Proceedings of the 15th International Conference on Manufacturing Systems – ICMaS
Published by Editura Academiei Române, ISSN 1842-3183
"Politehnica" University of Bucharest, Machine and Manufacturing Systems Department
Bucharest, Romania, 26–27 October, 2006

ROBOTS WITH SYNCRONIZED MOVES

Ilie BORCOŞI, Onisifor OLARU, Adrian RUNCEANU

Abstract: *The paper proposes the study of building a mobile robot, which detects the movement of another mobile robot and executes them, the result being imitation of the second one.*

Key words: *mobile robot, imitate, synchronization, infrared sensors.*

1. INTRODUCTION

Researching in mobile robots is a high interest domain nowadays. The robots must do different actions without the direct interaction of the human operator. The robots obtain information from the world with the help of its sensorial system.

The mobile robots are very much diversified.

The most complex are the autonomous robots. They have visual and auditory sensors, and embedded controllers, which may elaborate a plan for execution of the given task, may solve unexpected situations, generated by external environment, or by the robot, and also they can learn from their experience for improving their performances.

An important problem of the mobile robots is planning the movement, which consists of determination of an ideal trajectory between the initial position and the final position.

This planning of the movement must take into account, constrains and limitation conditions. The planned trajectory during the movement of the mobile robot may be modified, detailed or actualized. It depends of information from the sensorial system, which gives it new details about the evolution of the movement.

The robots with synchronized moves, which will be studied as follows, offer an interesting approach of the movement control.

2. PRESENTATION OF THE ROBOTS

First robot type, can move using more methods of movement: receiving commands manually from a remote control, following a given path, or being autonomous, equipped with a video camera which offering information about the operating environment.

The second robot type follows the moves of the first robot and imitates it. The movements of the second robot are the object of study for this paper.

The second mobile robot contains a metallic or plastic chassis, four driving wheels, a sensorial system and the command electronic circuit. Two driving systems are used for robot's four wheels: one for the two wheels located on the left side and the other one for the two wheels located on the right side of robot's chassis.

The sensorial system has the role to detect the movements of the first robot. These movements are: ahead, backwards, swerving left, swerving right. It is composed of five pairs of infrared sensors, five emitters and five receivers. These sensors are mounted on the robots, as shown in Fig. 1.

The emitters are mounted on the lateral side of the first robot (robot 1). The extremes emitters of the sensors, FS and BS, are disposed toward to the normal with a certain angle. This angle is identical with the swerving angle of robot 1.

The robot 2 detects the swerving angle of robot 1 and it swerves with the same angle. If the robot 2 swerves with an smaller angle, robot 1 do not swerves.

The emitter of the middle sensor, MS, is on the same direction with the receiver, and the emitters of the middle front and middle back, MFS and MBS, are positioned on parallel axes with the axes of the receivers, behind and in front of these.

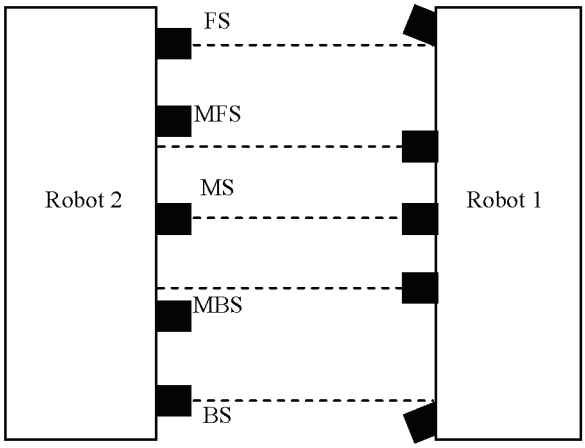

Fig. 1. The representation of the sensorial system.

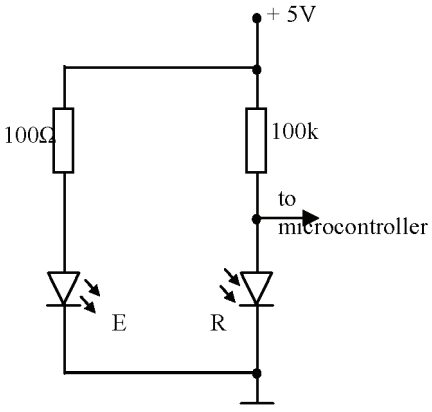

Fig. 2. The electrical scheme of the sensors alimentation.

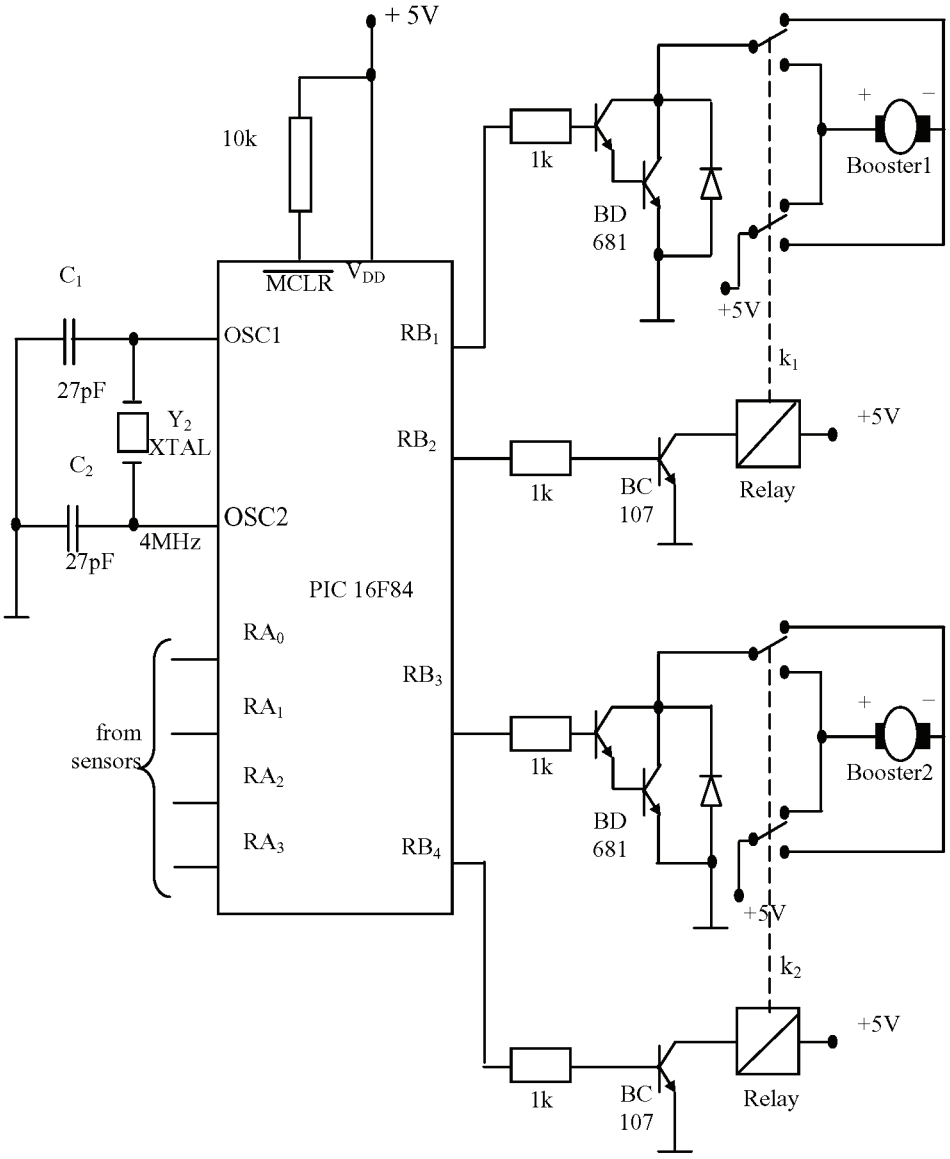

Fig. 3. The electronic control circuit.

The electrical scheme for the powering of a sensor is presented in Fig. 2. The sensors give logical "0" when the emitter and the receiver are on the same direction.

The control electronic circuit has the scheme in Fig. 3 and is powered from a voltage source composed of four 1,5 V batteries, stabilized at 5V DC.

The power supply of the two driving systems is made through the BD681 Darlington transistors and K1 and K2 relays. Two relays are used for changing the rotation direction of the boosters.

The PIC 16F84 microcontroller is used for command of the robot 2.

PIC16F84 belongs to a class of 8-bit microcontrollers of RISC architecture. Its general structure is shown on the Fig. 4 representing basic blocks.

Program memory (FLASH) is used for storing a written program. Since memory made in FLASH technology can be programmed and cleared more than once, it makes this microcontroller suitable for device development.

EEPROM is a data memory that needs to be saved when there is no supply. It is usually used for storing important data that must not be lost if power supply suddenly stops. For instance, one such data is an assigned temperature in temperature regulators. If during a loss of power supply this data was lost, we would have to make the adjustment once again upon return of supply. Thus our device looses on self-reliance.

RAM is a data memory used by a program during its execution.

In RAM are stored all inter-results or temporary data during run-time.

PORTA and PORTB are physical connections between the microcontroller and the outside world. Port A has five, and port B has eight pins. PIC16F84 processor perfectly fits many uses, from automotive industries and controlling home appliances to industrial instruments, remote sensors, electrical door locks and safety devices. It is also ideal for smart cards as well as for battery-supplied devices because of its low consumption.

Free-Run Timer is an 8-bit registered inside a microcontroller that works independently of the program. On every fourth clock of the oscillator it increments its value

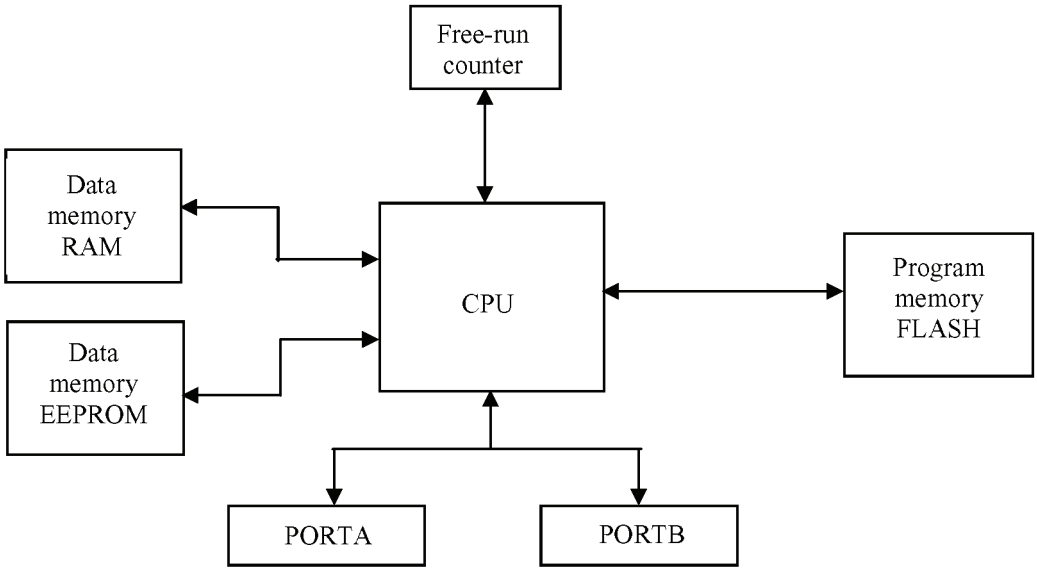

Fig. 4. PIC16F84 microcontroller outline.

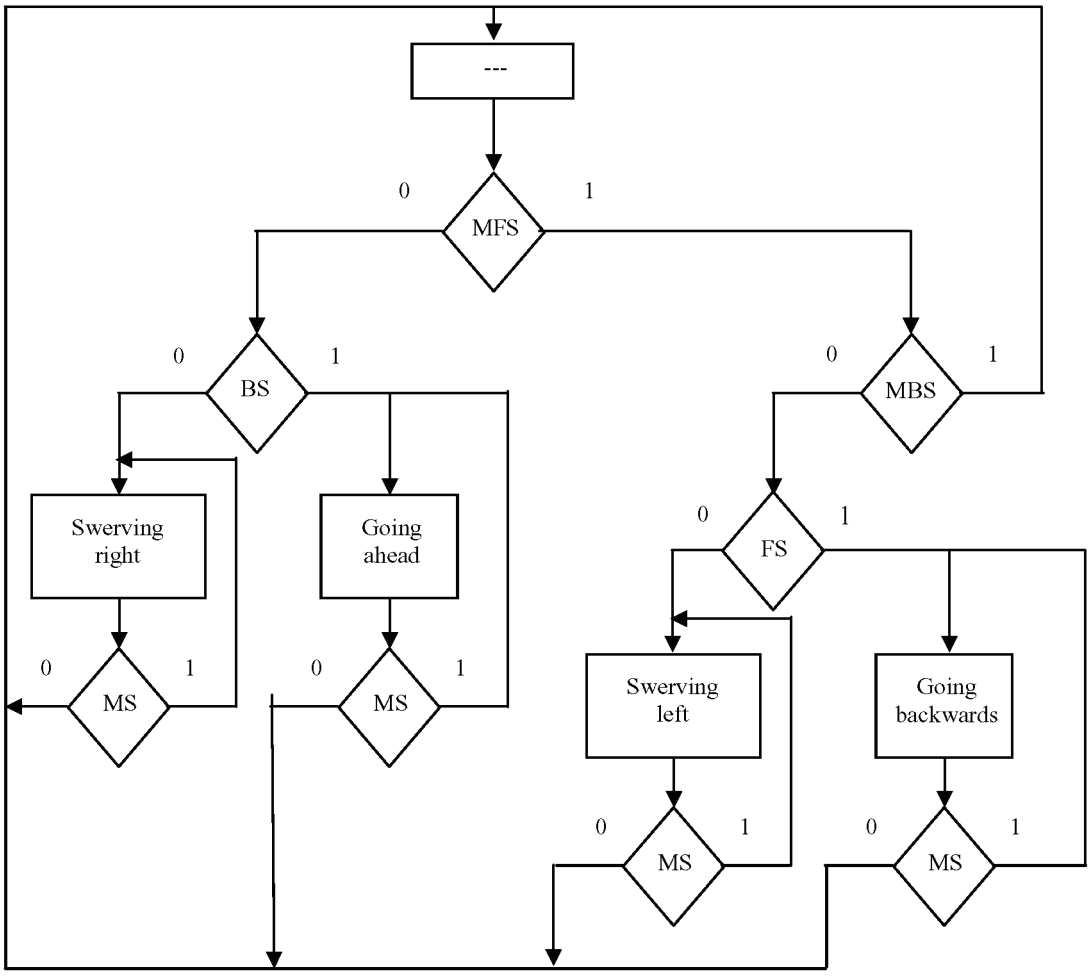

Fig. 5. The logical scheme.

until it reaches the maximum (250), and then it starts counting over again from zero. As we know the exact timing between each two increments of the timer contents.

Control Processing Unit has a role connective element between other blocks in the microcontroller. It coordinates the work of other blocks and executes the program.

PIC16F84 devices contain an 8-bit ALU and working register. The ALU is a general-purpose arithmetic unit. It performs arithmetic and Boolean functions between data in the working register and any register file.

The ALU is 8-bits wide and capable of addition, subtraction, shift and logical operations. Unless otherwise mentioned, arithmetic operations are two's com-

plement in nature. In two-operand instructions, typically one operand is used as working register (W register), and the other operand is used as a file register or an immediate constant. In single operand instructions, the operand is either the W register or a file register.

The W register is an 8-bit working register used for ALU operations. It is not an addressable register.

Depending on the instruction executed, the ALU may affect the values of the Carry (C), Digit Carry (DC), and Zero (Z) bits in the STATUS register. The C and DC bits operate in subtraction.

The program is written in the assembly language or in micro-Pascal language in according with the logical scheme in Fig. 5. First, the middle front sensor (MFS) is tested. If it transmits to the microcontroller logical "0", then back sensor (BS) is tested, and if it transmits the logical "1" value, the middle back sensor (MBS) is tested. When MFS = 0 and BS = 0, it means that the robot 1 makes a right swerve. In this situation BS emitter is on the direction of the BS receiver, and the MS emitter is on the direction of the MFS receiver. In this case, and the robot 2 must also execute a right swerve through the command of the driving systems, which moves the wheels on the left side.

The speed of the robot 2 must be higher than the speed of robot 1. For this is necessary to connect some resistances in series with the boosters of robot 1 which is using a part of the supply voltage.

Robot 2 executes the swerve with higher speed until the middle sensor MS = 0 (emitter and receiver are on the same direction).

On the contrary, if MFS = 0 and BS = 1 than the robot 1 moved forward and the robot 2 had to follow forward, too (both boosters of the robot 2 are supply) until MS = 0.

If MFS = 1, MBS = 0 and FS = 0, the robot 1 was a swerving left and the robot 2 must swerving left (it is powering the booster which drive the right side wheels) until MS = 0.

If MFS = 1, MBS = 0 and FS = 1, the robot 1 was a going backwards and the robot 2 must the same moving (they are powering both boosters which drive the right side wheels and the left side wheels) until MS = 0.

3. CONCLUSION

The speed of robot 2 must be higher than the speed of robot 1, in order for it to imitate its moves. This is an obvious necessity because in case of both robots swerving right, robot 2 has to cover a bigger distance.

The sensors must be mounted so that one doesn't influence another, mostly the middle ones.

The receivers of the middle back and middle front are mounted in such a way to be on the same direction with the emitter of the middle sensor, when the receiver and emitter of the back sensor are on the same direction, and respectively the receiver and emitter of the front sensor are on the same direction.

This solution may be extended to tri-dimensional mobile robots through mounting two sensorial systems: one on the horizontal and the other on the vertical.

REFERENCES

[1] Ivănescu, M. (2004). *Driving Automated Systems in Robotics*, "Universitaria" Publishing House, Craiova.

[2] Soloman, S. (1998). *Sensors Handbook*, McGraw-Hill, ISBN 0-07-059630-1.

[3] Predko, M. (2001). *Programming and Customizing the PIC Microcontroller*, McGraw-Hill, ISBN 1-901631-01-X.

[4] Miles, P., Carroll, T., *Build Your Own Combat Robot*, McGraw-Hill, ISBN 0-07-219464-2.

[5] *** ww1.microchip.com/downloads/en/DeviceDoc/35007b.pdf

[6] *** www.mikroelektronika.co.yu/romanian/product/books/PICbook/2_01Poglavlje.htm

Authors:

Eng. Ilie BORCOŞI, Lecturer, "Constantin Brâncuşi" University, Automation Dept. E-mail: ilie_b@utgjiu.ro

Eng. Onisifor OLARU, Professor, "Constantin Brâncuşi" University, Automation Dept., E-mail: olaru@utgjiu.ro

Eng. Adrian RUNCEANU, Lecturer, "Constantin Brâncuşi" University, Automation Dept., E-mail: adrian_r@utgjiu.ro