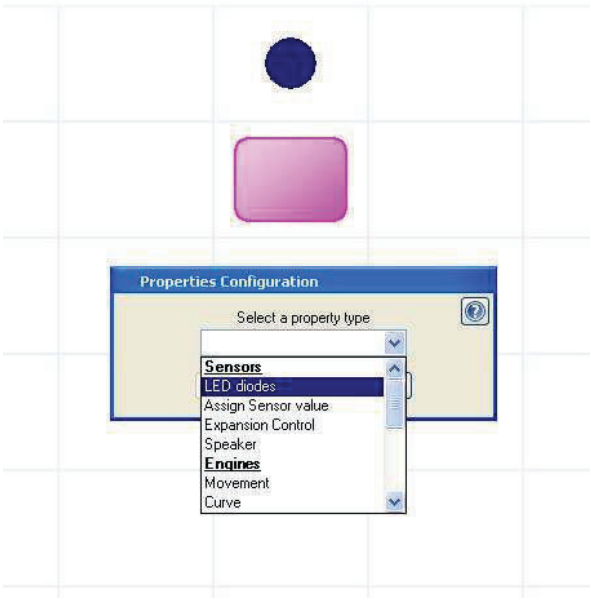


Image 32. Choose the type of module (Sensors)

- **LED Diodes**

This module enables you to operate on mOway's LED diodes. You can turn them on, turn them off or make them blink.

Image 33. Choose the LED diode and its action

- **Assign sensor value**

This function is to assign a variable to one sensor. This variable can be used to configure different aspects of the robot.

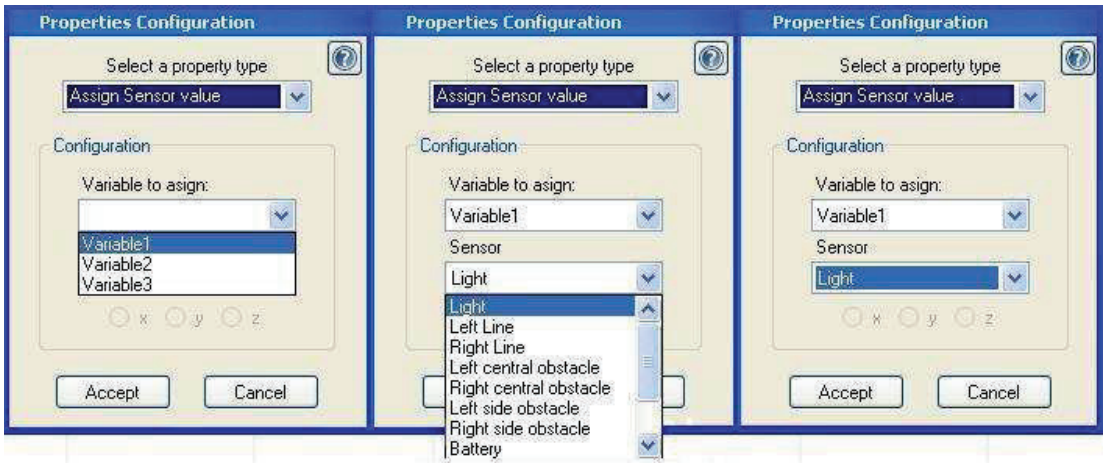


Image 34. Choose the variable to assign and the sensor

- **Expansion control**

Control of the expansion connector of the mOway robot. It can be used with the mOway expansion module.

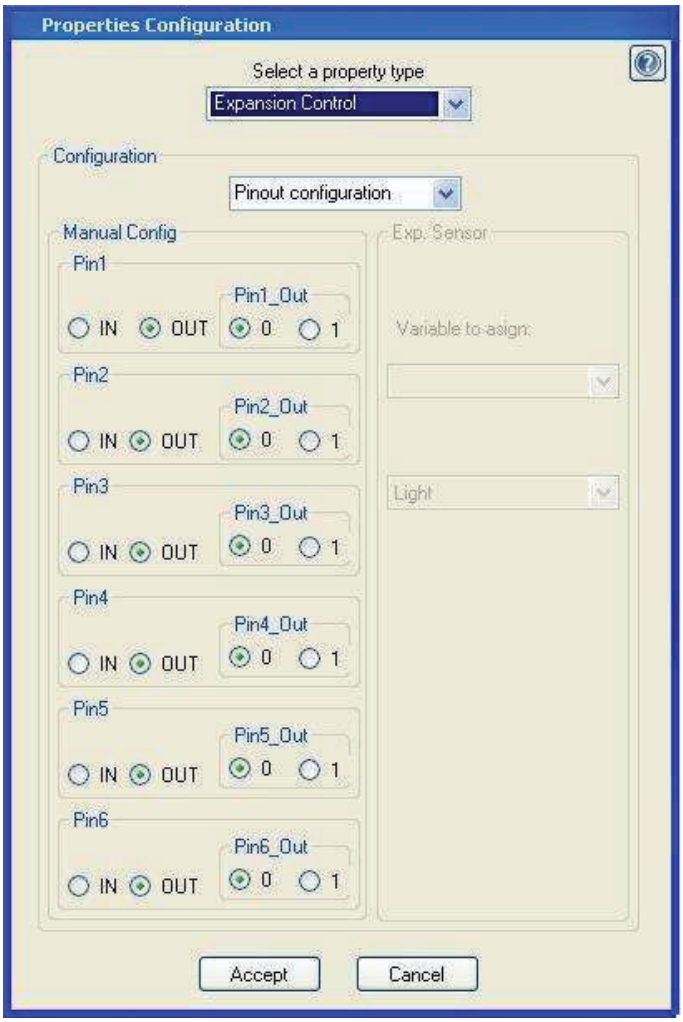


Image 35. Choose pinout configuration of the expansion connector

WARNING!

Only advanced users can use the pinout configuration. Any incorrect connection of electronic elements to the expansion connector may damage the robot irreversibly.

- **Speaker**

This function enables mOway to emit tones from 250 Hz to 65 KHz in pair sequences of 100 ms. This is possible because of the speaker installed on the robot.

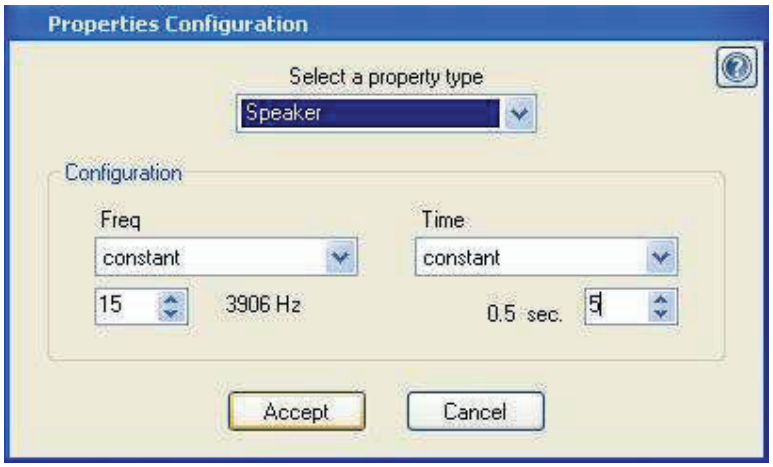


Image 36. Choose the frequency and the time of the tone

ENGINES

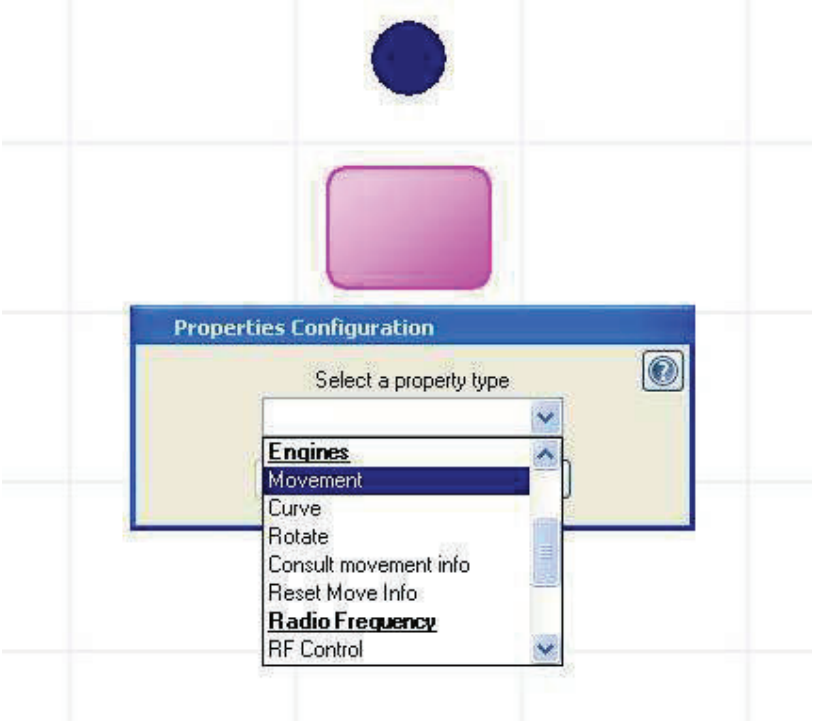


Image 37. Choose the type of module (Engines)

- **Movement**

mOway has two motors in each wheel. These give it a great flexibility in its movements. The movement commands allow the speeds of each motor to be controlled individually and to restrict movements in certain time or distance.

Another important option when configuring motors is the "**Wait until end of command**". This option allows you to block the movement command (the program stops running) until the movement module finishes (according to time or distance). This option is only accessible if we select the options "Enable end according to time" or "Enable end according to distance".

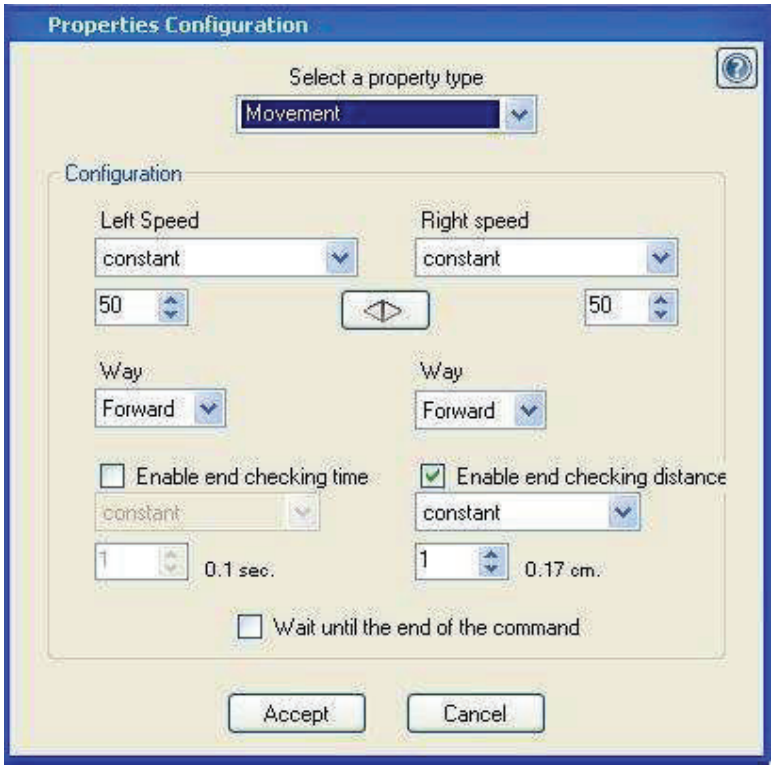


Image 38. Choose the speed, the way and the time or the distance

- **Curve**

The curve module is a specific case of the movement module. In this command, drive system will calculate the speed of the motors in order to be able to trace a curve, indicating the speed and turning radius.

We can also use here the time restrictions and distance and the "Wait until end of command" option.

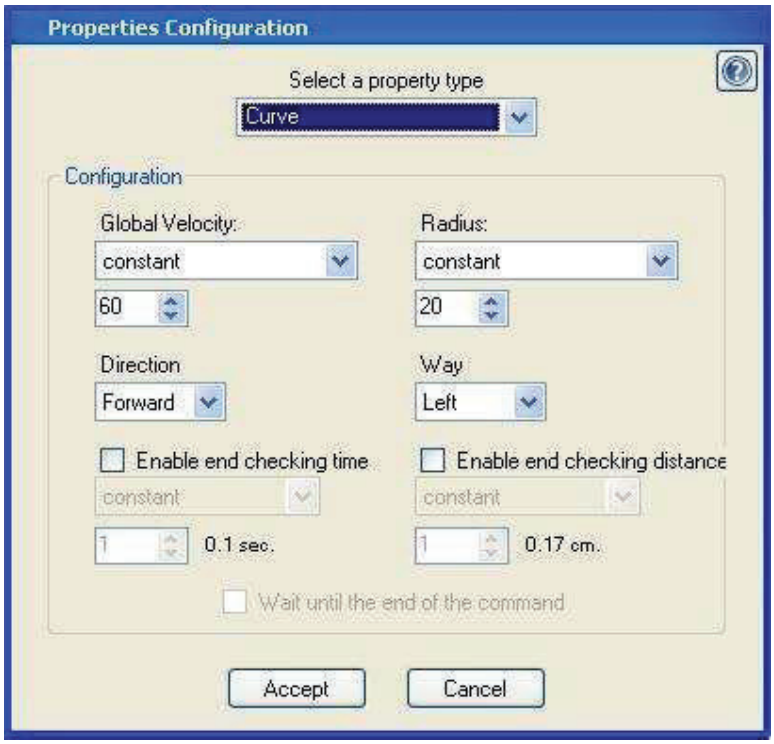


Image 39. Choose the speed, the curvature radio, the direction, the way and the time or the distance

- **Rotation**

The rotation module is another specific case of the movement module. With this command, mOway will rotate either on its centre or on one of its two wheels. We can configure the turning direction and the rotation speed.

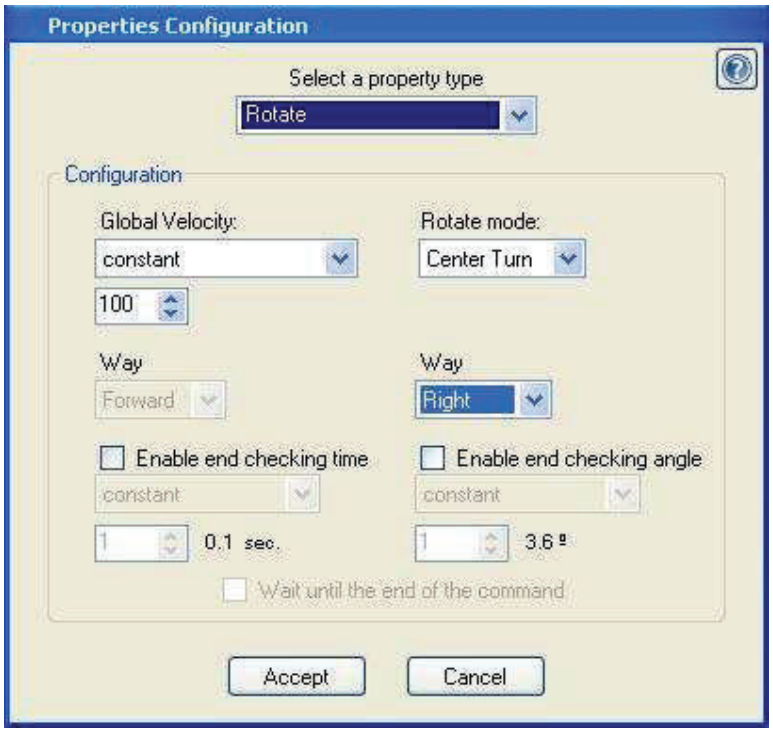


Image 40. Choose the speed, the rotate mode, the way and the time or the distance

We can also use here the time restrictions and turning angle as well as the "Wait until end of command" option.

- **Stop**

The Stop module is another specific case of the movement module. With this command, mOway will stop moving.

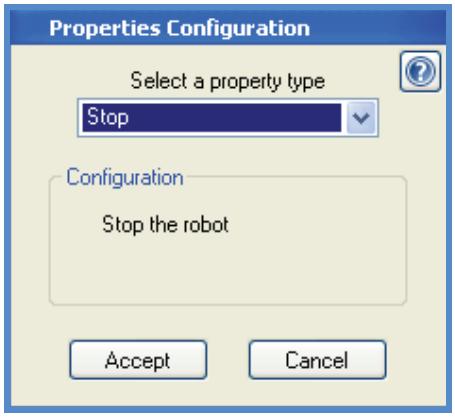


Image 41. Stop mOway

- **Consult movement info**

mOway keeps a record of the data of the movements it makes. This module enables you to consult this record: Current speed, Distance covered, Angle of turn, etc.

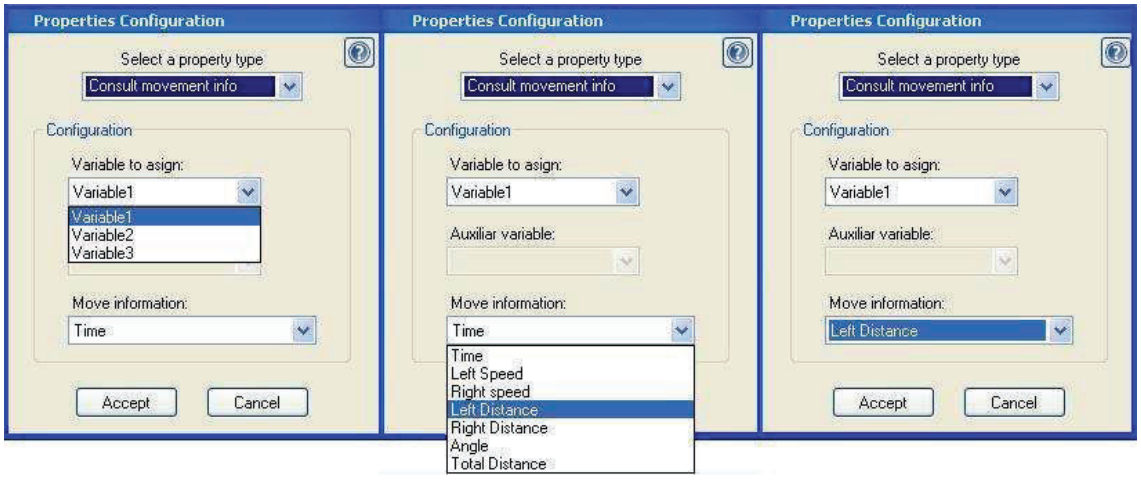


Image 42. Choose the variable and the move information

- **Reset movement data**

This module resets stored movement counters. You can select the specific pieces of data you wish to reset.

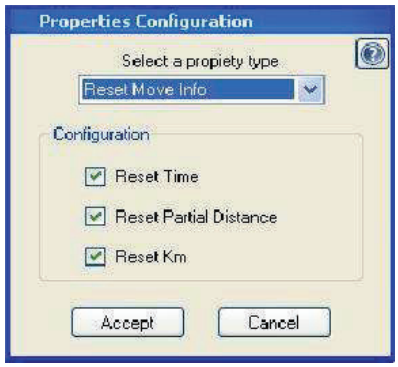


Image 43. Choose the options to be reset

RADIO FREQUENCY

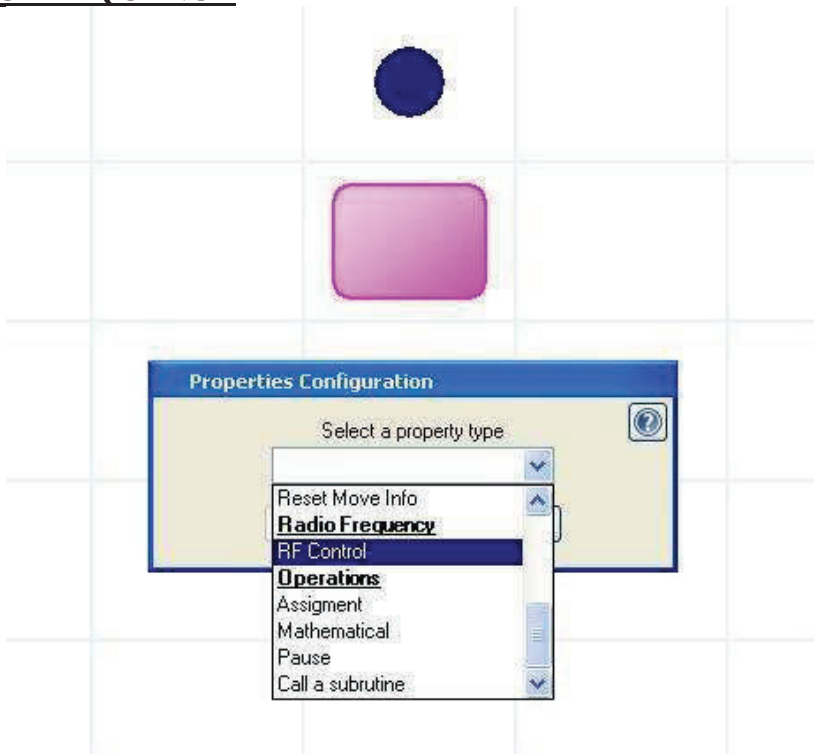


Image 44. Choose the type of module (Radio Frequency)

- **RF Control**

This activates or deactivates the RF module. When you activate this control, you must select which address the robot will use and in which channel you wish to operate. So that two mOways can communicate between each other, they must operate on the same channel.

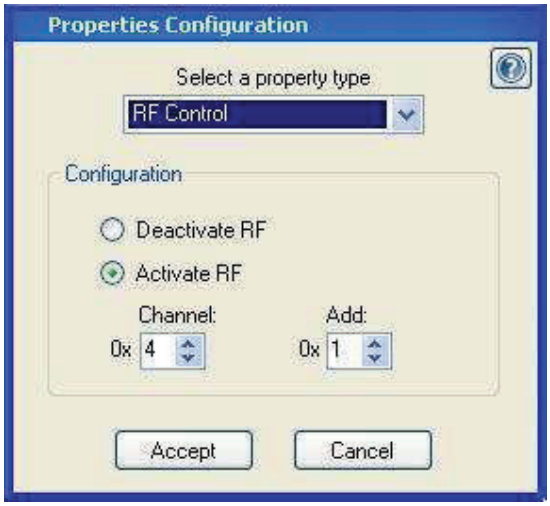


Image 45. Choose the channel and the address

CAMERA

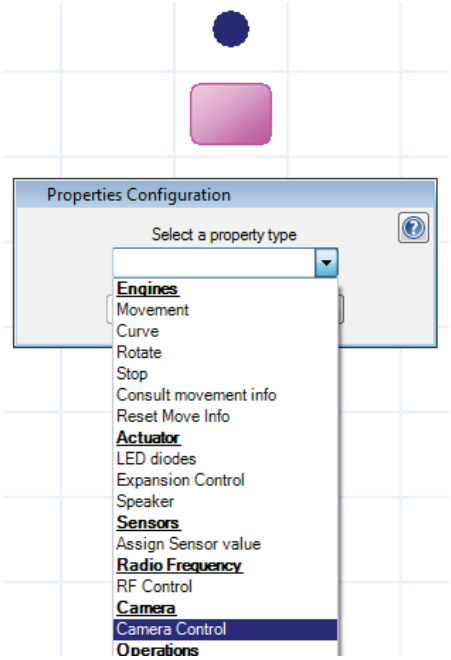


Image 46. Choose the type of module (Camera)

- **Camera Control**

This activates or deactivates the camera module. When you activate this control, you must select which channel the camera will send images to the video **Moway Videocap**[16]. Camera channel and video capturer channel must be the same.

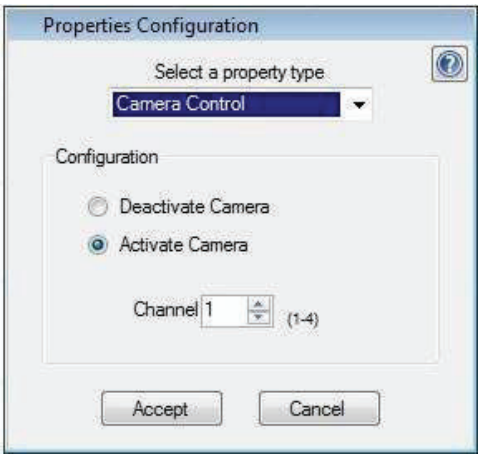


Image 47. Choose the channel and the address

[16] Module not available in all kits

OPERATIONS

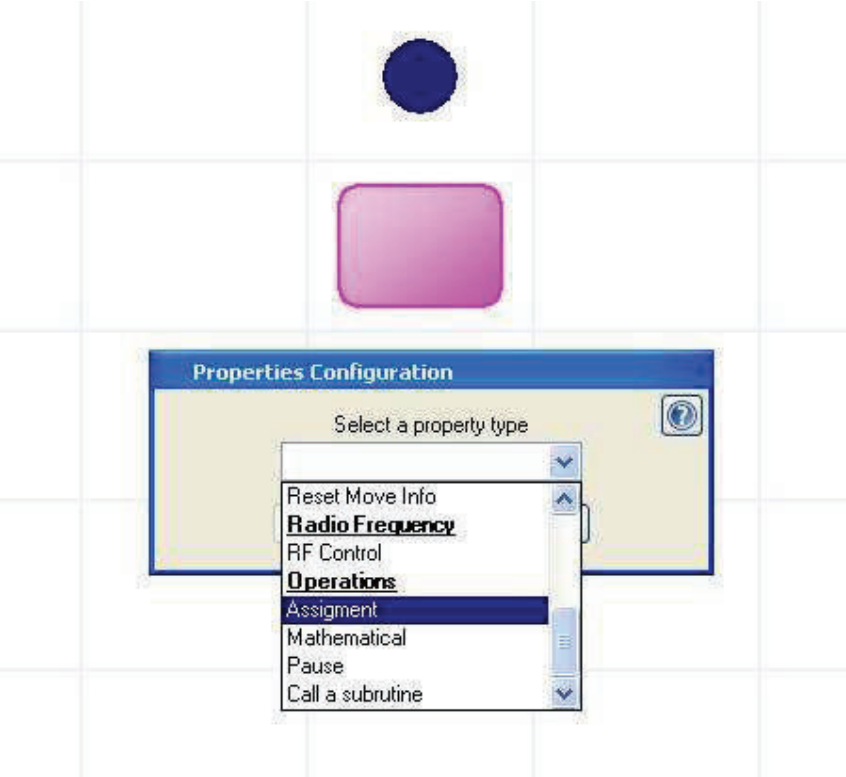


Image 48. Choose the type of module (Operations)

- **Assignment**

This function is to assign a value (a constant or variable) to a previously created variable. This variable can be used to configure different aspects of the robot.

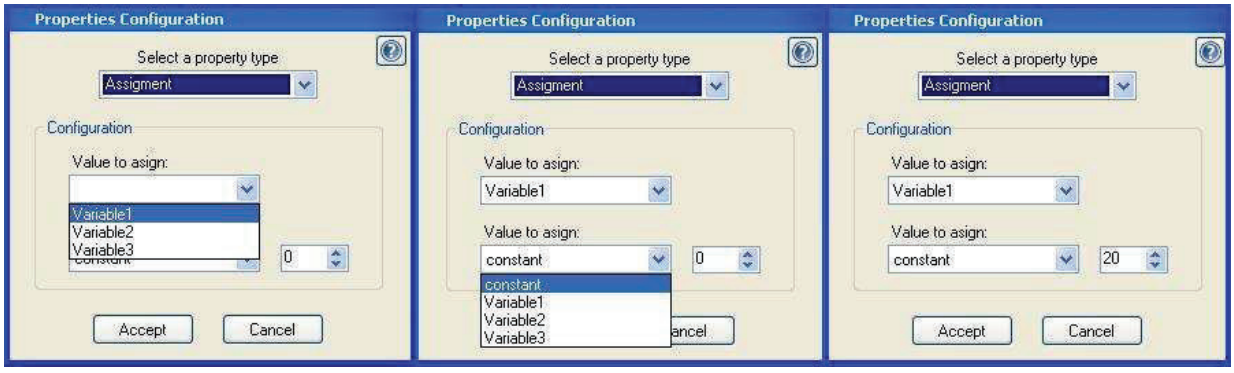


Image 49. Choose the variable and the value to assign

- **Mathematical**

This is used to carry out arithmetic operations to add or subtract to or from a variable. The first parameter must be a variable in each case and this will be used to store the result of the operation. The second operand may be a constant or a variable.

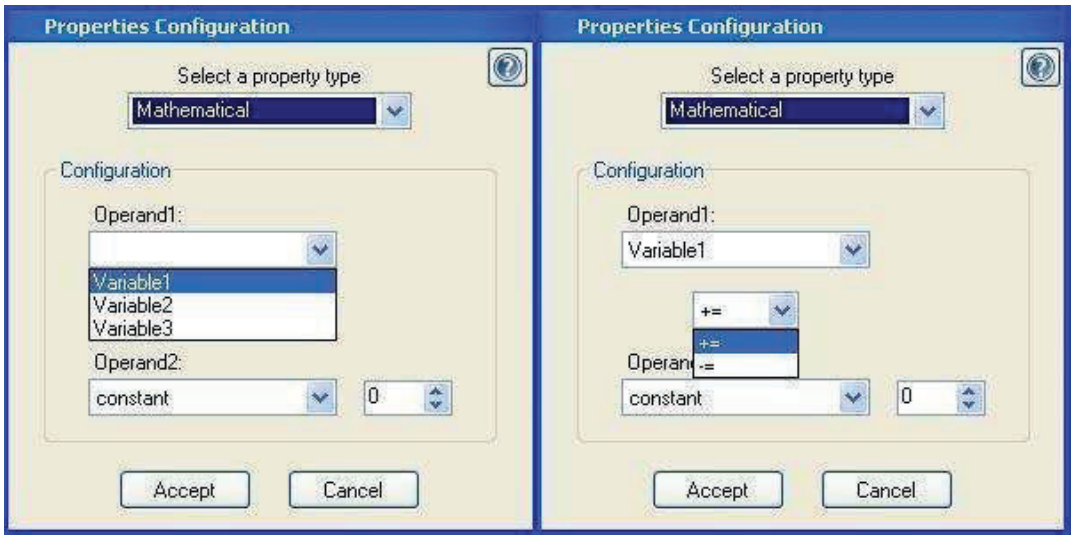


Image 50. Choose the operand1 and the operation

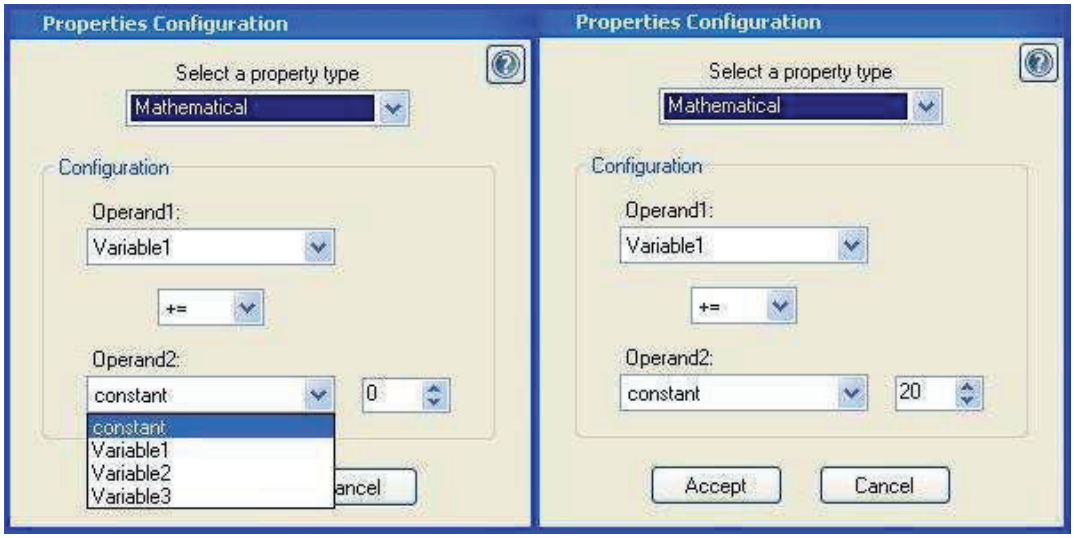


Image 51. Choose the operand2

- **Pause**

This allows you to insert a pause in the programme with a duration set in multiples of 0.05 seconds. The pause parameter may be a constant or a variable.

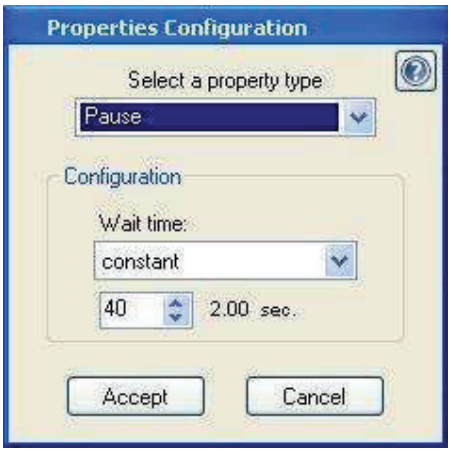


Image 52. Choose the time

- **Subroutine call**

Subroutine call, which can be reused in other mOway projects.

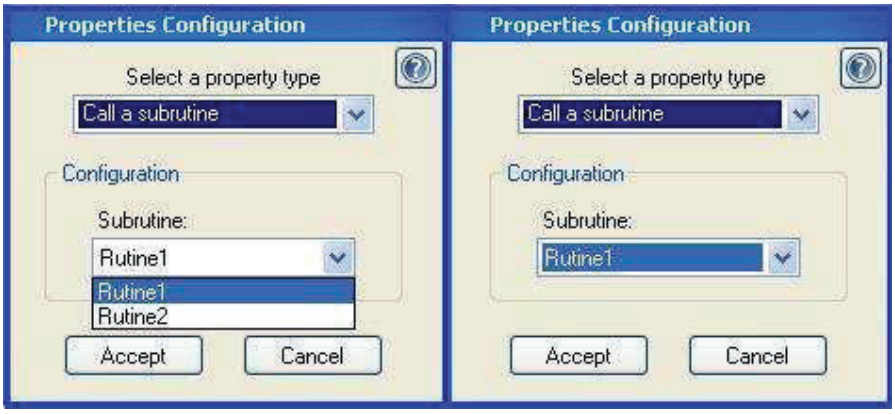


Image 53. Choose the subroutine

5.3.2. Conditionals

Conditionals are actions in which the output is important in order to operate with them: comparisons, sensor verification, etc. The following actions can be carried out with modules:

Image 54. Set of mOwayGUI conditionals

SENSORS

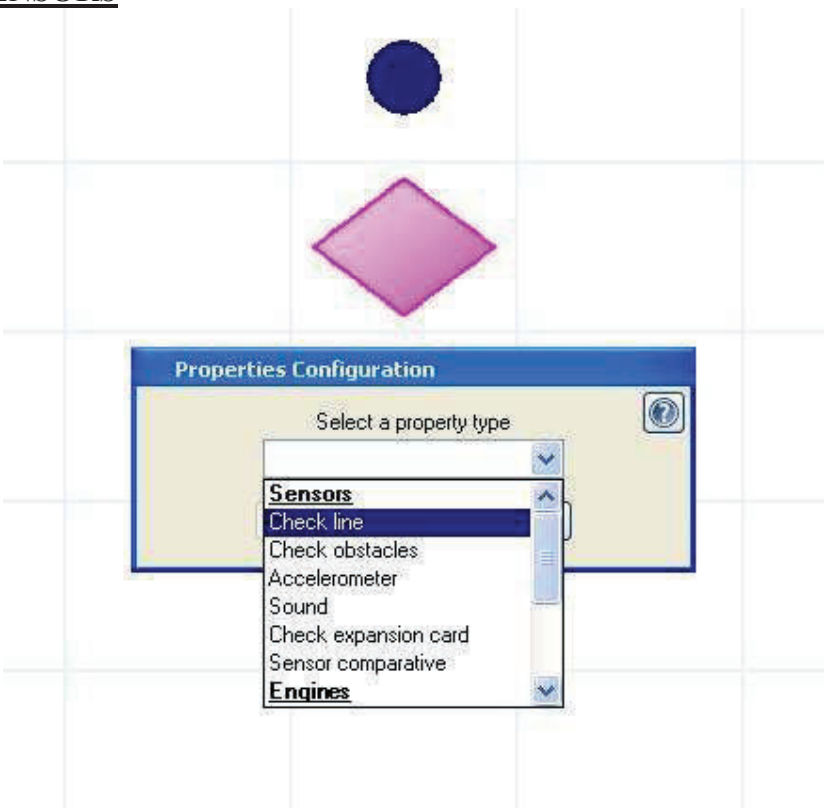


Image 55. Choose the type of conditional (Sensors)

- **Check line**

It checks the digital value of line sensors. This module is very useful for making mOway follow a line (black or white) on the floor,

detect boundaries, etc. User has to check the AND or OR boolean operation. With AND option both conditions must be true and on the other hand, with OR one of the two condition has to be true.

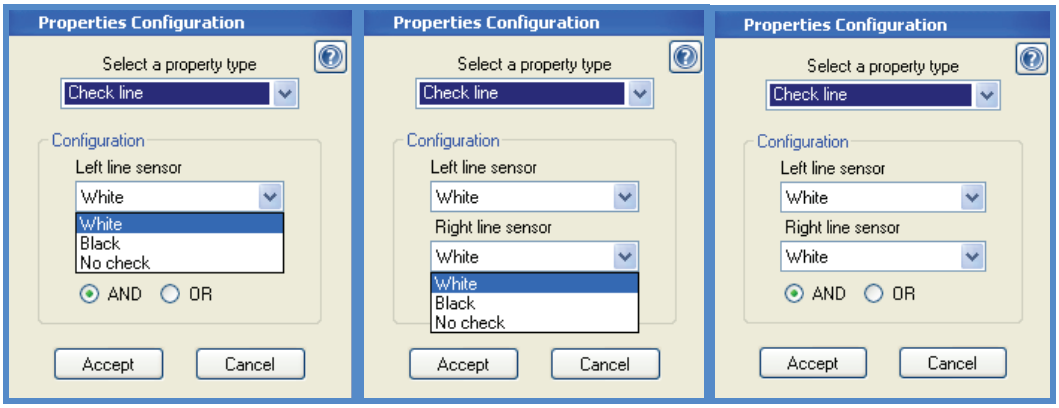


Image 56. Choose the left and the right line sensors: both have to be white

- **Check obstacles**

It checks the digital value of obstacle sensors. It is used to determine whether there is an obstacle or not in front, to the left or right. User has to check the AND or OR boolean operation. With AND both conditions must be true and on the other hand, with OR one of the two condition has to be true.

Image 57. If one of the sensors detects an obstacle: true output

- **Accelerometer**

With the accelerometer you can check if the mOway has been beaten once (tap) or twice (Double tap).

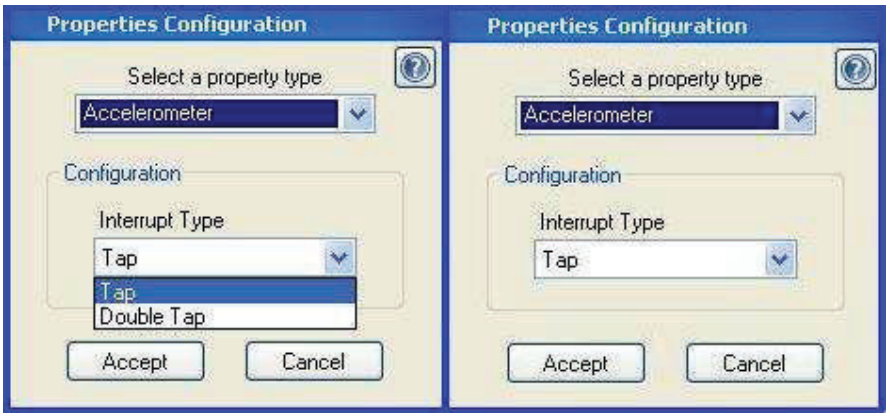


Image 58. Choose the interrupt type

- **Sound**

This sensor checks if there is a loud sound or not.

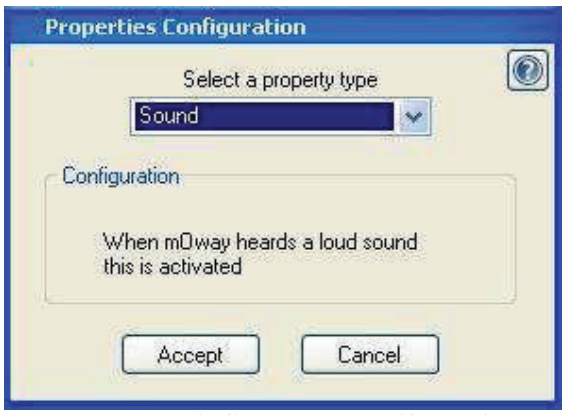


Image 59. Choose to check if there is a sound

- **Check expansion card**

This checks the digital value of the expansion connector pin.

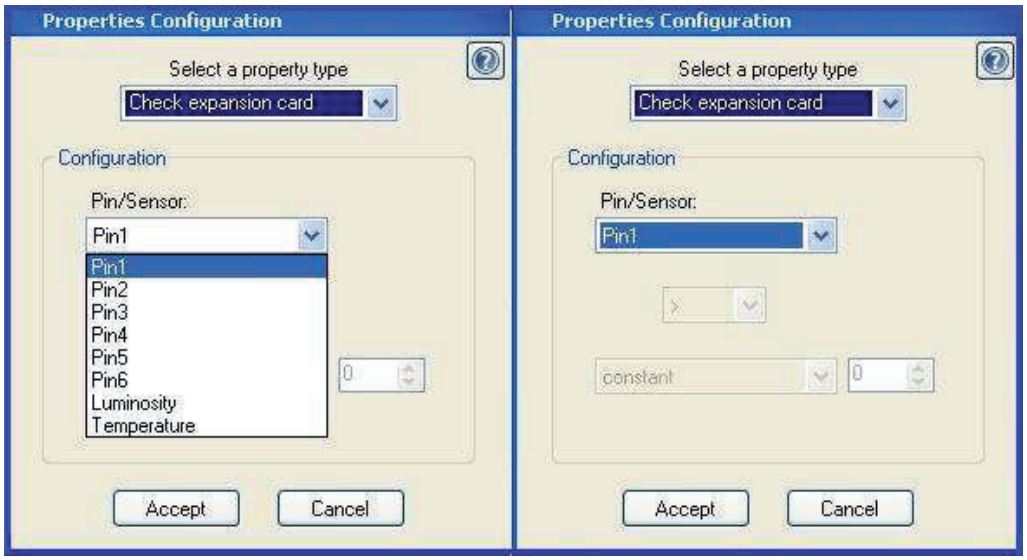


Image 60. Choose to expansion connector pin

WARNING!

Only advanced users can use the pinout configuration. Any incorrect connection of electronic elements to the expansion connector may damage the robot irreversibly.

- **Sensor comparative**

It compares the analogue value of obstacle, line, battery, temperature, accelerometer or microphone sensors. All mOway sensors return an analogue value. For example, the light sensor gives a value of 0 to 100 according to the intensity of the incident light, and obstacle sensors give a value of 0-255.

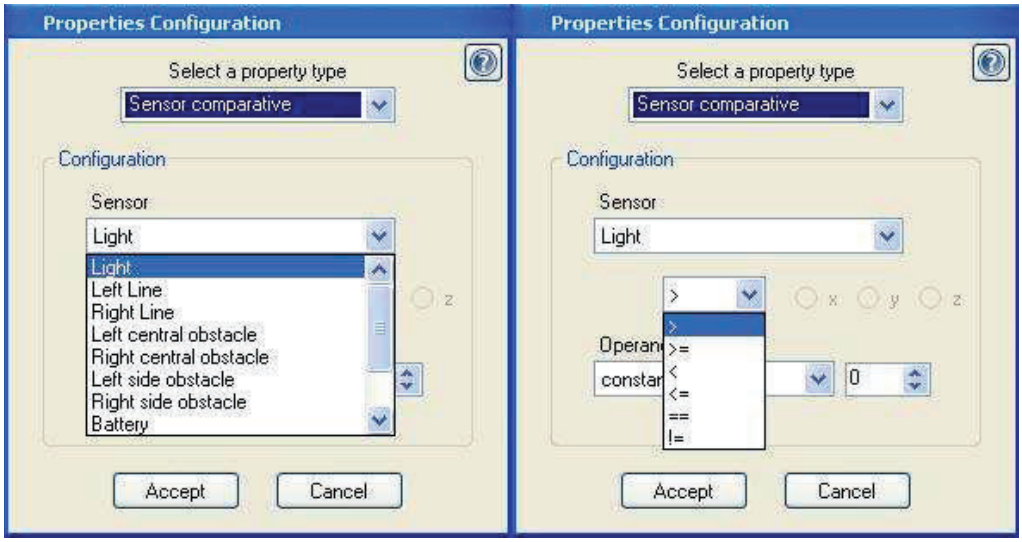


Image 61. Choose the sensor and the comparative

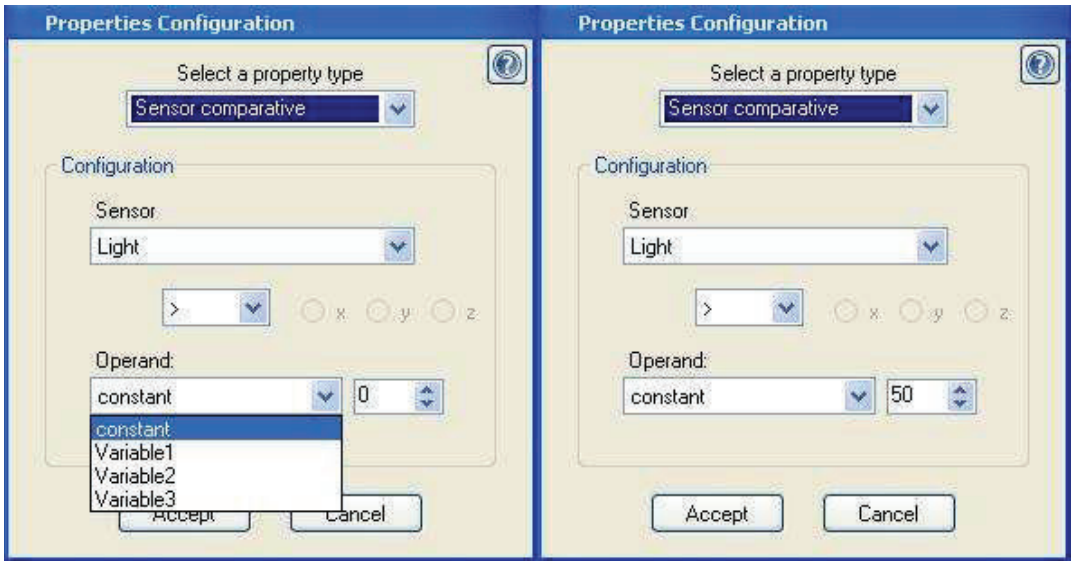


Image 62. Choose the variable to be compared

ENGINES

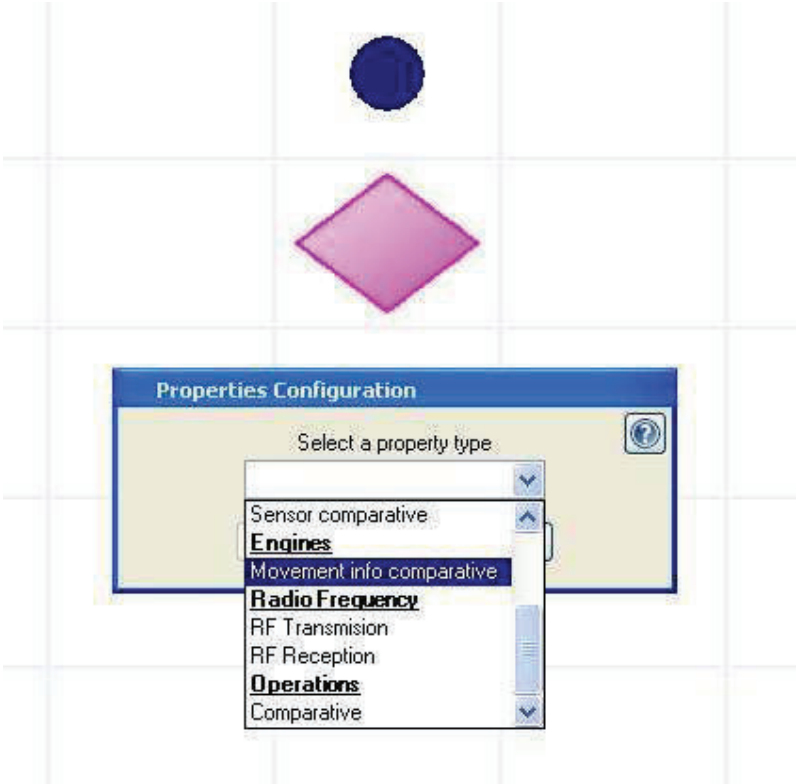


Image 63. Choose the type of conditional (Engines)

- **Movement info comparative**

A comparison is made with the information from the drive system. The drive system provides information about the total distance covered, partial distance, etc.

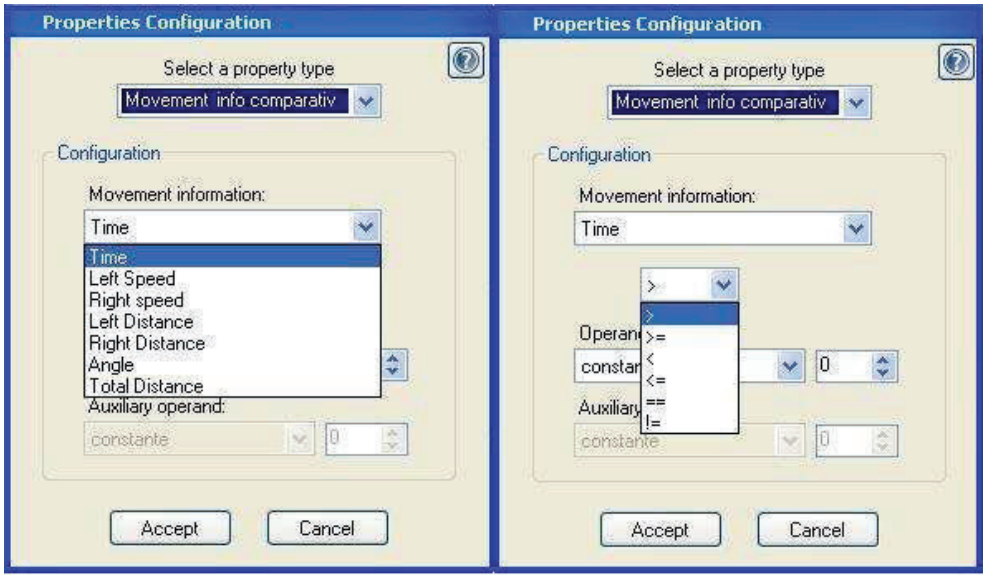


Image 64. Choose the movement information and the comparative

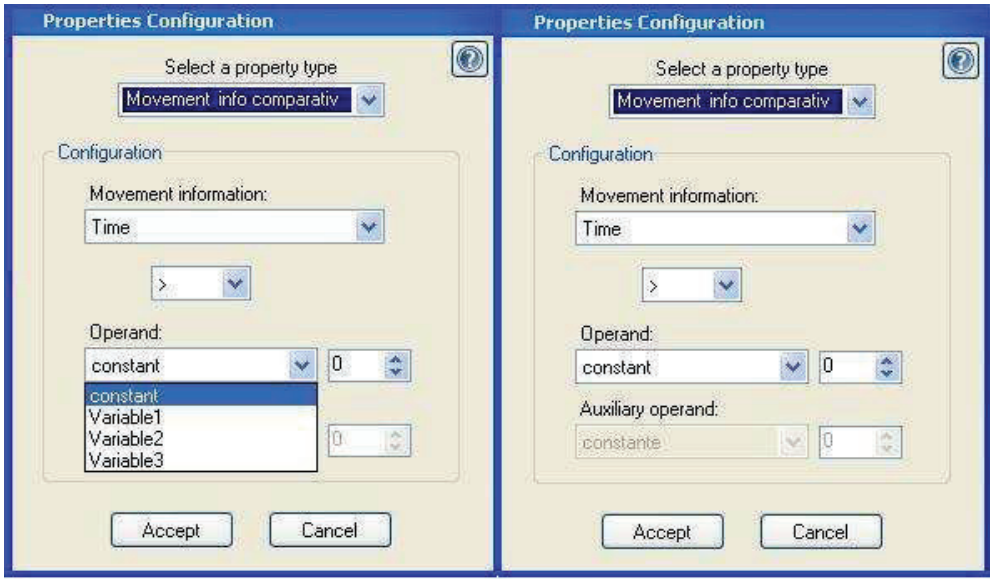


Image 65. Choose the variable to be compared

RADIO FREQUENCY

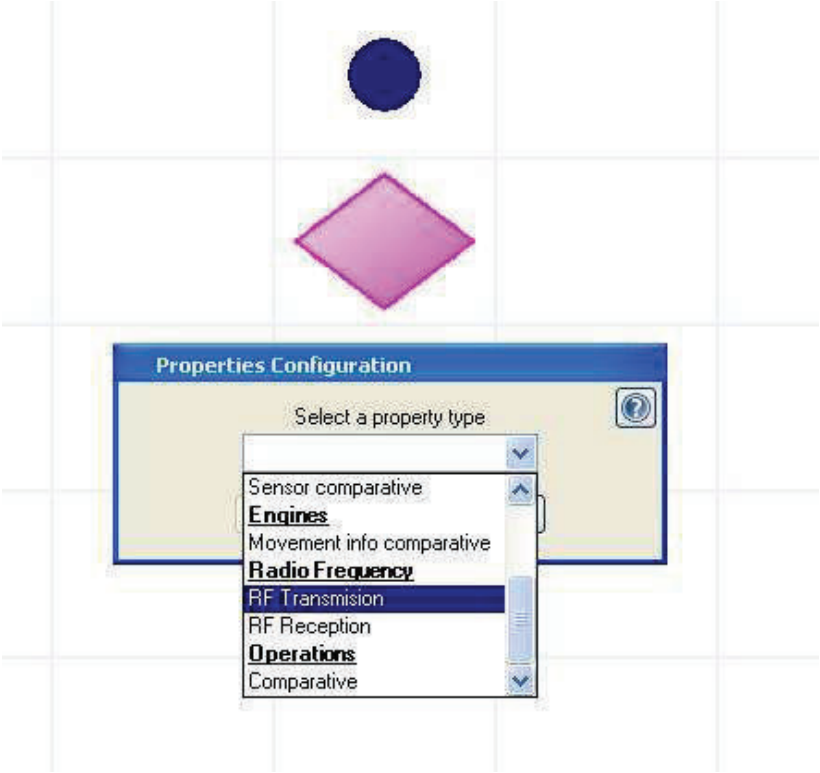


Image 66. Choose the type of conditional (Radio Frequency)

- **RF transmission**

It transmits a frame to a specific address. The address of the recipient and the data, which can consists of constants or variables, must be indicated in the frame. It must be remembered that before inserting this conditional, the module must be configured using the "RF Control" module. Remember that all the robots taking part in the RF communication must have the same channel and different addresses.

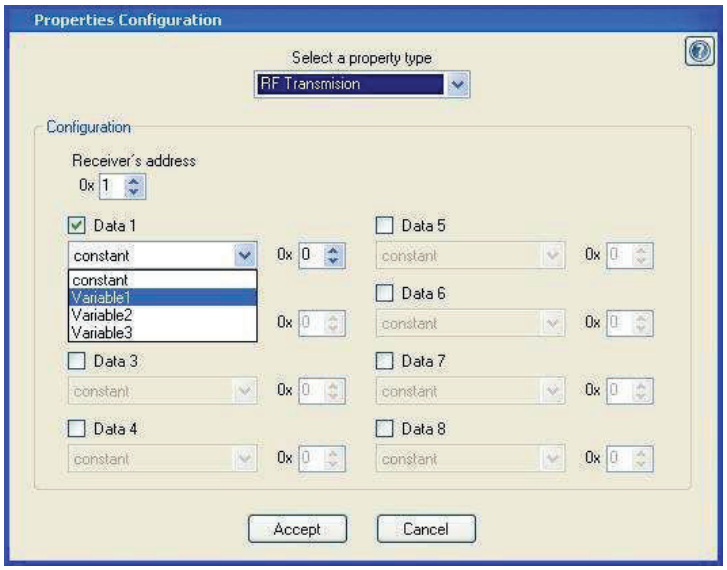


Image 67. Choose the first data to be transmitted

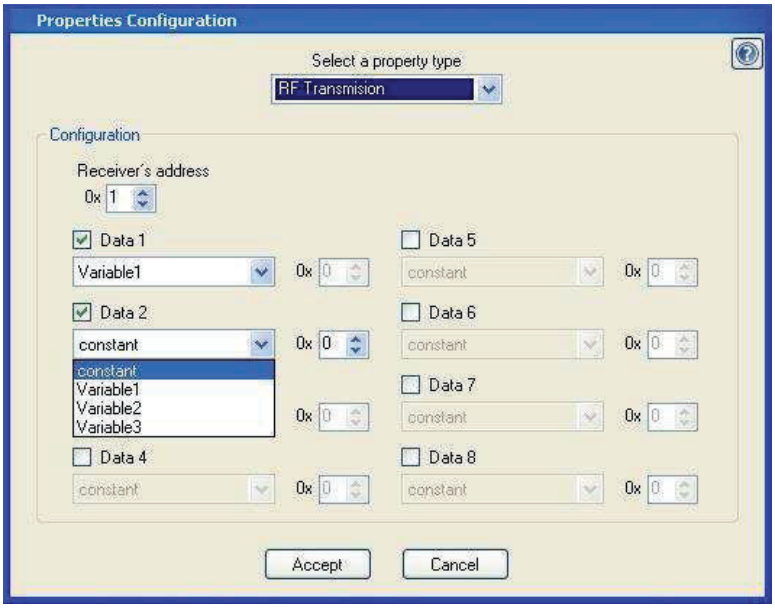


Image 68. Choose the second data to be transmitted

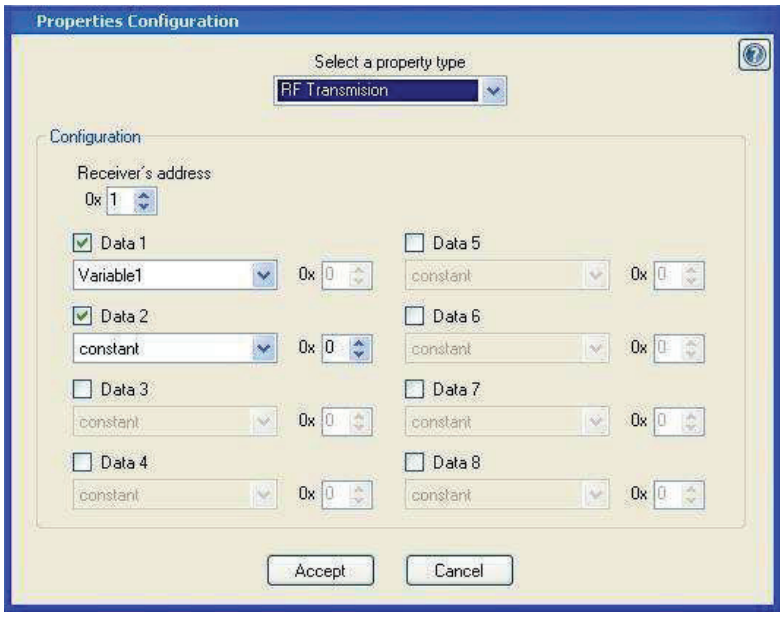


Image 69. First and second data ready to be transmitted

- **RF Reception**

It receives a frame from a specific address. It must be indicated at least two variables: one for collecting the transmitter address and the other for the data. It must be remembered that before this conditional, the module must be configured using the "RF Control" module. Remember that all robots taking part in the RF communication must have the same channel and different addresses.

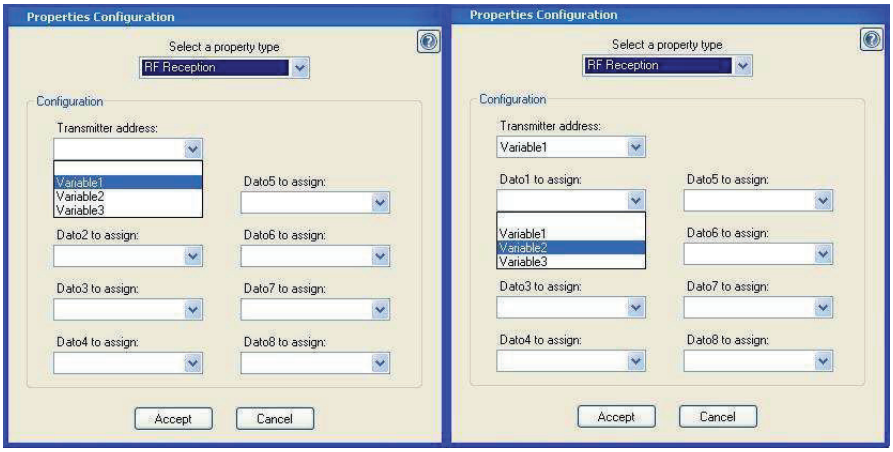


Image 70. Choose the address of the transmitter and the first data to transmit

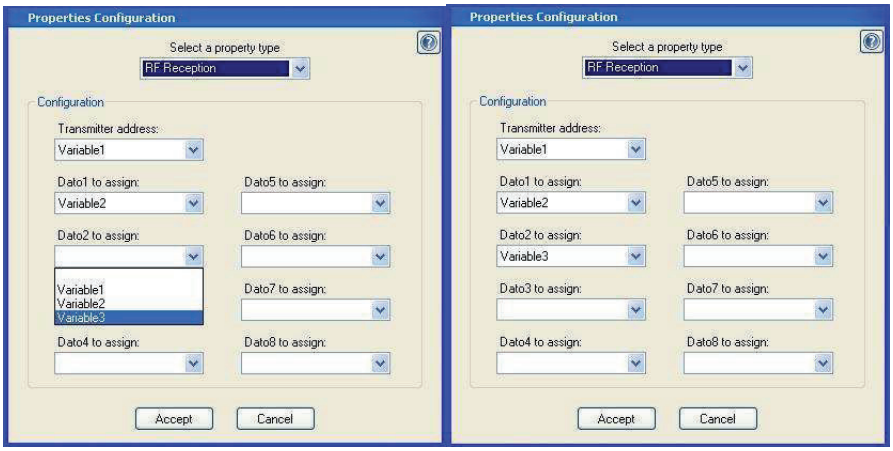


Image 71. Choose the second data to transmit

OPERATIONS

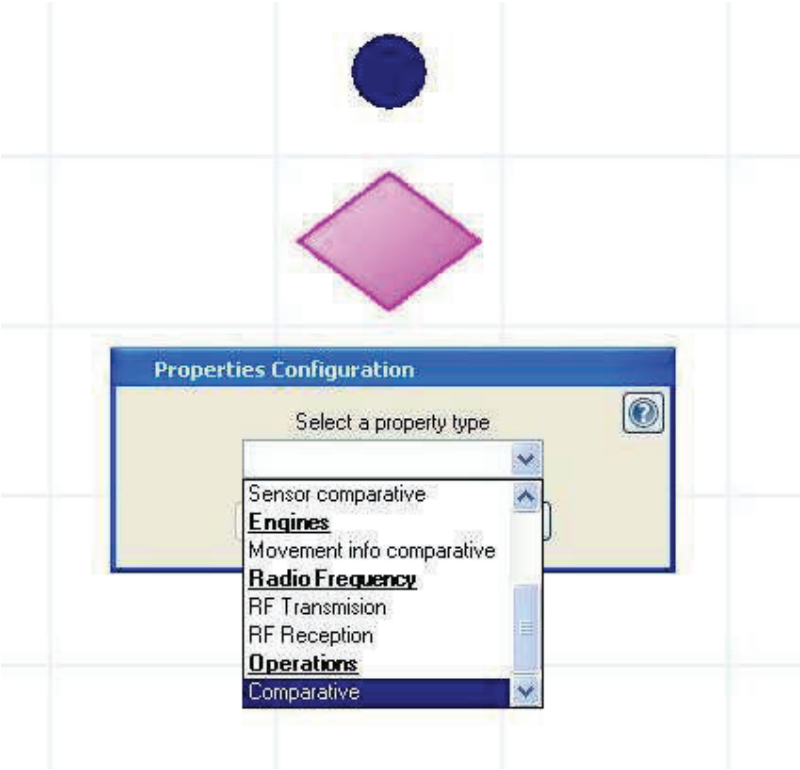


Image 72. Choose the type of conditional (Operations)

- **Comparative**

It makes a comparison on a variable. The variable can be compared with a constant or with another variable. This is very useful when comparing a variable used to carry out a mathematical operation.

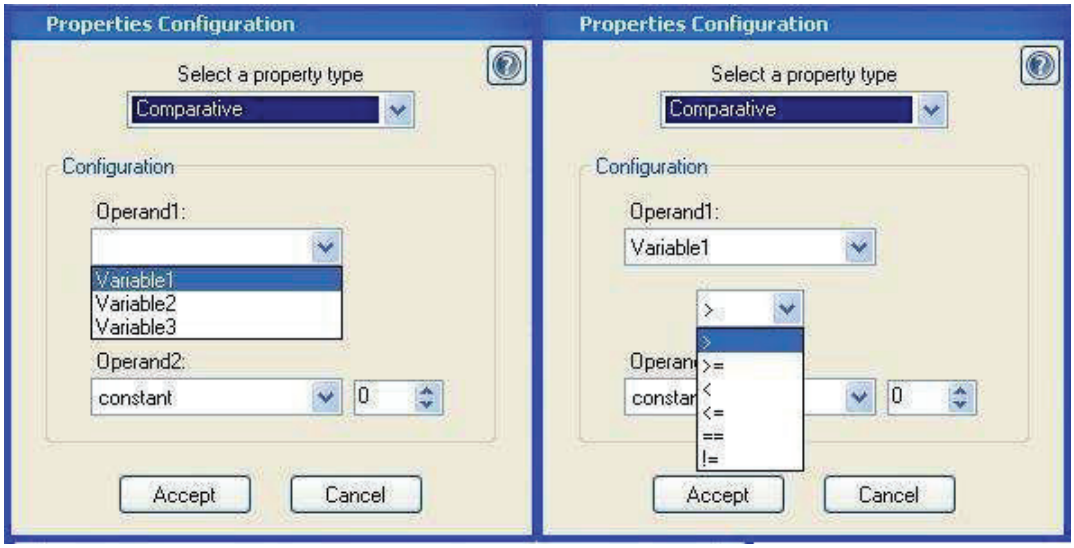


Image 73. Choose the first operand and the comparative

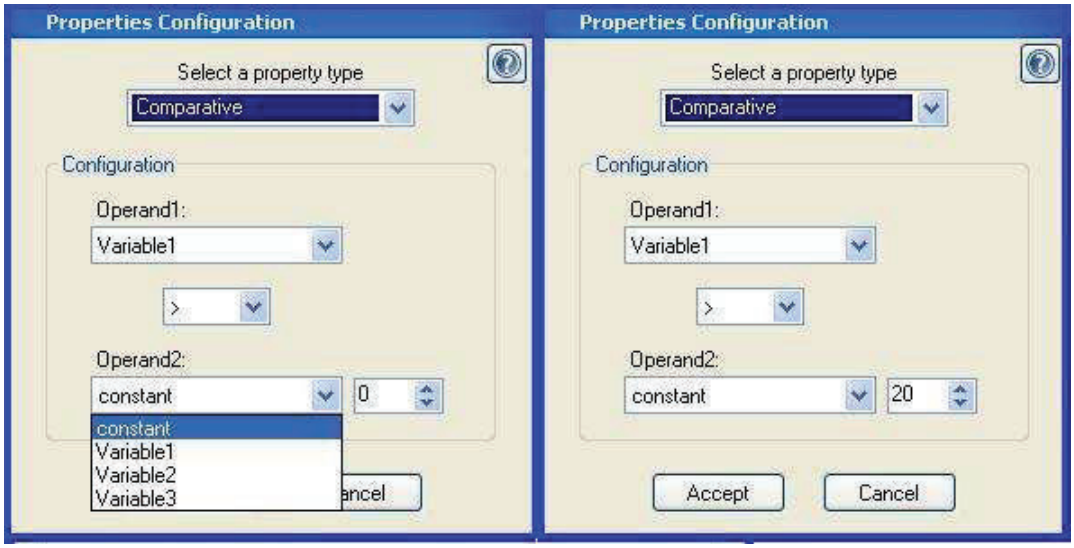


Image 74. Choose the second operand and the comparative

5.3.3. Start and End

Any program must have a Start element, but it does not need to have an End element (an infinite loop can be created).

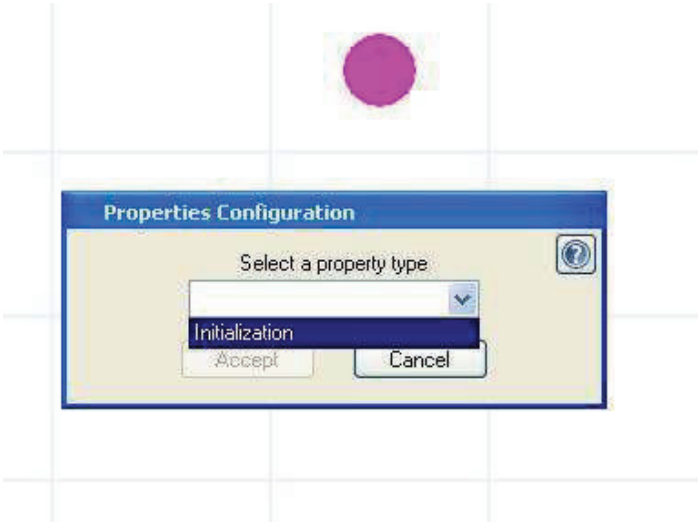


Image 75. Choose the option initialization

The Start element can initialize the variables.

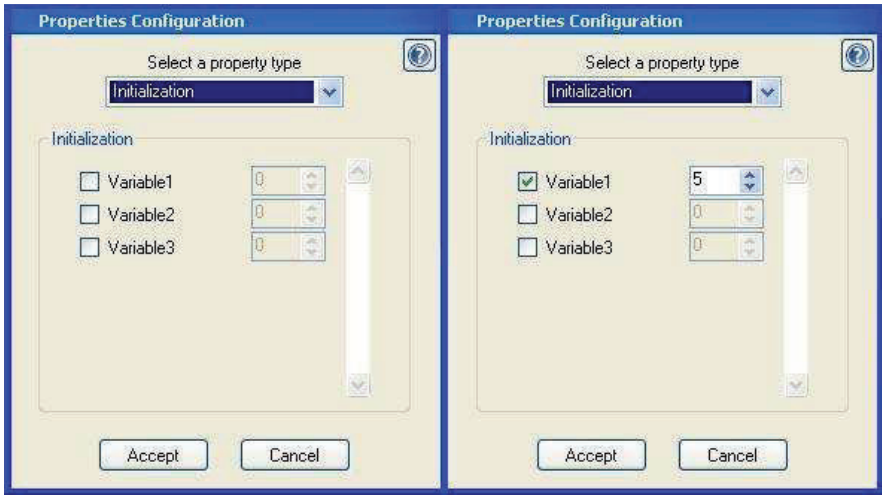
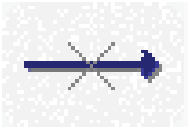


Image 76. Choose the variable and the value for the initialization

5.3.4. Arrow

Arrows are used to join Modules and Conditionals in order to create the program flow diagram. The same program indicates the user if the arrow is correctly positioned to ensure that the application operates correctly.

5.3.5. Erase Arrow



This tool is very useful to create the diagram. Erase Arrow is used to delete the link between the element and the next one. It can be done clicking on the element.

5.3.6. Subroutines

In order to simplify the diagrams and optimise the use of programme memory, reusable subroutines can be generated. In other words, if a part of the programme is repeated with great frequency, a subroutine can be created with this task, and replacing it in the main diagram with a subroutine module.

5.3.7. Recording

mOwayGUI can be used to record the diagram in the robot directly. The status of the recording process will be indicated at the top.

6. Moway RC Center

Moway RC Center is an application included in Moway's Pack to control Moway as if it was a radio control device and to monitor all the robot's sensors. This tool, which uses RF BZI-RF2GH4 modules and RFUsb (mOway Base is compatible), is very useful for all those users wishing to explore the field where the microbot will perform.

Its functioning concept is as follows: the application transmits commands by means of the USB to the RFUsb, which transmits them to Moway, where a recorded program interprets those commands (Moway_RC_Client included in Moway Pack).

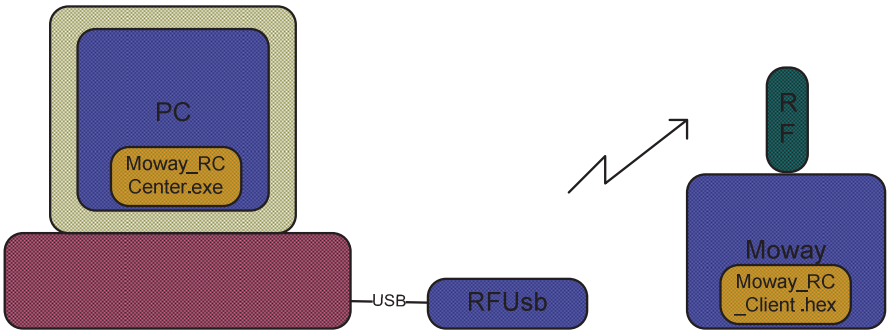


Image 77. Moway RC Diagram

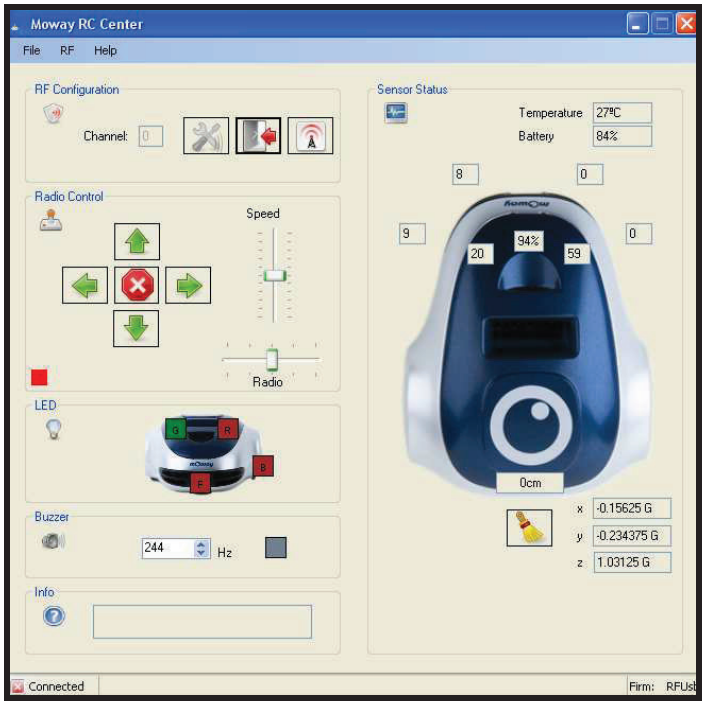


Image 78. Moway RC Center

You can access the application in Window/Radio Control or using the button shown in the next image.

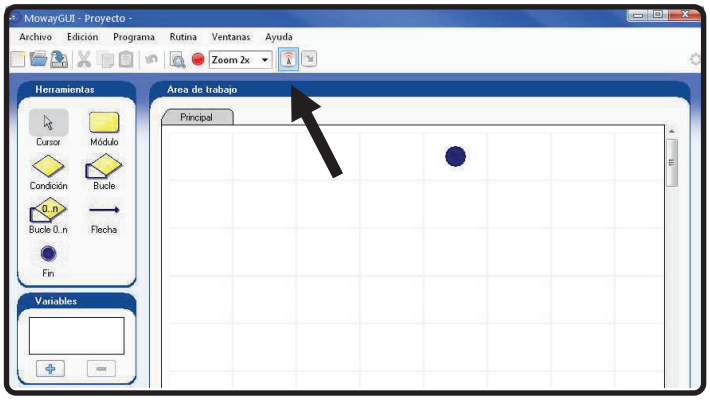


Image 79. Access from mOwayGUI

6.1. Description of the mOway RC Center

The different parts of the program are described below.

6.1.1. RF configuration

In this part the RFUsb module is configured with a 0x02 default address and 0x00 for the communications channel (default mOway RC program channel). The Radio Control's indicator (dispatch status) on the left lower part will glow red when configuring the module with the robot switched off.

Once connected, the communications channel can be changed if WI-FI, Bluetooth, Microwaves, etc. interferences are detected in this first channel. Click on the change channel button to select up to 16 channels. To change the channel the robot has to be switched on and be in communication with the RFUsb.

Every time the RFUsb is disconnected the default channel shall be 0x00.

The recommended procedure is as follows:

1) Turn the robot on
2) Connect the *RFUsb*
3) Test the channel sending mOway commands
4) If the robot does not react well change the channel and try again

6.1.2. Radio control

Once the RFUsb is connected mOway can be sent commands. The robot's movements can be controlled by means of the buttons and the keyboard.

There also are two bars to determine the speed and turning radius.

When mOway captures the transmitted data a small green indicator will light on the lower left side. On the contrary, when no data is captured its color changes to red.

6.1.3. LED

In this section Moway's four LEDs are switched on and off.

6.1.4. Speaker

In this section is checked the switched on and off of the robot´s speaker in a particular frecuency

6.1.5. Info

Displays information about ***Moway RC Center.***

6.1.6. Sensor status

This section describes the values returned by the sensors at all times (updated every second).

1) Analog value from obstacle sensors: higher when the object is closer.
2) Percentage of inciding light.
3) Values from line tracking sensors: higher when the terrain is dark.
4) Distance covered by the robot after being switched on or the distance is reset.
5) Accelerometer values.
6) Battery meter
7) Temperature of mOway

6.1.7. Keyboard control

The keyboard controls:

W-Forward
A- Left
S- Back
D-Right

7. MowayCam

MowayCam application displays the camera image and lets the user to save a static image in a storage device connected to the computer.

MowayCam is launched from mOwayGUI by clicking the camera icon:

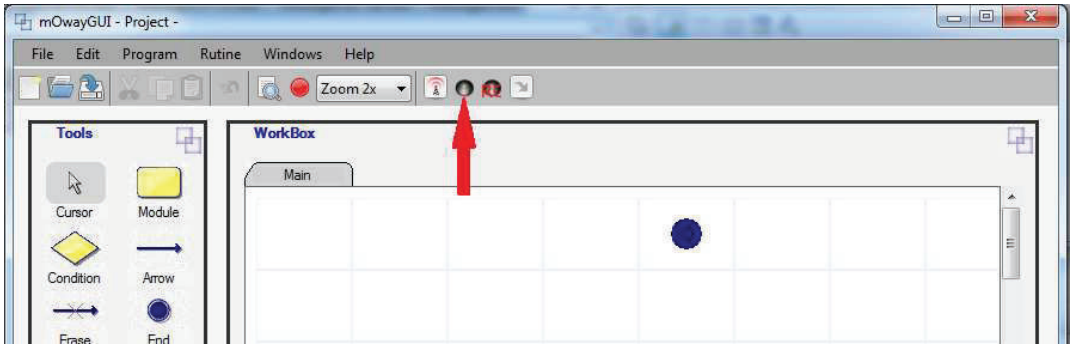


Image 80. MowayCam access from mOwayGUI

Before MowayCam starts, a message indicates that mOwayGUI application will close. Therefore, Moway should be programmed with an user's camera program. This can be easily done in mOwayGUI by adding a camera module and selecting "Activate camera". Then, Moway can be programmed as usual in mOwayGUI.

After this, MowayCam window is shown.

- Click on **Start** button to start displaying camera images.
- Click on **Stop** button to deactivate video **Moway Videocap**.
- Click on **Save** button to save the current image in the path and name displayed on that fields. These can be modified by writing on them.

IMPORTANT: Video **Moway Videocap** MUST NOT be disconnected from USB port while MowayCam is showing camera images. If it is disconnected while showing camera images, some computers could restart. To disconnect it, click on Stop button or close MowayCam window.

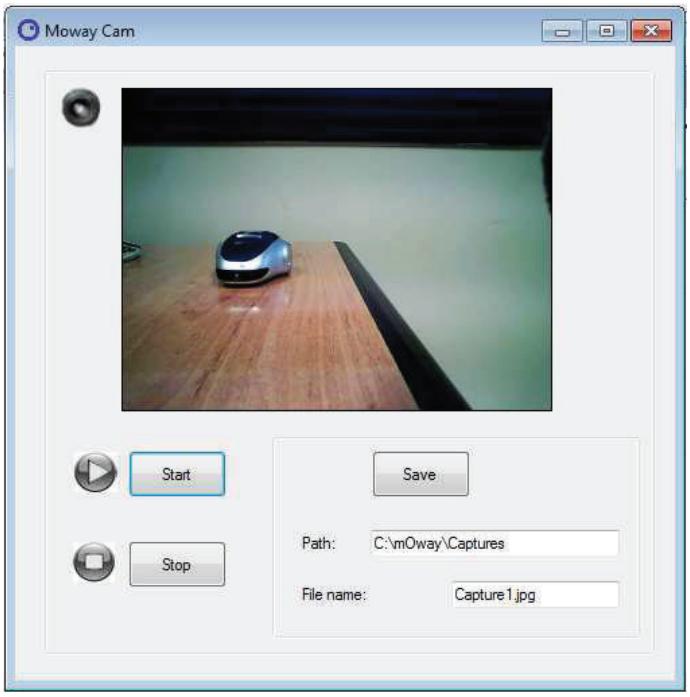


Image 81. MowayCam window

8. Moway RC CAM Center

Moway RC CAM Center is an upgraded version of **Moway RC Center**, with a window to display images from Moway camera.

RF window has the same functionality of RC Center (sensor status, radio control).

Camera window displays images from camera. The control of this window is detailed below.

Image 82. Moway RC CAM window

- **Videocap channel:** Selects the transmission channel of the camera. It should be the same of Moway Videocap.

- **Activation time:** Seconds that camera will be activated. During this time, images are displayed on the camera window.

- **Activate button:** Activates the camera. This button is disabled during camera activation time.

- **Save:** Saves a still image in "Path" and "File name" defined by user. This button is disabled when camera is off.

When camera is activated, RF window data will be stop during the activation time.

You can access the application in Window/Radio Control or using the button shown in the next image.

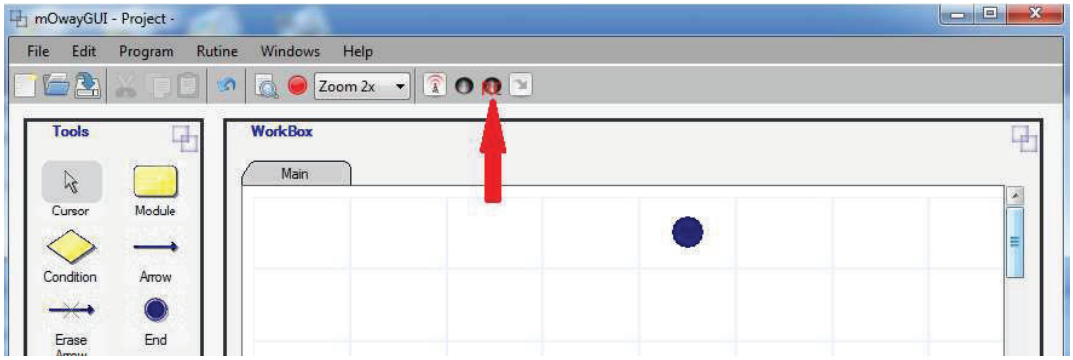


Image 83. Access from mOwayGUI

IMPORTANT: Video **Moway Videocap** MUST NOT be disconnected from USB port while Moway RC CAM Center is running. If it is, some computers could restart. To disconnect it, please close Moway RC CAM Center.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