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Mobile Robot Command

This article presents the components of a mobile robot assembled by modules; its mechanical, driving and command systems are described. The dedicated software and the programming manner of different tasks for the mobile robot are shown.

Keywords: *mobile robot, command, mobile robot tasks*

1. The Mobile Robot

The mobile robot, known as TriBot [2, 3], is assembled of modular parts from a Lego Mindstorms NXT kit, as shown in figure 1.

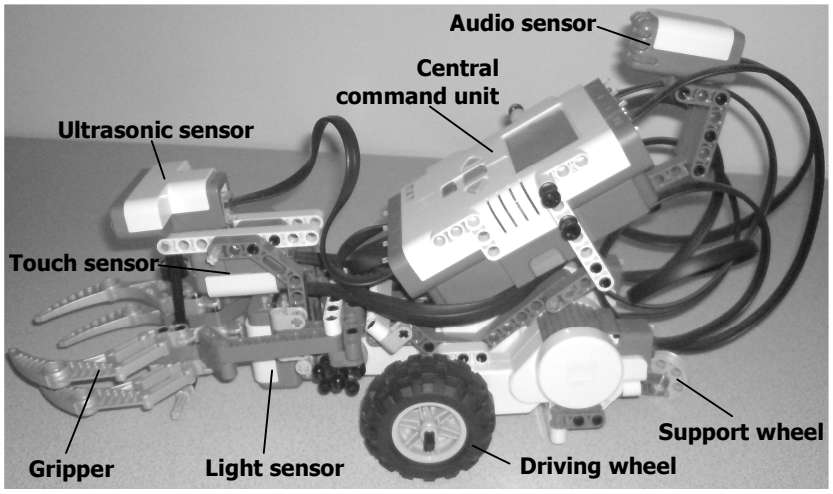


Figure 1. The mobile robot.

The mechanical system contains a mobile platform, with 2 driving wheels and 1 support wheel. It also contains a 2-finger gripper.

The driving system has 3 servo motors; 2 are for the driving the wheels and 1 is for the prehension device. These can be programmed to execute rotational motions with certain durations, certain angles or certain rotations numbers. The servo motors have embedded gear transmissions.

The command system presents:

- the central unit of the robot with a 32-bit microcontroller, a display, buttons and ports for servo motors and sensors;
- 4 sensors.

The touch sensor can detect the contact with an object; it generates signals when push or free the contact part. The sound sensor can detect a certain intensity sound up to 90 db on a scale of 1-100. The light sensor can detect light signals of a certain intensity, on a scale of 1-100. The ultrasonic sensor can detect objects on a radius of 2500 mm. The communication of the robot's central unit with the computer is made through an USB port.

2. Tasks to Be Done

The desired tasks of the mobile robot are as follows:

- start at a sound of 20 db (for example a clap of hands);
- follow a black line on the ground;
- detect a spherical object at a distance of 250 mm;
- slow down and move straight ahead;
- open gripper fingers;
- detect horizontal bar in front of the support of the spherical object with the touch sensor;
- stop in front of the object;
- close gripper fingers and catch spherical object;
- stop;
- turn back right;
- move straight;
- turn left;
- move straight;
- detect final stop panel at 300 mm;
- slow down;
- detect final stop panel at 150 mm;
- stop;
- open gripper fingers to free the spherical object;
- wait;
- close gripper fingers.

The mobile robot, black line, spherical object, support, horizontal bar and final stop panel are presented in figure 2.

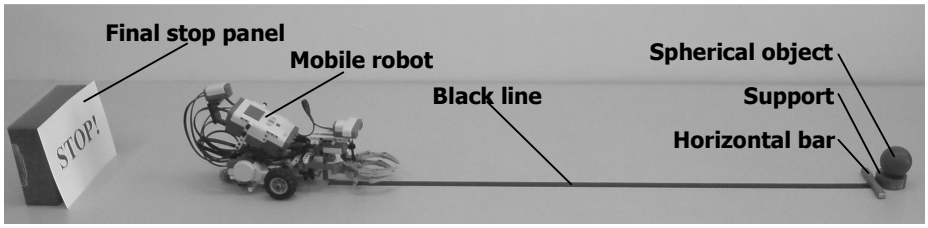


Figure 2. The mobile robot and the environment.

3. The Mobile Robot Command

The Lego Minstorms NXT command interface is shown in figure 3.

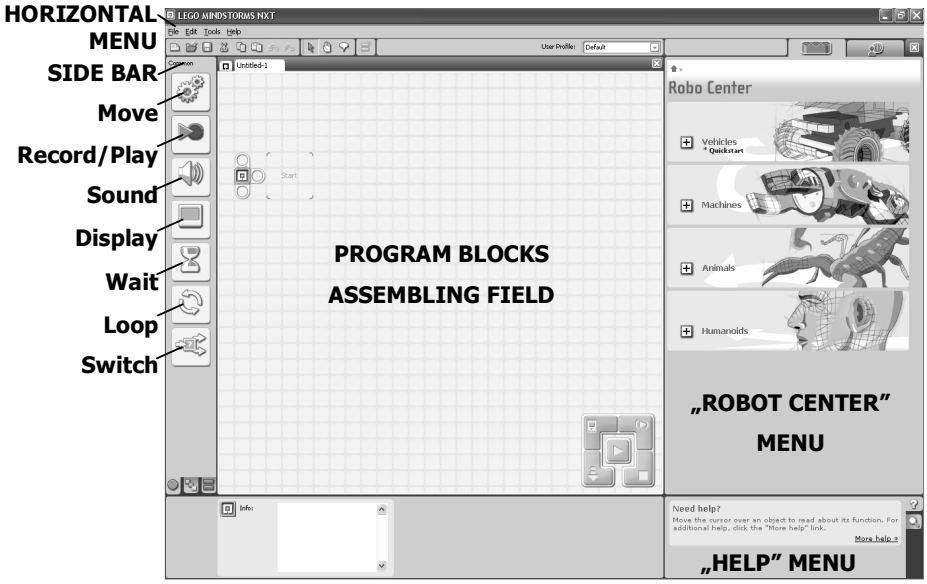


Figure 3. Lego Mindstorms NXT command interface.

The whole program for the tasks presented above can be realized by assembling command blocks on the assembling field using "drag and drop" method; then the program is downloaded on the memory of the central command unit of the mobile robot.

The command blocks assembly for the tasks presented above is shown in figure 4.

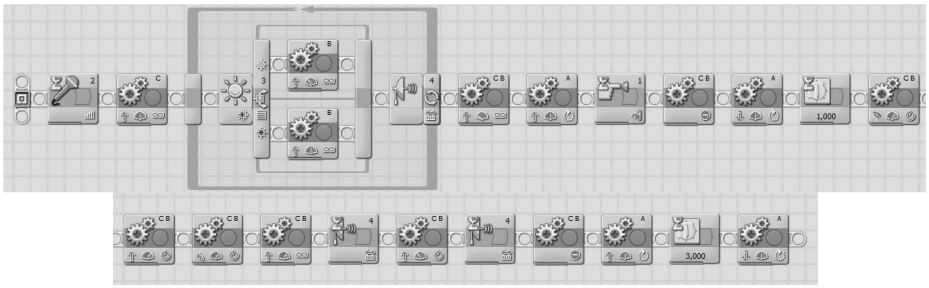
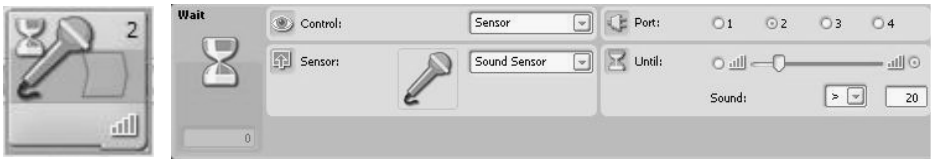


Figure 4. The command blocks assembly.

The command blocks have certain parameters which can be changed, depending on the required tasks. Some examples are detailed below.

The first block and its properties are shown in figure 5. It refers to the sound sensor, which detects a signal higher than 20 db and determines the robot to do the next program sequence. The sound sensor communicates with the robot's command central unit by port number 2.



a) b)

Figure 5. Sound sensor block (a) and its parameters (b).

For the robot to follow a black line [3], the blocks sequence shown in figure 6 is used. A driving wheel (corresponding to port C) is rotating forward using 50% servo motor power. For the other driving wheel a "Loop" sequence is used. This contains a "Switch" block which determines the variation of driving wheel servo motor power (corresponding to port B). Depending on the light sensor from the robot's bottom (corresponding to port 3), if the received light intensity is higher than 50% (light ground) the driving wheel servo motor power decreases to 40%; if the received light intensity is lower than 50% (black line) the driving wheel servo motor power increases to 60%. In fact, the robot follows the border between the light ground and the black line. The loop sequence ends when the ultrasonic sensor detects the spherical object at a distance of 250 mm.

In the next stage, the robot moves forward, lowering the power of both driving wheels to 20%.

For the next tasks, the parameters of the blocks presented in figure 4 are set in a manner like the one presented.

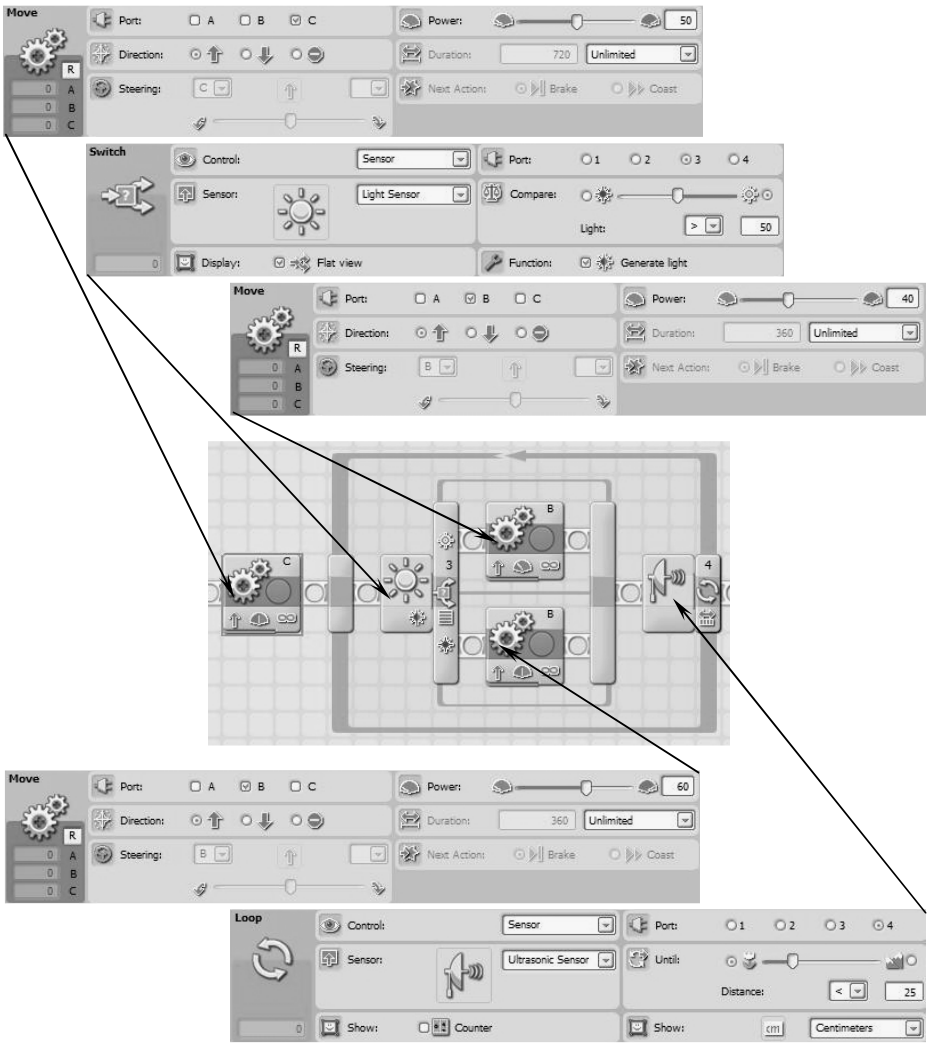


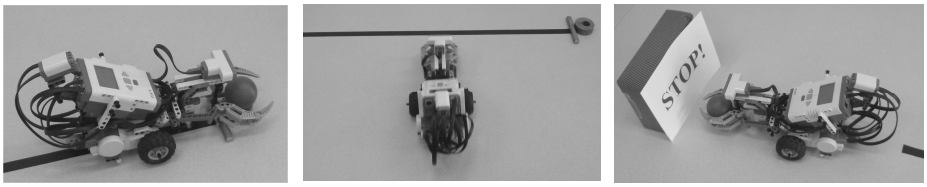
Figure 6. Sequence for following the black line with the blocks parameters.

The gripper servo motor (corresponding to port A) gives a rotation of 25° to the fingers, with a power of 50%, through a gear transmission. This determines the opening of gripper fingers.

The press of touch sensor in contact with the horizontal bar determines the robot's stop and the gripper closing and catching of the spherical object; the robot awaits 1 second and turns back to right with 3,2 rotations of the driving wheels servo motors (power 75%), moves straight with 0,4 rotations, then moves forward

left with 3 rotations of the driving wheels servo motors. The robot moves straight with the driving wheels servo motors power at 75%, detects the final stop panel at 300 mm with the ultrasonic sensor and the power decreases at 30%. At 150 mm the same ultrasonic sensor determines the stop, the opening of gripper fingers, a 3 seconds await and closing of gripper fingers.

Different positions of the mobile robot are shown in figure 7: catching of the spherical object (a), turning back right (b) and the final stop (c).



a) b) c)

Figure 7. Different positions of the mobile robot.

4. Conclusions

For this mobile robot other tasks can be programmed in the manner shown. The robot structure can also be modified, e.g. it can become a walking robot.

References

[1] Kovacs F.V., Varga Şt., Pau V.C. *Introducere în Robotică*. Ed. Printech, Bucureşti, 2000.
[2] ***** *Lego Mindstorms NXT*. Software Help.
[3] ***** *http://mindstorms.lego.com/Overview/MTR_TriBot.aspx#*.

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