MASTER-SLAVE BEHAVIOR OF ROBOTS (LEGO NXT)

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Abstract

Article delas about the collective behavior of robots. The aim is to create a robots with a modular robotic system, LEGO Mindstorm NXT and validate its use in the field of collective behavior of robots. Communication, which is ensured by Bluetooth technology, is bidirectional, both robots send and receive messages.

The MASTER robot consists of one NXT brick, two gyroscopic sensors and two pressure sensors. Gyroscopic sensors record two movements: frot-back, left-right. SLAVE robot uses one brick NXT, two motors and one ultrasonic sensor.

MASTER and SLAVE robots have been programmed in the BrixCC tool. The verify process of the solution functionality revealed several shortcomings (Mindstorm NXT LEGO), which limit their use in the field of collective behavior of robots.

The communication works well for a distance of several meters, but if the distance among robots is over 2 meters, robots cannot communicate .

Lego NXT Mindstor can be easily used for simulating of the insects behavior (eg ants, in search of food or in defense of the territory). The robots would use a compass and an accelerometer (to detect direction of motion, speed and movement time). The work area has to be large enough (large robots workspace), but also small enough (limitation of bluetooth communication).

Video: http://www.youtube.com/watch?v=I85YVzk-Q2g

Keywords: collective behavior of robots, Lego Mindstorm NXT, insects behavior

1 Introduction

Robotics is the basis for collective behavior of robots. The industry is developing very fast, because man has always tried to facilitate their work or do more work for the same time by using tools, by using machines and later by using robots. Mobile robotics offers to robots the possibility of movement, to pursue (through the sensor) the ability of their environment and to communicate with him. Robots that communicate with each other lay a cornerstone for the area of collective behavior of robots. This area is principally engaged in the behavior of the robot or robots in an environment that was not previously defined. The most famous examples of this field is robot soccer, robot vacuum cleaner, or simulation of the colonies to achieve a global goal. Thanks to advances in this field, robots are becoming smarter and have better adaption to the surrounding environment.

Lego Mindstorm is a series of Lego kits comprising a programmable unit "brick" with motors and sensors. To simulate the collective behavior of robots, we use two robots that communicate with each other by Bluetooth technology that is built right in the NXT brick. Lego Mindstorm NXT combines robotics and programming. Construction of robots is easier than doing the compilation of robots with the electronic components. On the programming was used NXC programming language, which is based on C syntax.

2 Characteristics of the object examination

Challenge lies in the combination of the two NXT bricks to control slave (robot) with the MASTER (the robot). NXT brick are named according to the tasks they will perform. The first NXT brick will be MASTER - Driver, and hence the kind of commander who will send instructions. The second NXT brick will be SLAVE - mobile robot, a servant who will listen to instructions.

3 Robots assembly

To compile the MASTER we used one NXT, two gyro sensors and two pressure sensors. A gyro sensor records the rotating to front and back and the other left and right. Gyroscopic sensors are connected to the input port 1 and 2 of NXT brick. Two pressure sensors on MASTER solve problems related to easier stopping and easier cornering of SLAVE, which, when control by gyroscopes requires considerable skill. Press the two pressure sensors at the same time and the SLAVE stops. After releasing the pressure sensor the SLAVE will remain on place until we begin to move with the Master. For easier cornering we will use the pressure sensors for cornering on place. Pressure sensors are connected to the input port 3 and 4 of NXT brick. In Fig. 1 is shown schema of MASTER. MASTER has been designed in order to push the pressure sensors, either individually or both at once. We have to be careful, because the gyroscopic sensors have to be attached to the structure as shown in Fig. 1. Bad connection to the structure, could result in management that would not work correctly.

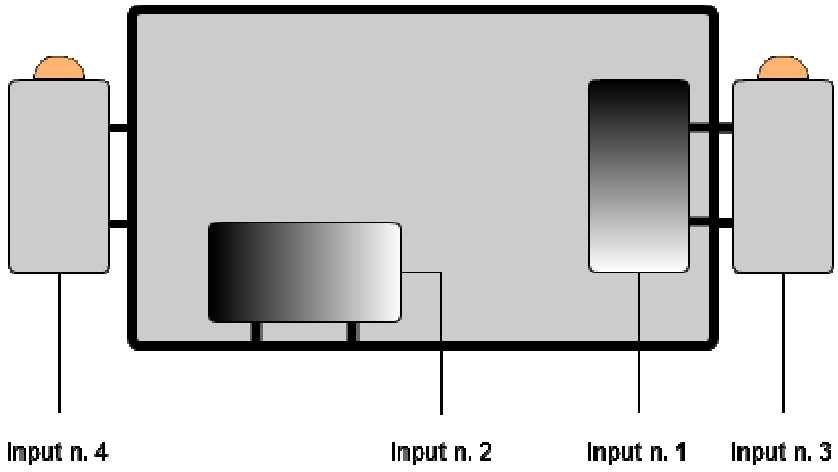

Fig. 1: MASTER Composition

To compile the SLAVE we used the NXT brick, two motors and one ultrasonic sensor. To avoid hitting an obstacle ahead SLAVE, it uses ultrasonic sensor. Information form ultrasonic sensor is sent to MASTER (ensures feedback). Ultrasonic sensor is connected to input port 1 of NXT brick. The motors are connected to the output port B and C. In *Fig. 2* shows SLAVE scheme (bottom view), because the ultrasonic sensors and motors are located under the NXT[2]. It is important that the engines were mounted in such a position, as shown in *Fig.2* (flat surface of the engine down, with another connection the SLAVE will not work correctly).

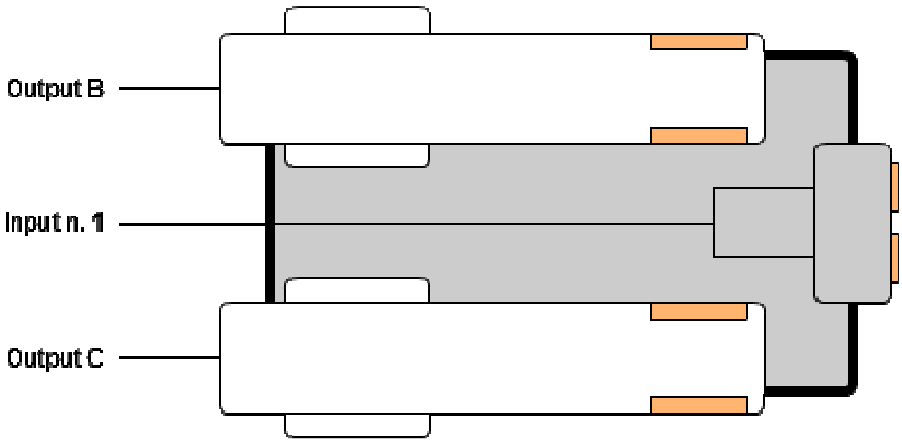

Fig. 2: Composition SLAVE

4 Source Code

Fig. 3 describes a real form of source code, namely the function 'dopredu_dozadu'. This function detects the direction of MASTER rotating and the rate of rotating i.e. solves rotating to back and forward. The value of variable "x" represents the current value of output from the gyro number 1. The function 'dostran' works in the same way as this function, but the current value of gyro number 2 represents the value of the variable "a".

```
void dopredu_dozadu()
{
if(x>1)
{
        if(x>y)
        {
                if(z<100){z=z+x;}
                }
}
else if(x<-1)
{
         if(x<y)
        {
                if(z>-100){z=z+x;}
        }
}
NumOut(5,LCD_LINE1,x);
NumOut(5,LCD_LINE2,y);
NumOut(5,LCD_LINE3,z);
y=x;
dostran();
}
```

Fig. 3: Source code function 'dopredu_dozadu'

Communication between MASTER and SLAVE is through Bluetooth wireless technology (*Figure 4*). MASTER block consists of function 'main' and function 'BTCheck' and the SLAVE block consists of a functions 'main', 'BTCheck', 'dopredu_dozadu', 'dostran' and the 'pohyb'.

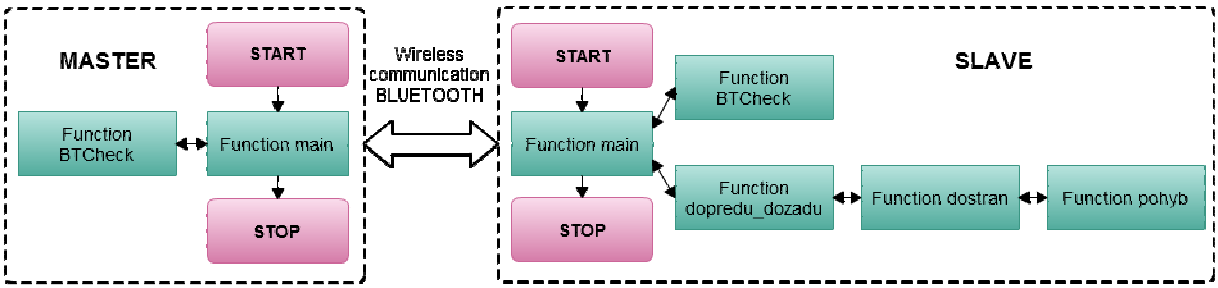

Fig. 4: Relationship between MASTER and SLAVE blocks and their internal structure

5 SLAVE - The function 'dopredu_dozadu'

Flowchart function 'dopredu_dozadu' is shown in Figure 5. The function determines in which direction is rotating the gyroscope number 1, whether it was rotated forward or backward. The first condition ("x"> 1) represents rotation to forward. The second condition ("x"> "y") determines whether the current value of variable "x" is greater than the previous one, which was stored in the variable "y". From this it is possible to determine that the gyroscope number 1 is rotating in the same direction, and that his rotation did not stop. Reason for the third condition ("z" <100) is that the slave engines can only work with values ± 100. If all three conditions met, so the value of the variable "z" added value of the variable "x" means that the forward movement will be faster (backward slower). The following three conditions are equivalent to the first three, but with negative numbers. A negative value of the variable "x" represents a backward rotation. If all three conditions met, so the value of the variable "z" added (negative) value of the variable "x" means that the backward movement will be faster (forward slower). Last operation is run function 'dostran'.

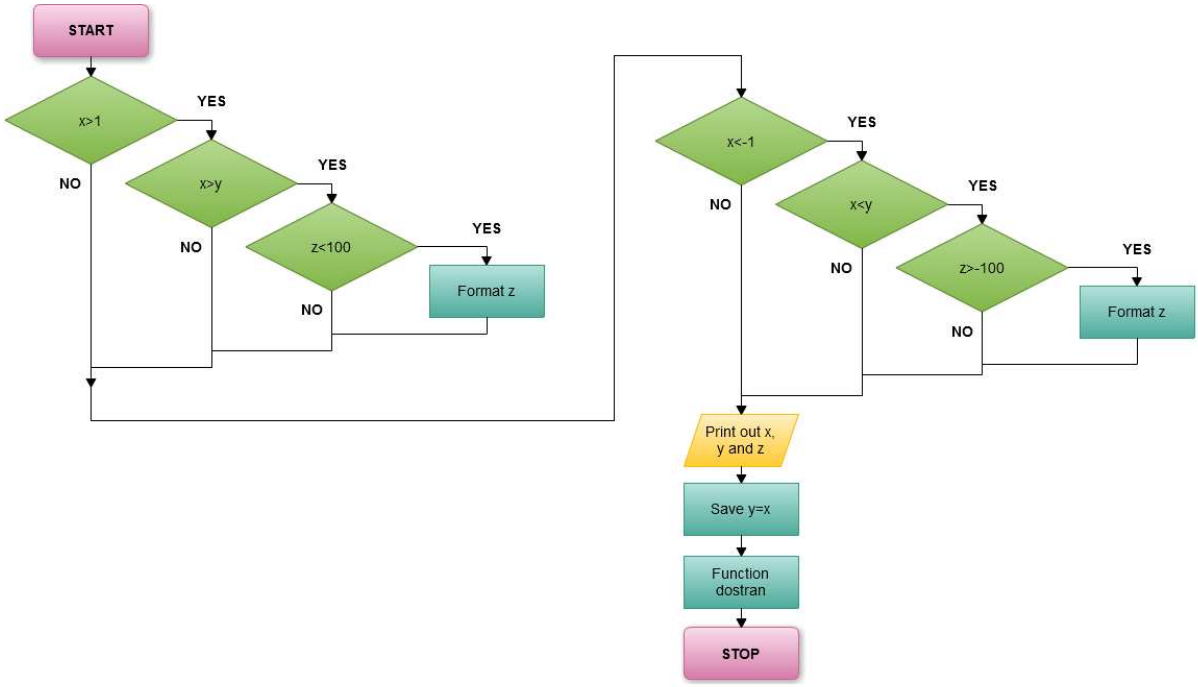

Fig. 5: Slave - The 'dopredu_dozadu'

Conclusion

The role of the combination of the two robots using Bluetooth technology and ensure two-way communication has been greatly simplified by using NXT LEGO Mindstorm (than to build robots using electronics). Another advantage is the possibility of using the built-in functions for communication via Bluetooth. Created MASTER and SLAVE robots are programmed into BrixCC. Verifying the functionality of the solution as well as the functionality of communication between MASTER and SLAVE revealed several shortcomings (Mindstorm NXT LEGO), which limit their use in the field of collective behavior of robots. The first shortcoming is the number of inputs and outputs on the NXT bricks, which limits the number of sensors and motors on a robot. This problem partially address the products from HiTechnic [1], which provides products to expand the number of ports. The second problem is more severe. Concerns the impact of communication via Bluetooth between MASTER and SLAVE. Communication works very well for a distance of several meters, but if the robots are far away from each other, the communication will be disconnected. As part of these dimensions we can use Lego NXT Mindstor for simulating the behavior of insects (eg ants, in search of food or in defense of the territory). The robots would use a compass and an accelerometer (to detect direction of motion, speed and movement time). The work area must be large enough to move the robots, but small enough to communication works correctly.

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